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92. Curriculum for Master's Degree Programme "Copernicus Master in Digital Earth" at the University of Salzburg

(Version 2023)

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In its session on April 25, 2023 the Paris Lodron University of Salzburg Senate formally approved the curriculum for the European Joint Master's Degree programme "Copernicus Master in Digital Earth" finalised by the Geoinformatics curriculum committee at the University of Salzburg in its March 28, 2023 meeting in the version that follows.

The legal basis for the curriculum is the 2002 Federal Act on the Organisation of Universities and their Studies (Universities Act 2002 – UG), Federal Law Gazette No. 120/2002, and the section of the Statutes of the University of Salzburg pertaining to university studies.

§ 1 General Provisions

(1) The present version of the curriculum builds on the curriculum for the European Erasmus Mundus Joint Master's Degree "Copernicus Master in Digital Earth (CDE)", approved and published by the Paris Lodron University Salzburg (PLUS) on March 15, 2019.

(2) The number of ECTS points necessary to complete a degree in this Master's programme is 120. This corresponds to four semesters of study.

(3) Graduates of the double degree Erasmus Mundus Joint Master programme "Copernicus Master in Digital Earth" will be awarded the academic degree "Master of Science", abbreviated "MSc", with another corresponding degree awarded by UPOL (Palacky University Olomouc, Czech Republic) or UBS (University of South Brittany, France).

(4) In order to be admitted to this Master's programme, students must hold a bachelor's degree in a geospatial discipline or from an equivalent programme at an internationally recognised tertiary educational institution (cf. UG 2002 § 64 para. 5), and the admission by the consortium of the Erasmus Mundus Joint Master programme. Further general admission rules are published on the PLUS (https://www.plus.ac.at/studium/studienangebot/masterstudien/) and the CDE programme's websites (https://www.master-cde.eu/admission/).

(5) If a student's bachelor's degree is not deemed equivalent to an acceptable extent, the student may be required to complete additional work up to 45 ECTS points; these requirements must be satisfied by the end of the Master's programme. Only the Rectorate or a person designated by the Rectorate is authorised to make a determination of equivalency.

(6) All graduation requirements to be fulfilled by students have been assigned ECTS points. One ECTS point equals 25 hours of study, which corresponds to the average number of hours required to achieve the expected learning objectives. An academic year consists of 1500 hours, corresponding to 60 ECTS points.

(7) Students with disabilities and/or chronic illnesses will not be subject to any form of discrimination in their studies. The University is committed to the basic principles laid out in the UN Convention on the Rights of Persons with Disabilities and Austrian non-discrimination laws as well as the policy of positive action.

§ 2 Overview of the degree programme and professional skills

(1) Overview of the degree programme

CDE is carried out as an Erasmus Mundus Joint Master programme coordinated by Paris Lodron University Salzburg (PLUS), Department of Geoinformatics, together with Palacky University Olomouc, Czech Republic (UPOL), and University of South Brittany, France (UBS), referred to as the Consortium.

Copernicus is the European Union's Earth Observation programme, looking at our planet and its environment for the ultimate benefit of all European citizens. It offers information services based on satellite Earth Observation and in situ (non-space) data. Copernicus is attributed to the discipline of Earth Observation and Geoinformatics (EO*GI), which offers highly sought-after qualifications well founded in concepts and technologies of geospatial computing, tied into inter- and multidisciplinary application domains.

The knowledge and skills acquired throughout the programme's modules are based on the common grounding of spatial sciences and a 'Digital Earth' perspective, based on concepts typically acquired during undergraduate Geography, Surveying, Environmental Studies, Cartography or Planning programmes.

The Master of Science programme CDE aims at building advanced competences in geospatial data acquisition and data management, data analytics and simulation as well as interactive communication. Graduates are expected to interface with different spatially oriented application domains, contribute to solving problems across societies, economies, and environments as well as leading teams assigned pertinent tasks.

Graduates in particular will be qualified to work in the domains of Copernicus services and related emerging application fields in the context of monitoring and observing the atmosphere, the marine environment, the land surface, climate change and its impact, emergency response and societal security.

(2) **Professional skills and competences (Learning Outcomes)**

Geoinformatics and spatial information management has been established as a methodology-oriented, cross-disciplinary subject based on spatial concepts and approaches. Such 'spatial view' competences for representing our world as a 'Digital Earth' are invaluable within any subject-specific context whilst widely applicable across domains such as planning, resource management, logistics, mobility, marketing, nature and environmental protection, and security.

Graduates of this programme will be confident in using key technologies pertinent to spatial information handling and upcoming trends in the field of Copernicus and Digital Earth. Graduates with a CDE Master's degree are able to answer research questions, including the development of hypotheses, definition of objectives, selection of methods, implementation of workflows, collection, analysis and interpretation of data as well as a written and oral communication and interpretation of outcomes in a decision support context.

The study programme provides application-oriented knowledge based on relevant theories and methods. Blended learning methods for critical thinking, practicing language and inter-cultural skills are an integrative part of the study programme. Discipline-specific ways of thinking in space-related research and spatial thinking, analytical skills and techniques as well as problem-solving competences are developed in core areas of Copernicus and Digital Earth, especially in:

- Geospatial data acquisition and spatial representations across scales;
- Advanced visualisation methods and cartographic communication;
- Data modelling and spatial data management;
- Data analytics across the spectrum of Geoinformatics and Earth Observation: georeferenced data and data streams; in-situ, remote and mobile sensing; statistics; machine learning and knowledge-based systems;

- Spatial analysis, system understanding and dynamic system simulation;
- Information extraction routines from imagery and continuous observations including cloud processing;
- Development of geospatial applications.

Graduates of the CDE programme will be able to independently plan and manage complex projects and applications in EO*GI as well as to cooperate on projects in spatial data infrastructures. The aim is to support and enhance decision-making in all application domains of Copernicus.

The study programme is challenge- and research-driven, provides a broad range of academic analysis and scientific methods, and prepares students for a doctoral degree programme. It corresponds to International Standard Classification of Education (ISCED 2011): level 7, European Qualification Framework (EQF), and National Qualification Framework (NQR): level 7.

(3) **Importance and relevance of the degree for society, the scientific community and the labour market**

Graduates of the CDE programme develop a focus on methodological and technical areas of expertise, thus emphasizing career perspectives in public administration (e.g., spatial data management and EO*GI services and application development, as well as in application domains such as in spatial planning, regional management, mobility, environment and nature conservation) and in business across a broad spectrum of industries. The study programme covers all areas of EO and geospatial data collection and data management, spatial analytics, communication of results and spatial decision support, interaction with stakeholders, as well as transversal aspects of project management. Graduates have special career opportunities through compulsory internships or work placements, and an increased awareness on novel application areas in the emerging EO*GI sector.

