Universität Münster

AMTLICHE BEKANNTMACHUNGEN

Jahrgang 2026 | Ausgegeben zu Münster am 25. August 2026 | Nr. 41

Inhalt

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Herausgegeben vom
Rektor der Universität Münster
Schlossplatz 2, 48149 Münster
AB Uni 2026/41
http://www.uni-muenster.de/Rektorat/abuni/index.html

Examination Regulations
for the Master Program in Geospatial Technologies
at the
Universität Münster, Germany,
Universitat Jaume I, Castellón, Spain, and
Universidade Nova de Lisboa, Portugal
17.08.2026

C o n t e n t s

I. Master Program

§ 1 Goal of the Master Program

The Master examination forms a continuative career-qualifying degree of the program of study in Geospatial Technologies. Graduates of the International Master program apply and develop methods for computer-supported solutions for spatially related problems (global, regional, local). The Master examination proves, if the candidate has acquired the necessary specialized knowledge and additional core competences in order to start or precede a professional career in the public and private sector, or research.

§ 2 Master degree

The successful Master candidate will be awarded with the academic degree "Master of Science" (M.Sc.) with the adjunct "in Geospatial Technologies".

§ 3 Requirements for admission

(1) A requirement for admission is an adequate Bachelor degree of six semesters or more in Germany, Portugal, or Spain, or an equivalent Bachelor degree from other countries.

(2) The study program is in English language. Therefore, a TOEFL certificate (500 points paper-based), or equivalent, is required. In case of uncertainty, the Examination board or Master program coordinator according to § 8 decides about equivalence.

(3) Applicants will be evaluated based on the following criteria:

1. Grades of the previous degree(s)
2. Relevance of the previous degree(s)
3. Professional or other experience in GI application areas
4. Skills in GI and/or IT
5. Motivation and fit for the study program
6. Social and multi-cultural competences
7. Formal aspects of application

In case of verification of 150 ECTS credit points and fulfilment of the other criteria, a Bachelor student can be admitted tentatively. For final admission, the Bachelor diploma has to be provided until the 1st of September of the respective program year.

Details of each year's evaluation procedure will be published on the homepage of the University of Münster (UM), Universidade Nova de Lisboa (UNL), and Universitat Jaume I (UJI).

(4) Detailed admission requirements are defined by the respective enrollment and legal regulations, to be published on the universities' respective homepages.

(5) The Master´s programme in Geospatial Technologies always starts at UJI, Castellón, Spain, or at UNL, Lisboa, Portugal. The selection process, including verification of compliance with the admissions requirements in § 3 (1) – (4), is regulates according to Spanish and Portugues law and takes place at UJI or UNL.

§ 4 Previous knowledge

The Master Program in Geospatial Technologies is recommended to students with relevant Bachelor degrees in application areas of geographic information. In case of uncertainty, the Examination board or Master program coordinator according to § 8 decides about relevance.

§ 5 Duration and structure of the study program

(1) The duration of the study program including all examinations and Master thesis is 3 semesters.

(2) The study program is structured into

1. An introductory course semester, either at the UNL or UJI.
2. An advanced course semester at the UM
3. A one-semester Master thesis including its defense. The Master thesis consists of a supervised

independent work on a scientific problem. Considering students' preferences, the students will be equally distributed to the three universities.

(3) The volume of the study program is 90 credit points, 30 credit points per semester. One credit points equals a students' workload of 30 hours in Germany, 28 hours in Portugal, and 25 hours in Spain.

§ 6 Examinations and deadlines

(1) The Master examination including Master thesis and its defense (see § 14) should be terminated within three semesters.

(2) The Master examination consists of course-related, program-accompanying examinations, which can consist of several components, according to the credit point system.

§ 7 Program-accompanying examinations (excluding Master thesis)

(1) Certificates will be issued, which recognize the student's achievements program-accompanying examinations being part of the Master examination. Program-accompanying examinations are individual achievement related to single courses according to § 14. The grades of program-accompanying examinations have to be announced to the students within one week (UNL) up to six weeks (UJI, UM) after the completion of the last examination component. Examinations in the module "Master thesis" (see § 14) are not subject of the following sub- paragraphs 2-7 but will be described separately in § 16 and 17.

(2) Program-accompanying examinations and its components can be provided by written and oral exams, colloquia, presentations, homework, and reports (including programming).

(3) The teacher of each course defines the components of a program-accompanying examination, and criteria for grading. She/he announces these conditions at the beginning of each course.

(4) Within examinations, the candidate has to show that she/he has gained a coherent knowledge of the respective topic and is able to address problems in this specific area. As a general rule, examinations only include what has been taught before.

(5) All examinations are in English language.

(6) Written examinations might include multiple-choice questions. The duration is up to 240 minutes.

(7) At UM, oral examinations are supervised by examiners according to § 9, and also co-supervised by a competent assessor. The duration is up to 45 minutes. The major topics and results of the oral examination have to be documented. The grade of the oral examination has to be announced to the student directly afterwards.

(8) The Module Description defines the type, duration, and scope of the examinations for the respective module.

§ 8 Examination board or Master program coordinator

(1) Each of the partner universities forms an examination board (in the case of UM, and UJI) or a Master program coordinator (in the case of UNL) that organizes and supervises the examinations within these examination regulations. These examinations in the case of UNL only refer to the final examination of each course within a specific module. The respective Examination board or Master program coordinator is responsible for the examinations the university is performing. The examination board or Master program coordinator consist of the following representatives:

1. UJI forms an examination board consisting of a chair, her/his proxy, and three additional members. Chair, proxy, and the additional members are elected from the group of professors directly involved in organizing and teaching the Master.
2. UNL: The Master program coordinator, together with the academic services, under supervision of NOVA IMS's scientific council, is responsible for organizing all examinations
3. UM: The Faculty of Geosciences forms an examination board consisting of a chair, her/his proxy, and three additional members. Chair, proxy, and one additional member are elected from the group of professors, one member from the group of research assistants, and one member from group of students. The election for the group of professors and research assistants is valid for three years, for the group of students for one year. Re-elections are possible. Members from the group of students do not cooperate in the grading and recognition of students' achievements, definition of

examination tasks, and selection of examiners. The examination board has a quorum, if two members of the group of professors, and one additional member are present. Decisions are made by simple majority; in the case of equality of votes the chair affects the majority vote.

(2) The examination boards or Master program coordinator supervise the examination regulations and its execution. The boards report to the respective faculties, and, if applicable, provide suggestions for innovations. The examination boards can transfer the regular tasks to its chair. This is not applicable to decisions on appeals. For decisions on appeals the procedures according to Spanish, Portugues and German law must be followed, depending on where the examination has been passed.

(3) The members of the examination boards or Master program coordinator can attend all examinations.

(4) The members of the examination boards or Master Program coordinator underlay discreetness. If the members are not obliged to discreetness by their position, the chair has to oblige the members to discretion. Examination board meetings are not public.

§ 9 Examiners and assessors

(1) In general, a lecturer of a course is responsible for examinations according to § 7.

(2) Examiners according to § 7 are

1. at UM:
   a. All persons qualified in terms of § 65 (1) Hochschulgesetz Nordrhein-Westfalen (HG NRW) (Universities Act of the Federal State of North Rhine-Westphalia) (UM) who regularly teach in the programme in which the examination is taken or the thesis written can be appointed as examiner or supervisor. Exceptions have to be decided upon by the examination board.
   b. Only persons with a master's degree, an equal qualification or higher degree can be appointed as assessor.
   c. Examiners and assessors are independent in their decisions.
   d. Oral examinations are taken by an examiner in the presence of an observer. Before grading the examination, the examiner has to consult the observer. Minutes of the examination including the most important content and the grade are taken and signed by examiner and assessor.
   e. Written examinations in the context of modules are assessed by a single examiner. Assessment and grading of the master's thesis follow § 17.
   f. Written and oral examinations that form a third attempt in accordance with § 19 have to be assessed by two examiners. The overall grade equals the arithmetic average of the two individual grades. § 15 comes into effect respectively.
   g. Students from the same programme can take part in oral examinations as audience if the candidate does not object. The audience is not allowed to counsel the candidate or notify the candidate of the result of the examination.
2. at UNL: All Professors designated by the scientific council as responsible for a specific course.
3. at UJI: Chair, proxy, and the three additional members are elected from the group of professors directly involved in organizing and teaching the Master.

(3) As for UM, and UJI, the examination board appoints the examiners and assessors of the module „Master thesis" according to § 9-5. As for the UNL, the Scientific Council together with the student designates the Masters thesis supervisor. The responsible body (examination board or Master program coordinator) is the one from the partner where student and the supervisor are engaged.

(4) A Master thesis is supervised by a thesis board. The thesis board consists of a supervisor from the hosting university and at least two additional co-supervisors. If a student did not attend courses of one of the three partner universities before, one of the co-supervisors has to be a member of that university.

(5) The Master thesis can be supervised and co-supervised by:

1. each professor, assistant professor, junior professor and scientific assistant, regularly employed at the Institute for Geoinformatics, UM; UJI, and at NOVA IMS – UNL.
2. with permission of the examination board, or the scientific council in the case of UNL , by a research assistant with a Master.

3. with permission of the examination board by external professors and assistant professors or PhDs.

(6) On request, the chair of the examination board or Master program coordinator assures that a candidate receives a topic for a Master thesis. The date has to be documented.

(7) The candidate might suggest supervisors and co-supervisors, although this is no legal entitlement.

(8) The chair of the examination board or Master program coordinator assures that the candidate will be informed about the names of the examiners, latest two weeks before the examination.

(9) Assessor of oral examinations according to § 7 and the defense of a Master thesis can be persons, who have a Master degree or equivalent in the examination topic.

§ 10 Recognition of study times, study achievements, and foreign exam results

(1) Required coursework (Studienleistungen) and degree-relevant examinations (Prüfungsleistungen), from within the same programme at other German or Spanish or Portuguese universities are recognised upon request, unless the examination board or Master program coordinator determines that the programmes differ substantially in terms of the resulting acquired skills. The same applies for required coursework and degree-relevant examinations from other programmes at the UM or other German or Spanish or Portuguese universities.

(2) Upon recognition of academic credit in accordance with § 10 (1) and upon request, the student may be assigned a degree-relevant semester based on the number of credits earned in a previous degree programme in proportion to the total number of credits required to complete the degree programme in question. If the first decimal place is lower than five, the number is rounded down to the previous full semester; otherwise, it is rounded up.

(3) § 10 Sections (1) and (2) also apply to the recognition of required coursework and degree-relevant examinations completed in state-recognised distance-learning study programmes, in distance-learning units developed by the state of North Rhine-Westphalia together with the other German states or the federal government, at state or state-recognised universities of cooperative education (Berufsakademien), or in further education study programmes (see § 62 of the Universities Act (HG NRW)).

(4) The basis for determining academic equivalence between degree programmes is the comparison of the content, scope, and requirements of the degree programmes in question. The determination of equivalence should not be based on a schematic comparison, but rather on an overall review and evaluation. For the equivalence of required coursework and degree-relevant examinations from foreign universities, the equivalence agreements of the Standing Conference of the Ministers of Education and Cultural Affairs of the Federal Republic of Germany and the German Rectors' Conference apply. In the case of doubt concerning equivalence, the Central Office for Foreign Education (Zentralstelle für ausländisches Bildungswesen) may be consulted.

(5) If students are entitled to enter the programme at a higher semester after passing a classification test, they receive academic credit in terms of both required coursework and degree-relevant examinations for the knowledge and the skills they demonstrated in the classification test. The examination board or Master program coordinator is legally bound by the assessments made in that test.

(6) Additional skills and qualifications for which documentation is provided can be taken into consideration upon the student's request, provided that the required coursework and degree-relevant examinations which they replace are equivalent in terms of content and level. At most, up to half of the coursework and examinations can be replaced in this way.

(7) If external examinations are recognized, the grades – if the grading systems are comparable – have to be taken over and included in the calculation of the final overall grade according to § 15. For incomparable grading systems, the note "passed" is added. The recognition is indicated in the degree certificate. If recognition of services provided under incomparable grading systems leads to the fact that a module grade can not be obtained, this module will not be included in the calculation of the overall grade.

(8) The student is responsible for providing the necessary documentation for recognition. This must include information on the knowledge and qualifications, for which the student is requesting recognition. If required coursework and degree-relevant examinations from other degree programs are to be recognized, the student must provide the corresponding examination regulations, module descriptions, and Transcript of Records or equivalent document.

(9) The examination board or Master program coordinator is responsible for recognising academic achievement. Before equivalence can be determined, members of staff representing the subjects in question must be consulted.

(10) The student is to be informed about the decision on recognition within four weeks after the application has been made and the required documents have been submitted. In the case of rejection, the student receives a written explanation justifying the decision.

§ 11 Absence, withdrawal, fraud, offence

(1) An examination is considered as "failed", if the candidate does not show up to an examination date or withdraws after the beginning of an examination without cogent reasons. An examination is also considered as "failed", if a written examination is not provided within the foreseen deadline. At the UM, examinations may not be conducted if the UM does not let students take an active role in their education in accordance with the Maternity Protection Act (Mutterschutzgesetz).

(2) Reasons for absence or withdrawal have to be claimed immediately to the examination board or Master program coordinator. In the case of illness, the candidate has to provide a medical certificate. In case of approval of justification, the candidate will be informed, and a new examination date will be determined.

(3) In case of fraud or usage of not-permitted means, the examination is considered as "failed". Evidence will be assessed and documented by the respective examiners. A candidate, who is disturbing an examination, can be excluded. In this case, the examination is considered as "failed". Reasons for exclusion have to be documented. In severe cases, the examination board or Master program coordinator can exclude a candidate from further examinations.

(4) A candidate can request that decisions according to § 11-3 must be checked by the examination board or Master program coordinator within 14 days. The candidate has to be informed immediately about a negative decision, its reasoning, and to be provided with legal instructions.

II. Master Examination

§ 12 Admission

(1) Only enrolled students of the UM, UJI, or UNL, fulfilling the requirements according to § 3 can be admitted to the Master examination. The enrollment in the first semester has to take place at the UJI, Castellón, or the UNL.

(2) The admission to the Master thesis requires a separate application to the responsible examination office. The written application for admission to the Master examination has to be submitted to the chair of the examination board or Master program coordinator. The application has to include:

1. Topic of the Master thesis
2. A confirmation from the supervisor and the two co-supervisors stating that they will supervise respectively co-supervise the thesis.

(3) For starting the Master thesis, 60 credit points of the previous two semesters have to be fulfilled. In exceptional cases, the chair of the examination board or Master program coordinator may allow the candidate to start with the Master thesis with less than 60 credit points, but at least 50 credit points.

§ 13 Admission procedure

The examination board or Master program coordinator according to § 8 decides about the admission of a candidate to the Master examination. Admission has to be rejected, if the requirements in § 12 are not fulfilled.

