Examination Regulations
for the Master Program in Geospatial Technologies
at the
Westfälische Wilhelms-Universität Münster, Germany
Universitat Jaume I, Castellón, Spain, and
Universidade Nova de Lisboa, Portugal
30. October 2020

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, Universidade Nova de Lisboa, and Universitat Jaume I.

(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 Universitat Jaume I, Castellón in Spain or at Universidade Nova de Lisboa in 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 Universitat Jaume I or Universidade Nova de Lisboa.

§ 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 Universidade Nova de Lisboa or Universitat Jaume I.
2. An advanced course semester at the University of Münster
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 (Universidade Nova de Lisboa) up to six weeks (Universitat Jaume I, University of Münster) 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 WWU, 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 University of Münster, and Universitat Jaume I) or a Master program coordinator (in the case of Universidade Nova de Lisboa) 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. Universitat Jaume I 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. Universidade Nova de Lisboa: The Master program coordinator, together with the academic services, under supervision of NOVA IMS's scientific council, is responsible for organizing all examinations
3. Westfälische Wilhelms-Universität Münster: 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 the University of Münster:
   a. All persons qualified in terms of § 65 (1) Hochschulgesetz Nordrhein-Westfalen (HG NRW) (Universities Act of the Federal State of North Rhine-Westphalia) (WWU) 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 the Universidade Nova to Lisboa: All Professors designated by the scientific council as responsible for a specific course.
3. at the Universitat Jaume I: 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 the University of Münster, and Universitat Jaume I, the examination board appoints the examiners and assessors of the module „Master thesis“ according to § 9-5. As for the Universidade Nova to Lisboa, 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, University of Münster; Universitat Jaume I, and at NOVA IMS - Universidade Nova de Lisboa by any professor holding at doctorate degree.
2. with permission of the examination board, or the scientific council in the case of Universidade Nova de Lisboa, 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 University of Münster 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 can be taken into consideration upon the student's request when documentation is provided, as long as these are equivalent in terms of content and level to the required coursework and degree-relevant examinations which they replace.

(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 programmes are to be recognised, 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, withdrawl, 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 University of Münster, examinations may not be conducted if the University of Münster does not let students take an active role in their education in accordance with the Maternity Protection Act (Mutterschutzgesetz).

(2) Reasons for absence or withdrawl 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 University of Münster, Universitat Jaume I, or Universidade Nova de Lisboa, 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 Universitat Jaume I, Castellón, or the Universidade Nova de Lisboa.

(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				**7,5**
	Geographic Information Science	lecture/practical	2	7,5
Module 2: Advanced Topics in Geographic Information Science I (1 of 2 courses)				**7,5**
	Spatial Analysis and Visualization	lecture/practical	2	7,5
	Remote Sensing	lecture/practical	2	7,5
Module 3: Analytical Tools (2 out of 3 courses)				**15**
	Spatial Statistics	lecture/practical	2	7,5
	Geospatial Datamining	lecture/practical	2	7,5
	Group Project Seminar on Programming and Analysis	lecture/practical	6	5
				Sub-total: 30 credit points
UJI				
Module 1: Foundations of Informatics				**10**
	Programming	lecture + practicals		4
	Databases and Data Management	lecture + practicals		3
	Artificial Intelligence and Machine Learning	lecture + practicals		3
Module 2: Advanced Informatics and Data Analytics				**12**
	Data Science	lecture + practicals		4
	Development of Applications for Geographic Data Exploration and Visualization	lecture + practicals		5
	Spatial Data Services, Sources, Standards and Infrastructures	lecture + practicals + self-study		3
Module 3 Geospatial Technologies				**8**
	Geographic Information Systems: Desktop to Web	lecture + practicals		3
	Geographic Information Systems applications and trends	lecture + practicals		2
	Earth Observation and Remote Sensing	lecture + practicals		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 WWU)				
WWU				
Module 4: Foundations of Geographic Information Science II				**4**
	Core Topics in Geographic Information Science	seminar	2	2
	GI Forum	lecture	1	1
	GI Forum Discussion Group	seminar	1	1
Module 5: Advanced Topics in Geographic Information Science II (2 of 5 courses)				**10**
	Location-based services	practical/seminar	4	5
	Spatial cognition	practical/seminar	4	5
	Study project	practical	2	5
	Programming in GI	practical/seminar	4	5
	Reference Systems	practical/seminar	4	5
	According to upcoming research fields, courses might be added or replaced			5
Module 6: Applied Topics in Geographic Information Science				**10**
	From data to knowledge	practical/seminar	4	5
	Applied topics: Students choose one out of the following courses 1. Applied geospatial technologies 2. Advanced digital cartography 3. According to upcoming research fields, courses might be added or replaced.	practical/seminar	4	5
Module 7: Transferable Skills				**6**
	Project management/GeoMundus conference	practical/seminar	2	3
	Research methods in GI Science	seminar	2	3
				Sub-total: 30 credit points
3. Semester (at WWU, 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 perfomance 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 perfomance 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 at
1. University of Münster: First position after the decimal point
2. Universidade Nova de Lisboa: Not after the decimal point
3. Universitat Jaume I: 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 University of Münster. Furthermore, the Master thesis has to be provided as a digital version (pdf) to the University of Münster, to Universitat Jaume I, and to NOVA IMS - Universidade Nova de Lisboa.