§ 3 Structure of the programme

A Programme Board consisting of one representative per consortium partner plus two representatives from associate partners governs all matters not exclusively under the jurisdiction of individual partners (including but not limited to assignment to specialization tracks, agreement to internship/work placement options, thesis supervision and decisions regarding short intensive programmes such as summer schools or blended learning programmes).

The CDE programme comprises seven (7) modules with a total number of 75 or 81 ECTS points. 6 or 12 ECTS points are assigned for elective subjects (ES) and 12 or 18 ECTS points for an obligatory skills-based internship/work placement. The Master’s Thesis is rated 18 ECTS, the Master’s exam 3 ECTS points. A research-based Master’s Thesis can be chosen in the context of a collaborative research/work placement at a consortium partner or at any institution worldwide. The Master’s Thesis is completed in collaboration with UBS, UPOL or PLUS supervisors.

The first academic year at PLUS includes the modules B1-B5, with a total of 42 ECTS. Modules provide profound EO*GI application-oriented expertise based on relevant theories and methods. Orientation Project (B1, 6 ECTS) offers courses from Copernicus in Digital Earth, spatial thinking, scientific writing to ePortfolio and career development. Two major modules (12 ECTS each) focus on Digital Earth Observation and Technologies (B3); Integrated Applications (B5), deepens software and application development expertise and enhances skills in project management.

Short Intensive Programmes such as blended learning courses, international summer schools, conferences, or workshops integrate the student cohort across partners and offers placement options beyond the consortium (3 or 9 ECTS).

Alternative specialization tracks (GeoData Science vs. Geovisualisation and Geocommunication) with 30 ECTS are completed at one of the designated partner universities in semester 3, typically leading to a Master's Thesis in line with the respective track and co-supervised at this partner university. GeoData Science (GeoDSc) and Artificial Intelligence (AI) for EO specializes in Computer Science/Data Science including computer vision, machine learning and big data with a focus on data analytics for Earth Observation at the University of South Brittany (France), Computer Science Department, OBELIX team of IRISA (Institute for Research in Computer Science and Random Systems), France. Geovisualisation and Geocommunication (GeoVIS) specializes in geovisualisation, geocommunication and application development, including cartography and design in geovisualisation, web and cognitive cartography, 3D visualisation, and advanced visualisation methods at Palacky University Olomouc (Czech Republic), Faculty of Science, Department of Geoinformatics.

The obligatory skills-based internship / work placement typically is conducted in blocked mode (1 or 2 periods) outside of course (semester) periods, but also can be completed as equivalent part-time activity. A research-based Master's Thesis chosen in the context of a collaborative research / work placement at a consortium partner or at any institution worldwide including non-academic organisations must be confirmed by the Programme Board until the end of the first semester. Throughout the programme a personal portfolio ('ePortfolio') has to be maintained. It contains individual presentations of materials resulting from coursework and work placements. The portfolio is developed in a suitable digital online format, e.g., as a website, blog or storymap.

	Modules	**ECTS**
B1 –	Orientation Project	6
B2 –	Space-time Models & Representations	6
B3 –	Digital Earth Observation & Technologies	12
B4 –	Spatial Image Analysis	6
B5 –	Integrated Applications	12
SIP –	Short Intensive Programmes[(i)]	9 | 3
GeoVIS or	at UPOL: Geovisualisation and Geocommunication[(i)]	30
GeoDSc	at UBS: GeoData Science[(i)]	30
ES -	Elective Subjects[(i)]	6 | 12
	Master's Thesis (incl Master's exam)	21
INT -	Work Placement / Internship[(i)]	12 | 18
	Total	**120**

[(i)] §§ 7, 8, 10

§ 4 Course Types

The programme contains the following course types:

Lecture (VO) provides an overview of a subject or one of its sub-areas and its theoretical approaches and presents different teachings and methods. The contents are mainly presented in lecture style. Attendance is not mandatory but highly recommended.

Lab / Practical (UE) serves the acquisition, testing and optimization of practical skills and knowledge in the field of study or one of its sub-areas. Course participation is continuously assessed, and attendance is mandatory.

Excursion (EX) supports experiential and applied learning outside of classrooms and is focussed on active learning through contact with real world phenomena and experiences. Course participation is continuously assessed, and attendance is mandatory.

Pro-seminar (PS) is a scientifically oriented course in preparation for seminars. Students acquire fundamental knowledge and skills for scientific research through practical as well as conceptual work. Course participation is continuously assessed, and attendance is mandatory.

Seminar (SE) is a graduate level scientific course. It serves the acquisition of advanced expertise as well as the discussion and reflection of scientific topics based on active participation of the students. Course participation is continuously assessed, and attendance is mandatory. The focus of each seminar will be outlined in the course description (e.g., supervision seminar, empirical seminar, project seminar, interdisciplinary seminar, ...).

Interdisciplinary Project (IP) integrates approaches, concepts and methods from various disciplines for holistic problem solving across disciplines, including practical as well as conceptual synergies. Course participation is continuously assessed, and attendance is mandatory.

§ 5 Required courses and plan of study

The following table contains a list of modules and courses in the CDE programme. The semester structure serves as a recommendation designed to ensure that the order in which courses are taken builds on a sequence of knowledge acquisition and that the workload of 60 ECTS points in an academic year is not exceeded. If there are no stated prerequisites, modules and courses can however be taken in any order in accordance with requirements outlined in § 12.

Detailed descriptions of the modules including the knowledge, methods and competences to be acquired can be found in Annex I: Module descriptions.

Erasmus Mundus Joint Master Programme "Copernicus Master in Digital Earth"								
Module	**Course**	**SHrs**	**Type**	**ECTS**	**Semester with ECTS**			
					I	**II**	**III**	**IV**
(1) COMPULSORY MODULES								
B1 – Orientation Project (6 ECTS)								
	Copernicus in Digital Earth (EO*GI)	1	UE	1	1			
	Spatial Thinking & Modelling	1	UE	2	2			
	Career Development & ePortfolio	1	UE	1	1			
	Scientific Methods and Writing	1	UE	2		2		
Subtotal B1		4		6	4	2		
B2 - Space-Time Models & Representations (6 of 12 ECTS)								
	Geovisualisation and Advanced Cartography	4	PS	6	6			
	Systems Thinking in Spatial Representations	1	VO	3	3			
	Design of Geospatial Data Models	2	VO	3	3			
Subtotal B2		7		6	6			
B3 - Digital Earth Observation & Technologies (12 ECTS)								
	Advanced Remote Sensing	4	PS	6	6			
	Copernicus Hubs and Institutions	1	SE (EX)	3		3		
	Digital Earth: Big Earth Data Concepts	2	UE	3	3			
Subtotal B3		7		12	9	3		
B4 - Spatial Image Analysis (6 ECTS)								
	Object-Based Image Analysis	2	UE	3	3			
	Analysis and Modelling (Remote Sensing)	2	SE	3		3		
Subtotal B4		4		6	3	3		
B5 - Integrated Applications (12 ECTS)								
	Project Management	2	UE	3		3		
	Practice Software Development	2	PS	3		3		
	Application Development (Earth Observation)	3	IP	6		6		
Subtotal B5		7		12		12		