§ 14 Structure, scope and mode of the Master examination

(1) The Master examination consists of the study-accompanying examinations in the following courses:

Module	Course	Type (e.g., seminar, lecture, e-learning course)	Semester hours/ week	ECTS credit points (1 CP = 30 h students' workload in Germany, 28 h in Portugal, 25 h in Spain)
1. Semester (at UNL or UJI)				
UNL				
Module 1: Foundations of Geographic Information Science I				**5**
	Geographic Information Science	lecture/practical	2	5
Module 2: Advanced Topics in Geographic Information Science I (3 of 4 courses)				**15**
	Spatial Analysis and Visualization	lecture/practical	2	5
	Remote Sensing	lecture/practical	2	5
	Spatial Statistics	lecture/practical	2	5
	Project in Geospatial Technologies	seminar	2	5
Module 3: Advanced Informatics and Data Analytics (2 out of 2 courses)				**10**
	Group Project Seminar on Programming and Analysis	lecture/practical	2	5
	Geospatial Datamining	lecture/practical	2	5
				Sub-total: 30 credit points
UJI				
Module 1: Foundations of Informatics				**10**
	Programming	lecture + practicals	2,5	4
	Databases and Data Management	lecture + practicals	2	3
	Artificial Intelligence and Machine Learning	lecture + practicals	2	3
Module 2: Advanced Informatics and Data Analytics				**12**
	Data Science	lecture + practicals	2,5	4
	Development of Applications for Geographic Data Exploration and Visualization	lecture + practicals	3.5	5
	Spatial Data Services, Sources, Standards and Infrastructures	lecture + practicals + self-study	2	3
Module 3 Geospatial Technologies				**8**
	Geographic Information Systems: Desktop to Web	lecture + practicals	2	3
	Geographic Information Systems Applications and Trends	lecture + practicals	1,5	2
	Earth Observation and Remote Sensing	lecture + practicals	2	3
				Sub-total: 30 credit points

Module	Course	Type (e.g., seminar, lecture, e-learning course)	Semester hours/ week	ECTS credit points (1 CP = 30 h students' workload in Germany, 28 h in Portugal, 25 h in Spain)
2. Semester (at UM)				
UM				
Module 4: Foundations of Geographic Information Science II				**4**
	Core Topics in Geographic Information Science	seminar	2	2
	Geoinformatics Forum	lecture	1	1
	Geoinformatics Forum Discussion Group	seminar	1	1
Module 5: Advanced Topics in Geographic Information Science II (2 of 5 courses)				**10**
	Location-based Services	seminar	4	5
	Spatial Cognition	seminar	4	5
	Machine Learning for Visual Spatial-temporal Data	seminar	4	5
	Spatial Data Science in R	seminar	4	5
	Advanced courses in emerging research fields might be provided	Lecture/practical/seminar (depending on selected course)	2-4	5
Module 6: Applied Topics in Geographic Information Science (1 course in applied geospatial technologies and either 1 course in applied geospatial technologies or 1 study project)				**10**
	Applied Geospatial Technologies (for example: Unmanned Aerial Systems for Applied Research)	Lecture/practical/seminar (depending on selected course)	4 (2 for study project)	5
	Study Project (removed from module 5)	Practical	2	5
Module 7: Transferable Skills				**6**
	Project Management/GeoMundus conference	practical	2	3
	Research Methods in GI Science	seminar	2	3
				Sub-total: 30 credit points
3. Semester (at UM, UNL, or UJI)				
Thesis				
	Master thesis seminar	seminar		2
	Master thesis including defense	Thesis		28
				Sub-total: 30 credit points
Total				***Total: 90 credit points***

(2) The credit points of a courses of the first and second semester are awarded, if the required component(s) of the examination are approved and the examination is graded with an ECTS grade of „E“ or better.

(3) Awarding credit points for the Master thesis and its defense will be described in § 16 and §17.

(4) If a candidate can credibly assure by a medical certification that she/he is not able to perform an examination because of long illness or disablement, the chair of the examination board or Master program coordinator has to allow the candidate to perform an equivalent examination in another way.

§ 15 Grading of examinations

(1) The examiners determine the grades of single examinations and its components. For grading, the examiners have to use one of the national grading systems, which can be transferred to ECTS grades:

ECTS Grade	Definition ECTS	University of Münster	Universidade Nova de Lisboa	Universitat Jaume I
A	EXCELLENT - outstanding performance with only minor errors	1,0 (A+)	19-20 (Muito Bom, Very Good)	9,5-10 (sobresaliente, including matricula de honor, very rare grade)
A	EXCELLENT - outstanding performance with only minor errors	1,3 (A-)	18 (Muito Bom, Very Good)	9,00-9,49 (sobresaliente)
B	VERY GOOD - above the average standard but with some errors	1,7 (B+)	17 (Bom com distinção, Good with Distinction	8,5-8,99 (notable)
B	VERY GOOD - above the average standard but with some errors	2,0 (B-)	16 (Bom com distinção, Good with Distinction	8,0-8,49 (notable)
C	GOOD - generally sound work with a number of notable errors	2,3 (C+) 2,7 (C)	15 (Bom, Good)	7,5-7,99 (notable)
C	GOOD - generally sound work with a number of notable errors	3,0 (C-)	14 (Bom, Good)	7,0-7,49 (notable)
D	SATISFACTORY - fair but with significant shortcomings	3,3 (D)	12-13 (Suficiente, Sufficient)	6,0-6,99 (aprobado)
E	SUFFICIENT - performance meets the minimum criteria	3,7 (E+)	11 (Suficiente, Sufficient)	5,5-5,99 (aprobado)
E	SUFFICIENT - performance meets the minimum criteria	4,0 (E-)	10 (Suficiente, Sufficient)	5,0-5,49 (aprobado)
FX	FAIL - some more work required before the credit can be awarded	5,0 (FX/F)	8-9 (Reprovado, Mediocre, Fail, Mediocre)	0,0-4,99 (suspenso)
F	FAIL - considerable further work is required	5,0 (FX/F)	0-7 (Reprovado, Mau, Fail, Bad)	0,0-4,99 (suspenso)

(2) An examination is approved with an ECTS grade of “E” or better.

(3) The overall grade of a Master examination is a weighed arithmetic average of the single modules; the grade of a module is a weighed arithmetic average of the single courses. Weighing is on the basis of the ratio of the credit points of a course examination, respectively module grade, to the overall amount of credit points

of a module, respectively Master examination.

(4) Grades are weighed within the national grading systems. Grades are rounded to
   1. UM: the first position after the decimal point, which will be rounded for final grades of courses, modules, and overall grade, to the next existing national grade (1.0, 1.3, 1.7, 2.0, 2.3, 2.7, 3.0, 3.3, 3.7, 4.0).
   2. UNL: the nearest whole number (no decimals);
   3. UJI: to the second position after the decimal point.

(5) The overall grade of the Master examination is determined according the following table:

University of Münster	Universidade Nova de Lisboa	Universitat Jaume I	ECTS Grade	Definition ECTS
1,0 - 1,5	18-20	9-10	A	Excellent
1,6 - 2,0	16-17	8,0-8,99	B	Very Good
2,1 - 3,0	14-15	7,0-7,99	C	Good
3,1 - 3,5	12-13	6,0-6,99	D	Satisfactory
3,6 - 4,0	10-11	5,0-5,99	E	Sufficient
less than 4,0	0-9	0,0-4,99	FX/F	Fail

§ 16 Master thesis

(1) With the Master thesis, the candidate shows that she/he is capable to independently handle a defined scientific problem within a defined schedule, and in a way that is ready to publish.

(2) The editing time of a Master thesis is six months. Topic and scientific problem have to be defined in a way that it can be completed within this schedule. The thesis topic can be replaced only once within the first month. In exceptional cases, the examination board or Master program coordinator can extend the processing time.

(3) The composition of the supervising Thesis Board follows § 9 (4).

(4) The candidate is allowed to provide suggestions for the Master thesis topic.

(5) The volume of the Master thesis is less than 60 pages. It has to be provided in English language.

(6) The Master thesis has to be provided in one original paper version to the UM. Furthermore, the Master thesis has to be provided as a digital version (pdf) to the UM, to UJI, and to NOVA IMS - UNL.

(7) The candidate has to declare that she/he has independently composed the thesis and only used the sources and means indicated in the thesis. The declaration also applies to tables, sketches, drawings, graphic illustrations etc. Furthermore, the candidate must include a written declaration consenting to have the thesis stored in a database and compared with other texts to detect possible plagiarism.

§ 17 Approval and grading of the Master thesis

(1) The Master thesis has to be provided to the chair of the responsible examination board or Master program coordinator within the deadline in seven original paper versions and a single digital file. In the case of the UNL, no papers versions are submitted, on a single digital file. The delivery has to be documented. In case of the UNL, a letter from the supervisor and co- supervisors stating that the document is ready for discussion, has to be added.

(2) In case of the UM and UNL, not providing the Master thesis within the deadline without stringent reasons will be graded as „failed“.

(3) The Master thesis will be graded by the thesis board according to § 9-4.

(4) The three examiners of the thesis board grade the Master thesis according to § 15 and justify grading in written form. The grade of the Master thesis is the arithmetic average of the single grades, if the single grades do not differ by more than two ECTS grades, and none or one single grade is “failed”. The Master thesis is not approved, if two or three examiners grade the Master thesis with “failed”, or the arithmetic average is below the ECTS grade “E” according to § 15-4 and § 15-5. If the single grades differ by more the two ECTS grades, the examination board or Master program coordinator defines a fourth examiner. In this

case, the Master thesis grade is the arithmetic average of four single grades; the Master thesis is approved, if the arithmetic average is not below the ECTS grade "E" according to § 15-5.

(5) The candidate should be informed about the Master thesis grade within 6 weeks after delivery.

(6) The Master thesis is defended to the thesis board. In case of external members of the thesis board, the supervisors or co-supervisors can be represented by professors, assistant professors, junior professors and scientific assistants of the university, where the defense takes place, according to § 9-5.

(7) In the Master thesis defense, the thesis board members, or representatives, interrogate the candidate for a detailed analysis of the Master thesis. The defense is up to 90 minutes. The defense is graded and documented. At the UM and UJI, the examiners of the defense have to agree on a common grade. At the UNL, the final grade is the average of the grades of each of the board members.The candidate has to be informed about the grade of the defense immediately afterwards.

(8) The "module Master thesis" is approved, if both, Master thesis and its defense, are graded with an ECTS grade "E" or better. At the UM and UJI, the grade of the "module Master thesis" is weighed by 75 % for the Master thesis (25 % per (co-)supervisor) and 25 % for the defense – a failure in the defense is automatically a failure in the "module Master thesis". At UNL, the "module Master thesis" has a unique grade that takes into consideration the document and the defense.

§ 18 Approval of the Master examination

(1) The Master examination is approved, if all examinations according to § 14 are graded with an ECTS grade "E" or better, and 90 credit points according to § 14 are recognized.

(2) The overall grade of the approved Master examination is calculated according to § 15.

§ 19 Repetition of the Master examination

(1) The examinations according to § 14, except for the module "Master thesis" can be repeated twice, if they are not approved. Examination at other Higher Education Institutions have to be considered. The repetition of an approved examination is not allowed at the UM.

(2) The examination board or Master program coordinator defines the deadlines of re-examinations. Re-examinations should be repeated within six months, but not before 6 weeks after the failure.

(3) The defense of the Master thesis according to § 14 and § 16 can only be repeated once, if not approved. If the re-examination of the defense is graded as "failed", the entire module Master thesis has to be repeated. This does not affect the duration of the Master thesis itself of 6 months.

(4) The module "Master thesis" can be repeated once, if not approved. In this case, and at the UM, a new topic has to be defined.

(5) For re-examination according to § 19-3 and § 19-4, the candidate may suggest new examiners and a new topic for the Master thesis and its defense.

§ 20 Master diploma

(1) The Master diploma will be awarded at the same time by the Faculty of Geosciences, UM, Nova Information Management School (NOVA IMS) of the UNL Instituto Superior de Estatística e Gestão de Informação, and UJI, Castellón.

(2) The diploma of an approved Master examination includes:

Line 1: Portuguese Republic; Spanish Kingdom; The Federal Republic of Germany
Line 2: The administrations of the
Line 2: UJI; UM; UNL
Line 3: Have jointly conferred upon
Line 4: Name of student
Line 5: The degree of Masters in Geospatial Technologies
Line 6: the overall grade according to the ECTS grading scale
Line 7: with all rights and privileges thereto pertaining
Line 8: Given at LOCATION the DATE
Line 9: Signatures of the three Universities (by the Dean of the Faculty of Geosciences for the UM; by the

Rector for the UNL and the UJI)

(3) If the Master examination is not approved, the examination board or Master program coordinator provides information to the candidate about possible re-examinations and deadlines, and legal instructions. On demand, the candidate has to be provided with a certification about approved and not approved examinations and options for re-examinations.

(4) The diploma is dated on the day of the last examination.

(5) In addition to the diploma, the successful candidate is provided with a diploma supplement. The diploma supplement informs about the profile of the Master program, includes the overall grade, the grades of the single examinations, the topic and grades of the Master thesis and its defense, and contains a detailed description of approved examinations.

III. Final regulations

§ 21 Invalidity of the Master examination

(1) If a candidate's attempt of fraud gets known after the provision of the diploma, the examination board or Master program coordinator can declare the Master examination or single examinations invalid.

(2) If the requirements for admission to an examination were not fulfilled without a purpose of the candidate, and this fact gets known after the provision of the diploma, this fault can be compensated by a re-examination. If the candidate was approved or wrongly admitted to an examination through intentional fraud, the examination board or Master program coordinator decides about the consequences.

(3) Before a decision, the candidate has to be heard.

(4) A wrongly acquired diploma has to be confiscated. A decision according to § 21-1 and § 21-2 can be made within 5 years after the date of issuing the diploma.

§ 22 Access to the examination files

(1) After the termination of the Master examination, the candidate is allowed to look at the documentations of the examinations.

(2) The application for look at the documentations of the examination has to be submitted within three months after the delivery of the diploma. The examination board chair or Master program coordinator decides about location and time of looking at the documentations.

§ 23 De-recognition of the Master degree

The Master degree can be de-recognized, if a fraud or the lack of essential requirements for awarding the Master degree gets known. This requires a common decision of the legal entities of the Universität Münster, Faculty of Geosciences, Germany Universitat Jaume I, Castellón, Spain, and Nova Information Management School of the UNL, Instituto Superior de Estatística e Gestão de Informação, Lisboa, Portugal.

§ 24 Coming into force, and publication

(1) The examination regulations are coming into force on the day after publication in the "Amtliche Bekanntmachungen" of UM.

(2) They apply to all students that enroll in the master programme beginning from semester 2026/2027.

(3) Students that are already enrolled in the master programme may finish their studies according to the previous version of the examination regulations until 31.03.2028. After that, they are automatically transferred to the current version of the examination regulations. Their study achievements (required coursework and degree-relevant examinations) will be recognized to the extent they are comparable. If a student wishes to transfer to the current examination regulations before that point in time, they can file an irrevocable application in writing with the examination board. Their study achievements will then be recognized if and to the extent they are comparable, the number of attempts for examinations will be transferred.

Ausgefertigt aufgrund des Fachbereichsratsbeschlusses des Fachbereichs Geowissenschaften vom 22.07.2026. Die vorstehende Ordnung wird hiermit verkündet.

Es wird darauf hingewiesen, dass gemäß § 12 Abs. 5 des Gesetzes über die Hochschulen des Landes Nordrhein-Westfalen (Hochschulgesetz – HG NRW) eine Verletzung von Verfahrens- oder Formvorschriften des Ordnungs- oder des sonstigen autonomen Rechts der Hochschule nach Ablauf eines Jahres seit dieser Bekanntmachung nicht mehr geltend gemacht werden kann, es sei denn

1. die Ordnung ist nicht ordnungsgemäß bekannt gemacht worden,
2. das Rektorat hat den Beschluss des die Ordnung beschließenden Gremiums vorher beanstandet,
3. der Form- oder Verfahrensmangel ist gegenüber der Hochschule vorher gerügt und dabei die verletzte Rechtsvorschrift und die Tatsache bezeichnet worden, die den Mangel ergibt, oder
4. bei der öffentlichen Bekanntmachung der Ordnung ist auf die Rechtsfolge des Rügeausschlusses nicht hingewiesen worden.