(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 Universidade Nova de Lisboa no papers versions are submitted, on a single digital file. The delivery has to be documented. In case of the Universidade Nova de Lisboa, 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 University of Münster and Universidade Nova de Lisboa, 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 University of Münster and Universitat Jaume I, the examiners of the defense have to agree on a common grade. At the Universidade Nova de Lisboa 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 University of Münster and Universitat Jaume I, the grade of the “module Master thesis“ is weighed by 75 % for the Master thesis and 25 % for the defense – a failure in the defense is automatically a failure in the “module Master thesis”. At Universidade Nova de Lisboa 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 University of Münster.

(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 University of Münster, 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, University of Münster, Nova Information Management School (NOVA IMS) of the Universidade Nova de Lisboa Instituto Superior de Estatística e Gestão de Informação, and Universitat Jaume I (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: Universitat Jaume I; University of Münster; Universidade Nova de Lisboa

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 University of Münster; by the Rector for the Universidade Nova de Lisboa and the Universitat Jaume I)

(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 Westfälische Wilhelms-Universität Münster, Faculty of Geosciences, Germany Universitat Jaume I, Castellón, Spain, and Nova Information Management School of the Universidade Nova de Lisboa, Instituto Superior de Estatística e Gestão de Informação, Lisboa, Portugal.

§ 24 Coming into force, and publication

The examination regulations are coming into force on 01.09.2020.

Ausgefertigt aufgrund des Fachbereichsratsbeschlusses des Fachbereichs Geowissenschaften vom 13. Mai 2020. 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 30. Oktober 2020

Der Rektor

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

Anhang: Modulbeschreibungen – Module Description

Program description

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

- Westfälische Wilhelms-Universität Münster (WWU), 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), and project reference FPA-2016-2054 (2016-2021).

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 WWU. 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. 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)	7,5
Workload (h) in total	210
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 module is organized in four Learning Units (LU) in a single course:
1. GEOGRAPHIC INFORMATION SCIENCE
LU1. An introduction to Geographic Information Science (GISc)
1. The importance and the particularities of Geographic Information
2. Geospatial Awareness - Understanding the distinctive features of geographic data
3. From Geospatial Awareness to GISc
4. Towards a GISc definition
5. A history of Geographic Information Systems (GIS)
LU2. Components of Geographic Information Science
6.Ontology and Representation
7.Geocomputation
8.Cognition
9.Applications, Institutions and Society

10.Crosscutting Research Themes: Time and Scale

LU3. Functional Components of GIS

11.The 4 M's activities that can be enhanced through the use of GIS: Measurement; Mapping; Monitoring; Modeling

12. An Holistic Model of GIS

13.GIS Functional Components: Input; Storage and Management; Manipulation and analysis; Output

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: 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 be aware of future challenges LO2: Identify the properties of Geographic Information (GI) LO3: Recognize the importance of GI at present LO4: Understand how GIS is applied 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 GISc's 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

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	182
Elective options within the module			NA			

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	partial	Midterm 1 (written test)	2h	1	0,25
1	partial	Midterm 2 (written test)	2h	1	0,25
1	partial	Term paper	30min	1	0,45
1	partial	Participation	Semester	1	0,05
Weight of the module grade for the final overall grade		7,5/85			
Required coursework					
Type	Type		Type	Type	Type
-					

5	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

6	CP allocation	
Participation (= attendance time)	Course no. 1	0
Examination(s)	Course no. 1	7,5
Assignment(s)	Course no. 1	0
Degree-relevant examination(s)		7,5

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

9	Miscellaneous
	-

2. 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)	7,5
Workload (h) in total	210
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, one out of two courses will be chosen.

The curricular unit in Spatial Analysis and Visualization aims at providing students with a practical introduction to principles, methods, and techniques of geographical information systems (GIS) analysis and visualization. The practical component of the course is based on ESRI software although the use of other tools is also encouraged. Several tutorials will be solved during the classes after a short introduction to the concepts being covered. Students are expected to learn how to acquire the data, model, analyze, visualize and develop a GIS application for sharing the results. Ideally the final project work will fit the objectives of the student's final master project/thesis and/or will be submitted to a conference or an academic journal.

Satellite remote sensing (digital images acquired by satellites) is nowadays an essential tool for characterizing and monitoring the Earth. The main objectives of this course are to understand the potentialities of satellite images as a source of spatial data of the territory, and to know how to apply automatic methods for satellite image information extraction. In addition, it is expected that students at the end of the course understand the remote sensing principles, are able to select a satellite/sensor for a specific project and can identify most important socio-economic benefits of remote sensing.