SIP – Short Intensive Programmes (9 or 3 ECTS see § 7 linked elective modules)							
International Summer School I	1	IP|EX	3		3		
International Summer School II	1	IP|EX	3		3		
Blended Intensive Programme (BIP)	1	UE|VO	6		6		
Subtotal Short intensive programmes	3		9 | 3				
SPECIALIZATION TRACKS (30 ECTS)							
GeoVIS – Geovisualisation and Geocommunication							
Module Geovisualisation							
Systematic Geovisualisation		PS				6	
Advanced Methods of Geovisualisation		SE				6	
Design in Geovisualisation		UE				3	
Module Geocommunication							
Cognitive Cartography		UE				3	
Web Cartography		UE					6
UPOL electives (6 out of 9 ECTS)							
3D Visualisation[(i)]		UE				3	
Cartographic Project[(ii)]		UE				3	
Desktop Publishing in Cartography[(ii)]		UE				3	
Subtotal GeoVIS			30			24	6
GeoDSc – GeoData Science (UBS)							
Module Fundamentals of Data Science							
Machine Learning		UE				6	
Foundations of Deep Learning		UE				3	
Big Data		UE				6	
Module Artificial Intelligence for Earth Observation							
Efficient Remote Sensing Image Processing		UE				6	

Deep Learning for Computer Vision		UE				3	
Geospatial Data Analytics Project		UE				6	
Subtotal GeoDSc			30			30	
Total for compulsory modules[iii]			75 | 81				
(2) Electives cf § 8			6 | 12	3	3		6
(3) Work Placements (12 or 18 ECTS see § 3)							
Skills-Based Internship / Work Placement							12
Collaborative Research / Work Placement				6			12
Subtotal Work Placements			12 | 18				
(4) Master's Thesis							
Master's exam			3				3
Thesis			18				18
Subtotal Master's Thesis			21				21
Total			**120**	**60**		**60**	

[i]UPOL elective in Geovisualisation, [ii]UPOL elective in Geocommunication

[iii]B1-B5+ST+SIP (students choosing 12 ECTS work placement / internship §§ 7, 8, 10)

§ 6 Optional specialization tracks and mobility periods

(1) All students spend the first academic year at PLUS in order to acquire a set of core EO*GI Earth Observation and Geoinformatics competences.

(2) At the time of application for admission, candidates select and prioritize at least one specialization track offered by the Consortium. The assigned specialization can be changed until the end of the first semester with the agreement of the Programme Board.

(3) Students will move to the selected joint programme specialization track partner for the second academic year.

(4) Students may move to an industry/SME, higher education or research partner for their Master's Thesis (collaborative research/work placements).

(5) The Programme Board can identify and define additional focus subjects based on demand and according to available course offerings.

§ 7 Linked elective module (Wahlpflichtfach)

(1) Within the scope of the module Short Intensive Programmes (SIP, 3 or 9 ECTS) selected events (e.g., courses on special and in-depth topics, summer schools, workshops, blended learning programmes, Massive Open Online Courses (MOOCs)) shall be completed complementary to the compulsory modules listed above. The recognition of practice-oriented, subject-relevant further education and training programmes with proof by certificates of recognized post-secondary educational institutions is to be made possible, provided that they deepen and/or complement the skills and competences acquired in the compulsory modules.

(2) Students must complete a total of 3 ECTS. Students from the Geovisualisation and Geocommunication specialization track choosing the skills-based internships/work placement must complete a total of 9 ECTS. Requirements for work placements / internships are outlined in § 10.

§ 8 Free elective subjects

(1) In the CDE programme students are to complete elective courses totalling 6 (12) ECTS points (according to module ES). These elective courses are designed to further the acquisition of additional professional skills and strengthen individual areas of focus within a student's course of study.

(2) Elective subjects can be completed at any time throughout the programme. Students are particularly encouraged to take courses recommended by the Programme Board, online courses, MOOCs and other international offerings as electives, as long as these are offered by recognized Higher Education Institutions. GeoData Science specialization track students must complete electives during the first academic year (12 ECTS) when choosing the skills-based internships/work placement, and students choosing a collaborative research/work placement must complete a total of 6 ECTS electives during year one. Requirements for work placements / internships are outlined in § 10.

(3) Should the courses chosen as electives for 12 ECTS points have a demonstrable complementary role to this Master's programme, the electives can constitute a supplementary certificate in a specific area, which is recorded on the Master's degree certificate.

§ 9 Master's Thesis

(1) The Master's Thesis serves to demonstrate that students have acquired the ability to perform independent academic research in the area of Earth Observation and Geoinformatics corresponding to § 2 and according to current academic research methods and standards.

(2) The topic of the Master's Thesis should be chosen in such a way that it is reasonable and appropriate for completion of the thesis within six months.

(3) The topic of the Master's Thesis shall relate to the selected specialization track of the student. The student may suggest a topic or choose from a number of topics provided by one of the available thesis advisors.

(4) It is to be noted that both the student's work on the topic and advisor's work with the student are governed by Austrian copyright law, Federal Law Gazette No. 111/1936 (cf. UG2002 § 80 para. 2), or equivalent.

(5) Extensive thesis topics jointly researched and developed by more than one student are admissible as long as individual's contribution and results are well documented and can be separately and independently assessed.

(6) The Master's Thesis is co-supervised by two faculty members from the consortium, one from PLUS and one from the university representing the chosen specialization track selected by the student. These faculty members supervising the thesis must be qualified according to the regulations of their own institution.

(7) If agreed by the Programme Board and conforming with institutional regulations at the degree awarding partner institutions, the Master's Thesis can be also produced with the support of one or more experts from an associated partner institution of the Consortium.

(8) The Master's Thesis has to be submitted in English language.

(9) Due to the double degree character of this programme, a single thesis is submitted in identical form at two partner institutions as a graduation requirement.

§ 10 Work placement / internship

(1) As part of the CDE programme, students must complete a compulsory skills-based internship/work placement related to the programme comprising 8 weeks, which is comparable to full-time employment and corresponding to 12 ECTS points. The skills-based internship/work placement should enable students to use the knowledge and skills they have gained during their studies.