Münster, den 17.08.2026

Der Rektor

Prof. Dr. Johannes W e s s e l s

Anhang: Modulbeschreibungen – Module Descriptions

Program description

The international Master program (Master of Science, M.Sc.) in Geospatial Technologies is a cooperation of:

- Universität Münster (UM), Institute for Geoinformatics (ifgi), Münster, Germany
- Universitat Jaume I (UJI), Castellón, Dept. Lenguajes y Sistemas Informaticos (LSI), Castellón, Spain
- Universidade Nova de Lisboa (UNL), Instituto Superior de Estatística e Gestão de Informação NOVA Information management School (NOVA IMS), Lisboa, Portugal.

The Master program in Geospatial Technologies has been selected within the program of excellence of the EU, Erasmus Mundus, project reference 2007-0064/001 FRAME MUNB123 (2007-2013), project reference FPA-2012-0191 (2012-2018), project reference FPA-2016-2054 (2016-2021), and project reference 101049796 (2021-2027).

The Master program is entirely international – in terms of English as a medium of instruction, joint degree within the Consortium, and international students of all over the world.

The Master program targets holders of a Bachelor's degree with a qualification in *application areas* of Geographic Information (GI), e.g., environmental planning, regional planning, geography, logistics, transportation, marketing, energy provision, computer science, forestry, agriculture, etc.

The Master in Geospatial Technologies is a career-qualifying degree of the program of study in Geospatial Technologies. Graduates apply and develop methods for computer-supported solutions for spatially related problems (global, regional, local). The Master examination makes sure that the candidate has acquired the necessary specialized knowledge and additional core competences in order to start or continue a professional career with excellent career perspectives in this field. The Master of Science in Geospatial Technologies qualifies for a professional career in the following domains:

- Private sector: GI applications and consulting in the domains of regional planning, landscape planning, financial services industry, energy providing industry, transportation, agriculture and forestry, and retailing/marketing.
- Research: Applied sciences at universities and other research institutions
- Public sector: GI applications and consulting in local and regional administrations, especially in cadaster and different types of planning (e.g., regional, traffic, ecology).

The Master program provides added value over existing national and international programs, standing out in Europe and world-wide as a center of excellence for education in Geospatial Technologies, through the following unique points:

- educating graduates in a field where more qualified personnel is urgently needed, economically and socially;
- being unique in terms of contents and complementary excellence of sites;
- implementing a joint Master degree, unifying second cycle education across three different national systems in Northern and Southern Europe. The consortium builds on a joint track record of successful scientific and educational collaboration at three individually strong sites.

Module overview

The Study program consists of three semesters (90 ECTS credit points), including two semesters of courses (30 ECTS credit points each) and the Master thesis in the third semester (30 ECTS credit points).

The Master's Program will be performed with up to 32 students per year, starting in September. Half of them attend their first semester at UJI, half at UNL. On purpose, UJI and UNL offer courses with a different focus, in order to address the different backgrounds and requirements of incoming students. In the second semester, all students attend the courses at UM. In the third semester (Master thesis), students are distributed to the three partners. With the Master thesis, the candidate shows that she/he is capable to independently handle a defined scientific problem within a defined schedule, and in a way that is ready to be published. Typically, the Master thesis will be integrated into an ongoing research project at one of the partners. In the following, please find the detailed descriptions of all modules.

1.--UNL Foundations of Geographic Information Science I

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Foundations of Geographic Information Science I**
Module number	1 (UNL)

1	**Basic data**
Programme semester	1
Credits (CP)	5
Workload (h) in total	140
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**

Aim of the module / Integration in the curriculum

GIS will be analyzed under a science and historic perspective: Is there a science behind the GIS? When and where did they begin? What are the factors responsible for their creation and evolution? What are the contributions given by several disciplinary fields?
The nature of spatial information and the integrating character of the analysis approaches and methods used by GIS and their growing application in different sectors of activity have contributed for a greater disciplinary convergence around the usually referred to as "geographic problems". The curricular unit will explore these "geographic problems" that express the main issues raised using geographic information and associated technologies, setting the limits and scope of this new knowledge area.
Geographic Information Systems have the potential to improve our understanding of the real-world forms and processes. This potential is related with GIS functions, or key geographical information activities, that can be enhanced using geographic information technologies and geographic information systems:

- The measurement of spatial features parameters
- The mapping of the earth surface phenomena
- The monitoring of spatial changes across space and time
- The modeling of geographical forms and processes

Teaching content

The curricular unit is organized in six Learning Units (LU):

LU1. What is geographic information and why is it important?
LU2. What are the particularities of geographic information?
LU3. The science behind the system
LU4. Components of Geographic Information Science (I)
LU5. Components of Geographic Information Science (II)
LU6. Functional components of Geographic Information Systems

Conveyed competences are:

- Expertise: definition of geographic information science, components of geographic information science, functional components of geographic information systems
- Methodological competences: critical literature review
- Learning competences: ethical use of AI, critical thinking
- Social competences: working across interdisciplinary teams, communication and presentation skills

Learning outcomes
LO1 Know the main events related to Geographic Information Systems (GIS) evolution and future challenges LO2 Identify the properties of Geographic Information (GI) LO3 Recognize the importance of GI at present LO4 Know the use of GIS to different knowledge domains LO5 Know and apply correctly the concepts related to the use of GI and associated technologies LO6 Understand the relations between GI Science (GISc) and GIS LO7 Identify the main GISc components LO8 Frame the main geographic problems in the context of GIS components and explore their relations and challenges LO9 Recognize the main advantages on presenting a holistic model of a functional GIS LO10 Identify the four main GIS functional components and its challenges LO11 Recognize the importance of applying well-known principles of map design during GIS outputs generation LO12 Understand how Artificial Intelligence can support learning

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture		Geographic Information Science	M	28/2	112
Elective options within the module			NA			

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME / MC E	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	partial	Individual assignments – assessment based on written exercises, reflections, case analyses, or other documented outputs	20 hours	1	0,05
2	partial	Project presentation	Max 15 min (group)	1	0,20
3	partial	Written tests	10 min per class	1	0,15
4	partial	Written Exam	2h	1	0,20
5	partial	Individual term paper presented and discussed in class (max. 5000 words). To be written in conference format.	15 min. presentation + 10 min. discussion	1	0,40
Weight of the module grade for the final overall grade			5/90		

5	**Allocation of workload**	
Participation (attendance or contact time)	Course no. 1	0 CP
Required coursework (and self-study)	RC no. 1	0 CP
Degree-relevant	D-RE no. 1	5 CP

examinations (and self-study)		
Total credits		**5 CP**

The workload of the module is represented in credits (CP). Please note the following:

- The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.
- If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.
- Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	**Requirements**
Module-related requirements for participation	NA
Awarding credits	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	Not required

7	**Module administration**
Frequency	Fall semester
Module representative	Marco Painho
Responsible faculty	NOVA Information Management School, Universidade Nova de Lisboa

8	**Mobility / Recognition**
Usability in other degree programmes	Yes, Master's in Information Management, Master in Statistics and Information Management, Master in Geographical Information Systems and Science

9	**Miscellaneous**
	-

2.-UNL Advanced Topics in Geographic Information Science I

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Advanced Topics in Geographic Information Science I**
Module number	2 (UNL)

1	**Basic data**
Programme semester	1
Credits (CP)	15
Workload (h) in total	420
Module duration	1 Semester
Module status (M/EM)	M

2	**Profile**

Aim of the module / Integration in the curriculum

Competencies in Advanced Topics contribute at the same time for improving the knowledge, skills, and abilities required to ensure that the principles of data acquisition by satellite and the underlying abilities in data analysis and visualization. Based on the student's background and interests, three out of four courses will be chosen.

Spatial Analysis and Visualization:
The curricular unit is based on a mix of theoretical lectures and practical lectures and tutorials. Theoretical lectures introduce and discuss the main concepts, methods, principles, best practices, methodologies and examples. The practical component includes in-class and homework step-by-step tutorials to familiarize students with the software, tools and techniques. The hands-on component is geared towards solving problems and exercises, including discussion and interpretation of results.
The presentation of theoretical concepts and methodologies, followed by application exercises will provide students with the knowledge, skills and abilities listed as learning objectives at the beginning of the semester. Problem-solving and projects are stimulating and relevant in understanding the themes addressed in the course and increase student background in areas of particular interest to them. The project topic should (preferably) be chosen by the students according to their professional or personal preferences. The project work should be a practical application. The debates that follow the oral presentation of projects foster the skills and competencies of analysis and discussion. Projects and assignments require extensive use of computing. The applied computing aspect is an important complement that greatly helps in understanding the theoretical concepts and methodology.

Remote sensing:
The course has lectures and laboratory sessions. In the lectures, the instructor uses slides to illustrate the theory. The laboratory sessions consist on the use of an image processing software for deriving a thematic map based on spectral and/or temporal pattern analysis. The course also includes seminars to discuss the socioeconomic benefits of remote sensing and research and development trends in satellite remote sensing.
Lectures provide all the theoretical background so the student can understand satellite image characteristics and acquisition process, select a satellite and sensor for a specific application, and acquire knowledge on image processing for information extraction. Practical classes will help the student to implement the theoretical knowledge to transform satellite data into relevant information (e.g. thematic cartography). Seminar classes, with active student presentations and discussions, will allow the understating of research and development trends in satellite image classification and the exploration of socio-economic benefits of remote sensing. A final practical project will allow the development of skills to real world problem solving based on satellite image classification.

Spatial Statistics:
The curricular unit is based on theoretical lectures and practical application of methods using software applications or programming languages, such as R or Python. A variety of instructional strategies will be applied, including lectures, slide show demonstrations, step-by step tutorials on using the tools and techniques in the ArcGIS software, questions and answers. The practical component is geared towards solving problems and exercises, including discussion and interpretation of results. During the semester, students must also work in one sample set of interest with the spatial statistics concepts and techniques and present their work results to the professor, as well as to the other students. Finally, the students must write reports about these results.
The presentation of theoretical concepts and methodologies, followed by application exercises will provide students with the knowledge, skills and abilities listed as learning objectives at the beginning of the semester. Problem solving and projects are stimulating and relevant in understanding the themes addressed in the course, and increase student background in areas of particular interest to them. The project topic should (preferably) be chosen by the students according to their professional or personal preferences. The project work should be a practical application, although theoretical studies can also be accepted. The students must write a report detailing the project results. The results from the project work are orally presented to the professor, as well as to the other students. The debates that follow these presentations foster the skills and competences of analysis and discussion.
Projects and assignments require extensive use of computing. The applied computing aspect is an important complement that greatly helps in understanding the theoretical concepts and methodology

Project in Geospatial Technologies:
The syllabus is designed to align with the course's learning objectives, providing a coherent pathway through key topics in the field. Each seminar session builds foundational knowledge and practical skills, enabling students to achieve objectives such as exploring Geographic Information Science ethical and security dimensions, and developing hands-on skills in analytical tools. The inclusion of sessions on programming, spatial data science, and project management ensures that students gain relevant technical skills and the ability to apply these in real-world contexts, fostering an integrated understanding of geospatial technologies. This coherence between syllabus topics and learning objectives ensures that students emerge from the course with both a broad and deep competency in the theoretical, practical, and ethical aspects of geospatial science, fully preparing them for advanced applications in the field.
This course engages students in advanced, seminar-style exploration of geospatial technologies, focusing on technical, and applied aspects of the field. Through critical discussions and practical applications, students develop a well-rounded perspective on current issues and innovative methodologies in geospatial science. Each seminar session will cover a specific topic, allowing students to gain specialized knowledge and skills relevant to the geospatial industry

Teaching content

The module is composed of three out of the four following courses:

1. SPATIAL ANALYSIS AND VISUALIZATION
2. REMOTE SENSING
3. SPATIAL STATISTICS
4. PROJECT IN GEOSPATIAL TECHNOLOGIES

1. SPATIAL ANALYSIS AND VISUALIZATION is organized in 8 learning units (LU):

LU1. Introduction to GIS
LU2. Spatial data and data management
LU3. Spatial data input and manipulation
LU4. Spatial analysis
LU5. Terrain analysis
LU6. Spatial data visualization
LU7. Spatial decision analysis and modelling - principles of GIS-based Multicriteria Analysis
LU8. Emerging trends in spatial data analysis and visualization

Conveyed competences are:
- Expertise: GIS technology, WebGIS
- Methodological competences: data acquisition, data processing, spatial analysis, visualization
- Learning competences: develop GIS solutions for spatial problems, present solutions to an interdisciplinary audience
- Social competences: working within small teams, communication and presentation skills

2. REMOTE SENSING is organized in 12 learning units (LU):
LU 1 Introduction to remote sensing and to the course
LU 2 Remote sensing principles
LU 3 Characteristics of Earth observation satellites and sensors
LU 4 Exploratory analysis
LU 5 Image pre-processing
LU 6 Band transformations
LU 7 Image information extraction (image classification)
LU 8 Multi-temporal image analysis
LU 9 Error analysis in thematic maps
LU 10 Socioeconomic benefits of remote sensing
LU 11 Practical exercises on satellite image processing
LU 12 Real world problem solving based on satellite image processing

Conveyed competences are:
- Expertise: Remote Sensing technology (satellites and sensors) and satellite image processing
- Methodological competences: image acquisition, image processing and classification, map error assessment
- Learning competences: develop technological and methodological solutions for environmental, economic, disaster management and social problems, ethical use of AI, critical thinking
- Social competences: working within small teams, communication and presentation skills

3. SPATIAL STATISTICS is organized in four learning units (LU):

LU1. EXPLORATORY DATA ANALYSIS
- Introduction
- General concepts on data description
- Exploratory Spatial Data Analysis (ESDA) tools

LU2. DETERMINISTIC METHODS
- General concepts on spatial interpolation
- Thiessen polygons (Voronoi maps)
- IDW – Inverse distance weighting
- Validation and cross-validation

LU3. KRIGING
- Spatial continuity analysis
- Variography
- Geostatistics estimation concepts
- Empirical Bayesian Kriging

LU4. GEOGRAPHICALLY WEIGHTED REGRESSION
- Concepts of statistical testing
- General concepts on regression analysis
- OLS – Ordinary Least Squares
- GWR - Geographically Weighted Regression
- MGWR – Multiscale GWR

Conveyed competences are:
- Expertise: modelling, examining, and exploring spatial patterns and spatial relationships
- Methodological competences: statistical techniques and concepts, analyzing spatial data, combining exploratory, deterministic, geostatistical, and regression-based techniques
- Learning competences: Problem-solving, ethical use of AI, critical thinking and analytical rigor in using a range of spatial analytical tools and methods enabled by technology for Earth sciences problems, health geographics, economic geography problems, among others
- Social competences: synthesis and reporting, working within small teams, communication and presentation skills

4. PROJECT IN GEOSPATIAL TECHNOLOGIES is organized in 4 learning units (LU):

Seminar sessions may include, but are not limited to, the following topics:
LU1 Geospatial perspectives on intelligence, security and ethics.
LU2 Problem formulation in geography and geospatial science.
LU3 Remote sensing applications and emerging technologies.
LU4 Web mapping and geovisualization analytics.
LU5 Geospatial analysis and applications. LU6 Programming for geospatial analysis.
LU7 Spatial data science.
LU8 Geospatial technology project management.

Conveyed competences are:
- Expertise: interdisciplinary integration of theoretical, ethical, and technical perspectives in geospatial technology
- Methodological competences: emerging remote sensing technologies, interactive web mapping, code-based methods, spatial analysis methods tailored to diverse application areas
- Learning competences: self-directed learning and critical thinking, ethical use of AI, strategic problem-solving from problem formulation to the implementation of analytical or technological solutions.