Teaching content

The module is composed one out of the two following courses:

1. SPATIAL ANALYSIS AND VISUALIZATION
2. REMOTE SENSING

1. SPATIAL ANALYSIS AND VISUALIZATION is organized in 10 learning units (LU):

LU1. Introduction to GIS
LU2. Spatial data and data management
LU3. Spatial data input and manipulation
LU4. Spatial analysis

LU5. Spatial statistics
LU6. Terrain analysis
LU7. Spatial visualization
LU8. Spatial decision analysis and modelling
LU9. WebGIS and GIS as a service
LU10. GIS Applications
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 11 learning units (LU):
LU1. Introduction to remote sensing and to the course
LU2. Remote sensing principles
LU3. Characteristics of Earth observation satellites and sensors
LU4. Exploratory analysis
LU5. Image pre-processing
LU6. Band transformations
LU7. Image information extraction
LU8. Multi-temporal image analysis
LU9. Socioeconomic benefits of remote sensing
LU10. Practical exercises on satellite image processing
LU11. 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
- Social competences: working within small 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 can these 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: How to create effective spatial visualizations for analysis and sharing the results.
LO8: To develop spatial multicriteria evaluation models for decision making.
LO9: To share results in WebGIS/cloud environments.
LO10: To create GIS applications for web and smartphones.

REMOTE SENSING:
LO1: Describe the types of measurements in remote sensing and explain why satellite images can be used to produce geographic information

LO2: Develop in an autonomous way a project to produce information based on satellite images with a spatial resolution from 1m to 1000m LO3: Select the satellite and sensor more adequate to use on the production of different types of information on different spatial scales LO4: Describe and apply classification algorithms of spectral, spatial and temporal patterns of satellite images in order to derive information LO5: Assess and interpret the error within information derived from satellite images LO6: Describe and evaluate the social economic benefits of remote sensing

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	L/P		Spatial Analysis and Visualization	M	28/2	182
or						
2	L/P		Remote Sensing	M	28/2	182
Elective options within the module			Students take at least one of the two courses of the module			

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	Partial	GIS exercise	25h	1	0,10
2	Partial	Test	2h	1	0,24
3	Partial	Project report and presentation	60 pages/15 min.	1	0,60
4	Partial	Web courses	15h	1	0,06
or					
5	Partial	Midterm	2h	2	0,30
6	Partial	Essay on Remote Sensing socio-economic benefits	15 minutes	2	0,24
7	Partial	Project	60h	2	0,40
8	Partial	Participation	Semester	2	0,06
Weight of the module grade for the final overall grade		7,5/85			
Required coursework					
Type	Type		Type	Type	Type
-					

5	**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

6	CP allocation	
Participation (= attendance time)	Course no. 1	0
	Or Course no. 2	0
Degree-relevant examination(s)	Course no. 1	7,5
	Or Course no. 2	7,5
Required coursework	Course no. 1	0
	Course no. 2	0
Total CP		7,5

7	Mobility / Recognition
Frequency	Fall semester
Module representative	Pedro Cabral
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

9	Miscellaneous
	-

3. Analytical Tools

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Analytical Tools**
Module number	3 (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 Analytical Tools 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 curricular unit of Spatial Statistics will explore the concepts of standard geostatistics and spatial statistics.
Students will acquire theoretical knowledge, as well as skills and abilities in tools for Exploratory Spatial Data Analysis (ESDA), deterministic and geostatistical procedures for spatial interpolation, and spatial regression methods. Students are expected to evaluate the potential of spatial statistics for their own research.

The curricular unit of Geospatial Datamining (GSDM) aims to present the methodology of data mining, as well as its main tools and further emphasize the specifics that exist in geospatial data exploration. Thus, by the end of this course students should have a good understanding of the main tools of data mining, as well as critical thinking regarding its application in the context of geographic information science (GISc).

The curricular unit of Group Project Seminar on Programming and Analysis is an additional and optional course in the semester break. It gathers all the competences acquired during the semester. The students apply the competences in a real project. Furthermore, the students acquire programming skills to support project development.

Teaching content

The module consists of three courses:

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

1. SPATIAL STATISTICS is organized in four Learning Units (LU):
LU1. Exploratory Data Analysis
- Introduction
- General concepts on data description

- 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
- Univariate kriging
LU4. Geographically Weighted Regression
- General concepts on regression analysis
- Ordinary Least Squares (OLS)
- Geographically Weighted Regression (GWR)
Conveyed competences are:

- Expertise: modelling, examining, and exploring spatial patterns and spatial relationships
- Methodological competences: analysis of surfaces, statistical techniques and concepts, geostatistical methods
- Learning competences: analysis 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

2. GEOSPATIAL DATAMINING is organized in in four Learning Units (LU):

LU1. Introduction to Data Mining
- Introduction to Data Mining: definition, tools and tasks
- Implications of the Geo prefix.