(2) The skills-based internship/work placement (12 ECTS) is to be completed at a university where less than one full semester of study is being completed, or at a non-academic CDE programme partner, or at another institution pre-approved by the responsible body. Pre-approval of the internship and the selected institution is required and must be granted by the responsible body. Further requirements are outlined in §§ 7, 8.

(3) A collaborative research/work placement (18 ECTS) is to be completed at a consortium partner or at any institution worldwide. Work placement at non-academic partners are encouraged. It must be confirmed by the responsible body until the end of semester one. The research-based Master's Thesis shall lead to a joint publication after graduation. Further requirements are outlined in §§ 7, 8.

(4) Students with disabilities and/or chronic illnesses will be supported in the completion of their internship by the University (Office of the Rectorate for Disability & Diversity). Should the requirements of potential internships be rendered impossible to fulfil due to architectural and/or structural barriers, students with disabilities and/or chronic illnesses will be given the opportunity to complete this part of the curriculum in a different form.

(5) An internship certificate issued by the host institution and serving as a basis for recognizing a completion of this requirement has to document these items:

a. Institution and location where the internship has been completed.
b. Timeframe / duration and workload (hours per week) of the internship.

c. Description of assigned tasks and responsibilities.
d. Written assessment of internship by supervisor at host institution.

As part of their internships, students can gain the following qualifications (among others):

- Ability to put the theoretical knowledge acquired in the field of study into practice in a professional context.
- Acquaintance with different scenarios in which theoretical concepts can be used.
- Acquisition of soft skills such as teamwork, communication skills, planning and organisational skills in a professional context.
- Acquisition of business-related and entrepreneurial skills.
- Familiarity with professional environments of Earth Observation and Geoinformatics applications.

§ 11 International study

As an international multi-partner joint degree programme taught in English language, the CDE programme has an inherently international character and does not require specific provisions for further enhancing the international experience of students.

In addition to studying for the first academic year at PLUS and the second year at the selected specialization partner, students are exposed to further experiences aimed at integrating the student body across partners as well as offering options beyond the Consortium:

- Summer schools, workshops, blended learning programmes will be offered across the entire partnership, in addition the Programme Board will identify additional summer school opportunities worldwide.
- Periods of study at associate partner institutions can support the development of the Master's Thesis.
- Students are encouraged to leverage international online courses approved by the Programme Board either as Elective Subjects or, based on demonstrated academic equivalence, instead of compulsory courses or modules.

§ 12 Allocation of places in courses with a limited number of participants

(1) For the admission to and priorities in all individual courses, the admission regulations of the institution hosting the course are applied.

(2) All applicable prerequisites for prioritizing the admission to courses will be made available to students at the beginning of the programme.

§ 13 Admission requirements for exams

(1) For the admission to all course exams, admission regulations of the institution hosting the respective course are applied. At the University of Salzburg, no exam admission requirements beyond the assessment and attendance rules specified in § 4 are applicable.

(2) All requirements for the admission to exams will be made available to the students at the beginning of the respective course.

§ 14 Examination regulations

(1) All courses with the exception of type VO require course attendance and are continuously assessed. Lectures (VO) are assessed based on a single written or oral exam at the end of the course. All modules listed in § 5 can be assessed through module or individual course exams (or combinations thereof) at the discretion of course instructors, notwithstanding stated continuous assessment requirements.

(2) For all the individual course or module examinations, the examination regulations of the institution hosting the exam are applied.

(3) All institutions hosting exams will apply their national, legally binding general grading system for course examination. A common grading system based on the ECTS grading table and including conversion rules is established by the consortium and made available to the students at the beginning of their studies.

(4) The supervisor of the Master's Thesis confirms the successful completion of the ePortfolio requirement.

§ 15 Master's exam before an examination committee

(1) This Master's programme will be completed with a Master's exam before an examination committee.

(2) Candidates must have successfully completed all required courses, the compulsory skills-based or collaborative internship/work placement, the ePortfolio as well as received a positive evaluation of the Master's Thesis in order to be eligible to take the Master's exam.

(3) The Master's exam consists of the thesis defence and two examination subjects, including at least one related to the specialization track.

§ 16 Effective date

The curriculum comes into force October 1, 2023 and applies to the students registered in the academic year 2023/2024 and onwards.

§ 17 Transitional provisions

(1) Students of the Master's programme Copernicus Master in Digital Earth who are subject to the Curriculum 2019, as published in the version 2019, Bulletin No 88 of March 15, 2019, at the time of the entry into force of this curriculum, are entitled to complete their studies until 30.9.2026 according to the provisions of the Curriculum Version 2019. If they do not complete their studies by 30.9.2026, they are subject to the curriculum in its current version.

(2) Students who are registered for the EMJMD Copernicus Master in Digital Earth (CDE) at the Paris Lodron University Salzburg (Version 2019, Bulletin No 88 of March 15, 2019) at the time of entry into force of this curriculum shall be entitled to voluntarily transfer to this curriculum specified in this document at any time within the admission deadlines. A written, binding declaration specifying their intention to transfer to the new curriculum shall be addressed to the Admissions Office.

Annex 1: Module descriptions

Module title	ORIENTATION PROJECT
Module code	B1
Total workload	6 ECTS
Learning Outcomes	Students are building adequate expectations and adjusting to the requirements of the MSc CDE programme depending on their respective (and different) first degrees. Based on admission interviews, students receive recommendations to compensate any deficiencies from their undergraduate studies, particularly in the areas of Earth observation and geoinformation (EO*GI) skills, basic spatial literacy and cartographic competences, fundamental understanding of spatial sciences and general digital and analytical methods. In addition, students enhance their general orientation in scientific methods and scientific writing in a dedicated set of classes, as a preparation for supervised and independent work in advanced classes. Students apply the acquired knowledge and write a scientific report or article. This module guides students towards establishing their individual ePortfolio and career development skills. Coursework aiming at adjusting prerequisites will secure coverage of knowledge according to: EO4GEO BoK *Remote sensing data and imagery* & *Data formats* (https://bok.eo4geo.eu/PS3-6) - Discuss the purposes of obtaining remote sensing data - Discuss how remote sensing data is organized and stored EO4GEO BoK *Organizational and Institutional Aspects* (https://bok.eo4geo.eu/OI) - List and explain relevant organizational and institutional aspects related to GIS&T. EO4GEO BoK *Spatial Thinking* (https://bok.eo4geo.eu/CV6-6) - Arrange previously observed objects in a place - Recognize spatial schemes like patterns and shapes - Represent an object or a scene from different viewpoints EO4GEO BoK *GI and Society* (https://bok.eo4geo.eu/GS) - List and explain the different societal aspects that are important in dealing with geospatial information GIS&T Body of Knowledge (https://www.ucgis.org/assets/docs/gist_body_of_knowledge.pdf) - Foundations of Geoinformatics: CF3, CF4, CF5-1,4,5, DA4, DM1-4, GD12, OI51-2, GS3 - Cartography and Visualisation: GD1-5, GD10, CV2, CV3, CV4-1, CV6-1-3, DN2
Module content	Orientation regarding structure of entire curriculum, the scope of the emerging fields of Earth observation and geoinformation (EO*GI), and student life at CDE partner universities. Integration with student cohort. Planning and design of one's individual course of study, including specific methodology and / or domain.

