Module Description – M.Sc. in Geospatial Technologies

15.10.13

Program description

The international Master's 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 (ISEGI), Lisboa, Portugal.

The Master's program in Geospatial Technologies has been selected within the program of excellence of the EU, Erasmus Mundus, project reference 2007-0064/001 FRAME MUNB123. The Master's program has been reselected for another five editions, starting in 2012, project reference FPA-2012-0191.

The Master's 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's 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's 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.

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)	Exami-nations
1. Semester (at UNL or UJI)					
UNL					
Module 1: Mathematics and Statistics (1 of 2 courses)				**7,5**	
	Geostatistics	lecture/practical	2	7,5	1
	Data analysis	lecture/practical	2	7,5	1
Module 2: Data modeling (1 of 2 courses)				**7,5**	
	Geospatial datamining	lecture/practical	2	7,5	1
	Database management systems	lecture/practical	2	7,5	1
Module 3: GI basics (2 of 4 courses)				**15**	
	Geographic Information Systems	lecture/practical	2	7,5	1
	Remote sensing	lecture/practical	2	7,5	1
	GIS applications	lecture/practical	2	7,5	1
	Group project seminar	lecture/practical	1	6	1
				Sub-total: 30 credit points	
UJI					
Module 1: Informatics and Mathematics				**12**	
	Programming	lecture + practicals		4	1
	Spatial databases	lecture + practicals		4	1
	Software engineering	lecture + practicals		2	1

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)	Exami-nations
	Applied mathematics: logic and statistics	lecture + practicals		2	1
Module 2: New technologies				**12**	
	Spatial data visualization	lecture + practicals		3	1
	Multimedia	lecture + practicals		3	1
	Remote sensing applications	lecture + practicals		3	1
	Web and mobile GIS	lecture + practicals		3	1
Module 3: GI basics				**6**	
	Introduction to GIS	lecture + practicals		3	1
	Spatial analysis	lecture + practicals		2	1
	Spatial data infrastructures	e-learning		1	1
				Sub-total: 30 credit points	
2. Semester (at WWU)					
WWU					
Module 4: Fundamentals of Geographic Information Science				**10**	
	Digital Cartography	e-Learning/practical	4	5	1
	Reference Systems for Geographic Information	lecture/practical	4	5	1
Module 5: Advanced Topics in Geographic Information Science				**14**	
	Selected Topics in GI	lecture/practical	4	5	1
	Usage-centered design of geospatial applications	seminar	2	2	1
	Applications of GI within and outside geosciences	lecture/practical	4	5	1
	Geoinformatics forum and discussion group	seminar	2	2	Participation
Module 6: Core competences				**6**	
	Research methods in GIScience	practical	2	3	1
	Project management/GeoMundus conference	practical	2	3	1 (not graded)
				Sub-total: 30 credit points	
3. Semester (at WWU, UNL, or UJI)					

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)	Exami-nations
Thesis					
	Master thesis seminar			2	Participation
	Master thesis including defense			28	1
				Sub-total: 30 credit points	
Total				***Total: 90 credit points***	

In the following, please find the detailed descriptions of all modules.

Module description

Module 1: Mathematics and Statistics (ISEGI)

0	**Overall goals**	Learning basic concepts needed for a structured understanding of the fundamental concepts of inferential and descriptive statistics and data analysis, also needed for professional skills
1	**Courses (1 out of 2)**	7,5 of 15 credit points: Geostatistics (lecture and practical/2 semester hours per week/7,5 CP) Data analysis (lecture and practical/2 semester hours per week/7,5 CP)
1.1	**Geostatistics**	
	Competences and learning outcomes	Conveyed competences are: SC 1:Calculate a range of descriptive statistics and use graphical tools for exploratory data analysis SC 2:Make surface predictions using deterministic procedures SC 3:Analyse and model the spatial continuity of anisotropic attributes SC 4:Interpret the parameters of the variogram model The main learning outcomes (LO) are: LO 1:Acquire a good mastership of variogram modeling LO 2:Understand the random function model for the analysis of spatial data LO 3:Make surface predictions using univariate kriging techniques LO 4:Make predictions using multivariate kriging techniques LO 5:Know how to interpolate geographical data, calibrate model parameters and validate model results LO 6:Discuss the main geostatistical inference tools (advantages and drawbacks) LO 7:Use the Geostatistical Analyst functionality of the ArcGIS software
	Syllabus	The curricular unit is organized in five Learning Units (LU): LU1:Introduction and exploratory data analysis:univariate and bivariate description spatial description LU2:Deterministic methods:general concepts on spatial interpolation Thiessen polygons Inverse distance weighting validation and cross-validation LU3:Variography:spatial continuity analysis modelling spatial continuity LU4:Univariate geostatistics:estimation concepts Simple kriging Universal kriging Ordinary kriging LU5:Multivariate geostatistics:modelling a coregionalization Simple kriging with varying local means Kriging with an external drift Cokriging and collocated cokriging

	Teaching methodologies	The curricular unit is based on theoretical lectures and practical application of methods using software applications, such as Excel and ArcGIS. The practical component is geared towards solving problems and exercises, including discussion and interpretation of results. A variety of instructional strategies will be applied, including lectures, slide show demonstrations, step-by-step instructions on using the Geostatistical Analyst functionality of the ArcGIS software, questions and answers.
	Grading	In-course assessment: 1. Three individual reports with the answers to the proposed problems (15% of final grade each) 2. Oral presentation of the students' project (15% of final grade) 3. Article reporting the work done related to the project (40% of final grade). The project can be developed individually or in groups of 2 students.
1.2	**Data analysis**	
	Competences and learning outcomes	Conveyed competences are: SC1. To know and to understand the main techniques of Multivariate Descriptive Statistical Analysis. At the end of the unit students should be able to: LO1. To be able to apply these techniques in the development of univariate, bivariate and multivariate data associated with quantitative or qualitative variables. LO2. To be able to use the SAS Enterprise Guide software for the statistical analysis of multivariate real data.
	Teaching methodologies	The curricular unit is based on theoretical-practical classes where the contents are presented in Powerpoint through a heuristic approach and where students are faced with real data from various fields of knowledge. During the course, there are some practical classes in computer rooms, where students make multivariate data processing using the SAS Enterprise Guide software. Additionally, in each session or afterwards via email, students are invited to formulate questions and bring up broader issues, feeding a FAQ system that will support the learning process.
	Grading	The evaluation method considers two assignments of multivariate data analysis and a final exam. The assignments can be performed individually or in groups with a maximum of three students. The first assignment has a weight of 20%, the second assignment has a weight of 40% and the final exam has a weight of 40%. The

		minimum grade in any of the work or the final exam is eight values.		
2	**Requirements for participation**	-		
3	**Workload, requirements for awarding credit points, grading system**	Course name	Exam	7,5 credit points
		Geostatistics, OR	1	7,5
		Data analysis	1	7,5
		National grading system: 20-10 pass; 9-0 Fail Can be transferred to other national grading systems and ECTS		
4	**Duration and frequency of module offer**	Each fall semester		
5	**Teachers**	Prof. Ana Cristina Marinho da Costa, Paulo Jorge Mota de Pinho Gomes		
6	**In charge of module**	Prof. Ana Cristina Marinho da Costa		