LU2. The role of Data in Data Mining
- Data preparation
- Data pre-processing

LU3. Unsupervised Classification (clustering)
- Introduction to unsupervised classification (k-means)
- Introduction to unsupervised classification (self-organizing maps)

LU4. Supervised Classification (predictive modelling)
- Introduction to supervised classification (predictive modelling)
- Introduction to supervised classification (classification trees)
- Introduction to supervised classification (neural networks)

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 method to analyze geospatial data.
- Social competences: working within small teams, working across interdisciplinary teams, communication and presentation skills

3. GROUP PROJECT SEMINAR ON PROGRAMMING AND ANALYSIS is organized as a seminar with one Learning Unit LU1)

LU1. Programming in Geographic Information Science

Conveyed competences are:

- Expertise: Programming, geospatial data analysis, external data sources, LISA, clustering data
- Methodological competences: data acquisition, data processing, project management techniques
- Learning competences: develop technological solutions for diverse applications, present solutions to an interdisciplinary audience

- Social competences: team work, working across interdisciplinary teams, 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:

SPATIAL STATISTICS:
LO1: Compute descriptive statistics and use tools for Exploratory Spatial Data Analysis (ESDA)
LO2: Describe the main characteristics and patterns of spatial data
LO3: Discuss the differences between different types of spatial interpolators
LO4: Describe the cross-validation and validation processes
LO5: Explain the purpose of different prediction errors' statistics
LO6: Interpret the variogram model's parameters
LO7: Acquire a good mastership of variogram modelling
LO8: Discuss the differences between Simple, Universal and Ordinary kriging
LO9: Make surface predictions using Inverse Distance Weighting and Ordinary kriging, calibrate the model and validate the results
LO10: Discuss the advantages/drawbacks of deterministic and kriging approaches
LO11: Understand the linear regression model and its limitations; know how to diagnose and apply corrections to some problems of Ordinary Least Squares
LO12: Understand the Geographically Weighted Regression model and its limitations; apply and interpret its results

GEOSPATIAL DATAMINING:
LO1: Define Data Mining;
LO2: Explain the characteristic features of Data Mining;
LO3: Explain why Data Mining can be a valuable addition in the context of GIScience;
LO4: Discuss the implications of the geo prefix in Geographic Data Mining;
LO5: Understand the basic data preparation and pre-processing tasks;
LO6: Understand the k-means algorithm and how it works;
LO7: Understand what a Self-Organizing Map is and how it works;
LO8: Autonomously use Self-Organizing Maps in unsupervised classification tasks;
LO9: Understand what a Classification Trees is and how it works;
LO10: Understand what a Multi-Layer Perceptron Neural Network is and how it works;
LO11: Autonomously use Classification Trees and Multi-Layer Perceptron Neural Networks in supervised classification tasks.

GROUP PROJECT SEMINAR ON PROGRAMMING AND ANALYSIS:
LO1: To learn how to work in an interdisciplinary and in group
LO2: To demonstrate ability to apply knowledge, methods and techniques acquired in other curricular units of the study cycle
LO3: To demonstrate ability to integrate knowledge acquired in other curricular units
LO4: To be able to produce quality professional work using geographic Information
LO5: To produce project proposals and reports
LO6: To able to use a programming language to build a project

3	Structure

Module components

No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	T/P	-	Spatial Statistics	M	28/2	182
2	T/P	-	Geospatial Datamining	M	28/2	182
3	T/P	-	Group Project Seminar on Programming and Analysis	M	24	116
Elective options within the module			The curricular unit of Group Project Seminar on Programming and Analysis is an additional and optional course in the semester break.			

4	Examination structure

Degree-relevant examination(s)

No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	Partial	Graded Assignment 1	Report	1	0,08
2	Partial	Graded Assignment 2 (report)	Report	1	0,05
3	Partial	Written Exam	2h	1	0,15
4	Partial	Oral presentation of project	15min	1	0,05
5	Partial	Project	Report	1	0,18
6	Partial	Graded Assignment 1	Report	2	0,05
7	Partial	Graded Assignment 2	Report	2	0,05
8	Partial	Graded Assignment 3	Report	2	0,12
9	Partial	Graded Assignment 4	Report	2	0,12
10	Partial	Written Exam	2h	2	0,15
Weight of the module grade for the final overall grade		15/85			

Required coursework

Type	Type	Type	Type	
-	-			

5	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

6	CP allocation	
Participation (= attendance time)	Course no. 1	0
	Course no. 2	0
	Course no. 3	0
Degree-relevant examination(s)	Course no. 1	7.5
	Course no. 2	7.5
	Course no. 3	5.0
Required coursework	Course no. 1	0
	Course no. 2	0
	Course no. 3	0