Social competences: working across interdisciplinary teams, communication and presentation skills

Learning outcomes

Learning outcomes (LO) for the module:
LO1: To acquire a wide range of spatial analysis knowledge and skills
LO2: To acquire an understanding of satellite remote sensing principles and applications

Specific learning outcomes:

SPATIAL ANALYSIS AND VISUALIZATION:
LO1. Understand the main components of GIS and how these relate to GIS working flows.
LO2. To know what spatial data is and how these can be managed within a GIS environment.
LO3. To know how spatial data can be acquired and manipulated within a GIS environment.
LO4. To know the main spatial analysis operations and how to use them within a GIS environment.
LO5. To know the basics of spatial distributions and pattern analysis.
LO6. To understand and carry out terrain analysis within a GIS environment.
LO7. To know how to create effective visualizations for analysis and dissemination.
LO8. To understand spatial multicriteria evaluation models for decision-making.
LO9. To get acquainted with WebGIS standards.

LO10. To know and apply up-to-date tools and resources for spatial data analysis and visualization
REMOTE SENSING:

On successful completion of the course students are expected to be able to (i.e. Learning Outcomes - LO):
LO 1 Describe the types of measurements in remote sensing and explain why satellite images can be used to produce geographic information
LO 2 Develop in an autonomous way a project to produce information based on satellite images with a spatial resolution from 1m to 1000m
LO 3 Select the satellite and sensor more adequate to use on the production of different types of information on different spatial scales
LO 4 Describe and apply classification algorithms of spectral, spatial and temporal patterns of satellite images in order to derive information
LO 5 Assess and interpret the error within information derived from satellite images
LO 6 Describe and evaluate the social economic benefits of remote sensing

SPATIAL STATISTICS:
LO1 Compute descriptive statistics; use graphical and mapping tools for Exploratory Spatial Data Analysis
LO2 Describe the main characteristics and patterns of spatial data
LO3 Discuss the differences between different spatial interpolators
LO4 Describe the cross-validation and the validation processes
LO5 Explain the purpose of prediction errors' statistic
LO6 Interpret the parameters of the variogram model
LO7 Discuss the differences between Simple, Universal and Ordinary kriging
LO8 Make surface predictions using Inverse Distance Weighting and Empirical Bayesian kriging, calibrate the model parameters and validate the model results
LO9 Discuss the advantages and drawbacks of deterministic and kriging approaches
LO10 Understand the linear regression model and its limitations and know how to diagnose and apply corrections to some problems of Ordinary Least Square
LO11 Understand Multiscale Geographically Weighted Regression and its potential problems and know how to use it and interpret the results.

PROJECT IN GEOSPATIAL TECHNOLOGIES:
LO1 Explore and critically assess the ethical, security, and intelligence applications of geospatial technologies.
LO2 Formulate geospatial research questions and define problem-solving approaches in geography and geospatial science.
LO3 Apply geospatial technologies to solve real-world problems.
LO4 Develop web mapping, geovisualization, and geospatial analytical skills.
LO5 Utilize programming skills for data processing, geospatial analysis, and visualization.
LO6 Implement principles of spatial data science in real-world contexts.
LO7 Manage projects effectively within the context of geospatial technology.

3	**Structure**					
Module components						
No.	Course category	Course type	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture		Spatial Analysis and Visualization	EM	28/2	112
or						
2	Lecture		Remote Sensing	EM	28/2	112
Or						
3	Lecture		Spatial Statistics	EM	28/2	112
Or						
4	Practical		Project in Geospatial Technologies	EM	28/2	112
Elective options within the module			Students take three of the four courses of the module			

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/CE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
SPATIAL ANALYSIS AND VISUALIZATION					
1	Partial	GIS Hands-on excercise	25 hours	1	0,15
2	Partial	Project proposal	Max. 2 pages	1	0,10
3	Partial	Midterm written test (individual)	2 hours	1	0,15
4	Partial	Project presentation	15 min. presentation + 10 min.	1	0,15

			discussion		
5	Partial	Final project report	Max. 15 pages	1	0,40
6	Partial	Individual assignments. Assessment based on written exercises, reflections, case analyses, or other documented outputs completed during the course	28 hours	1	0,05
OR REMOTE SENSING					
7	Partial	Quizzes (individual)	10 minutes each	2	0,10
8	Partial	Midterm written test (individual)	2 hours	2	0,25
9	Partial	Practical Project: Group project to solve a real problem by using satellite images and an image software chosen by the group. The problem has to be defined by the group. (Presentation and Report);	15 min. presentation + 10 min. discussion; Report in scientific paper format (max. 15 pages)	2	0,45
10	Partial	Pitch and participation in class - Individual essay on socio-economic benefits of remote sensing within a specific theme selected by the student from a list provided by the Professor. The essay topic may be focused in another domain agreed between student and professor (Just presentation- no report)	5 min. presentation + 10 min. discussion	2	0,20
OR SPATIAL STATISTICS					
11	Partial	Two Assignments, i.e. individual reports with the answers to the proposed problems (individual)	‹15 pages first one; ‹5 pages second one ; plus appendices	3	0,15 first one, 0,10 second one
12	Partial	Midterm written test (individual)	2 hours	3	0,30
13	Partial	Oral presentation of the project	15 min. presentation + 10 min. discussion	3	0,10
14	Partial	Project report	Max. 15 pages	3	0,35
OR PROJECT IN GEOSPTATIAL TECHNOLOGIES					
15	Partial	Individual assignments. Assessment based on written exercises, reflections, case analyses, or other documented outputs completed during the course	28 hours	4	0,20
16	Partial	Individual Reflection Papers– Short essays reflecting on seminar topics, synthesizing key concepts, and presenting critical insights	5 essays with max. 2 pages each	4	0,30
17	Partial	Group Project and Presentation– A comprehensive project where students collaboratively apply their knowledge and practical skills to a specific geospatial issue, culminating in a formal presentation and written report.	Report (‹8000 words) 15 min. presentation + 15 min. discussion	4	0,50
Weight of the module grade for the final overall grade		15/90			
Required coursework					
No.		Type		Duration/ Scope	Connection to course no. (if applicable)

-	-		

5	Allocation of workload	
Participation (attendance or contact time)	Course no. 1	0 CP
	Or Course no. 2	0 CP
	Or Course no. 3	0 CP
	Or Course no. 4	0 CP
Required coursework (and self-study)	Course no. 1	0 CP
	Or Course no. 2	0 CP
	Or Course no. 3	0 CP
	Or Course no. 4	0 CP
Degree-relevant examinations (and self-study)	Course no. 1	5 CP
	Or Course no. 2	5 CP
	Or Course no. 3	5 CP
	Or Course no. 4	5 CP
Total credits	3 out of 4 courses	**15 CP**

The workload of the module is represented in credits (CP). Please note the following:

- The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.
- If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.
- Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	Requirements
Module-related requirements for participation	NA
Awarding credits	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	Not required

7	Mobility / Recognition
Frequency	Fall semester
Module representative	Ana Cristina Costa
Responsible faculty	NOVA Information Management School, Universidade Nova de Lisboa

8	Mobility/recognition

Usability in other degree programmes	Yes, Master in Information Management, Master in Statistics and Information Management, master in GIS & Science

9	**Miscellaneous**
	-

3.-UNL Advanced Informatics and Data Analytics

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Advanced Informatics and Data Analytics**
Module number	3 (UNL)

1	**Basic data**
Programme semester	1
Credits (CP)	10
Workload (h) in total	280
Module duration	1 Semester
Module status (M/EM)	M

2	**Profile**

Aim of the module / Integration in the curriculum

Competencies in Advanced Informatics and Data Analytics include knowledge, skills, and abilities required to ensure that the various elements and approaches of GIS are properly understood in order to successfully manage, analyze, and model data that is linked directly to a location.

The module consists of two courses:

The curricular unit “Geospatial Datamining” (GSDM) is based on theoretical and practical lessons. A variety of instructional strategies will be applied, including lectures, slide show demonstrations, step-by-step applications (with and without software), questions and answers. The sessions include presentation of concepts and methodologies, solving examples, discussion and interpretation of results. The practical component includes exercises to consolidate the theoretical concepts covered in the theoretical classes.
The presentation of theoretical concepts and methodologies, followed by application exercises will provide students with the knowledge, skills, and abilities listed as learning objectives at the beginning of the semester. For each learning unit (LU), detailed learning objectives and recommended readings on different resources are listed. The project is supervised by the teacher and is subject to a detailed report. The project topics are defined by the lecturer. The application exercises are stimulating and relevant in understanding the topics of study. The learning objectives are evaluated in the final exam. The tests, or final exam, require students to integrate the entire contents of the course and prove their mastery of it.)

The curricular unit “Group Project Seminar on Programming and Analysis” will be lectured in presential classes. Each student should bring his personal computer. In the first half of the course, there will be 10 classes of lecturing and follow-along exercises that each student should follow on their computer. The second period will be working on the group project. During the group project period, there will be 2 hours classes to follow each group's progress and provide orientation.
Being an intensive course, the use of practical examples to teach the base concept should accelerate the students' understanding of the utility of each technology. The group project will force the students to solidify the learning objectives, as well as encourage them to explore other technologies that better fit their needs and interests.

Teaching content:

The module consists of two courses:

1. GEOSPATIAL DATAMING
2. GROUP PROJECT SEMINAR ON PROGRAMMING AND ANALYSIS

1. GEOSPATIAL DATAMINING is organized in in five Learning Units (LU):

LU1. Introduction to Data Mining
LU2. The role of Data in Data Mining
LU3. Data Preprocessing
LU4. Unsupervised Classification (clustering)
LU5. Supervised Classification (predictive modelling)

Conveyed competences are:

- Expertise: predictive modelling, Exploratory spatial data analysis (ESDA), and discovery of spatial patterns using unsupervised learning methods.
- Methodological competences: data preparation and pre-processing tasks, data mining methods
- Learning competences: autonomously use predictive and exploratory data mining methods to analyze geospatial data, critical thinking.
- Social competences: working within small teams, working across interdisciplinary teams, communication and presentation skills

2. GROUP PROJECT SEMINAR ON PROGRAMMING AND ANALYSIS is organized as a seminar with ten Learning Units (LU):

LU 1. Introduction and installs
LU 2. Introduction to Python I
LU 3. Introduction to Python II
LU 4. Introduction to Pandas and Geopandas
LU 5. Introduction to relational databases
LU 6. Introduction to SQL SQL
LU 7. Introduction to PostGIS
LU 8. ETL Working Example
LU 9. API working example
LU 10. Routing Working Example

Conveyed competences are:

- Expertise: geospatial programming tools and data structures, geospatial data analysis, external data sources
- Methodological competences: programming, spatial data processing, problem-solving and critical thinking through the development of full data analysis workflows
- Learning competences: hands-on experience with tools and methods widely used in geospatial programming and data engineering, reproducibility and automation, ethical use of AI for coding, critical thinking
- Social competencies: Teamwork and collaboration, leadership and initiative, communication and presentation skills

Learning outcomes
Learning outcomes (LO) for the module: LO1: to acquire analytical competences LO1: to apply competences to real world problems Specific learning outcomes: GEOSPATIAL DATAMINING: LO1: Define Data Mining and explain the characteristic features of Data Mining; LO2: Discuss the implications of the geo prefix in Geographic Data Mining; LO3: Understand the basic data preparation and pre-processing tasks; LO4: Understand the k-means algorithm and how it works; LO5: Understand what a Self-Organizing Map is and use Self-Organizing Maps in unsupervised classification tasks; LO6: Understand what Classification Trees are and be able to implement them LO7: Understand what Multi-Layer Perceptron Neural Network are and be able to implement them GROUP PROJECT SEMINAR ON PROGRAMMING AND ANALYSIS: LO1 Distinguish and describe the use of the most common Python objects LO2 Use some of those objects to create medium-sized scripts LO3 To install and use external packages and modules LO4 Organize the code in a reusable way, creating functions, modules, and packages LO5 Document the code correctly using comments and docstrings LO6 To import, manipulate and visualize data using pandas and geopandas LO7 Enumerate the advantages of the use of relational databases LO8 Describe relational database basic terminology LO9 Explain the entities relationships LO10 Query a relational database using SQL LO11 Implement a simple spatial database using PostgreSQL/PostGIS LO12 Query and manipulate spatial data using PostGIS functions LO13 Create an ETL pipeline in Python to download, manipulate and load data into PostgreSQL LO14 Use Rest API to download data from as Rest API LO15 Create a Rest API in Python to expose data to other analysts LO16 Perform simple network analysis using PgRouting

3	**Structure**					
Module components						
No.	Course category	Course type	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture/Practical	-	Geospatial Datamining	M	28/2	112
2	Theory/Practical	-	Group Project Seminar on Programming and Analysis	M	28/2	112
Elective options within the module						

4	Examination structure				
Degree-relevant examination(s)					
No.	FME/CE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	Partial	Project 1	Written report max. 5 pages	1	0,10
2	Partial	Project 2	Written report, Max. pages	1	0,10
3	Partial	Project 3	Written report, Max. 5 pages	1	0,25
4	Partial	Project 4	Written report max. 5 pages	1	0,25
5	Partial	Final exam	<2 hours	1	0,30
6	Partial	Project The project is open in nature, but it must include all of the following components: an ETL module; a CRUD module, and an API module.	Max. 60 pages (including code)	2	0,60
7	Partial	Presentation	20 min. presentation + 15 min. discussion	2	0,20
8	Partial	Individual assignments – Assessment based on reflections, case analyses, or other documented outputs completed during the course	6 hours	2	0,10
9	Partial	Oral Exam: a group discussion and/or presentation of a topic individually assigned to each student.	Max. 1 hour	2	0,10
Weight of the module grade for the final overall grade		10/90			
Required coursework					
No.		Type		Duration/ Scope	Connection to course no. (if applicable)
-					

5	Allocation of workload	
Participation (attendance or contact time)	Course no. 1	0 CP
	Course no. 2	0 CP
Required coursework (and self-study)	RC no. 1	0 CP
	RC no. 2	0 CP
Degree-relevant examinations (and self-study)	D-RE no. 1	5 CP
	D-RE no. 2	5 CP
Total credits		**10 CP**

The workload of the module is represented in credits (CP). Please note the following:

- The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.
- If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.
- Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	**Requirements**
Module-related requirements for participation	NA
Awarding credits	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	Not required

7	**Module administration**
Frequency	Fall semester
Module representative	Marco Painho
Responsible faculty	NOVA Information Management School, Universidade Nova de Lisboa

8	**Mobility / Recognition**
Usability in other degree programmes	Yes, Master in information management, Master in Statistics and Information Management, Master in GIS & Science

9	**Miscellaneous**

1.-UJI Foundations of Informatics

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Foundations of Informatics**
Module number	1 (UJI)

1	**Basic data**
Programme semester	1
Credits (CP)	10
Workload (h) in total	250
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**