Module description

Module 2: Data Modelling (ISEGI)

0	**Overall goals**	Provide the students with fundamental modelling and analysis skills, focused on problem solving and making use of a wide range of methods and tools available for diagnosis and prediction in a GI context.
1	**Courses (1 out of 2)**	7,5 of 15 credit points: Geospatial datamining (lecture and practical/2 semester hours per week/7,5 CP), OR Database management systems (lecture and practical/2 semester hours per week/7,5 CP)
1.1	**Geospatial datamining**	
	Competences and learning outcomes	Conveyed competences are: SC1- Be able to Define Data Mining SC2- Explain the main characteristics of Data Mining SC3- Explain why Data Mining can be a valuable addition in the context of GIScience SC4- Discuss the implications of the geo prefix in Geographic Data Mining The main learning outcomes (LO) are: LO1- Understand the basic data preparation and pre-processing tasks LO2- Understand the k-means algorithm and how it works LO3- Understand what a Self-Organizing Map is and how it works LO4- Autonomously use Self-Organizing Maps in unsupervised classification tasks LO5- Understand what a Classification Trees is and how it works LO6- Understand what a Multi-Layer Perceptron Neural Network is and how it works LO7- Autonomously use Classification Trees and Multi-Layer Perceptron Neural Networks in supervised classification tasks.
	Syllabus	The syllabus is organized in 5 Learning Units (LU): LU1. Introduction to Data Mining LU2. Data Mining in the geographic information science context LU3. The role of Data in Data Mining LU4. Unsupervised Classification (clustering) LU5. Supervised Classification (predictive modelling)
	Teaching methodologies	The course is based on a problem-oriented approach with active knowledge acquisition. There is an asynchronous part which includes self-study based on online materials and projects and a synchronous part composed by face to face sessions and tutoring sessions.
	Grading	Assessment: One exam at the end of the course (30%)

		Four individual projects:2 theoretical (10% each) and 2 practical (25% and 20%)
1.2	**Database management systems**	
	Competences and learning outcomes	Conveyed competences are: SC1 -Understanding the importance of Information Technology in business life. SC2 -Getting to know and using Databases. SC3 -Getting to know and using Database Management software SC4 -Giving students the necessary base to conceive build and analyze relational databases. Main learning outcomes: LO1- Understand the main architectures and concepts of database management systems LO2 -Getting to know the Entity-Relationship model and the relational data model, and the basics of the relational model LO3 -Learning the basics of SQL LO4 -Understanding the normalization of databases based on functional and multi value needs LO5- Knowing how to formulate complex questions in SQL LO6- Understand the main challenges posed to database construction
	Syllabus	The curricular unit is organized in the following Learning Units (LU): LU1 - Introduction LU2-The Database Management System LU3-Architecture and concepts LU4-Relational Algebra a. Concepts b. Standardization c. Relational Languages d. SQL Language (Structured Query Language) e. Processing and Optimizing Questions LU5-Relational Model a. Basic features b. Tables and relationships c. Referential integrity and entity integrity LU6-Data modeling using the ER model a. Logical and Physical model b. Normalization c. Conceptual model LU7- Introduction to Programming with SQL (basic level) a. Designing the frame of business applications b. SQL as a programming language c. Elements of the SQL language d. Additional elements of the SQL language e. Ways of executing SQL instructions LU8- Draft a database using the relational model LU9-SQL language (Advanced) LU10-Need for new models a. Extensions to the relational model

<table>
<tr><td></td><td></td><td colspan="3">b. Model logical/deductive</td></tr>
<tr><td></td><td>Teaching methodologies</td><td colspan="3">Teaching based on lectures and practical classes. The lectures are, in essence, for expository sessions, which serve to introduce the fundamental concepts of databases associated with each of the topics. The practical classes are based on design and implementation of database systems, using the computers and software.

Teaching Methods
• Expository and interrogative teaching:lectures and discussions.
• Declarative:tutorials tools
• Active and participative:case studies, participation in project teams, use of database management systems</td></tr>
<tr><td></td><td>Grading</td><td colspan="3">Evaluation:
1st round:two Theoretical tests (50%) + Practicals Works (50%)
2nd round: final exam (100%).</td></tr>
<tr><td>2</td><td>Requirements for participation</td><td colspan="3">-</td></tr>
<tr><td rowspan="4">3</td><td rowspan="4">Workload, requirements for awarding credit points, grading system</td><td>Course name</td><td>Exam</td><td>7,5 credit points</td></tr>
<tr><td>Geospatial datamining, OR</td><td>1</td><td>7,5</td></tr>
<tr><td>Database management systems</td><td>1</td><td>7,5</td></tr>
<tr><td colspan="3">National grading system: 20-10 pass; 9-0 Fail
Can be transferred to other national grading systems and ECTS</td></tr>
<tr><td>4</td><td>Duration and frequency of module offer</td><td colspan="3">Each fall semester</td></tr>
<tr><td>5</td><td>Teachers</td><td colspan="3">Prof. Roberto André Pereira Henriques, Prof. Vitor Manuel Pereira Duarte dos Santos</td></tr>
<tr><td>6</td><td>In charge of module</td><td colspan="3">Prof. Roberto André Pereira Henriques</td></tr>
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Module description

Module 3: GI basics (ISEGI)