Total CP		15

7	**Module administration**
Frequency	Fall semester
Module representative	Ana Cristina Marinho da Costa
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

9	**Miscellaneous**

4. Informatics

Degree programme	**Master of Science in Geospatial Technologies**
Module	**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)	mandatory

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: 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: normalization, regularization, feature selection.
LU3. Classification problems: K-Nearest Neighbor and variants. 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: 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

3. 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	40	60
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/ MCE	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		12/85			
Required coursework					
Type	Type		Type	Type	
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	**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

6	**CP allocation**	
Participation (= attendance time)	Course no. 1	1.6 CP
	Course no. 2	1.2 CP
	Course no. 3	0.8 CP
Degree-relevant examination(s)	Course no. 1, ex. 1	0.8 CP
	Course no. 1, ex. 2	1.2 CP
	Course no. 2, ex. 1	1.15 CP
	Course no. 2, ex. 2	0.49 CP
	Course no. 3, ex. 1	0.95 CP
Required coursework	Course no. 1, assign. 1	0.4 CP
	Course no. 2, assign. 1	0.04 CP
	Course no. 2, assign. 2	0.04 CP
	Course no. 2, assign. 3	0.04 CP
	Course no. 2, assign. 4	0.04 CP
	Course no. 3, assign. 1 (LU2)	0.1 CP
	Course no. 3, assign. 2 (LU3)	0.1 CP
	Course no. 3, assign. 3 (LU4)	0.1 CP
	Course no. 3, assign. 4 (LU5)	0.1 CP
	Course no. 3, assign. 5 (LU6)	0.1 CP
Total CP		10 CP

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 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. 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).

5. 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)	Mandatory

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
- 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, infrastructures

This course gives the student basic knowledge about WebGIS platforms, and an ample perspective about the complexity and multidisciplinary dimensions that characterizes modern scientific research and industrial projects. The first part deals with WebGIS platforms, and the dissemination of geospatial data through map, feature and coverage web services. Special attention is paid to the application of Internet Technologies to Geographic Information Systems (GIS), as is the case of WebMapping tools and mobile applications used to

capture and validate GIS data in the field. The second parts deals with data sources, standards and infrastructures, both from a theoretical and practical point of view. While spatial referenced datasets and resources, widely-used geo standards and geographic information infrastructures have traditionally taken a traversal role in multidisciplinary projects and applications, students should be aware that, due to new paradigms and technological advances and trends, new sources of information are coming out alongside corresponding standards and information infrastructures. The student learns to take a holistic view in order to properly formulate a project requirements/question and make informed decisions with respect to finding new, complementary data sources, standards and other infrastructures that might be connected and bridged with the geospatial world. As such, the focus will be more on the wide spectrum of available data sources. Besides, the student learns the importance of considering, at the same level of the technical aspects, aspects related to responsible research and innovation such as ethics, government and gender equality, in the process of developing software solutions, as these solutions may have a different impact depending on the type of end user (e.g., civil society, research, education, industry, policy makers, etc.).
The course consists of 9 learning units. The first treats basics of GIS servers, the second discusses GIS web services and types, the third discusses caching techniques for GIS services, the fourth explains online WebGIS platforms and web mapping applications to exemplify geospatial services, and the fifth handles live data and dashboards. Unit 6 discusses issues related to data sources (how to find them, judge suitability, novel data sources). Unit 7 discusses well known data standards, and unit 8 well known data infrastructures. Finally, unit 9 pays attention to responsible research and innovation.
Learning units:
LU1. GIS Servers - evolution of server-based GIS, sharing geographic information, connecting to a GIS server, (Author – Share – Use) GIS services, managing GIS servers for performance and scalability
LU2. GIS Web Services Types - GIS services, map service, geoprocessing service, image service, standards (e.g., OGC)
LU3. Dynamic vs Cached Services - map caching benefits, cached services Vs dynamic services, authoring and caching map services, tiling schemas
LU4. Consuming Geospatial Services - Web and mobile data collection, online WebGIS Platforms, Webmaps, Web mapping application templates, configuring a Web editing application for field data collection
LU5. Dashboards and live data – live feeds, GeoRSS, dashboards, connecting graphs and charts to feature services
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, process design, cocial 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 know how 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.
L10: To know the basic concepts of RRI and the implications of not considering them.