	Review basic concepts of spatial orientation and geospatial thinking. Practice and apply spatial thinking through online platforms. Perspectives on professional outlook and career development for informed career choices. Comprehend professional development as a continuous and dynamic process including importance of strengthening the network within the geospatial community. Personal SWOT analysis and translation of outcomes into action. Written communication in science. Structuring of documents according to media and target audience. Scientific writing in English language. Adequate use and referencing of sources, empirical evidence and pertinent tools. Elementary research design. Professional ethics.
Courses	All courses are taught as practicals fostering problem-oriented and experiential learning through individual or group assignments. - Copernicus in Digital Earth (EO*GI) - Spatial Thinking & Modelling - Career Development & ePortfolio - Scientific Methods and Writing
Type of exam	Submission of several individual and group mini-projects aiming at orientation, social environments and use of geomedia / geospatial communication. These projects serve as assignments graded from a combination of peer and teacher assessment.

Module title	**SPACE-TIME MODELS & REPRESENTATIONS**
Module code	B2
Total workload	6 ECTS
Learning Outcomes	Students will be able to apply the selected methods in project-oriented work and take methodological responsibilities in working groups and complex workflows. Coursework will secure coverage of knowledge according to: EO4GEO BoK *Cartography and Visualisation* (https://bok.eo4geo.eu/CV)[i] - Choose from different options to create a map. - Explain the importance of visualisation of cartographic materials over time. - Relate the science and technology of graphical representation of geographic data. EO4GEO BoK *Data Modeling, Storage and Exploitation / Standards for Spatial Data Modeling* (https://bok.eo4geo.eu/DM)[ii] - Knowledge and skills to read and implement geospatial data models based on standardized techniques. Model geospatial data. - Determine the standards that are essential for geospatial data modelling. EO4GEO BoK *Design and Setup of Geographic Information Systems* (https://bok.eo4geo.eu/DA)ii - Design databases for spatial data management. - Design workflows, procedures, and customized software tools for using geospatial technologies and methods. - Develop effective mathematical and other models of spatial situations and processes. - Understand spatial data models and structures. GIS&T Body of Knowledge (https://www.ucgis.org/assets/docs/gist_body_of_knowledge.pdf)[i] - Design and implement advanced geovisualisation interfaces for use-case oriented media, devices and user experiences [DM5-3, DN2-4, GS3-3]. - Acquire knowledge and skills in thematic cartography, including overview on current research. [i]course: Geovisualisation and Advanced Cartography [ii]courses: Systems Thinking in Spatial Representations & Design of Geospatial Data Models
Module content	Courses introduce theory of cartographic communication, principles of map design, methods for preparing thematic maps, and examples for the application of thematic cartography in various subject areas. Geospatial data models as the foundation of efficient geospatial data processing impacting service interfaces, performance and the ability to flexibly exchange data. Systems thinking as a transversal concept for space-time representation. Hierarchical or ontological organisation of natural and technical systems. Systems theory foundations of spatial science, modelling and simulation.

Courses	Courses are taught as introductory seminar course (PS) to acquire fundamental knowledge and skills for scientific research through practical as well as conceptual work. Two lecture courses (VO) provide an overview of system thinking in spatial representations and design of geospatial data models. - Geovisualisation and Advanced Cartography - Systems Thinking in Spatial Representations - Design of Geospatial Data Models
Type of exam	PS course participation is continuously assessed, and attendance is mandatory Teacher and peer assessment of individual assignments, optionally presentations and portfolio entries, plus overview tests. Lecture courses require a written assignment.

Module title	**DIGITAL EARTH OBSERVATION & TECHNOLOGIES**
Module code	B3
Total workload	12 ECTS
Learning Outcomes	This core module of the Copernicus in Digital Earth study programme builds advanced translation skills from application domain problems towards conceptual reframing and structuring, towards analytical methods and toolsets of EO*GI. Utilising operational methods and tools, complete workflows representing complex processes are modelled in structured frameworks to support spatial decisions across domains. Students will acquire knowledge according to: EO4GEO BoK *Remote Sensing* (https://bok.eo4geo.eu/GD2-2) - Explain which types of geospatial data are collected through satellite remote sensing. - Understand the larger space policy context of satellite Earth observation with a particular focus on the Copernicus programme - Familiarise with advanced methods, tools and techniques of remotely sensed imagery. - Master image analysis tools and methods to a degree to be confident in tackling 'real-world' application scenarios. - Apply specific image acquisition techniques (VHR optical data, Radar data, Lidar, UAV). - Perform image pre-processing (calibration, filtering, and pre-classification). - Conduct spatial image analysis using image segmentation, advanced classifiers (both physical-model based and statistical) and assess the quality of the results. EO4GEO BoK *EO services and applications* (https://bok.eo4geo.eu/TA13) - Designing the description of a service for the need of a particular user of EO information. - Having in-depth knowledge on Copernicus-relevant topics such as land monitoring, emergency response including (geo-) humanitarian action, and climate change. EO4GEO BoK *Earth Observation Big Data* (https://bok.eo4geo.eu/PS3-2-4) - Explain and discuss the concept of big data in the field of Earth observation. - Understand current trends of big data in remote sensing and its background as well as applying new concepts and approaches. GIS&T Body of Knowledge (https://www.ucgis.org/assets/docs/gist_body_of_knowledge.pdf) - Design, implement and validate complex workflows and process models built from individual methods and operations. [AM5-6,78]. - Move from data analysis to generation of context-specific information and the creation of higher-level domain knowledge. [AM1-1,2]. - Choose and apply spatial- and geo-statistical methods to analyse multidimensional and multivariate data sets to explain

	and model complex relations and processes [CF6, AM7, AM8, AM9-2,4, GC2-4]. - Manage information extraction from large ('big') data sets, including flow of data, DBMS aspects and pattern analysis [AM10].
Module content	Automated image analysis of remotely sensed data covering the full workflow from image acquisition (new sensor types and devices), over advanced pre-processing and pre-classification techniques, and object-based image understanding including quality assessment. Opportunities and trends of the European Union's Earth observation programme – Copernicus, including topics such as the (emerging) Copernicus service portfolio, data and information access services, user appraisal and uptake, "Women in Copernicus", specific challenges of the service domains (climate change, security, etc.). Recent trends in Earth observation referred to "big Earth data" including topics such as accessing and processing of massive amount of big data online, building and exploiting data cubes, utilizing cloud-based data processing and related application areas for continental- or global-scale remote sensing image processing. In a mixture of theoretical and hands-on sessions students will learn to understand current trends and challenges as well as applying new concepts and approaches in remote sensing.
Courses	Through a combination of a practical class including extensive lab components with an advanced seminar, students develop broad competences across the spectrum of analytical methods (optionally including spatial statistical and remote sensing methods), as well as a deeper understanding and critical appreciation of results through application experience of selected methods and their parameterization contexts. - Advanced Remote Sensing - Copernicus Hubs and Institutions - Digital Earth: Big Earth Data Concepts
Type of exam	Assessment of individual lab assignments plus overview test. Hands-on exercises and assignments using relevant software packages. Presentation of seminar (project) paper with peer and teacher assessment.