0	**Overall goals**	Learning basic concepts needed for a structured understanding of the GI field, also needed for professional skills
1	**Courses**	15 of 30 credit points: Geographic information systems (lecture and practical / 2 semester hours per week / 7,5 ECTS), OR Remote sensing (lecture and practical / 2 semester hours per week / 7,5 CP), OR GIS applications (practical / 2 semester hour per week / 7,5 CP), OR Group project seminar (lecture and practical / 2 semester hours per week / 6 CP)
1.1	**Geographic information systems**	
	Competences and learning outcomes	Conveyed competences are: SC1 Know the main events related to Geographic Information Systems (GIS) evolution and future challenges SC2 Identify the properties of Geographic Information (GI) SC3 Recognize the importance of GI at present SC4 Know the use of GIS to different knowledge domains Main learning outcomes: LO1 - Know and apply correctly the concepts related to the use of GI and associated technologies LO2 - Understand the relations between GI Science (GISc) and GIS LO3 - Identify the main GISc components LO4 - Frame the main geographic problems in the context of GISc's components and explore their relations and challenges LO5 - Recognize the main advantages on presenting a holistic model of a functional GIS LO6 - Identify the four main GIS functional components and its challenges LO7 - Recognize the importance of applying well-known principles of map design during GIS outputs generation LO8 - Be familiar with the topics of spatial analysis and modelling and their GIS applications LO9 - Know how models of spatial form and process are represented using GIS
	Syllabus	The curricular unit is organized in four Learning Units (LU): 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 1.Ontology and Representation 2.Geocomputation 3.Cognition 4.Applications, Institutions and Society 5.Crosscutting Research Themes:Time and Scale LU3. Functional Components of GIS 1.The 4 M's activities that can be enhanced through the use of GIS:Measurement Mapping Monitoring Modelling 2.An Holistic Model of GIS 3.GIS Functional Components:Input Storage and Management Manipulation and analysis Output LU4. Introduction to Spatial Data Analysis and Modelling 1.Spatial Modeling and analysis in GIS 2.GIS Application Areas
	Teaching methodologies	The curricular unit is based on theoretical lectures and seminar sessions. The theoretical lectures include presentations of concepts and methodologies and discussion. The seminar sessions are geared towards the presentation oftopics by students followed by discussion. Preparation for the short essays and term papers is carried out outside the classroom.
	Grading	Evaluation: 1st round:midterm 1 (20%) midterm 2 (20%) Short essay (15%) Term paper (40%) participation in class (5%) 2nd round:final exam (100%).
1.2	**Remote sensing**	
	Competences and learning outcomes	Conveyed competences are: SC1 - Describe the types of measurements in remote sensing and explain why satellite images can be used to characterise the Earth by using the principles of remote sensing SC2 - Develop in an autonomous way a project to produce information based on satellite images SC3 Select the satellite and sensor more adequate to use on the production of different types of information Main learning outcomes: LO1 Describe and apply classification algorithms of spectral, spatial and temporal patterns of satellite images in order to derive information LO2 Assess and interpret the error within information derived from satellite images LO3 Describe and evaluate the social economic benefits of remote sensing
	Syllabus	The curricular unit is organized in seven Learning Units (LU): LU 1 Introduction LU 2 Remote sensing principles LU 3 Remote sensing and the internet LU 4 Characteristics of Earth observation satellites and

		sensors LU 5 Image pre-processing LU 6 Exploratory analysis LU 7 Band transformations LU 8 Image information extraction LU 9 Change detection techniques LU 10 Accuracy assessment LU 11 Socioeconomic benefits of remote sensing
	Teaching methodologies	The course has lectures and laboratory sessions. In the lectures, the instructor uses slides to illustrate the theory. The lectures also include the presentations by the students of essays on the applications of remote sensing. The laboratory sessions consists on the use of a image processing software for deriving a thematic map based on spectral, spatial and/or temporal pattern analysis.
	Grading	Evaluation: 1st round:midterm (40%) group project (40%) essay20%) 2nd round:midterm (30%) project (40%) essay (30%)
1.3	**GIS applications**	
	Competences and learning outcomes	The conveyed competences are: SC1 - The objective of this course is to put in perspective the concepts related with the development and management of Geographical Information Systems (GIS) through the presentation of several practical examples. This unit has three main learning objectives (LO): LO1 - to provide a framework of useful concepts and approaches for the formulation of a spatial problem LO2 - to present different operational methods to design and implement a GIS LO3 - to discuss strategies to implement a GIS.
	Syllabus	UA 1:Introduction to ArcGIS UA 2:Spatial analysis and geoprocessing tools UA 3:3D analysis UA 4:Network analysis UA 5:WebGIS based in free open source software (Geoserver and PostgreSQL/Postgis). OGC clients for WebGIS Mapbuilder, Openlayers, uDig and ArcGIS).
	Teaching methodologies	The learning method includes teacher support through synchronous sessions and email. The learning is done through exercises, some of them compulsory. There is a final project oriented by the professor about GIS Applications, being the topic selected by the student according to their individual/professional experiences.
	Grading	Evaluation: Project (70%). Optional exercises (up to 30%). Virtual Campus courses (up to 5%).
1.4	**Group project seminar**	
	Competences and learning	The conveyed competences are:

<table>
<tr><td></td><td>outcomes</td><td colspan="3">SC1 - To learn how to work in an interdisciplinary and in group

Main learning outcomes:
LO1 - To demonstrate ability to apply knowledge, methods and techniques acquired in other curricular units of the study cycle
LO2 - To demonstrate ability to integrate knowledge acquired in other curricular units
LO3 - To be able to produce quality professional work using geographic Information
LO4 - To produce project proposals and reports</td></tr>
<tr><td></td><td>Syllabus</td><td colspan="3">1 Spatial data acquisition
2 Spatial data management
3 Spatial data analysis
4 Spatial data modelling
5 Spatial data presentation</td></tr>
<tr><td></td><td>Teaching methodologies</td><td colspan="3">The curricular unit is offered as a seminar. The students are given the power to organise a project of their choice, given a data set initially provided. The students function as consultants and the teachers as clients.</td></tr>
<tr><td></td><td>Grading</td><td colspan="3">The evaluation includes:
1. Final group presentation (40%)
2. Final project report (40%)
3. Self-evaluation form (10%)
4. Participation in the presentations and discussions (10%)</td></tr>
<tr><td>2</td><td>Requirements for participation</td><td colspan="3">-</td></tr>
<tr><td rowspan="7">3</td><td rowspan="7">Workload, requirements for awarding credit points, grading system</td><td>Course name</td><td>Exam</td><td>15 credit points</td></tr>
<tr><td>Geographic information systems, OR</td><td>1</td><td>7,5</td></tr>
<tr><td>Remote Sensing, OR</td><td>1</td><td>7,5</td></tr>
<tr><td>GIS applications, OR</td><td>1</td><td>7,5</td></tr>
<tr><td>Group project seminar</td><td>1</td><td>6</td></tr>
<tr><td colspan="3">National grading system: 20-10 pass; 9-0 Fail
Can be transferred to other national grading systems and ECTS</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>4</td><td>Duration and frequency of module offer</td><td colspan="3">Each fall semester</td></tr>
<tr><td>5</td><td>Teachers</td><td colspan="3">Prof. Marco Painho, Prof. Mário Sílvio Rochinha de Andrade Caetano, Prof. Pedro da Costa Brito Cabral</td></tr>
<tr><td>6</td><td>In charge of module</td><td colspan="3">Prof. Dr. Marco Painho</td></tr>
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Module description

Module 1: Informatics and Mathematics (UJI)

0	**Overall goals**	Provide students with those basic maths and programming skills needed to later successfully complete the Master.
1	**Courses**	• Programming (lecture and laboratory, 4 credits) • Spatial databases (lecture and laboratory, 4 credits) • Software engineering (lecture and laboratory, 2 credits) • Applied mathematics: logic and statistics (lecture and laboratory, 2 credits)
1.1	**Programming**	
	Competences and learning outcomes	Generic and specific competences: SC1: To identify the main characteristics of the object oriented paradigm SC2: To know why we need programming languages SC3: To know the main characteristics of the Java programming language SC4: To properly use the Java programming language to implement a solution to computing problems Learning outcomes: LO1: To know the syntax of the Java programming language LO2: To know how to declare and use variables of any allowed type in Java LO3: To know how to use control structures to perform iterative tasks LO4: To be able to define a class: define its attributes and methods LO5: To know the access control modifiers and use them properly LO6: To know the benefits of using inheritance and how to extend a class in Java LO7: To know how to manage runtime errors LO8: To know how to use some pre-defined classes in the standard Java library LO9: To know how to read data from a source of data and how to write data to a consumer of data.
	Syllabus	Foundations of programming. The object oriented programming paradigm. The Java programming language as an object oriented programming language. Tools to easily develop computer programs. Six Units: 1. Introduction. Java syntax. Data types. Control structures. 2. Classes 3. Inheritance 4. Exceptions 5. Utility classes 6. Input / Output.