Aim of the module / Integration in the curriculum
Provide students with those basic informatics skills needed to later successfully complete the Master.
Teaching content
The informatics module teaches the student the basic informatics concepts needed to be able to develop a basic web or mobile geographic information application, with persistent data storage, and optionally using automated learning techniques. The module consists of three courses: 1. "Programming" teaches the basic concepts of programming and the use of existing (external) libraries and APIs. 2. "Databases and Data Management" teaches the foundations of data storage and management, with particular attention for geospatial data. 3. "Artificial Intelligence and Machine Learning" teaches basics of artificial intelligence, and supervised and unsupervised machine learning techniques focused on practical use for geospatial data. 1. Programming The programming course introduces the student to basic programming concepts and a concrete programming language (target language: JavaScript). The main primitive data types (numbers, strings, Booleans), along with their basic operations and arithmetic on them, are discussed, followed by composite data types (e.g., arrays), and basic operations and arithmetic (e.g., iterators). Basic control flow is treated, including conditional statements (e.g., if-else) and loops (e.g., for loop, while loop). Functions, basic object-oriented programming and event handling are introduced. The student then learns basic web technologies (HTML & CSS), and how to develop programs running in the browser. The student learns techniques and tools to professionally develop and debug programs. Finally, the student learns how to use third-party libraries and (HTML) Application Programming Interfaces (API), to use and incorporate pre-defined functionality in their own client applications. Learning units: LU1. Introduction. Basic programming concepts. Variables. Primitive Data types. Communication with the user. LU2. Numbers

LU3. String
LU4. Booleans and conditions
LU5. Arrays
LU6. Iterations
LU7. Functions
LU8. Object Orientation & classes
LU9. HTML & CSS
LU10. Document Object Model
LU11 Event Handling
LU12. Debugging
LU13. Geospatial Libraries and HTML Application Programming Interfaces
Conveyed competences are:

- Expertise: dominating basic programming concepts, developing basic web-based applications, using existing software libraries and application programming interfaces, debugging
- Methodological competences: software analysis, software development
- Learning competences: ethical use of AI, methodic thinking, problem analysis, problem solving, applying conceptual solutions to practical applications
- Social competences: working in small team (duo), documenting

2. Databases and Data Management

The Databases and Data Management course will provide students the basic concepts and skills need to be able to design, manage and query a standalone database including geospatial information. A broad overview of data management technology will be provided, starting with an introduction to the relational model. The basics of relational database design and SQL (Structured Query Language) will be presented, including all of its standard query language statements, providing the necessary background to allow the students to dive into geospatial data management using extensions of SQL that allow it to deal with geospatial data management capabilities. Finally, the students will learn about some emerging technologies such as NoSQL databases and Big Data, and how to integrate databases in other systems using a graphical interface.
Learning units:
LU1: Introduction to Database Management Systems
LU2: The relational model
LU3: Basics of relational database design
LU4: Introduction to the SQL language
LU5: SQL statements
LU6: Geospatial data types in SQL
LU7: Geospatial functions in SQL
LU8: Introduction to NoSQL databases
LU9: Integration of databases in other systems
Conveyed competences are:

- Expertise: dominating basic database concepts, designing databases that fulfill the requirements of an application, using SQL to manage and query databases, using extensions of SQL to manage geospatial data.
- Methodological competences: database design, database management, integration of databases in GIS systems
- Learning competences: methodic thinking, problem analysis, problem solving, applying conceptual solutions to practical applications
- Social competences: working in small team (duo), documenting

3. Artificial Intelligence and Machine learning

The Artificial Intelligence and Machine Learning course introduces the student to basic concepts about Artificial Intelligence and Machine Learning. The first learning unit is focused on introducing the most basic concepts using linear regression as the simplest method. Then, the procedures to prepare data for real experiments are detailed. This will data normalization, data regularization, feature selections and outliers removal. The concepts of classification and parameter selection will be introduced to the students with the simplest method, k-NN, and some variants. The students will learn about supervised and non-supervised classification methods with Artificial Neural Networks and k-means clustering as base classifiers. Some state-

of-art network architectures will be reviewed and introduced to the students to solve complex and large problems exploring deep learning. Finally, some use cases will be provided to the students who must learn how to prepare the experiments involving machine learning to solve them focusing on aspects such as reproducible and be compliant with the best practices in this research area.
Learning units:
LU1. Introduction. Revision of linear regression model for prediction. Software available for Machine Learning.
LU2. Data Preparation and curation for machine learning methods: missing attributes, normalization, regularization, feature selection, instance selection, class imbalance.
LU3. Classification problems: K-Nearest Neighbor and variants, Decision trees, Multi-classifiers. The importance of selecting the appropriate parameters.
LU4. Supervised-learning: Neural networks
LU5. Unsupervised-learning: K-Means-Clustering
LU6. State-of-the-art network topologies: Deep Learning
LU7. Preparing Machine Learning experiments and best-practices: Use Cases, Cross-Validation, Comprehensive testing
Conveyed competences are:

- Expertise: dominating basic machine learning methods, understanding supervised and unsupervised learning, understanding the difference between traditional machine learning approaches and deep learning, provide an experimental setup for use cases, be able to choose the right model for a particular problem
- Methodological competences: data analysis, heterogenous solutions development
- Learning competences: ethical use of AI, methodic thinking, problem analysis, problem solving, choosing the right tools and models for particular problems.
- Social competences: application of technical solutions to social problems and issues

Learning outcomes

Module learning outcomes:
LO1: To know the basic concepts of programming
LO2: To know the basic concepts of databases and data management systems
LO3: To know the basic concepts of artificial intelligence and machine learning
LO4: To know the basic concepts of geographic information application development
Specific learning outcomes:

1. Programming

LO1: To know the syntax of a concrete programming language
LO2: To know how to declare and use variables
LO3: To know how to use and compose primitive data types
LO4: To know how to use conditional statements
LO5: To know how to use control structures to perform iterative tasks
LO6: To know how to define and use functions
LO7: To know how to define and use objects and classes
LO8: To know how to handle, access, navigate through the Document Object Model
LO9: To know how to define and handle events
LO10: To know how to create a basic Web application
LO11: To know how to debug
LO12: To know how to use and embed third-party geospatial libraries and use HTML Application Programming Interfaces

2. Databases and data management

LO1: To know the different kinds of database management systems
LO2: To know the basic elements and rules of the relational model
LO3: To know how to use the basic SQL DDL statements: CREATE, ALTER, DROP
LO4: To know how to use the basic SQL DML statements: SELECT, INSERT, UPDATE, DELETE
LO5: To know the SQL/MM spatial types and how to create databases that use them
LO6: To know how to use SQL/MM functions to query and manage geospatial data in databases
LO7: To know how to use access a spatial database from a GUI interface
LO8: To know basic concepts about NoSQL databases and Big Data management applied to geo

1. Artificial intelligence and machine learning

LO1: To know how to identify the kind of problem dealt with
LO2: To know how to preprocess data before using Machine Learning
LO3: To know how to apply tuning of method parameters
LO4: To know how a Neural Network works and avoid using them as black boxes

LO5: To know how to prepare experiments involving Machine Learning models
LO6: To be able to select the correct Machine Learning model for a particular problem
LO7: To be able to choose the correct evaluation framework

3	**Structure**

Module components

No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h)	Self-study (h)
1	Lecture / Practical	-	Programming	M	37.5	62.5
2	Lecture / Practical	-	Databases and Data Management	M	30	45
3	Lecture / Practical	-	Artificial Intelligence and Machine Learning	M	30	45
Elective options within the module						

4	**Examination structure**

Degree-relevant examination(s)

No.	FME / CE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	Partial	Project report 1	Max 4 pages	1	1.6/10
2	Partial	Project report 2	Max 8 pages	1	2.4/10
3	Partial	Project report 1	Max 8 pages	2	2.1/10
4	Partial	Written exam	2 hours	2	0.9/10
5	Partial	Use Case report 1	Max 8 pages	3	3/10
Weight of the module grade for the final overall grade			10/90		

Required coursework

No.	Type		Duration/ Scope	Connection to course no. (if applicable)
1	Programming homework 1		Max 4 pages	1
2	Databases homework 1		Max 4 pages	2
3	Databases homework 2		Max 4 pages	2
4	Databases homework 3		Max 4 pages	2
5	Databases homework 4		Max 4 pages	2
4	Self-assesment test 1 (LU2)		Max 2 pages	3
5	Self-assesment test 2 (LU3)		Max 2 pages	3
6	Self-assesment test 3 (LU4)		Max 2 pages	3
7	Self-assesment test 4 (LU5)		Max 2 pages	3
8	Self-assesment test 5 (LU6)		Max 2 pages	3

5	Allocation of workload	
Participation (attendance or contact time)	Course no. 1	1.8 CP
	Course no. 2	1.2 CP
	Course no. 3	1.2 CP
Required coursework (and self-study)	RC no. 1 (Course no. 1, assign. 1)	0.4 CP
	RC no. 2 (Course no. 2, assign. 1)	0.04 CP
	RC no. 3 (Course no. 2, assign. 2)	0.04 CP
	RC no. 4 (Course no. 2, assign. 3)	0.04 CP
	RC no. 5 (Course no. 2, assign. 4)	0.04 CP
	RC no. 6 (Course no. 3, assign. 1 (LU2))	0.1 CP
	RC no. 7 (Course no. 3, assign. 2 (LU3))	0.1 CP
	RC no. 8 (Course no. 3, assign. 3 (LU4))	0.1 CP
	RC no. 9 (Course no. 3, assign. 4 (LU5))	0.1 CP
	RC no. 10 (Course no. 3, assign. 5 (LU6))	0.1 CP
Degree-relevant examinations (and self-study)	D-RE no. 1 (Course no. 1, ex. 1)	0.8 CP
	D-RE no. 2 (Course no. 1, ex. 2)	1.0 CP
	D-RE no. 3 (Course no. 2, ex. 1)	1.15 CP
	D-RE no. 4 (Course no. 2, ex. 2)	0.49 CP
	D-RE no. 5 (Course no. 3, ex. 1)	0.55 CP
Total credits		**10 CP**

The workload of the module is represented in credits (CP). Please note the following:

- The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.
- If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.
- Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	Requirements
Module-related requirements for participation	-
Awarding credits	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	Not required

7	Module administration

Frequency	winter semester
Module representative	Prof. Dr. Joaquín Huerta
Responsible faculty	Departament de Llenguatges i Sistemes Informàtics, Universitat Jaime I

8	**Mobility / Recognition**
Usability in other degree programmes	Not applicable

9	**Miscellaneous**
Alignment of courses	All courses in the module are mandatory. A particular effort was put into aligning the content of different courses, both within and across modules, where one course builds upon and/or complements the content of another. This alignment is also apparent in project works: bigger projects are performed over the boundaries of the different courses, where each individual aspects of the project is tackled in a particular course as a smaller project. For example, throughout the module, the students develop a small-scale geographic Information web application, whereby basic preparatory programming is performed as a "Programming" assignment, the database design is a project for the "Databases and data management" course, and the client-side application development is a project in the "Development of Applications for Geographic Data exploration and visualization" course (Advanced Informatics and Data Analytics module).

2.-UJI Advanced Informatics and Data Analytics

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Advanced Informatics and Data Analytics**
Module number	2 (UJI)

1	**Basic data**
Programme semester	1
Credits (CP)	12
Workload (h) in total	300
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**

Aim of the module / Integration in the curriculum

Provide students with those basic data and data analytics skills needed to later successfully complete the Master.

Teaching content

The advanced informatics and data analytics module teaches the student the basic data and data analytics concepts needed understand, analyse, interpret data and data sources, and make them available for data consumption using well known standards and infrastructures.

The module consists of three courses:

1. "Data science" teaches a number of capabilities required to describe, understand and analyze large amounts of data coming from a variety of real problems, ranging from crime data, forest fires, earthquakes or environmental pollution problems. At the source of these methods, we find methods for data mining, computational methods designed to handle large datasets, and scalable methods.
2. "Development of Applications for Geographic Data exploration and visualization" teaches how to develop client-side Web or mobile geographic information applications using geospatial data and algorithms through external libraries and Application Programming Interfaces (APIs). For exploring and understanding (large) data (sets) and of geospatial data visualization.
3. "Spatial Data Services, Sources, Standards and Infrastructure" teaches the basics of making geospatial data available through different types of services for client consumption, overviews characteristics and searching for spatial referenced datasets and resources, and discusses geo standards and geographic information.

1. Data science

The aim of this course is to introduce some basics about data mining, handling large amounts of data, and how to visualize such data. In addition, we also learn about computational scalable methods, how to fit complex statistical models and perform future predictions. The real problems are driving the methods to apply, and we try to provide the student with a toolbox of possible ways to handle and analyze such real problems.

Learning units:

LU1. Simple statistical methods for data mining

LU2. Computational methods to handle big data

LU3. Spatial and spatio-temporal analysis of point patterns
LU4. Geostatistics
Conveyed competences are:

- Expertise: exploring data, extracting the information underlying large sets of data, analysing spatial structures, analyzing spatial data with evolving with time, efficient computation
- Methodological competences: statistical tools to analyze data in space and time, software development in R, mathematical basis of numerical analysis and algebra
- Learning competences: obtaining insight in data, problem solving, decision making, ethical use of AI, critical thinking
- Social competences: work in groups, work with authorities (for example, when dealing with crime data, there is a direct contact with the Town Hall and the police), abilities to interpret real data and make it comprehensive to non-academics

2. Development of Applications for Geographic Data Exploration and Visualization

The aim of this course is to introduce the different possibilities of client-side Web-based application development, with specific focus on Geographic Information Applications and data exploration and visualization, and how to apply these techniques to incorporate them in applications using Web and mobile technologies. The course is structures in two main parts: The first is about application development, including units 1 to 6 covering app builders, content management systems, custom apps, basic client-side development, use of client-side development frameworks, consuming (data) services, using existing geo API/libraries (e.g., visualize a map with some features), and using Web technologies to develop mobile applications. The second part is structured into units 7 to 9. Unit 7, Data Exploration, teaches how to understand a (large) data source, without prior knowledge of its design or structure. Various characteristics of data are explained (e.g., size, structure, relationships, completeness/sparseness), along with techniques and tools to explore them, in order to finally understand the content, patterns, anomalies, etc. in the data. Unit 8, Visual Presentations, introduces the student to theoretical principles of data visualization. Students learn how to create and present data efficiently from a design perspective, considering elements such as typographies, colors, type of data, purpose of visualization, images and charts and their correct usage. Finally, in unit 9 students will learn how to create different data and map visualizations using popular software tools and (web-based) libraries. Thus, for each library for data and map visualization, some fundamentals and programming techniques will be taught in order to the students to take advantage of such as libraries in their own web-based software applications.
Learning Units:
LU1. Web Technologies in Geographic Information Systems
LU2. Web Design and Development Theory
LU3. Content Management Systems
LU4. Custom Web Applications
LU5. Web Services from Databases
LU6. Mobile Client-side Programming with Web Technologies
LU7. Data Exploration
LU8. Visual Presentations
LU9. Visualization Libraries
Conveyed competences are:

- Expertise: use of libraries, integration of software, develop web apps, develop mobile apps, digital content design, understanding data sources, use of visualization libraries, integration of software, debugging, develop Web apps, develop mobile apps, digital content design
- Methodological competences: software analysis, software development, software deployment, data analysis, software analysis, software development, software deployment
- Learning competences: obtaining insight in data, problem solving, decision making
- Social competences: work in groups

3. Spatial Data Services, Sources, Standards and Infrastructures

The course is taught through mixing theoretical lectures with practical exercises. Theoretical concepts and methodologies taught in each lecture are illustrated with practical examples and case studies. Practical exercises are done during class and outside the classroom. A final project is carried out outside the classroom, and covers all covered content.