Module title	**SPATIAL IMAGE ANALYSIS**
Module code	B4
Total workload	6 ECTS
Learning Outcomes	Students will be able to apply the selected methods in project-oriented work and take methodological responsibilities in working groups and complex workflows. Students will have acquired the following competences: EO4GEO BoK *Foundations of analytical methods* (https://bok.eo4geo.eu/AM1) - Apply analytical methods to solve spatial problems. - Understand current trends of big data in remote sensing and its background as well as applying new concepts and approaches. EO4GEO BoK *Object-based image analysis (OBIA)* (https://bok.eo4geo.eu/IP3-7) - Apply object-based classification methods for classifying very high-resolution satellite images. - Apply object-based image analysis methods for extracting information from optical imagery. - Compare pixel-based image classification methods with object-based techniques. - Describe the main advantages of object-based image analysis methods. - Develop and implement an object-based image analysis workflow for a specific application context. - Overall understanding of object-based image analysis as an advanced image understanding strategy. - Apply spatial concepts in image analysis, such as geometrical, form-related, context-related properties of objects - Handling basic technical principles of image segmentation and object-based classification and validation. GIS&T Body of Knowledge (https://www.ucgis.org/assets/docs/gist_body_of_knowledge.pdf) - Decide on adequate Remote Sensing data sources and workflows across available passive and active sensors. - Apply the Object-Based Image Analysis (OBIA) paradigm to the extraction of features and monitoring of change across remote sensing application domains. - Select and implement advanced geodata acquisition processes using e.g. photogrammetry, LiDAR, in-situ and mobile sensors, crowdsourcing and UAV platforms, including real-time data streams [DN1-6, components from GD]. - Prepare and support decisions through (geo-)simulation [DA5-3,4, GC].
Module content	Students are offered a selection of core EO*GI on advanced geospatial data analysis using mixed input data and analytical methods. Object-based image analysis (OBIA) providing methods and tools for multi-scale representation and class modelling by integrating spatial concepts and knowledge-based strategies for advanced image under-

	standing. At the interface between GIS and remote sensing technologies, OBIA offers a powerful approach for utilizing image information for various application fields. Advanced spatial analysis techniques with a particular focus on remote sensing applications and image analysis. Addressing both, GI methods with a particular flavour in EO image analysis, e.g., filters and advanced classifiers. Comprehending and applying techniques of hybrid AI and EO analytics for complex data-driven and/or knowledge driven image understanding. Combining rule-based analysis techniques with deep learning.
Courses	All courses have a strong practice orientation, combining conceptual foundations with a view towards applications. Participants familiarize with spatial analysis by conducting small hands-on experiments or comparative methodological studies. - Object-Based Image Analysis - Analysis and Modelling (Remote Sensing)
Type of exam	Course participation is continuously assessed, and attendance is mandatory Teacher and peer assessment of individual assignments, optionally presentations and portfolio entries, plus overview tests.

Module title	**INTEGRATED APPLICATIONS**
Module code	B5
Total workload	12 ECTS
Learning Outcomes	Students will gain a well-structured understanding of software development from a combined problem-solving and software engineering perspective, enabling them to work as geospatial experts in technical teams and to successfully communicate with software developers. Students are enabled to translate from Copernicus thematic applications to software solutions via use cases. Based on the foundations of programming and application development, students acquire competences in at least two development environments and languages, enabling them to design simple software programmes, to customize existing applications, and to automate basic workflows. This includes practical skills in geo-application development in the areas of web applications, mobile applications, or desktop analytical applications. Having completed this module, students are able to carry out basic development tasks on a variety of platforms and architectures with an emphasis on understanding and translating demands from typical EO*GI domains. This key competence is developed and verified through a development project in one IP. Students will be able to: EO4GEO BoK *Project management* (https://bok.eo4geo.eu/DA2-1) - Explain what a project is, and the difference between a project, programme, and product. - Illustrate each of the project management areas with an example of a technique or tool used. - List the key elements of a project management. - List the phases of a project management life cycle. - Select the most appropriate techniques for a EO*GI project. EO4GEO BoK *System design* (https://bok.eo4geo.eu/DA1) - Analyse suitability of a network. - Demonstrate why the system design is important in any GIS implementation. - Identify data center platform tier configuration and identify platform selection for each tier. - Identify platform assignment for each workflow software component peak transaction processing load. - Identify user locations, network connectivity, and data center server locations. - Interpret business needs and translate them to IT needs. - Interpret user needs as an input for the design process. - Model project workflows. GIS&T Body of Knowledge (https://www.ucgis.org/assets/docs/gist_body_of_knowledge.pdf - Design and carry out software projects in accordance with standardized and structured SWE processes [DA7-1, DA7-2, DA6-1, DA6-3]. - Select the appropriate programming or scripting language according to the specific goals of a software project [DA5-4 , DA6-3 , DA7-1, DA2-4].