	Teaching methodologies	Work in classroom: Theoretical concepts will be presented first. Afterwards some exercises will be proposed in order to practice these concepts. Individual work: Students will be asked to develop an incremental programming project.
	Grading	Evaluation: Assignments (Java application using classes): 30% Project (Java application using exceptions, collection classes and input/output): 20% Project (Java program using inheritance): 50%.
1.2	**Spatial databases**	
	Competences and learning outcomes	Generic and specific competences SC1: Understand the basic features and usage of relational databases (including the fundamentals of the SQL language) and their role in GIS. SC2: Apply techniques for logical design involving spatial data, and implement the resulting designs using the SQL language with standard spatial extensions. Learning outcomes LO1: Understand the fundamental concepts of relational database systems [SC1] LO2: Perform data querying and database management statements using the SQL language [SC1] LO3: Understand the role of databases in GIS [SC2] LO4: Design a relational database involving spatial and attribute data from a problem specification [SC2] LO5: Implement a relational logical design involving spatial and attribute data using the SQL language with a spatial-oriented extension [SC2] LO6: Query spatial data using a spatial-oriented extension of SQL [SC2] LO7: Integrate a database as a backend of a GIS [SC2].
	Syllabus	This course focuses on the design, implementation and usage of GIS databases including both spatial and attribute data. The initial sessions will introduce the basic concepts needed for designing relational databases involving spatial data, and the rest of the course will be devoted to providing a working knowledge of techniques for building and querying spatial databases, and integrating them in GIS. Topics include relational database concepts; database design involving spatial features; basic database administration; fundamentals of the SQL language; spatial extensions to SQL; and database integration in GIS. Part 1: Introduction to databases Database concepts. Introduction to relational databases and the SQL language. Logical design of geospatial databases Part 2: Implementing and using spatial databases Using the SQL language for database administration and queries.

		Using SQL spatial types and functions Using databases as GIS backends.
	Teaching methodologies	In theoretical sessions students will learn the main concepts of relational databases and logical design (including designs with spatial features). In practical sessions, students: will practice the SQL language will learn the usage of spatial-enabled DBMSs (such as PostgreSQL with the PostGIS extension) will learn how to integrate a database with a geospatial user interface (such as gvSIG) The practical sessions will be organized around guided collection of exercises and problems to be solved over a DBMS. Prompt, personalized feedback will be provided by the teachers. Individual work: The students will work in problems and exercises to assess and reinforce their learning during in-class hours. Prompt, personalized feedback will be provided by the teachers. Group work: The students will be asked to complete in groups a project that will require the integration of all the techniques learned during the course.
	Grading	Assessment: Class exercises (10%); group project (50%); written exam (40%).
1.3	**Software engineering**	
	Competences and learning outcomes	Generic and specific competences: Social competences: team building via group projects. The students should learn to interpret the main diagrams of the UML and their practical usage in GIS application design. Learning outcomes: LO 1: To carry out some exercises on UML Use Case Diagram LO2: To develop some exercises on UML Class Diagram LO3: To be able to perform a project by the group in order to model a GIS using UML and to deliver the corresponding project report LO 4: To extend individually the UML Class Diagram provided in the group project.
	Syllabus	Units: Unit 1: Software Engineering Introduction Unit 2: UML Introduction Unit 3: UML Use Case Diagram Unit 4: UML Class Diagram.
	Teaching methodologies	To promote the autonomy of the students, they have to prepare several readings or exercises before the sessions. The teacher explains the main topic at the beginning of the session, and then, the students have time to do practical exercises using software tools based on UML. To perform the final project, based on a practical case study, they must form several groups in order to develop an extension of the proposed case study.

	Grading	Evaluation: Assignment 1 - 10% Assignment 2 - 20% Project (Group) - 20% Project (Individual) - 50%.		
1.4	**Applied mathematics: logic and statistics**			
	Competences and learning outcomes	Conveyed competences are: - To apply fundamental mathematics to GI applications - To apply fundamental technical skills necessary to analyze and develop geospatial technologies - Methodological competences in statistical analysis Learning outcomes are: LO1: To be able to read and map data sets LO2: To simulate and handle random variables LO3: To test hypothesis LO4: To calculate Monte-Carlo tests LO5: To analyze Variance and Regression LO6 To know principal component Analysis, discriminant analysis and cluster analysis LO7: To know how to use multivariate techniques in practice		
	Syllabus	1. Introduction to descriptive statistics 2. Introduction to graphical procedures 3. Working with R 4. Linear models: analysis of variance and regression 5. Cluster analysis 6. Discriminant analysis 7. Principal component analysis 8. Factor analysis		
	Teaching methodologies	In practical sessions, students: - will practice with the R free software - will learn the usage of several libraries Individual work: The students will work in problems and exercises to assess and reinforce their learning during in-class hours. Prompt, personalized feedback will be provided by the teachers. Group work: The students will be asked to complete in groups a project that will require the integration of all the techniques learned during the course		
	Grading	Assessment: Assignment (30%: Homework ONE in groups of maximum 3 members) Assignment (30%: Homework TWO in groups of maximum 3 members) Individual project (40%)		
2	**Requirements for participation**	None		
3	**Workload, requirements for awarding credit points, grading**	Course name	Exam	12 credit points
		Programming	1	4

	system	Spatial databases	1	4
		Software engineering	1	2
		Applied mathematics: logic and statistics	1	2
		National grading system: 0 (min) -10 (max), with 5,0 being a passing grade. Can be transferred to other national grading systems and ECTS.		
4	**Duration and frequency of module offer**	Offered annually during the UJI semester.		
5	**Teachers**	Prof. Jorge Mateu Mahiques, Prof. Ismael Sanchez, Prof. Óscar Belmonte Fernández, Prof. María de los Reyes Grangel Seguer		
6	**In charge of module**	Prof. Jorge Mateu Mahiques		

Module description

Module 2: New technologies (UJI)