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h)	Self-study (h)
1	Lecture / Practical	-	Data science	M	40	60
2	Lecture / Practical	-	Development of Applications for Geographic Data exploration and visualization	M	50	75
3	Lecture / Practical / Self-study	-	Spatial data service, sources, standards, infrastructures	M	30	45
Elective options within the module						

4	Examination structure				
Degree-relevant examination(s)					
No.	FME/ MCE	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		12/85			
Required coursework					
Type	Type		Type	Type	
2	Practical HomeWork		Max 4 pages	2	

5	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

6	CP allocation	
Participation (= Attendance)	Course no. 1	1.6 CP
	Course no. 2	2.0 CP
	Course no. 3	1.2 CP
Examination(s)	Course no. 1, ex. 1	0.72 CP
	Course no. 1, ex. 2	0.72 CP
	Course no. 1, ex. 3	0.96 CP
	Course no. 2, ex. 1	0.6 CP
	Course no. 2, ex. 2	0.9 CP
	Course no. 2, ex. 3	0.5 CP
	Course no. 2, ex. 4	0.5 CP
	Course no. 3, ex. 1	0.33 CP
	Course no. 3, ex. 2	0.33 CP
	Course no. 3, ex. 3	0.33 CP
	Course no. 3, ex. 4	0.33 CP
	Course no. 3, ex. 5	0.48 CP
Assignment(s)	Course no. 2, assign. 1	0.25 CP
	Course no. 2, assign. 2	0.25 CP
Total CP		12 CP

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. 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.

6. 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)	mandatory

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: 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
- 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 form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h)	Self-study (h)
1	Lecture / Practical	-	Geographic Information Systems: Desktop to Web	M	30	45
2	Lecture / Practical	-	Geographic Information Systems applications and trends	M	20	30
3	Lecture / Practical	-	Earth Observation and Remote Sensing	M	30	45
Elective options within the module						

4	Examination structure				
Degree-relevant examination(s)					
No.	FME/ MCE	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		8/85			
Required coursework					
Type		Type	Type	Type	
-					

5	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

6	CP allocation	
Participation (= attendance time)	Course no. 1	1.2 CP
	Course no. 2	0.8 CP
	Course no. 3	1.2 CP
Degree-relevant examination(s)	Course no. 1, ex. 1	0.72 CP
	Course no. 1, ex. 2	0.54 CP
	Course no. 1, ex. 3	0.54 CP
	Course no. 2, ex. 1	0.48 CP
	Course no. 2, ex. 2	0.72 CP
	Course no. 3, ex. 1	0.40 CP
	Course no. 3, ex. 2	0.40 CP
	Course no. 3, ex. 3	0.40 CP
	Course no. 3, ex. 4	0.60 CP
Required coursework	-	-
Total CP		8 CP

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.

7. Foundations of Geographic Information Science II

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

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: core concepts of Geographic Information Science
- Methodological competences: scientific reading, scientific discourse
- Learning competences: analysis of scientific content,

- 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
- 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
- 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 form	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			N/A			

4	Examination structure				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	MAP	Final written assignment	1500-2500 words	1	2/2
Weight of the module grade for the final overall grade		2/85			
Required coursework					
No.	Type		Duration/ Scope	Connection to course no. if appl.	
1	Reading a publication and preparing discussion by questions		3 questions x 7 sessions	3	

5	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 course 2 and 3 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

6	CP allocation	
Participation (= attendance time)	no. 1	1 CP
	no. 2	1 CP
	No. 3	0.5 CP
Degree-relevant examination(s)	No. 1	1 CP
Required coursework	No. 3	0.5 CP
Total CP		4 CP

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

8	Mobility / Recognition
Usability in other degree programmes	N/A

9	Miscellaneous
	N/A

8. 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 (WWU)

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. Study project (5 CP)
4. Programming in GI (5 CP)
5. Reference Systems (5 CP)
6. According to upcoming research fields, courses might be added or replaced.

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
- 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
- Social competences: oral presentations, group discussions, communication skills

3. 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
- Social Competences: teamwork, communication skills

4. Programming in GI

Learning units:

- LU 1: Introduction to different Python libraries for spatial data analysis
- LU 2: Processing and editing input data of different formats in Python
- LU 3: Spatial Data Analysis in Python
- LU 4: Visualization and further processing of results
- LU 5: Integrating Python with GIS

Conveyed competences are:

- Expertise: Python libraries for spatial data analysis
- Methodological: Using Python and basic Python 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
- Social: Presenting research results, working in a team on a research project, writing a scientific report

5. Reference systems

Learning units:

- LU 1: Mathematical, physical and semantic foundations for referencing spatial and spatiotemporal information
- LU 2: Theory and practice of spatial reference systems, coordinate conversions and coordinate transformations
- LU 3: Introduction to temporal reference systems
- LU 4: Introduction to thematic and semantic reference systems

Conveyed competences are:

- Expertise: Understanding of spatial, temporal, and semantic reference systems in GIS
- Methodological Competences: Usage of R, understand how reference systems work in GIS
- Learning Competences: self-study, group exercises
- Social Competences: group discussions, communication skills