Learning units:
LU1. GIS Servers
LU2. GIS Web Services Types
LU3. Dynamic vs Cached Services
LU4. Consuming Geospatial Services (Web and mobile data collection, online WebGIS platforms, Webmaps, Web mapping templates, and configuring Web applications for field data editing and collection)
LU5. Dashboards and live data
LU6. Data sources (finding data and/or judging suitability of data. New data sources such as citizen science, IoT, sensors, social media, and Open City Portals)
LU7. Standards (OGC, W3C, Open Data, OASIS, etc.)
LU8. Infrastructures - Digital Earth, Geographic Information Infrastructures, IoT infrastructures, Sensor networks
LU9: Research Responsibility and Innovation (RRI) concepts and tools

Conveyed competences are:

- Expertise: Understand the role of GIS Services in web and mobile applications, Design and implement GIS Services for data dissemination, Differentiate types of GIS Services and their functionalities, Learn standards (OGC) and interoperability of GIS Services, Management of GIS Servers to guarantee performance and scalability, multidisciplinary perspective, responsible research, ethics
- Methodological: requirement gathering, data sharing, data integration, user-centered design, critical reflection, documents review
- Learning: methodic and critical thinking, ethical use of AI, process design, social responsibility, social impact, applying conceptual solutions to practical applications
- Social: communication and presentation skills, application of technical solutions to social problems, working in small team

Learning outcomes

Module learning outcomes:
LO1: To know the basic concepts of data science
LO2: To know the basic concepts of data exploration and visualization
LO3: To know the basic concepts of spatial data services, data sources, standards, infrastructures

Specific learning outcomes:

1. Data science

LO1. To know how to explore and understand large datasets by performing data mining
LO2. To perform visual descriptive analysis in a more efficient way
LO3. To know how to compute and code in a scalable way when dealing with large datasets
LO4. To know how to model and interpret data evolving in space and time
LO5. To analyse correctly spatial data, either point patterns or geostatistical data

2. Development of Applications for Geographic Data exploration and visualization

LO1. To know how to design web applications
LO2. To know how to develop web applications
LO3. To understand what is a Content Management System (CMS)
LO4. To know how to install and set up a CMS
LO5. To know how to develop custom Geographic Information System web applications
LO6. To know how to create web services from popular databases
LO7. To know how to use Web technology to develop a mobile app
LO8. To know how to explore and understand data
LO9. To know how to visually present data and information effectively
LO10. To know how to consume web services exposing data sources from a web app
LO11. To know how to create graphs and maps using popular visualization/mapping libraries
LO12. To know how to use services of popular visualization/mapping libraries

3. Spatial data services, sources, standards, infrastructures

LO1: Be able to select the right service type to share geospatial data.
LO2: To understand server limitations when serving geospatial data.
LO3: To know how to optimize geospatial service for better server performance, depending on client-side use.
LO4: To know how to exemplify and visualize geospatial data using geospatial services.
LO5: To be able to handle and visualize live data feeds.
LO6: To know the existence of new data sources and the importance of obtaining representative data to address a problem with a reduced or low level of bias.
LO7: To know how to find and evaluate the suitability of new data sources.
LO8: To know the existence of established standards of other communities and practices.
LO9: To know the existence of other infrastructures, linked to the previous data sources and standards.
LO10: To know the basic concepts of Research Responsibility and Innovation (RRI) and the implications of not considering them.

3	**Structure**					
Module components						
No.	Course category	Course type	Course	Status (M/EM)	Workload (h)	
					Attendance time (h)	Self-study (h)
1	Lecture / Practical	-	Data science	M	37.5/2.5	62.5
2	Lecture / Practical	-	Development of Applications for Geographic Data exploration and visualization	M	52.5/3.5	72,5
3	Lecture / Practical / Self-study	-	Spatial data service, sources, standards, infrastructures	M	30/2	45
Elective options within the module						

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ CE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade

1	Partial	Project report 1	Max 6 pages	1	1.2/10
2	Partial	Project report 2	Max 6 pages	1	1.2/10
3	Partial	Project report 3	Max 8 pages	1	1.6/10
4	Partial	Project report 1	Max 8 pages	2	1.0/10
5	Partial	Project report 2	Max 8 pages	2	1.5/10
6	Partial	Project report 3	Max 8 pages	2	1.0/12
7	Partial	Project report 4	Max 8 pages	2	1.5/12
8	Partial	Homework report 1	Max 1 pages	3	0.3/10
9	Partial	Homework report 2	Max 1 pages	3	0.3/10
10	Partial	Homework report 3	Max 1 pages	3	0.3/10
11	Partial	Homework report 4	Max 1 pages	3	0.3/10
12	Partial	Project report 1	Max 8 pages	3	0.8/10
13	Partial	Written exam	Max 1 hour	3	0.5/10
14	Partial	Oral exam: a group discussion and/or presentation of a topic individually assigned to each student.	Max 1 hour	3	0.5/10
Weight of the module grade for the final overall grade		12/90			
Required coursework					

No.	Type	Duration/ Scope	Connection to course no. (if applicable)
2	Practical Homework	Max 4 pages	2

5	Allocation of workload	
Participation (attendance or contact time)	Course no. 1	1.6 CP
	Course no. 2	2.0 CP
	Course no. 3	1.2 CP
Required coursework (and self-study)	RC no. 1 (Course no. 2, assign. 1)	0.25 CP
	RC no. 2 (Course no. 2, assign. 2)	0.25 CP
Degree-relevant examinations (and self-study)	D-RE no. 1 (Course no. 1, ex. 1)	0.72 CP
	D-RE no. 2 (Course no. 1, ex. 2)	0.72 CP
	D-RE no. 3 (Course no. 1, ex. 3)	0.96 CP
	D-RE no. 4 (Course no. 2, ex. 1)	0.6 CP
	D-RE no. 5 (Course no. 2, ex. 2)	0.9 CP
	D-RE no. 6 (Course no. 2, ex. 3)	0.5 CP
	D-RE no. 7 (Course no. 2, ex. 4)	0.5 CP
	D-RE no. 8 (Course no. 3, ex. 1)	0.33 CP
	D-RE no. 9 (Course no. 3, ex. 2)	0.33 CP
	D-RE no. 10 (Course no. 3, ex. 3)	0.33 CP
	D-RE no. 11 (Course no. 3, ex. 4)	0.33 CP
	D-RE no. 12 (Course no. 3, ex. 5)	0.48 CP
Total credits		**12 CP**

The workload of the module is represented in credits (CP). Please note the following:

- The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.
- If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.
- Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	Requirements
Module-related requirements for participation	-
Awarding credits	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	Not required

7	Module administration
Frequency	winter semester
Module representative	Prof. Dr. Joaquín Huerta
Responsible faculty	Departament de Llenguatges i Sistemes Informàtics, Universitat Jaime I

8	Mobility / Recognition

Usability in other degree programmes	Not applicable

9	**Miscellaneous**
Alignment of courses	A particular effort was put into aligning the content of different courses, both within and across modules, where one course builds upon and/or complements the content of another. This alignment is also apparent in project works: bigger projects are performed over the boundaries of the different courses, where each individual aspects of the project is tackled in a particular course as a smaller project. For example, on top of data services created in the course “Spatial data services, sources, standards and infrastructres“, visualizations are built in the project of the course “ Development of Applications for Geographic Data exploration and visualization ”. We note that, in case a real dependency is present, an alternative is always foreseen, so that no negative effect is present for the student in case a single project result is of insufficient quality to built upon.

3.-UJI Geospatial Technologies

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Geospatial Technologies**
Module number	3 (UJI)

1	**Basic data**
Programme semester	1
Credits (CP)	8
Workload (h) in total	200
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**
Aim of the module / Integration in the curriculum	
Provide students with those basic geospatial technology skills needed to later successfully complete the Master.	
Teaching content	

The geospatial technology module teaches the basics of Geographic Information Systems (GIS), and overviews technologies, trends and applications fields.
The module consists of three courses:

1. "Geographic Information Systems: Desktop to Web" teaches the fundamental structure and operation of a professional GIS software platform, from data creation and editing on the desktop to publishing and exploitation on the web
2. "Geographic Information Systems applications and trends" teaches about the wide variety of uses of GIS, today and in the near future, and explains the wide view of GIS as a long-term project rather than just software.
3. "Earth Observation and Remote Sensing" teaches an introduction to earth observation sensor data processing and applications. It covers the underlying physics, data types and algorithms. Practical exercises using leading software provide insights into a variety of applications

1. Geographic Information Systems: Desktop to Web

This introductory course establishes a common vocabulary and understanding of the modern view of Geographic Information Systems (GIS) - assuming that some students will have taken a traditional GIS course in the past, and others will be starting fresh. The course starts with introducing the student to the specificities of geographic problems and spatial thinking, followed by the GIS and their history. The students then learn how to use a GIS to create geospatial data, perform basic spatial analysis and automate GIS workflows with scripts. Finally, the students learn how to share and visualize analysis results using webmapping application templates.
Learning units:
LU1. Nature of geographic problems and spatial thinking
LU2. History and definitions of GIS
LU3. Creating geospatial data
LU4. Spatial analysis

LU5. GIS data processing using scripts
LU6. Creating basic geospatial apps using cloud GIS platforms
Conveyed competences are:

- Expertise: comprehending the migration from desktop to webGIS, knowledge of the operation of a professional GIS platform (creating geospatial data, performing basic spatial analysis, sharing geospatial data in cloud GIS platforms)
- Methodological competences: spatial reasoning, operation of desktop and webGIS, creation of basic web mapping applications
- Learning competences: systems thinking, building models, basic database concepts
- Social competences: teamwork, public presentation skills, data sharing culture

2. Geographic Information Systems Applications and Trends

This course covers in some detail the wide range of extraordinary application areas where GIS is being used and widens the context of GIS, from software on a desktop computer to a platform connecting multiple profiles of professionals who are creating, publishing, analysing, and consuming geospatial data. GIS is considered from a project point of view, along with project structure and project management method and methodologies, in order to let multi-disciplinary GIS teams work together to achieve success. Then, a sampling of GIS projects are shown, and future research and development topics in the GIS world are covered, coming from recent developments in the field.
Learning units:
LU1. GIS seen as a project, with examples from multiple fields
LU2. GIS project structure and management
LU3. New topics and trends in GIS
LU4. Preparation to adapt to new fields, methods and technologies
Conveyed competences are:

- Expertise: comprehension of GIS as a project created to solve specific societal problems in areas including traditional land management and others less traditional in fields such as business and transportation/mobility, project structure and management method and methodologies, notions of novelties in the field
- Methodological competences: project management, agile methods, desk study and research on a specific topic
- Learning competences: ethical use of AI, synthesis of previous ideas and creation of a realistic GIS project, ideation of new applications of geospatial technologies, applying conceptual knowledge to practical problems
- Social competences: teamwork, public presentation skills

3. Earth Observation and Remote Sensing

The course starts with an introduction to earth observation: goal, data sources, data gathering techniques, technologies and applications. Next, we focus our attention to remote sensing, and start with the physics foundation of electromagnetic energy as it relates to the earth observation. It follows with a discussion of data structures, corrections to data and data products. The course continues with an introduction to LiDAR. Next it covers image classification, feature extraction and mosaicking. Finally, an introduction to Unmanned Areal Vehicle (UAV) data processing is provided, and similarities/differences with satellite images are pointed out.
LU1. Earth Observation: introduction
LU2. Fundamentals Principles and Theory of Remote Sensing
LU3. Characteristics of earth observation satellites and other sensors
LU4. Data organization, data structures and data products
LU5. Introduction to LiDAR
LU6. Image classification
LU7. Pansharpening and Mosaic
LU8. Introduction to unmanned aerial vehicle (UAV) data processing
Conveyed competences are:

- Expertise: earth observation and remote sensing foundation and applications, basic error correction in satellite data, LiDAR technology, basic image classification techniques, digital image data representation, feature extraction and mosaicking, operation of leading remote sensing software.
- Methodological competences: systemic thinking, workflow processing, data analysis

- Learning competences: understanding earth observation data concepts and how to apply them is geospatial applications, problem solving, ethical use of AI
- Social competences: teamwork, public presentation skills

Learning outcomes

Module learning outcomes:
LO1: To know the basic concepts and use of Geographic Information Systems
LO2: To know about Geographic Information Systems' application areas and recent trends
LO3: To know the basic concepts of earth observation and remote sensing

1. Geographic Information Systems: desktop to web

LO1: To know the basic principles and concepts behind GIS software
LO2: To know how to operate modern GIS software
LO3: To know how to apply basic spatial analysis tools and automate GIS analysis workflows using scripts
LO4: To know how to share and visualize geodata using web mapping applications

2. Geographic Information Systems applications and trends

LO1: To know about the diverse range of GIS application areas
LO2: To be able to set up a project management structure with suitable methodology
LO3: To learn more than in typical GIS courses about new trends to prepare for future development
LO4: To know about the many ways in which GIS intersects with other information systems

3. Earth Observation and Remote Sensing

LO1: To be able to apply image processing tools to remote sensing images
LO2: To attain an understanding of the Principles of Remote Sensing
LO3: To be able to Infer implications of classification and segmentation results of images to Land use, Feature Extraction and Change Detection
LO4: To be able to obtain classification maps from images applying different types of classification methods
LO5: To be able to apply knowledge about remote sensing systems, processing of remotely sensed data, and derived data products to a variety of GIS application scenarios and describe methods used to classify and analyze these data using software tools.
LO6: To be able to apply remote sensing skills to a real-world situation of personal or professional interest.

3 Structure

Module components

No.	Course category	Course type	Course	Status (M/EM)	Workload (h)	
					Attendance time (h)	Self-study (h)
1	Lecture / Practical	-	Geographic Information Systems: Desktop to Web	M	30/2	45
2	Lecture / Practical	-	Geographic Information Systems applications and trends	M	22.5/1.5	27.5
3	Lecture / Practical	-	Earth Observation and Remote Sensing	M	30/2	45
Elective options within the module						

4 Examination structure

Degree-relevant examination(s)

No.	FME/ CE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	Partial	Written exam	Max. 2 hours	1	1.2/8
2	Partial	Case study presentation	Max. 20 minutes	1	0.9/8
3	Partial	Project report	Max. 6 pages	1	0.9/8
4	Partial	Written exam	Max. 2 hours	2	0.6/8
5	Partial	Research presentation	Max. 20 minutes	2	1.4/8
6	Partial	Class attendance	30 hours	3	0.45/8
7	Partial	Project report 1	Max. 5 pages	3	0.6/8

8	Partial	Project report 2	Max. 5 pages	3	0.6/8
9	Partial	Project report 3	Max. 5 pages	3	0.6/8
10	Partial	Case study presentation	Max. 10 minutes	3	0.75/8
Weight of the module grade for the final overall grade		8/90			
Required coursework					

No.	Type	Duration/ Scope	Connection to course no. (if applicable)
-			

5	**Allocation of workload**	
Participation (attendance or contact time)	Course no. 1	1.2 CP
	Course no. 2	0.8 CP
	Course no. 3	1.2 CP
Required coursework (and self-study)	-	-
Degree-relevant examinations (and self-study)	D-RE no. 1 (Course no. 1, ex. 1)	0.72 CP
	D-RE no. 2 (Course no. 1, ex. 2)	0.54 CP
	D-RE no. 3 (Course no. 1, ex. 3)	0.54 CP
	D-RE no. 4 (Course no. 2, ex. 1)	0.48 CP
	D-RE no. 5 (Course no. 2, ex. 2)	0.72 CP
	D-RE no. 6 (Course no. 3, ex. 1)	0.40 CP
	D-RE no. 7 (Course no. 3, ex. 2)	0.40 CP
	D-RE no. 8 (Course no. 3, ex. 3)	0.40 CP
	D-RE no. 9 (Course no. 3, ex. 4)	0.60 CP
Total credits		**8 CP**

The workload of the module is represented in credits (CP). Please note the following:

- The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.
- If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.
- Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	**Requirements**
Module-related prequisites for attendance	-
Recognition of credit points	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all examinations and assignments that the module-related learning outcomes have been achieved.
Regulations governing attendance of courses	Not required

7	**Module administration**
Frequency	winter semester

Module representative	Prof. Dr. Joaquín Huerta
Responsible faculty	Departament de Llenguatges i Sistemes Informàtics, Universitat Jaime I

8	**Mobility / Recognition**
Usability in other degree programmes	Not applicable

9	**Miscellaneous**
Alignment of courses	A particular effort was put into aligning the content of different courses, both within and accoss modules, where one course builds upon and/or complements the content of another. This alignment is also apparent in project works: bigger projects are performed over the boundaries of the different courses, where each individual aspects of the project is tackled in a particular course as a smaller project, or projects performed in one course motivate and are re-used to drive the content (presentation) of another course. For example, a small GIS project is performed in a team in the course "Geographic Information Systems: Desktop to Web". Next, in the course "Geographic Information Systems applications and trends", these projects and the students experiences are taking as an input to discuss project management structures.