0	**Overall goals**	Provide background in related and supporting new technologies to GI.
1	**Courses**	• Spatial data visualization (lecture and laboratory, 3 credits) • Multimedia (lecture and laboratory, 3 credits) • Remote sensing applications (lecture and laboratory. 3 credits) • Web and mobile GIS (lectures and laboratory, 3 credits)
1.1	**Spatial data visualization**	
	Competences and learning outcomes	Generic and specific competences: SC1 To understand the challenges in spatial data visualization SC2 To know the impact of the current visualization software libraries SC3 To know the overall process needed to display GI data SC4 To be able to develop data visualization applications using current libraries library Learning outcomes: LO1 To know the main components of the spatial data visualization libraries [SC1, SC2] LO2 To know how to create a basic layout for a GI data visualization using the current libraries[SC3] LO3 To be able to deploy a data visualization application in a website [SC3, SC4] LO4 To know how to define objects in geovisualization [SC4] LO5 To know how to manipulate objects in geovisualization [SC4] LO6 To know how to include geospatial data in a web environment[SC4]
	Syllabus	Spatial data visualiztion 1. Introduction to Spatial Data Visualization 2. Graphical representation of spatial and temporal data 3. Interactive Mapping tools 4. Libraries and tools for Geovisualization
	Teaching methodologies	Work in classroom: Theoretical concepts will be presented first. Afterwards some exercises will be proposed in order to practice these concepts. Individual work: Students will be asked to develop an incremental programming project. Group work: Students will be asked to develop a small research task in

		group. Students will be gathered in two or three groups, depending on the number of students. Each research task will be presented to the rest of the class.
	Grading	Evaluation: 10% Work in group [SC1, SC2] 70% Programming project [SC2, SC4] 20% Written exam [SC1, SC2, SC3, SC4]
1.2	**Multimedia**	
	Competences and learning outcomes	Generic and specific competences: - To know the process of Multimedia Content Production - To know the different media types: text, image, audio, video and animation - To know the different tools available for Multimedia Content Production - Group Work Learning outcomes: LO1: Ability to apply different tools to produce an original Multimedia Application.
	Syllabus	1. Introduction to Multimedia. 2. Digital image: formats and tools. 3. Video and Animation: formats and tools. 4. Introduction to the Internet. 5. Multimedia Content Creation. 5.1. Planning, Design, Production. 5.2. Web Support: HTML and production tools.
	Teaching methodologies	Theory classes are taught in the classroom using a projector and a computer. Theoretical explanations are alternated with demonstrations of the main tools. The presentations used in the classroom will be available in the Virtual Classroom. Practical exercises are performed individually using the bulletins available in the Virtual Classroom. There will also be practice sessions for group work previously established.
	Grading	Evaluation: Class exercises - 10% Group Work - 50% Written Exam - 40%.
1.3	**Remote sensing applications**	
	Competences and learning outcomes	Generic and specific competences: - Learning competences: problem solving - Methodological competences: Image segmentation and classification - Social competences: group work, work within tight guidelines and due dates - Expertise: working with remote sensed images Learning outcomes:

		- LO1 Be able to apply basic image processing tools to remote sensing images - LO2 Attain an understanding of the Principles of Remote Sensing - LO3 Infer implications of classification and segmentation results of images to Land use - LO4 Obtain classification maps from images applying different types of classification methods - LO5 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 Develop a final project by the students demonstrating their ability to apply their new skills to a real-world situation of personal or professional interest.
	Syllabus	1. Introduction 2. Fundamentals Principles and Theory of Remote Sensing 3. Remote Sensing and the Internet 4. Characteristics of earth observation satellites and sensors 5. Image pre-processing 6. Exploratory analysis 7. Image classification 8. Image Information extraction 9. Change detection techniques 10. Use of Remote Sensing Data to tackle contemporary challenges in Geospatial Analysis.
	Teaching methodologies	In classroom: 30 % Out of classroom (individual Work): - Study: 50 % - Practical Excercises: 20%
	Grading	Evaluation: - Three Assignments (30%) - Exam (30%) - Final Project (40%).
1.4	**Web and mobile GIS**	
	Competences and learning outcomes	Generic and specific competences: - Learn e relevant concepts about web, mobile and internet technologies - Learn how geospatial web services work - Learn about mobile technologies for GI - Learn about cloud technology for GI - Develop communication skills - Work in a group - Usage and development of mobile applications Learning outcomes: LO1: To identify the best internet technologies to deploy, manage and use geospatial applications. LO2: To evaluate geospatial services regarding their web functionalities.

<table>
<tr><td></td><td></td><td colspan="3">L03: To be aware of new trends about web technology, especially those related to geospatial technologies.
LO4: To Gain a better understanding of how to use web, mobile, cloud, etc. to manage and access geospatial services and content.</td></tr>
<tr><td></td><td>Syllabus</td><td colspan="3">Unit 0: UJI network services
Unit 1: Introduction to web and mobile engineering
Unit 2: Web services
Unit 3: Cloud computing and services
Unit 4: Web systems design and implementation
Unit 5: Mobile applications
Unit 6: Virtual globes
Unit 7: Collaborative mapping initiatives.</td></tr>
<tr><td></td><td>Teaching methodologies</td><td colspan="3">For each unit, there is a lecture session, practical exercises done during class time and assignments for individual work. For some of the units there are recommended readings before the lecture.
There is also an individual project work consisting of a survey about different topics for each student. The topic for each student will be previously agreed with the teacher.
There is also a group project work, jointly with the SIK006 Multimedia course, consisting in adding geo features to the website developed for SIK006 course. These must include a map application in the website.</td></tr>
<tr><td></td><td>Grading</td><td colspan="3">Evaluation:
Group project: 15%
Individual project: 20%
Participation in class: 20%
Assignments (Practical exercises): 20%
Exam: 20%
Readings: 5%.</td></tr>
<tr><td>2</td><td>Requirements for participation</td><td colspan="3">None</td></tr>
<tr><td rowspan="6">3</td><td rowspan="6">Workload, requirements for awarding credit points, grading system</td><td>Course name</td><td>Exam</td><td>12 credit points</td></tr>
<tr><td>Spatial data visualization</td><td>1</td><td>3</td></tr>
<tr><td>Multimedia</td><td>1</td><td>3</td></tr>
<tr><td>Remote sensing applications</td><td>1</td><td>3</td></tr>
<tr><td>Web and mobile GIS</td><td>1</td><td>3</td></tr>
<tr><td colspan="3">National grading system: 0-10 (5=passing)
Can be transferred to other national grading systems and ECTS</td></tr>
<tr><td>4</td><td>Duration and frequency of module offer</td><td colspan="3">Annually during UJI semester.</td></tr>
<tr><td>5</td><td>Teachers</td><td colspan="3">Prof. Óscar Belmonte Fernández, Prof. Ricardo Javier Quirós Bauset, Prof. Sven Casteleyn, Prof. Joaquín Huerta Guijarro</td></tr>
<tr><td>6</td><td>In charge of module</td><td colspan="3">Prof. Joaquín Huerta Guijarro</td></tr>
</table>

Module description

Module 3: GI basics (UJI)