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. 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 4. Programming in GI • LO 1: Read and write vector data • LO 2: Perform attribute filters and spatial filters on vector layers • LO 3: Access features and their attributes in a vector layer • LO 5: Add and remove features in a vector layer • LO 6: Add and remove fields in a vector layer attribute table • LO 7: Analyze relations between vector attributes • LO 8: Read and write raster data • LO 9: Access and change the metadata of a raster • LO 10: Create QGIS plugins • LO 11: Create ArcGIS script tools • LO 12: Plot maps and graphs of vector and raster data 5. Reference systems • LO 1: Understand the foundations of referencing spatial information, such as geodetic datums, map projections, coordinate transformations, temporal systems or semantic translations • LO 2: Understand and compare key elements of different spatial reference systems and the underlying representations of the world • LO 3: Understand and explain the influence of spatial referencing on measurements in spatial data • LO 4: Apply mathematical techniques for conducting manual coordinate transformations • LO 5: Design and execute datum transformations • LO 6: Describe spatial, temporal and attribute reference systems of different spatial data sets

3	Structure					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Practical	-	First selected course out of 5 courses	M	60/4	90
2	Practical	-	Second selected course out of 5 courses	M	60/4	90
	Practical		In case of study project has been selected		30/2	120
Elective options within the module			For the module, students select two out of five courses.			

4	Examination structure				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	partial	Depending on the selected course: 1. Essay on a topic discussed in the course 2. Oral presentation 3. Technical report on implementation of project including oral presentation 4. Written Report on final programming assignment 5. Written Exam	Depending on the selected course: 1. Max. 4 pages 2. 45 minutes 3. 8-12 pages, 15 minutes 4. 8-12 pages 5. 30 minutes	-	5/10
2	partial	Depending on the selected course: 1. Essay on a topic discussed in the course 2. Oral presentation 3. Technical report on implementation of project including oral presentation 4. Written Report on final programming assignment 5. Written Exam	Depending on the selected course: 1. 8-12 pages 2. 45 minutes 3. 8-12 pages, 15 minutes 4. 8-12 pages 5. 30 minutes	-	5/10
Weight of the module grade for the final overall grade		10/85			

Required coursework				
No.	Type	Duration/ Scope	Connection to course no. if appl.	
1	Depending on the selected course: 1. For each exercise session, a short presentation of a scientific publication on the topic discussed in the lecture of the corresponding week 2. none 3. none 4. none 5. regular written exercises	Depending on the selected course: 1. ca. 2 min. each 2. - 3. - 4. - 5. 2-5 pages each		
2	Depending on the selected course: 1. For each exercise session, a short presentation of a scientific publication on the topic discussed in the lecture of the corresponding week 2. none 3. none 4. none 5. regular written exercises	Depending on the selected course: 1. ca. 2 min. each 2. - 3. - 4. - 5. 2-5 pages each		

5	**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 miss up to 2 of the weekly sessions in each of the two courses.

6	CP allocation	
Participation (= attendance time)	First selected course out of 5 courses	1. 2 CP 2. 2 CP 3. 1 CP 4. 2 CP 5. 2 CP
	Second selected course out of 5 courses	1. 2 CP 2. 2 CP 3. 1 CP 4. 2 CP 5. 2 CP
Degree-relevant examination(s)	First selected course out of 5 courses	1. 1 CP 2. 3 CP 3. 4 CP 4. 3 CP 5. 1 CP
	Second selected course out of 5 courses	1. 1 CP 2. 3 CP 3. 4 CP 4. 3 CP 5. 1 CP
Required coursework	First selected course out of 5 courses	1. 2 CP 2. – 3. – 4. – 5. 2 CP
	Second selected course out of 5 courses	1. 2 CP 2. – 3. – 4. – 5. 2 CP
Total CP		10 CP

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

8	Mobility / Recognition
Usability in other degree programmes	-

9	Miscellaneous
	-

9. Applied Topics in Geographic Information Science

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

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 and advanced digital cartography, e.g., 3D.

Teaching content

The module consists of two courses:

1. From data to knowledge (5 CP)
2. Applied topics: Students choose one out of the following courses
   2.1 Applied geospatial technologies (5 CP)
   2.2 Advanced digital cartography (5 CP)
   2.3 According to upcoming research fields, courses might be added or replaced.

1. From data to knowledge

Learning units:

- LU1: Introduction: related theories, technologies, and information
- LU2: Spatial problem identification
- LU3: Implementation period - the instructor will be in the role of assisting students by demonstrating necessary software and technologies, as well as seeking solutions to particular group's problems
- LU4: Student's demonstration of their project

Conveyed competences are:

- Expertise: applying geospatial technologies, design and implementation of web applications
- Methodological competences: data collection, information retrieval, knowledge generation through geospatial technologies, applying scientific methods on real-world problems, using case studies as a scientific method
- Learning competences: disseminating scientific results (orally, written), designing tools for solving real-world problems, understanding to generate knowledge out of raw data

- Social competences: working in small teams, communication and presentation skills

2.1 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

2.2. Advanced digital cartography
Learning units:

- LU1: Introduction
- LU2: Theoretical background, open data, commercial data sources, map making and production in 2D and 3D
- LU3: Design tasks and assignment of individual map projects to the students
- LU4: Discussion of intermediate results
- LU5: Students' presentations of map projects

Conveyed competences are:

- Expertise: apply GIS and related software to visualize and transform geodata.
- Methodological competences: master the fundamental methods of mapping geospatial information.
- Learning competences: learn to solve larger spatial analysis and presentation tasks in small groups; apply computational methods to related geospatial data.
- Social competences: small team work; cope with larger computational challenges in various tools under strict time constraints.