4.-UM Foundations of Geographic Information Science II

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Foundations of Geographic Information Science II**
Module number	4 (UM)

1	**Basic data**
Programme semester	2
Credits (CP)	4
Workload (h) in total	120
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**
Aim of the module / Integration in the curriculum	

The aim of this module is to provide students with thorough introduction to different areas that make up Geographic Information Science and to enable them to read, understand and discuss scientific publications in this area.
In the module, students are exposed to a series of academic papers and presentation – including both seminal papers from the past (via the Geographic Information Science seminar) as well as current research in the field (via the Geoinformatics forum and the corresponding discussion group). Regarding influential past work, students read scientific publications from fields such as geostatistics, spatial cognition, geovisualisation or interaction with geoinformation, and formulate questions regarding the content. These questions are discussed based on the papers under guidance of the teaching staff. In addition, students attend presentations by leading national and international researchers in the field, who are invited to the Geoinformatics forum to present their current work. In preparation to the expert presentations, students read and discuss in the GI Forum Discussion Group a publication by the presenting expert, and then can engage with the expert at the presentation.

Teaching content

The course consists of three courses:

1. Core Topics in Geographic Information Science (2 CP)
2. Geoinformatics Forum (1 CP)
3. Geoinformatics Forum Discussion Group (1 CP)

1. Core Topics in Geographic Information Science
Learning units:

- LU1: Introduction to Geographic Information Science
- LU2: Scientific publications of influential past work, e.g., in geostatistics, spatial cognition, geovisualisation or interaction with geoinformation

Conveyed competences are:

- Expertise: Awareness and understanding of core concepts of Geographic Information Science
- Methodological competences: scientific reading, scientific discourse
- Learning competences: analysis of scientific content, ethical use of AI
- Social competences: communication, discussion

2. Geoinformatics Forum
Learning units:

- LU1: Depending on the invited scientists, see GI Forum program at https://www.uni-muenster.de/Geoinformatics/GI-Forum/index.php

Conveyed competences are:

- Expertise: up-to-date innovative research topics
- Methodological competences: up-to-date innovative research topics
- Learning competences: scientific reading, scientific discourse, ethical use of AI,
- Social competences: communication, discussion

3. Geoinformatics Forum Discussion Group
Learning units:

- LU1: Discussion of selected papers of the invited scientists at the Geoinformatics Forum, see GI Forum program at https://www.uni-muenster.de/Geoinformatics/GI-Forum/index.php

Conveyed competences are:

- Expertise: up-to-date innovative research topics
- Methodological competences: up-to-date innovative research topics
- Learning competences: scientific reading, scientific discourse, ethical use of AI,
- Social competences: communication, discussion

Learning outcomes

Learning outcomes for the module:

- LO1: Capability to name different areas that make up Geographic Information Science
- LO2: Awareness of relevant papers in those different areas
- LO3: Capability to analyse and to discuss scientific content in scientific discourses

Specific learning outcomes:

1. Core Topics in Geographic Information Science
   - LO1: Awareness and understanding of core concepts of Geographic Information Science
   - LO2: Understanding of the theoretical concepts and scientific questions behind the technologies of Geoinformatics
2. Geoinformatics Forum
   - LO1: Overview on the key methods in Geoinformatics, current research topics and results, and the ability to relate this to other, nearby disciplines
   - LO2: Acquired skills in scientific discourse
3. Geoinformatics Forum Discussion Group
   - LO1: Overview on the key methods in Geoinformatics, current research topics and results, and the ability to relate this to other, nearby disciplines
   - LO2: Acquired skills include the formulation of scientific questions in response to academic literature from the field
   - LO3: Efficient handling of scientific literature, as well as communication skills in a scientific setting

3	**Structure**

Module components

No.	Course category	Course type	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Seminar	-	Core Topics in Geographic Information Science	M	30/2	30
2	Lecture	-	Geoinformatics forum	M	15/1	15
3	Seminar	-	Geoinformatics forum discussion group	M	15/1	15
Elective options within the module			-			

4	**Examination structure**

Degree-relevant examination(s)

No.	FME / CE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	MAP	Final written assignment; depending on the number of participants, an alternative form may be implemented (oral examination or oral presentation), announced at the beginning of the course.	Written assignment: 1500–2500 words; oral examination: up to 20 min; oral presentation: up to 20 min (the applicable form is announced at the beginning of the course).	1	100%
Weight of the module grade for the final overall grade			4/90		

Required coursework

No.	Type	Duration/ Scope	Connection to course no. (if applicable)
1	Reading a publication and preparing questions for discussion	3 questions	3

		in each of 7 sessions (21 in total)	

5	Allocation of workload		
Participation (attendance or contact time)		no. 1	1 CP
		no. 2	1 CP
		No. 3	0.5 CP
Required coursework (and self-study)		RC no. 1 (No. 3)	0.5 CP
Degree-relevant examinations (and self-study)		D-RE no. 1 (No. 1)	1 CP
Total credits			**4 CP**

The workload of the module is represented in credits (CP). Please note the following:

- The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.
- If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.
- Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	Requirements
Module-related requirements for participation	N/A
Awarding credits	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	Attendance in the three courses is required in order for students to participate in the discussion about the publications and presentations as well as to train their ability to argue about scientific content in GI Science. Therefore, students may only miss up to 2 of the weekly sessions in each of the three courses.

7	Module administration
Frequency	Summer semester
Module representative	Prof. Dr.-Ing. Christian Kray
Responsible faculty	UM - FB 14 – Geosciences

8	Mobility / Recognition
Usability in other degree programmes	-

9	Miscellaneous
	-

5.-UM Advanced Topics in Geographic Information Science II

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Advanced Topics in Geographic Information Science II**
Module number	5 (UM)

1	**Basic data**
Programme semester	2
Credits (CP)	10
Workload (h) in total	300
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**

Aim of the module / Integration in the curriculum

The aim of the module is to deepen understanding, knowledge, and skills in selected areas of GI Science. Students can select two courses, based on their background, interests, and career goals.

Teaching content

Students choose two out of the following courses, which provide innovative knowledge and skills in selected areas:

1. Location-based services (5 CP)
2. Spatial Cognition (5 CP)
3. Machine Learning for Visual Spatial-temporal Data (5 CP)
4. Spatial Data Science in R (5 CP)
5. Advanced course in emerging research fields (5CP)

1. Location-based Services
Learning units:

- LU 1: Application areas of location-based services
- LU 2: Conceptual and technical foundations of location-based services
- LU 3: Contextual factors of relevance to location-based services
- LU 4: Visualization for location-based services
- LU 5: Interaction with location-based services
- LU 6: Evaluation techniques for location-based services
- LU 7: Reading, presenting and discussing current research in location-based services

Conveyed competences are:

- Expertise: Theoretical concepts, technical foundations and practical application of location-based services
- Methodological Competences: Basic concepts of usability studies
- Learning Competences: Independent, issue-specific research based on scientific literature, ethical use of AI
- Social Competences: Group discussions, teamwork, communication skills

2. Spatial Cognition
Learning units:

- LU 1: Acquisition and processing of spatial information
- LU 2: Use of spatial information in decision making
- LU 3: Intelligent representation and processing of spatial information

- LU 4: Human strategies for organizing information about their environment

Conveyed competences are:
Expertise: Concepts of human cognition and organization of spatial information
Methodological competences: Design of experiments, using spatial ability tests
Learning competences: critical reading and assessing of research publications, ethical use of AI
Social competences: oral presentations, group discussions, communication skills

3. Machine learning for Visual Spatio-temporal Data
Learning units:
LU 1: Introduction to Machine Learning (esp. terminology, paradigms)
LU 2: Machine Learning Basics (esp. mathematical foundations, linear and nonlinear classification, first examples and applications, socio-ethical relevance)
LU 3: Deep Learning (esp. working with visual data, Convolutional Neural Networks)
LU 4: Dimensionality Reduction (esp. visualization, autoencoder, t-SNE, etc.)
LU 5: Gradient Decent Basics (esp. derivation of gradient decente, illustration of gradient decente, commonly used loss terms s.a. multi-class SVM-loss, overfitting, underfitting)
LU 6: Backpropagation (esp. computational graphs, chain rule, Backpropagation implementations, regularisation)
LU 7: Case study: Deep Learning for Earth Science (seminar paper)

Conveyed competences are:
Expertise: techniques from the field of machine learning on (visual) spatio-temporal data such as image and video data
Methodological Competences: application of these techniques in the context of different scenarios, e.g., classification of the different Machine Learning paradigms such as supervised and unsupervised learning, advanced concepts such as modern neural network architectures and advanced training methods
Learning Competences: critical thinking, to apply theoretical foundations on specific applications from the field of visual computing, ethical use of AI.
Social Competences: teamwork, communication skills

4. Spatial Data Science in R
Learning units:
LU 1: Introduction to different R libraries for spatial data analysis
LU 2: Data structures for spatial data in R
LU 3: Spatial Data Analysis in R
LU 4: Visualization and further processing of results
LU 5: Writing and sharing R packages
Conveyed competences are:
Expertise: R for spatial data analysis
Methodological: Using R and basic R libraries. Pre-processing, processing, analysis and visualization of spatial and spatio-temporal data
Learning competences: self-learning, group-learning, conducting independent research on specific programming issues, ethical use of AI, critical thinking
Social: Presenting research results, communication skills, working in a team on a research project, writing a scientific report

Learning outcomes

Learning outcomes for the module:

- LO1: to acquire deep knowledge in specific fields in GI Science
- LO2: to acquire knowledge in scientific methods
- LO3: to be able to analyse and to discuss high-level content in scientific discourses
- LO4: to acquire capabilities to apply research methods for solving real-world problems

Specific learning outcomes:

1. Location-based services
    - LO 1: Being able to name key application areas of location-based services
    - LO 2: Understanding of technical and conceptual foundations of location-based services such as location sensing technologies and representations of location
    - LO 3: Awareness of key contextual factors and how they affect location-based services
    - LO 4: Understanding of different visualisation techniques for location-based services and their properties
    - LO 5: Understanding of key issues affecting interaction with location-based services as well as of different interaction techniques
    - LO 6: Awareness of evaluation techniques for location-based services
    - LO 7: Awareness of current research in the topics covered by the lecture
    - LO 8: Ability to find, summarise and discuss current academic literature on location-based services
2. Spatial cognition
    - LO1: Know the relevance of Cognitive Sciences and Psychology to Geoinformatics
    - LO2: Know the specifics of cognitive processes for acquiring and understanding spatial information
    - LO3: Formulate interdisciplinary research questions
    - LO4: Design and develop cognitively efficient applications
3. Machine learning for visual spatio-temporal data
    - LO 1: Knowing the machine learning paradigms, learning strategies and scientific terminology
    - LO 2: Understanding of the classical machine learning algorithm
    - LO 3: Understanding of the mathematical foundation of machine learning
    - LO 4: Knowledge about Deep Learning with a particular focus on visual data
    - LO 5: Understanding of and capability to work with high-dimensional data
    - LO 6: Understanding of how deep learning models are trained
    - LO 7: Capability to name the mathematical foundation of Backpropagation
    - LO 8: Practical knowledge of how to apply deep learning to earth science challenges
4. Spatial Data Science in R
    - LO 1: learn the basics of R, lists and data.frames
    - LO 2: understand R spatial packages, and upstream libraries
    - LO 3: understand the difference between vector and raster data in R
    - LO 5: the basics of geometry: nodes, edges; points, lines polygons
    - LO 6: the simple feature standard, operations on geometries
    - LO 7: deriving new geometries
    - LO 8: understand the difference between flat and spherical geometries
    - LO 9: understand support, how attributes relate to geometries
    - LO 10: understand data cubes
    - LO 11: work with features and data cubes using R packages sf and stars
    - LO 12: Create an R package, and learn how to verify its correctness

3	Structure

Module components

No.	Course category	Course type	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Seminar	Practical seminar	Location-based services	EM	60/4	90
2	Seminar	Practical seminar	Spatial Cognition	EM	60/4	90
3	Seminar	Practical seminar	Machine Learning for Visual Spatial-Temporal Data	EM	60/4	90
4	Seminar	Practical seminar	Spatial Data Science with R	EM	60/4	90
5	Lecture/Seminar/Practical	Depending on selected course	Advanced course in emerging research fields (if offered/provided)	EM	60/4	90
Elective options within the module			For the module, students select two out of five courses.			

4	Examination structure

Degree-relevant examination(s)

No.	FME/ CE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	CE	Oral presentation and/or essay on a topic discussed in the course (the examination format will be announced by the teacher at the beginning of the course)	Up to 30 mins Up to four pages	1	5/10
2	CE	Oral presentation	45 mins	2	5/10
3	CE	Written report and oral report presentation	12-20 pages, 20 mins	3	5/10
4	CE	Portfolio consisting of self-developed software and documentation with reproducible example applications	Self-developed R-package and vignette for package (both components weighted equally)	4	5/10
5	CE	*One of the following, depending on the selected course; the specific form is announced by the teacher at the beginning of the course: written examination, oral examination, oral presentation, written report, essay, or portfolio.*	**Duration/Scope:** *Written examination: up to 120 min; oral examination: up to 30 min; oral presentation: up to 45 min; written report or essay: up to 20 pages; portfolio: scope as announced at the beginning of the course.*	5	5/10

Weight of the module grade for the final overall grade	10/90

Required coursework			
No.	Type	Duration/ Scope	Connection to course no. (if applicable)
1	A a Each student gives a short presentation of a scientific publication on each of the 13–15 topics discussed in the lecture.	Approx. 2 minutes per presentation; 13–15 presentations per student over the semester.	1
2	None	-	2
3	None	-	3
4	None	-	4
5	*A study achievement depending on the selected course (e.g. exercises, lab tasks, or a short presentation), announced by the teacher at the beginning of the course.*	As announced at the beginning of the course.	5

5	**Allocation of workload**	
Participation (attendance or contact time)	Course no. 1	2 CP
	Course no. 2	2 CP
	Course no. 3	2 CP
	Course no. 4	2 CP
	Course no. 5	2 CP
Required coursework (and self-study)	Course no. 1	1.5 CP
	Course no. 5	1.5 CP
Degree-relevant examinations (and self-study)	Course no. 1	1.5 CP
	Course no. 2	3 CP
	Course no. 3	3 CP
	Course no. 4	3 CP
	Course no. 5	1.5 CP
Total credits		**10 CP**

The workload of the module is represented in credits (CP). Please note the following:

- The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.
- If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.
- Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	**Requirements**

Module-related requirements for participation	Completion of the first semester
Awarding credits	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	The courses convey practical competences, which cannot be acquired in self-studying. Therefore, students may only miss up to 2 of the weekly sessions in each of the two courses.