0	**Overall goals**	Introduce students to GI topics in preparation for advanced topics at U. Münster.
1	**Courses**	• Introduction to GIS (lecture and laboratory, 3 credits) • Spatial analysis (lecture and laboratory, 2 credits) • Spatial data infrastructures (1 credit; distance learning)
1.1	**Introduction to GIS**	
	Competences and learning outcomes	Generic and specific competences: - To describe the use of GIS in a range of applications - To discuss what a GIS is in terms of its components and functionality Learning outcomes: LO1: To define what a raster and vector GIS are. LO2: To describe the basic vector objects. LO3: To explain relative and absolute concepts of space. LO4: To express the concept of topology. LO5: To express what a model is, with emphasis on spatial models.
	Syllabus	The lecture topics are: 1. Geographic Concepts for GIScience. Key concepts that affect how we view the spatial world and their implications for GIS. 2. Implementing Geographic Concepts in GISystems. Concepts and methods used to represent fields, objects, networks, and time. 3. Populating GISystems. Different types of geospatial data and methods used to create or access these data. 4. Conducting Spatial Analysis with GISystems. Advanced spatial analysis operations (managing errors, network analysis, spatial interpolation, terrain analysis etc.). 5. Current Issues and Future Trends. The increasing numbers of GIS users, changes in data supply, and the rapidly evolving role of the web in the storage, processing, and delivery of geographic information are reviewed. The laboratory topics are: 1. Introduction to ArcGIS 2. GIS Data Models 3. Data Management 4. Digitizing and Metadata 5. Simple Spatial Analysis 6. Network Analysis 7. Surface Analysis
	Teaching methodologies	The course teaches computer processing of geographic

		information using ArcGIS and other GIS software and programming languages. Students are expected to attend all class and they will be responsible for the materials covered in lectures, readings, lab assignments, and class discussions. Students must complete a total of 7 lab assignments, a short research paper, an individual project, and one final paper. The lab assignments will explore the computer hardware, GIS software, enabling structures, common protocols, and spatial data standards affecting the deployment of GIS and related technologies. The individual projects will utilize GIS tools to produce one or more pre-determined products. The final paper will be graded on their ability to write clear, informative, and thoughtful answers.
	Grading	Evaluation: Final paper (40%); Individual Project (20%); Laboratory Assignments (20%); Research Paper (20%).
1.2	**Spatial analysis**	
	Competences and learning outcomes	Conveyed competences: - Fundamental GIS concepts as implemented in many software packages - Methodologies of using point pattern spatial analysis Learning outcomes: LO1: Identify the need for point pattern spatial analysis. LO2: To know how to group place spatially; to knowing if they tend to be uniformly or randomly distributed LO3: To be able to identify the average density of events in an area and a density map. LO4: To determine the characteristics of the first and second order. LO5: To be able to apply theoretical models and simulate them. LO6: To know if you can simulate an adjusted model. LO7: Know if the correlation of spatial processes and outline settings can be modeled.
	Syllabus	Part I: Spatial Point Patterns 1. Introduction 2. Theory setup 3. Models for spatial point processes 4. Monte Carlo Tests (MCT) and MCT-based measures of Complete Spatial Randomness 5. Simulation techniques of Gibbs point processes 6. Estimation procedures for Gibbs point processes 7. Anisotropy and Orientation analysis 8. LISA functions for local product densities 9. Spectral analysis for spatial marked point processes Part II: Geostatistics 1. Introduction and motivation 2. Basic theory 3 Kriging 4 Bayesian Inference.
	Teaching methodologies	In practical sessions, students: - will practice with the R free software

		- will learn the usage of several libraries Individual work: The students will work in problems and exercises to assess and reinforce their learning during in-class hours. Prompt, personalized feedback will be provided by the teachers. Group work: The students will be asked to complete in groups a project that will require the integration of all the techniques learned during the course
	Grading	Evaluation: Assignment (30%: Homework ONE in groups of maximum 3 members) Assignment (30%: Homework TWO in groups of maximum 3 members) Individual project (40%).
1.3	**Spatial data infrastructures**	
	Competences and learning outcomes	Generic and specific competences Knowledge about international standards relevant to Spatial Data Infrastructures Spatial data services Standard data sources usage Learning outcomes LO1: to use and evaluate Spatial Data Infrastructures LO2: to create and deploy SDI's.
	Syllabus	Units 1. Introduction to SDIs 2. Components of SDI (1) 3. Standards 4. Metadata 5. SDI Components (2) 6. Future of SDI.
	Teaching methodologies	This is an on-line e-learning course. It is composed of several lessons that the student must complete, including readings and exercises.
	Grading	Evaluation: Course assignments - 50% Final Exam - 50%
2	**Requirements for participation**	N/A
3	**Workload, requirements for awarding credit points, grading system**	see table below
4	**Duration and frequency of module**	Annually during UJI semester.

Course name	Exam	6 credit points
Introduction to GIS	1	3
Spatial analysis	1	2
Spatial data infrastructures	1	1

National grading system: 0-10 (5=passing)

Can be transferred to other national grading systems and ECTS

	offer	
5	**Teachers**	Prof. Michael Gould, Prof. Jorge Mateu Mahiques,
6	**In charge of module**	Prof. Michael Gould

Module description

Module 4: Fundamentals of Geographic Information Science (ifgi)

0	**Overall goals**	Familiarize the students with the fundamental theoretical and practical notions of geographic information science and technologies.
1	**Courses**	• Digital cartography (lecture and labs, 2 semester hours each, 5 CP total) • Reference systems for geographic information (lecture and labs, 2 semester hours each, 5 CP total)
1.1	**Digital cartography**	
	Competences and learning outcomes	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 (key qualifications): 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 are: 1. Understand thematic maps as geospatial information products 2. Carry out a map design from the stage of planning through data acquisition and analysis to presentation 3. Use standard GIS mapping functionality adequately and productively 4. Develop a sense of map usability and aesthetics 5. Apply the basic theories of thematic mapping, in particular the theory of graphic variables (Bertin) 6. Learn to design the supplementary map elements: title, legend, grid, impressum, data sources and rights 7. Learn to criticize map designs and improve them.
	Syllabus	The curricular unit is organized as a practical course around the active design and revision of thematic maps. The necessary theoretical background is presented through an e-learning course that the students work through independently, but can ask questions on in the practical lab sessions. The weekly lab meetings • consist of Q&A sessions on the e-learning units followed by assistance with and critical discussion of the map • design tasks and their results as they arise in each participants mapping project.
	Teaching methodologies	The attainment of the objectives is verified step-by-step each week through a discussion of design tasks and intermediate results on them. At the end, the mapping project is being presented by the students.
	Grading	Mapping project (1 map)
1.2	**Reference systems for geographic information**	