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:
1. From data to knowledge

- LO1: Critical understanding of problems that exist in the geospatial and related domains
- LO2: Capability to design tools to address the above mentioned problems
- LO3: Know-how of the necessary steps of planning, organizing, executing, and finalizing a project utilizing geospatial technologies
- LO4: Capability to successfully implementing project with geospatial technologies to address particular research questions
- LO5: Skills to disseminate research results in both written and oral formats professionally

2.1 Unmanned aerial vehicles

- 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

2.2. Advanced digital cartography

- LO1: Understanding of thematic maps as geospatial information products
- LO2: Know-how to use standard GIS mapping functionality adequately and productively
- LO3: Developed sense of map usability and aesthetics
- LO4: Capability to apply the theories of thematic mapping
- LO5: Know-how to design the supplementary map elements: title, legend, grid, impressum, data sources and rights
- LO6: Capability to carry out a map design from the stage of planning through data acquisition and analysis to presentation
- LO7: Capability to criticize map designs and improve them.

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Practical/seminar	-	From data to knowledge	M	60/4	90
2	Practical/seminar	-	One selected course out of 2 courses	M	60/4	90
Elective options within the module			For course 2, students select one out of two courses. On student's request and with justified reasons, students may select one of the courses of module 5 instead of course 2 of this module.			

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	Partial	Group project (oral presentation and written report)	15 min./max. 30 pages per group	-	5/10
2	Partial	Depending on the selected course: 1. Group project (oral presentation and written report) 2. Mapping project	Depending on the selected course: 1. 15 min./max. 30 pages per group 2. 1 map + max. 5 pages description	-	5/10
Weight of the module grade for the final overall grade		10/85			
Required coursework					
No.	Type		Duration/ Scope	Connection to course no. if appl.	
1	3 x oral presentations of intermediate results		15 min. per group	1	
2	Depending on the selected course: 6. 2 x oral presentation of intermediate results 7. Mapping project intermediate results		Depending on the selected course: 6. 15 min. per group	2	

		7. 1 map + max. 5 pages description		

5	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 miss up to 2 of the weekly sessions in each of the two courses.

6	CP allocation	
Participation (= attendance time)	From data to knowledge	2 CP
	Selected course out of 2 courses	2 CP
Degree-relevant examination(s)	From data to knowledge	1 CP
	Selected course out of 2 courses	1 CP
Required coursework	From data to knowledge	2 CP
	Selected course out of 2 courses	2 CP
Total CP		10 CP

7	Module administration
Frequency	Summer semester
Module representative	Dr. Christoph Brox
Responsible faculty	WWU - FB 14 - Geosciences

8	Mobility / Recognition
Usability in other degree programmes	-

9	Miscellaneous
	-

10. Transferable skills

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

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 prepares 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. 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
- 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 form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Practical/seminar	-	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/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	module	thesis proposal	Max. 10 pages	2	3/3
Weight of the module grade for the final overall grade		3/85			
Required coursework					
No.	Type		Duration/ Scope	Connection to course no. if appl.	
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	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" convey discourse competences, which cannot be acquired in self-studying. Therefore, students may miss up to 2 of the weekly sessions in each of the two courses.

6	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

7	Module administration
Frequency	Summer semester
Module representative	Dr. Christoph Brox
Responsible faculty	WWU – FB 14 Geosciences

8	Mobility / Recognition
Usability in other degree programmes	-

9	Miscellaneous

11. Master thesis

Degree programme	**Master of Science in Geospatial Technologies**
Module	**Master thesis**
Module number	8 (WWU 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 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 (WWU 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 too 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 form	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/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	partial	Master thesis (at WWU and UJI)	60 pages	1	22.5/30
2	partial	Master thesis defence (at WWU and UJI)	Max. 1 hour	1	7.5/30
3	module	Master thesis including defence (at UNL)	60 pages/90 min.	1	30/30
Weight of the module grade for the final overall grade			30/85		

Required coursework

No.	Type	Duration/ Scope	Connection to course no. if appl.	
1	Presentation of intermediate thesis results	Max. 15 min.	2	

5	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 examinations and assignments that the module-related learning outcomes have been achieved.
Rules on course attendance	-

6	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

7	Module administration
Frequency	Winter semester
Module representative	Dr. Christoph Brox/Prof. Dr. Marco Painho/Prof. Dr. Joaquín Huerta

Responsible faculty	WWU – Institute for Geoinformatics/UNL/UJI

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

9	**Miscellaneous**