	- Apply their basic knowledge of modeling software systems for communication between different stakeholders in a SWE project [DA1-2, DA1-5, DA2-4, DA6-2]. - Programmatically access external code libraries and Application Programming Interfaces (APIs) of commercial off-the-shelf (COTS) and open-source software in their own programs to achieve their goals [DA7-2, DA1-5, DA6-3]. - Develop software programs to pre-process and analyse spatial data (read, manipulate, store, visualize, classify) that are available in a variety of formats (CSV, ShapeFiles, GML, KML, raster formats etc.) [DA7-1, DM1-2]. - Integrate data from service-oriented architectures (SOA), including OGC Web Services (OWS) into their software programs through service-based data access [DA7-2]. - Read and understand the documentation of software libraries - Create user interface components in selected development environments [DA6-2]. - Batch analysis tasks in the application domains of GIS and remote sensing [DA6-3]. - Develop geo-applications for different platforms (desktop, web, mobile) and application domains (GIS, remote sensing) [DA7-2, CV5-1, CV4-5].
Module content	Project management techniques and tools combined with fundamental management skills and principles. Introduction to leadership competences e.g., critical thinking, effective listening, taking initiative and motivating, and conflict management. Understanding and translating user requirements into software solutions via design thinking and use cases. Strong link to an applied research framework. Principles of software engineering. Procedural and object-oriented programming principles. Approaches to modelling software systems using UML. Service-oriented Architectures. OGC Web Services (OWS) and OGC API. Client-side and server-side scripting languages (e.g., JavaScript, Python, or similar). Object-oriented programming vs. scripting. Server-side OO programming and scripting (e.g., JSP, Python, PHP, or similar). Programmatic database access. Program development for spatial data pre-processing. APIs in commercial off-the-shelf (COTS) and/or open-source software. Web Mapping. Web GIS. Batch processing for GIS and remote sensing analysis and classification tasks. Basic GUI design. Deeper understanding of Application Development using Cognition Network Language (CNL) in an OBIA software environment. CNL language (using variables, loops/branching, arrays etc.). Realise selected applications within the context of applied research and elaborate on more advanced OBIA concepts using CNL as a programming language; applications development.
Courses	Through a combination of an introductory lecture and a lab exercise as well as an IP (selectable from different application domains) including extensive practical components, students develop broad competences across the spectrum of application development methods on different platforms and programming languages (at least two) as well as different application domains (optionally including remote sensing applications). - Project Management - Practice Software Development - Application Development (Earth Observation)

Type of exam	Assessment of individual lab assignments plus overview test. Presentation of focus topic with peer and teacher assessment. IP: hands-on project work with strong motivation from real world problems; detailed documentation according to corresponding standards. Evaluation of the approach to challenge during the project as well as the final results.

ST - Specialization Track GeoVIS – Geovisualisation and Geocommunication (UPOL)	
Module title	**GEOVISUALISATION**
Total workload	15 ECTS
Learning Outcomes	Upon completion of the module, students are able to explain the geovisualisation process. - understand general theory of systems, - implement geovisualisation processes using and combining spatial and non-spatial data; - evaluate visualisation approaches of spatial data and build new ones upon the theoretical framework; - design scientific atlases as products of systematic geovisualisation, - analyse and categorize available techniques in terms of quality, efficiency, and suitability for a particular data type, - evaluate available tools based on their functionality and apply these tools to create own geovisualisations. - understand general theory of systems, - implement geovisualisation processes using and combining spatial and non-spatial data; - evaluate visualisation approaches of spatial data and build new ones upon the theoretical framework; - design scientific atlases as products of systematic geovisualisation, - analyse and categorize available techniques in terms of quality, efficiency, and suitability for a particular data type, - evaluate available tools based on their functionality and apply these tools to create own geovisualisations. - understand current issues in design in geovisualisation; - evaluate design research approaches; - analyse and process geodata within a geovisualisation context; - evaluate different geovisualisation techniques, principles and methodologies according to the applicability to the intended project. EO4GEO BoK *Cartography and Visualisation* (https://bok.eo4geo.eu/CV) - Choose from different options to create a map. - Explain the importance of visualisation of cartographic materials over time. - Relate the science and technology of graphical representation of geographic data.
Module content	Through a combination of an introductory lecture and a lab exercise including extensive practical components, students develop broad competences across the scope of application development methods on different design platforms. Systematic Geovisualisation: - Fundamental geovisualisation concepts - Designing geovisualisation within theory of systems - Types of geovisualisation processes - Map and layout designing - Cartographic generalization - Map projections in geovisualisation concepts

	- Use and user issues in geovisualisation - Topographic and thematic mapping - Colors and labelling - Image mapping Advanced Methods in Geovisualisation: - Concept of thematic mapping - Composition of thematic maps - Methods for representing qualitative data - Methods for representing quantitative data - Colours in thematic maps - Digital tools for geovisualisation production - Multivariate mapping - Tactile mapping - 3D in geovisualisation Design in Geovisualisation: - Introduction to the design in geovisualisation - History of computer graphics - Fundamental principles of graphic design and principles of geovisualisation - Map layout and map styles - Bezier curves in geodata processes - Colours and tools for colour settings - Map symbology design - Designing infographics - Designing communication-oriented geovisualisations EO4GEO BoK *Cartography and Visualisation* (https://bok.eo4geo.eu/CV) - Choose from different options to create a map. - Explain the importance of visualisation of cartographic materials over time. - Relate the science and technology of graphical representation of geographic data.
Courses	Course taught with practicals, fostering problem-oriented and experiential learning through individual or group assignments. - Systematic Geovisualisation - Advanced Methods of Geovisualisation - Design in Geovisualisation
Type of exam	Written and oral examination. Map assignment and paper assignment.

ST - Specialization Track GeoVIS – Geovisualisation and Geocommunication (UPOL)	
Module title	**GEOCOMMUNICATION**
Total workload	9 ECTS
Learning Outcomes	Upon completion of the module, students are able to: - Explain theories of perception and effective user-driven map-design; - Understand current cognitive research issues in relations to cartographic research questions; - Get acquainted with different methods of map assessment; - Learn about recording of eye-movements; - Evaluate perception of cartographic products; - Analyse and process map reading; - Evaluate different cartographic techniques, principles and methodologies according to the cognitive processes; EO4GEO BoK *Cartography and Visualisation* (https://bok.eo4geo.eu/CV) - Choose from different options to create a map. - Explain the importance of visualisation of cartographic materials over time. - Relate the science and technology of graphical representation of geographic data.
Module content	Cognitive Cartography - Cartographic communication models - Methodological aspects of empirical research in cognitive cartography - History and the present of cognitive research - Methods of cognitive cartography - Questionnaire surveys in cartography - Eye-tracking and its use in cartography - Preparing of eye-tracking experiment and testing - Analyses, visualisation and statistical evaluation of recorded data - The use of GIS tools for visual analysis of eye-tracking data - Cartography and psychology Web Cartography - WebGIS 2.0, Map Application vs. Map Server - GIS software libraries - Different GIS data formats for Web Cartography - Vector and raster tiles - Server-side data publishing - Cloud GIS - JavaScript GIS mapping libraries - GIS API - Geospatial analysis and processing - Design and styling of web maps
Courses	Courses introduce advanced cartography methods and theory. - Cognitive Cartography - Web Cartography

Type of exam	Web map application and written examination.