	Competences and learning outcomes	Conveyed competences are: Expertise: apply GIS and related software to reference geodata. Methodological competences: master the fundamental methods of dealing with coordinate systems. Learning competences (key qualifications): 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 are: 1 Understand the idea and instrument of a reference system for geoinformation 2 Understand and know the technical details of spatial reference systems (coordinate- and name-based) 3 Understand and know the technical details of temporal reference systems (calendars) 4 Be able to identify and assign spatial and temporal reference systems for data sets 5 Understand the idea of attribute reference systems 6 Understand the generalization from spatial, temporal, and attribute to semantic reference systems 7 Be able to perform transformations of spatial reference systems, in GIS and through matrix computations.
	Syllabus	The curricular unit is organized around the contents of its textbook and a selection of key scientific articles and chapters from other text books. Learning units: - The Problem - Reference Systems for GI - Georeferencing - Coordinate Reference Systems - Map Projections - Coordinate Transformations - Heights and the Geoids - Review of Spatial Referencing - Test on spatial reference systems - Temporal Reference Systems - Gazetteers - Ontologies - Semantic Reference Systems
	Teaching methodologies	The curricular unit is based on advanced lectures in the form of brief summary presentations followed by extensive discussions. In the lab, participants are working in groups of two. The lectures or labs cannot be taken separately and form a didactic whole.
	Grading	Written exam (30 min.)
2	**Requirements for participation**	-

3	**Workload, requirements for awarding credit points,**	Course name	Exam	10 credit points
		Digital Cartography	Weekly labs and online test	5 CP (28 contact hours, 16 hours exam preparation, 46 hours self-

	grading system			studying)
		Reference systems for geographic information	Weekly labs and online test	5 CP (56 contact hours,, 16 hours exam preparation, 28 hours self-studying)
		National grading system: Can be transferred to other national grading systems and ECTS		
4	**Duration and frequency of module offer**	Each summer semester		
5	**Teachers**	All faculty at ifgi		
6	**In charge of module**	Prof. Angela Schwering		

Module description

Module 5: Advanced topics in Geographic Information Science (ifgi)

0	**Overall goals**	Build on the fundamental notions of module 4 to deepen understanding, knowledge, and skills in selected areas of geospatial technology applications.
1	**Courses**	• Selected topics in GI (lecture and labs/ 4 semester hours per week/ 5 credit points) • Usage-centered design of geospatial applications (seminar/2 semester hours per week/2 credit points) • Applications of GI (mixed/4 semester hours per week/ 5 credit points) • Geoinformatics forum and discussion group (lecture and discussion group 2 semester hours per week /2 credit points)
1.1	**Selected topics in GI**	Ifgi offers courses, which provide innovative knowledge and skills in selected areas of geospatial information. Topics will be updated according to up-to-date research fields. An exemplary course is "Location-based services", which will be described in the following:
	Competences and learning outcomes	Overall, the goal of this course is to equip students will all knowledge and skills necessary to build locationbased services using web-based technologies. More specifically, participants will be able to use a standard development environment to create basic applications independently. They will be aware of fundamental principles of programming in general and capable of using these principles to solve simple programming problems independently. They will acquire initial compencies in teamwork as it pertains to the development of larger applications. Key learning outcomes are as follows: LO1: to be familiar with the basic principles of imperative and event-based programming LO2: to be able to use a programming language to implement basic applications LO3: to be aware of key components of location-based services LO4: to be able to implement basic location-based services LO5: to improve team-working and other soft skills
	Syllabus	This course introduces participants to the development of mobile map-based applications that make use of (real-time) location information. Using existing libraries and toolkits, students learn about basic programming principles (control flow, event-based programming, structured approaches to program development) while modifying existing examples and creating simple new ones. The course uses current web-technologies to teach these principles and illustrate the basic components needed to implement a location-based service. The course chapters are: CH1: Location-based services – fundamentals CH2: Basic programming principles CH3: Building larger applications in teams CH4: Using web-based technologies to build location-based services CH5: Integrating maps, live location data and advanced user interfaces
	Teaching methodologies	The course relies on a combination of traditional lecturing (to relay basic knowledge and fundamental theoretical principles), practical exercises (to apply the acquired knowledge and to deepen the understanding), group-based project work (to gain initial insights into how larger programming projects are run) and interactive

		feedback sessions (to discuss any issues arising during the course). The assessment is based on a self-directed programming project, which is graded based on the quality of submitted application, the degree to which basic principles were followed and the quality of programming. Assessment criteria are defined at the time students start with their final project. Podcasts of all sessions are recorded and made available through an online learning platform, which also provides lecture slides, additional material and a discussion forum. Informal feedback is gathered throughout the course.
	Grading	Report on programming project
1.2	**Usage-centered design of geospatial applications**	
	Competences and learning outcomes	Conveyed competences are: • Assessment of the usability of products • Design of usable products • Iterative problem solving • Working in a team • Defending solutions Students learn how to LO1: conduct context interviews and write context scenarios LO2: develop task models and usage requirements LO3: develop usage scenarios LO4: do explorative prototyping LO5: design draft surfaces LO6: perform accompanying usability tests.
	Syllabus	The context of usage determines if a software product is useful and usable and thus successful on the market. Technical aspects still mainly drive its development , leading to products that fail to exploit opportunities and are difficult to use. A user interface designer is presented with existing function collections (monolithicgeospatial information systems or distributed geospatial services) for which he shall create nice surfaces adapted to applications like emergency response, bicycle navigation or ecological planning. A shift from the technical system perspective that mainly drove the development of these functions to the perspective of usage is necessary. The course offers a step by step usability engineering methodology for developing user interfaces centered in the context of usage: 1. Context interviews and write context scenarios 2. Task models and usage requirements 3. Usage scenarios 4. Explorative prototyping 5. Draft surfaces 6. Usability tests
	Teaching methodologies	Mediating theoretical background by short lectures. Emphasis is on students applying this know-how in practical exercises.
	Grading	Assessment by written test (multiple choice).
1.3	**Applications of GI**	Ifgi offers courses, which provide innovative knowledge and skills in selected areas of applications of geospatial information. Topics will be updated according to up-to-

		date research fields. An exemplary course is “Spatio-temporal modelling”, which will be described in the following:
	Competences and learning outcomes	Conveyed competences are: Expertise: select appropriate specialization area and become involved in solving problems in it. Methodological competences: apply methods described in the scientific and standards literature. Learning competences (key qualifications): self-motivated acquisition of essential methodological knowledge and skills in self-selected areas. Social competences: rapid knowledge acquisition, succinct oral presentations, written reports, team work depending on classes. Learning outcomes are: LO1: to acquire knowledge about applied spatial and spatio-temporal geostatistical and spatial statistical modeling LO2: to acquire knowledge about the difference in handling the different spatial statistical data types LO3: to analyze a number of simpler and more complicated practical use cases of spatial and spatio-temporal data analysis LO4: to develop a practical use case with available data, and write a short but complete scientific report about the outcomes.
	Syllabus	This course will introduce participants to core concepts and methodological approaches of applied geostatistics. Course chapters are as follows: Applied Spatial Data Analysis with R (Springer)
	Teaching methodologies	This course was taught in (i) 10 highly interactive lectures on topics related to applied geostatistics; the theory was brought into connection to knowledge of the students; (ii) all students presented (15 min.) their proposal for their practical work and (iii= students autonomously carried out research and reported on this. The course grade bases on the report handed in.
	Grading	Final report (up to 15 pages)
1.4	**Geoinformatics forum and discussion group**	
	Competences and learning outcomes	Conveyed competences are: Expertise in leading-edge research topics. Methodological competences: apply methods to read and to discuss scientific literature. Learning competences (key qualifications): self-motivated acquisition of knowledge for discussion in a scientific community Social competences: rapid knowledge acquisition, communication and discussions with colleagues Learning outcomes are: LO1: Rapidly acquire knowledge in up-to-date and innovative research topics in GIScience LO2: Analyze and discuss high-level content in scientific discourses.