7	**Module administration**
Frequency	Summer semester
Module representative	Prof. Dr. Christian Kray
Responsible faculty	UM – Institute for Geoinformatics

8	**Mobility / Recognition**
Usability in other degree programmes	-

9	**Miscellaneous**
	-

6.-UM Applied Topics in Geographic Information Science

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Applied Topics in Geographic Information Science**
Module number	6 (UM)

1	**Basic data**
Programme semester	2
Credits (CP)	10
Workload (h) in total	300
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**

Aim of the module / Integration in the curriculum

The aim of the module is to deepen understanding, knowledge, and skills in applying GI research methods. The first course places students in the role of GIS professionals who are responsible for the entire „value chain“ of collecting data, retrieving information, and transferring these data and information to knowledge using various geospatial technologies. This transferred knowledge is particular to address specific societal needs such as tourism, business, marketing, or natural resources. The second course aims to apply innovative technologies in a practical setting, such as unmanned aerial systems. As an alternative, students might choose one of the institute's study projects, which are each year created from the scratch according to very up-to-date research topics and ongoing research projects.

Teaching content

The module consists of two courses:

1. Applied Geospatial Technologies (5 CP), for example, Unmanned Aerial Systems
2. Study Project (5 CP)

Students select one course on Applied Geospatial Technologies and either a second course on Applied Geospatial Technologies or a Study Project.

1. Applied Geospatial Technologies:

Ifgi offers courses, which provide innovative knowledge and skills in selected topics of geospatial technologies. Topics will be updated according to up-to-date technologies. An exemplary course is "Unmanned Aerial Vehicles", which will be described in the following:

Learning units:

- LU1: Introduction to UAV technology
- LU2: Definition of the project (Unmanned Aerial Systems (UAS) as highly flexible and low-cost sensor platforms provide new opportunities for data acquisition for various environmental and geoscientific purposes) and organization of the project teams
- LU3: Conceptual phase to use such a platform to monitor the conservation process of a biotope (project teams and overall project)
- LU4: Implementation and preparation of UAV flights
- LU5: UAV flights
- LU6: Data analysis and processing for being displayed in a WebGIS
- LU7: Public presentation of project results

Conveyed competences are:

- Expertise: UAV technology, sensors, aerial photos, WebGIS, biotope monitoring
- Methodological competences: data acquisition, data processing, project management techniques
- Learning competences: develop technological solutions for ecological problems, present solutions to an interdisciplinary audience
- Social competences: working within small teams, working across interdisciplinary teams, communication and presentation skills

2. Study Project

Learning units:

- LU 1: Introduction to project topic
- LU 2: Identifying the research problem and project goals
- LU 3: Organization of project teams, preparation of research approach, work plan and schedule
- LU 4: Implementation of the approach
- LU 5: Intermediate reports on project progress
- LU 6: Final presentation/report of project results

Conveyed competences are:

- Expertise: deepened knowledge in a current geoinformatic/geoscientific research field (depending on project topic)
- Methodological Competences: project management, self-organization, time management, report writing
- Learning Competences: critical thinking, ability to independently identify research problems and approaches, ethical use of AI
- Social Competences: teamwork, communication skills

Learning outcomes

Learning outcomes for the module:

- LO1: to acquire capabilities to apply research methods for solving real-world problems
- LO2: to acquire practical skills in GI Science

Specific learning outcomes:

Applied Geospatial Technologies (using Unmanned aerial vehicles as an example)

- LO1: Being able to understand the spatial problems of a GI application area (ecology/biotope monitoring)
- LO2: Know-how in UAV technology
- LO3: Capability to apply geospatial technologies on a specific real-world problem
- LO4: Acquire project management skills by working within and across project teams
- LO5: Know-how to develop a WebGIS for presenting collected data
- LO6: Know-how in visualization techniques
- LO7: Capability to present project results

Study Project

- LO 1: Understand and analyze a complex geoinformatic task/problem
- LO 2: Formulate project goals and a project strategy
- LO 3: Independently organize project work
- LO 4: Apply geoinformatic skills and knowledge to address a given task/research problem
- LO 5: Report research outcomes in written and verbal forms
- LO 6: Critically reflect on overall project results and on own contribution
- LO 7: Apply project management techniques practically

3	**Structure**					
Module components						
No.	Course category	Course type	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture/Seminar/Practical		Applied Geospatial Technologies	M	60/4	90
2	Practical	-	Study project	M	30/2	120

Elective options within the module	Students select one course on Applied Geospatial Technologies and either a second course on Applied Geospatial Technologies or a Study Project.

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME / CE	Type	Duration / Scope	Connection to course no. if appl.	Weight in the module grade
1	CE	One of the following, depending on the selected course; the specific form is announced by the teacher at the beginning of the course: written examination, oral examination, oral presentation, written report, essay, or portfolio.	Written examination: up to 120 min; oral examination: up to 30 min; oral presentation: up to 45 min; written report or essay: up to 20 pages; portfolio: scope as announced at the beginning of the course.	1	5/10
2	CE	Portfolio consisting of a final presentation on the project outcome, a written report and documented code written during the project.	1. Group presentation (up to 45 min) 2. Written report (up to 15 pages) 3. Written code (depending on project outcome) Weighting scheme will be announced at the beginning of the course	2	5/10
Weight of the module grade for the final overall grade			10/90		
Required coursework					
No.		Type		Duration/ Scope	Connection to course no. if appl.
1		A study achievement depending on the selected course (e.g. exercises, lab tasks, or a short presentation), announced by the teacher at the beginning of the course.		As announced at the beginning of the course.	1
2		Oral presentation of intermediate results (sprint reviews)		Group presentation (up to 20 minutes, that can be divided up to 5 smaller presentations)	2

5	**Allocation of workload**	
Participation (attendance or contact time)	Course no. 1	2 CP
	Course no. 2	1 CP

Required coursework (and self-study)	RC no. 1 (Course no. 1)	1.5 CP
	RC no. 2 (Course no. 2)	3 CP
Degree-relevant examinations (and self-study)	D-RE no. 1 (Course no. 1)	1.5 CP
	D-RE no. 2 (Course no. 2)	1 CP
Total credits		**10 CP**

The workload of the module is represented in credits (CP). Please note the following:

- The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.
- If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.
- Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	**Requirements**
Module-related requirements for participation	Completion of the first semester
Awarding credits	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	The courses convey practical competences, which cannot be acquired in self-studying. Therefore, students may only miss up to 2 of the weekly sessions in each of the two courses.

7	**Module administration**
Frequency	Summer semester
Module representative	Dr. Fillipe Feitosa
Responsible faculty	UM - FB 14 - Geosciences

8	**Mobility / Recognition**
Usability in other degree programmes	-

9	**Miscellaneous**
	-

7.-UM Transferable skills

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Transferable skills**
Module number	7 (UM)

1	**Basic data**
Programme semester	2
Credits (CP)	6
Workload (h) in total	180
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**

Aim of the module / Integration in the curriculum

Within two semesters of courses, this module in Münster centrally conveys soft skills to all students, which are needed in their professional GI careers. In the context of project management, students learn to organize an international event (GeoMundus conference, http://geomundus.org), teamwork, communication, budgeting, presentation, moderation, etc. The research methods prepare students for their future scientific work in general, and, more specifically and closer, for their Master theses.

Teaching content

The module consists of two courses.

1. Project management/GeoMundus conference
2. Research methods in GI Science.

1. Project management/GeoMundus conference

Learning units:

- LU1: Introduction
- LU2: Setting up project teams, communication structures, and preliminary workplan
- LU3: Weekly meetings, presenting and discussing intermediate results of the project teams: Coordination (work plan, monitoring and controlling); Budget (project budget and acquisition of funding and sponsoring); Local Organization (location, catering, local students/study program, conference events); Program (guest speakers, call for and review of submitted papers and posters); Web and Promotion (website, registration, promotion materials & activities)
- LU4: Wrap-up of intermediate results
- LU5: Report of intermediate results
- LU6: Ongoing preparation and organization of the conference within and across the project teams
- LU7: Conduction of the conference – yearly conference GeoMundus, see http://geomundus.org.

Conveyed competences are:

- Expertise: Project management
- Methodological competences: project planning, controlling, budgeting, organization of a scientific event
- Learning competences: self-learning, group learning, problem solving

- Social competences: teamwork, networking

2. Advanced Research Methods
Research methods in GI Science
Learning units:

- LU1: Methodological approaches in research
- LU2: Scientific writing
- LU3: Scientific reading
- LU4: Literature search
- LU5: Referencing, citing, plagiarism
- LU6: Writing scientific comments
- LU7: Presentations.

Conveyed competences are:

- Expertise: Research tools
- Methodological competences: Writing, presenting, research methods, publishing
- Learning competences: self-learning, group learning, problem solving, ethical use of AI
- Social competences: communication and discussion of own research results

Learning outcomes

Learning outcomes for the module:

- LO1: skills to plan, organize, and conduct a Geoinformatics project in a project team
- LO2: skills for scientific writing, i.e., Master thesis

Specific learning outcomes:
1. Project management/GeoMundus conference

- LO1: to acquire and train project management skills
- LO2: to acquire and train organizational skills
- LO3: to work within a small team and to coordinate cooperation of several teams in a joint project
- LO4: to organize a scientific event
- LO5: to conduct a scientific event
- LO5: to try and train networking activities.

2. Research methods in GI Science

- LO1: to acquire knowledge about scientific methods in research
- LO2: to acquire know-how and practically train scientific writing
- LO3: to acquire know-how and practically train scientific reading
- LO4: to acquire know-how and practically train literature search
- LO5: to acquire know-how and practically train dealing with referencing, citing, and plagiarism
- LO6: to acquire know-how and practically train writing scientific comments
- LO7: to acquire know-how and practically train presentations.

3	**Structure**					
Module components						
No.	Course category	Course type	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Practical	-	Project management/GeoMundus conference	M	30/2	60
2	Seminar	-	Research methods in GI Science	M	30/2	60
Elective options within the module			-			

4	Examination structure				
Degree-relevant examination(s)					
No.	FME / CE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	thesis proposal	Max. 10 pages	2	3/3
Weight of the module grade for the final overall grade		6/90			
Required coursework					
No.	Type		Duration/ Scope	Connection to course no. (if applicable)	
1	Compiled joint report by all students		Max. 100 pages	1	
2	Thesis proposal draft		1-3 pages	2	
3	Thesis proposal presentation		10-15 min.	2	

5	CP allocation	
Participation (= attendance time)	Course no. 1	1 CP
	Course no. 2	1 CP
Degree-relevant examination(s)	No. 1	1 CP
Required coursework	No. 1	2 CP
	No. 2	0.5 CP
	No. 3	0.5 CP
Total CP		6 CP

5	Allocation of workload	
Participation (attendance or contact time)	Course no. 1	1 CP
	Course no. 2	1 CP
Required coursework (and self-study)	No. 1	2 CP
	No. 2	0.5 CP
	No. 3	0.5 CP
Degree-relevant examinations (and self-study)	No. 1	1 CP
Total credits		**6 CP**

The workload of the module is represented in credits (CP). Please note the following:

- The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.
- If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.
- Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	Requirements	
Module-related requirements for participation		Completion of the first semester

Awarding credits	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	The course „Project management/GeoMundus conference" bases on work in teams and discussion and decision-making on constantly updated progress of the conference organization. The course „Research methods in GI Science" conveys discourse competences, which cannot be acquired in self-studying. Therefore, students may only miss up to 2 of the weekly sessions in each of the two courses.

7	**Module administration**
Frequency	Summer semester
Module representative	Dr. Fillipe Feitosa
Responsible faculty	UM – FB 14 Geosciences

8	**Mobility / Recognition**
Usability in other degree programmes	-

9	**Miscellaneous**

8.-UM/UJI/UNLMaster thesis

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Master thesis**
Module number	8 (UM or UNL or UJI)

1	**Basic data**
Programme semester	3
Credits (CP)	30
Workload (h) in total	900
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**
Aim of the module / Integration in the curriculum	
The thesis is an independent work of the students on a GI topic using scientific methods, and presenting these results orally (defence) and in written form (thesis). Part of the Master thesis supervision is the Master thesis seminar, where progresses will be presented and discussed with supervisors, co-supervisors, and co-students.	
Teaching content	

The module consists of two parts.

- Master thesis including defence (28 CP)
- Master thesis seminar (2 CP)

Students are treating a specific GI topic and are solving a GI problem within a defined schedule and quality. They address a basic research question and apply specific research methods in GI. This includes acquiring learning competences in ethical use of AI, scientific writing, independent scientific work, and literature review, and acquiring social competences by communications with supervisors and co-researchers.

The thesis is supervised by a main supervisor of the hosting Institution (UM or UNL or UJI). Co-supervisors can be of any institution in case students have attended all three locations within the three semesters. In case of not having attended one of the institutions, one of the co-supervisors have to be from that institution.

Learning outcomes

Learning outcomes is to achieve level 7 of the European Qualifications Framework (EQF):

- Knowledge: Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research
- Skills: Specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields
- Responsibility and autonomy: Manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams

3	Structure

Module components

No.	Course category	Course type	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	thesis	-	Master thesis including defence	M	0	840
2	seminar	-	Master thesis seminar	M	8/1	52
Elective options within the module			-			

4	Examination structure

Degree-relevant examination(s)

No.	FME / CE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	CE	Master thesis (at UM and UJI)	60 pages	1	22.5/30
2	CE	Master thesis defence (at UM and UJI)	Max. 1 hour	1	7.5/30
1	CE	Master thesis including defence (at UNL)	60 pages/90 min.	1	30/30
Weight of the module grade for the final overall grade			30/90		

Required coursework

No.	Type	Duration/ Scope	Connection to course no. (if applicable)
-	Presentation of intermediate thesis results	Max. 15 min.	2

5	CP allocation

Participation (= attendance time)	Course no. 1	0 CP
	Course no. 2	0.25 CP
Degree-relevant examination(s)	No. 1	28 CP
Required coursework	No. 1	0 CP
	No. 2	1.75 CP
Total CP		30 CP

5	Allocation of workload

Participation (attendance or contact time)	Course no. 1	0 CP
	Course no. 2	0.25 CP
Required coursework (and self-study)	No. 1	0 CP
	No. 2	1.75 CP
Degree-relevant examinations (and self-study)	No. 1	28 CP
Total credits		**30 CP**

The workload of the module is represented in credits (CP). Please note the following:

— The time of credit entry in a campus management system is linked to the contact and attendance times, as well as the evaluation of the required coursework and degree-relevant examinations.

— If self-study workload has been allowed for (e.g. preparation and follow-up work for courses etc.) that is not directly related to degree-relevant examinations or required coursework, it will still be allocated to the examinations or coursework.

— Credits for the module are only awarded upon completion of the entire module, i.e. when students have proven – by passing all degree-relevant examinations and required coursework – that they have achieved the learning outcomes assigned to the module.

6	**Requirements**
Module-related requirements for participation	Completion of the first and second semester
Awarding credits	Credit points for the module will be recognized, if the entire module has been successfully completed. It has been proven by passing all partial or module examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	-

7	**Module administration**
Frequency	Winter semester
Module representative	Dr. Fillipe Feitosa/Prof. Dr. Marco Painho/Prof. Dr. Joaquín Huerta
Responsible faculty	UM – Institute for Geoinformatics/UNL/UJI

8	**Mobility / Recognition**
Usability in other degree programmes	-

9	**Miscellaneous**