ST - Specialization Track GeoDSc – GeoData Science (UBS)	
Module title	**FUNDAMENTALS OF DATA SCIENCE**
Total workload	15 ECTS
Learning outcomes	Upon completion of the module, students will be able to: - Understand the different machine learning problems and methods; - Design for a given data analytics problem the appropriate solution to be used; - Implement deep learning models within a standard framework; - Use software framework to design, implement and deploy a solution for big data analytics. EO4GEO BoK *Machine learning* (https://bok.eo4geo.eu/IP3-4-7) - Describe the role of machine learning classifiers to find patterns in the available data. EO4GEO BoK *Deep learning* (https://bok.eo4geo.eu/IP3-4-6) - Analyse the EO Image processing tools required for preparing EO data for deep learning. - Apply deep learning methods on EO data within online processing platforms like Google Earth Engine Cloud Computing, Amazon Web Service, Microsoft Azure, or Sentinel Hub. - Apply different DL approaches in EO imagery for classification, detection, or regression. - Compare different deep learning approaches in EO image classification. - Describe how deep learning works. - Identify programming languages (like Python, R, and C++) and the main open-source libraries (like OpenCV, PyTorch, TensorFlow, Google Colab, Github, Scikit-learn) that are common for deep learning. EO4GEO BoK *Earth Observation Big Data* (https://bok.eo4geo.eu/PS3-2-4) - Explain and discuss the concept of Big Data in the field of Earth Observation.
Module content	<u>Machine Learning</u> - Principles of supervised and unsupervised learning; - Data clustering; - Dimension reduction and feature selection; - Classification and regression algorithms; - Bayesian learning; - Time series analysis; - Training strategies and evaluation protocols; - Use of software libraries. <u>Foundations of Deep Learning</u> - Principles of neural networks; - Optimization and regularization; - Main architectures (CNN, RNN, AE, GAN);

	- Use of deep learning software frameworks. Big Data - Principles of Big Data processing and HPC; - Review of main software frameworks (e.g., Hadoop stack); - GPU-based processing (CUDA, OpenCL); - Application to Earth observations with Spark and SparkML;
Courses	Courses are taught as a combination of lectures with practical lab components. - Machine Learning - Foundations of Deep Learning - Big Data
Type of exam	Assessment of individual lab assignments, group-projects plus written exams.

ST - Specialization Track GeoDSc – GeoData Science (UBS)	
Module title	**ARTIFICIAL INTELLIGENCE FOR EARTH OBSERVATION**
Total workload	15 ECTS
Learning outcomes	Upon completion of the module, students will be able to: - Understand the main paradigms (both deterministic and learning-based) for image processing, and their relevance for large-scale remote sensing data - Design and implement the appropriate computer vision solution for a given EO data analytics problem; - Solve a challenging EO task using modern AI frameworks. EO4GEO BoK *Image enhancement* (https://bok.eo4geo.eu/IP1-4) - Identify and explain methods of image enhancement EO4GEO BoK *Image segmentation* (https://bok.eo4geo.eu/IP3-5) - Explain which principles a segmentation should follow to arrive at meaningful objects that are appropriate for a specific application - List the main segmentation methods used to group similar pixels into homogeneous objects EO4GEO BoK *Deep learning* (https://bok.eo4geo.eu/IP1-4) - Analyse the EO Image processing tools required for preparing EO data for deep learning - Apply deep learning methods on EO data within online processing cloud platforms - Apply different DL approaches in EO imagery for classification, detection, or regression - Compare different deep learning approaches in EO image classification - Describe how deep learning works

	- Identify programming languages (like Python, R, and C++) and the main open-source libraries that are common for deep learning EO4GEO BoK Computer vision in EO (https://bok.eo4geo.eu/IP3-2) - Explain how computer vision imitates the human visual system when interpreting EO images. EO4GEO BoK *Kernel analysis (convolution)* (https://bok.eo4geo.eu/IP3-6) - Calculate a set of filtered reflectance values for a given array of reflectance values and a digital image filtering algorithm - Describe a situation in which filtered data are more useful than the original unfiltered data - Interpret the effect of a convolution from a given mask and contained weights EO4GEO BoK *Scale space analysis* (https://bok.eo4geo.eu/IP3-9) - Create a scale space for an image by applying multiple iterations of low-pass filtering
Module content	<u>Efficient Remote Sensing Image Processing</u> - Classical methods for image processing and study of their complexity; - Graph-based image processing; - Tree-based image processing. <u>Deep Learning for Computer Vision</u> - Scene classification; - Semantic segmentation; - Object detection; - Other computer vision tasks (e.g., instance segmentation); - Applications to Earth Observation data (e.g., change detection, land cover mapping) <u>Geospatial Data Analytics Projects</u> - Research seminars; - Advanced remote sensing projects (LiDAR, SAR, time-series and/or video); - Geodata science practical workshop.
Courses	Courses are taught as a combination of lectures with practical lab components. - Efficient Remote Sensing Image Processing - Deep Learning for Computer Vision - Geospatial Data Analytics Project
Type of exam	Assessment of individual lab assignments, group-projects plus written exams.

Linked Elective Module (Wahlpflichtmodul)	
Module title	**SHORT INTENSIVE PROGRAMMES**
Module code	SIP
Total workload	9 | 3 ECTS
Learning Outcomes	As a core element in an international study programme integrating students from very diverse backgrounds and pursuing different pathways, participating in a summer school or Blended Intensive Programmes aims at several important objectives: - Social integration of student cohort through groupwork and a fulltime residential setting. - Deep dive into a specific topical domain with particular professional relevance. - Contact opportunity with practitioners from industry and application domains. - Experience with hands-on field work and data acquisition.
Module content	Depending on the chosen topic (summer schools and BIPs will be offering a variety of themes), the content will allow students to build a holistic understanding of the respective theme through an immersive experience.
Courses	International summer schools and Blended Intensive Programmes (BIPs)
Type of exam	Integrated, continuous assessment including group work (depending on summer school theme) and individual written and optionally oral presentation of assigned topic.

Module title	**WORK PLACEMENTS**
Module code	INT
Total workload	12 | 18 ECTS
Learning Outcomes	Obligatory work placements / internships during the course of studies expose students to the workforce. Aiming at several important objectives: - Secure better career opportunities for graduates through compulsory internships or / practical work placements. - Increased awareness on novel application areas in the emerging EO*GI sector. - Collaborative research activities in the context of projects.
Module content	The obligatory skills-based internship / work placement (12 ECTS) typically is conducted in blocked mode (1 or 2 periods) outside of course (semester) periods, but also can be completed as equivalent part-time activity. A research-based Master's Thesis chosen in the context of a collaborative research / work placement (18 ECTS) at a consortium partner or at any institution worldwide including non-academic organisations

	must be confirmed by the Programme Board until the end of the first semester.
Courses	- INT - Skills-based internships/practical (12 ECTS) - INT_OPT - Collaborative research/work placements (18 ECTS)
Type of exam	Report.

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