<table>
<tr><td></td><td>Syllabus</td><td>In a series of invited talks, the Geoinformatics Forum presents around 8-10 high-level and interdisciplinary scientific topics during the semester (Ch1). 5-6 selected talks are prepared in the Geoinformatics Forum Discussion Group (Ch2).
Examplary talks in summer semester 2012:
What is Geoinformatics about? A proposal for 10 core concepts. Werner Kuhn, WWU
Representing spatio-temporal data. Edzer Pebesma, WWU
Collocation and intercomparison of Earth Observation data from various sources: the GECA project. Ir. Sander Niemeijer. S&T corporation, Delft, The Netherlands.
Processing on a SDI: perspectives and thoughts. Lorenzo Bigagli, CNR, Italy
Evolutionary Geo-genomics of Ecological Key-species. Erich Bornberg-Bauer. Institute for Evolution and Biodiversity, University of Münster
Spatial Language and Spatial Cognition: Conceptual Foundations and Connections. Kenny Coventry, Northumbria U, UK</td></tr>
<tr><td></td><td>Teaching methodologies</td><td>Reading key articles of high-level researchers
Scientific discourse within the students group
Presentation by invited guest speakers and its discussions with the guest speaker and research colleagues.
The course is not graded, but assessed based on students' participation.</td></tr>
<tr><td></td><td>Grading</td><td>Not graded</td></tr>
<tr><td>2</td><td>Requirements for participation</td><td>Module 4 successfully completed or ongoing.</td></tr>
<tr><td>3</td><td>Workload, requirements for awarding credit points, grading system</td><td><table>
<tr><td>Course name</td><td>Exam</td><td>14 credit points</td></tr>
<tr><td>Selected Topics in GI</td><td>Yes</td><td>5 (56 contact hours, 94 hours self-studying and exam preparation)</td></tr>
<tr><td>Usage-centered design of geospatial applications</td><td>Yes</td><td>2 (28 contact hours, 32 hours self-studying and exam preparation)</td></tr>
<tr><td>Application of GI</td><td>Yes</td><td>5 (56 contact hours, 94 hours self-studying and exam preparation)</td></tr>
<tr><td>Geoinformatics Forum and Discussion Group</td><td>No</td><td>2 (20 contact hours, 40 hours self-studying)</td></tr>
</table>National grading system: 1 (very good) – 4 (sufficienct), and failed
Can be transferred to other national grading systems and ECTS</td></tr>
<tr><td>4</td><td>Duration and frequency of module offer</td><td>Each summer semester. Continual and broad choice of course offerings</td></tr>
<tr><td>5</td><td>Teachers</td><td>All faculty at ifgi, visiting professors</td></tr>
<tr><td>6</td><td>In charge of module</td><td>Prof. Christian Kray</td></tr>
</table>

Module description

Module 6: Core competences

0	**Overall goals**	Learning soft skills needed in professional GI careers
1	**Courses**	• Project management/GeoMundus conference (practical/2 semester hours per week/3 credit points) • Research methods in GI Science (practical/2 semester hours per week/3 credit points)
1.1	**Project management/GeoMundus conference**	
	Competences and learning outcomes	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 Learning outcomes are: LO1: to acquire and train project management skills LO2: to acquire and train organizational skills LO3: to organize and conduct a scientific event LO4: to work within a small team and to coordinate cooperation of several teams in a joint project LO5: to try and train networking activities.
	Syllabus	Students will prepare and organize the conference GeoMundus (http://geomundus.org). The event is prepared through: 1. Introduction 2. Setting up project teams, communication structures, and preliminary workplan 3. 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) 4. Wrap-up of intermediate results 5. Report of intermediate results 6. Ongoing preparation and organization of the conference within and across the project teams 7. Conduction of the conference including questionnaires for its evaluation.
	Teaching methodologies	1. Self-organized practical work of the students, supported by know-how of experienced teacher. 2. Organization in self-organized project teams (e.g., for budget, local organization, overall project management).

<table>
<tr><td></td><td></td><td colspan="3">3. Discussion of group results across teams.
4. Discussion of group results and progress in regular meetings with the teacher.
5. Conduction of a real-world conference.</td></tr>
<tr><td></td><td>Grading</td><td colspan="3">Evaluation: Group report of all participants on the conference organization, not graded (passed or not passed)</td></tr>
<tr><td>1.2</td><td>Research methods in GI Science</td><td colspan="3"></td></tr>
<tr><td></td><td>Competences and learning outcomes</td><td colspan="3">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 are as follows:
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.</td></tr>
<tr><td></td><td>Syllabus</td><td colspan="3">The course prepares students for their future scientific work in general, and more specifically for their Master
theses. The course is divided into the following chapters:
Ch1: Methodological approaches in research
Ch2: Scientific writing
Ch3: Scientific reading
Ch4: Literature search
Ch5: Referencing, citing, plagiarism
Ch6: Writing scientific comments
Ch7: Presentations.</td></tr>
<tr><td></td><td>Teaching methodologies</td><td colspan="3">The course includes short lectures on the topics of Ch1-7.
In this course, each of the participants will have to write a thesis proposal and present this to the group. The
group will then review and discuss the contents of the proposal and the presentation, as well as discuss the
writing and presentation skills of the presenter.</td></tr>
<tr><td></td><td>Grading</td><td colspan="3">Grading bases on a thesis proposal (max. 10 pages).</td></tr>
<tr><td>2</td><td>Requirements for participation</td><td colspan="3">-</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Workload, requirements for awarding credit points, grading system</td><td>Course name</td><td>Exam</td><td>6 credit points</td></tr>
<tr><td>Research methods in GI</td><td>Thesis</td><td>3 (28 contact hours, 47 hours self-studying, 15 hours preparation of</td></tr>
</table>

		Science	proposal	thesis proposal)
		Project management/GeoMundus conference	Written group report	3 (28 contact hours, 55 hours group work and 8 hours for final report)
		National grading system: 1 (very good) – 4 (sufficienct), and failed Can be transferred to other national grading systems and ECTS		
4	**Duration and frequency of module offer**	Each summer semester		
5	**Teachers**	Dr. Christoph Brox, Prof. EdzerPebesma,		
6	**In charge of module**	Dr. Brox		

Module description

Master thesis (ifgi, ISEGI, UJI)

<table>
<tr><td>0</td><td>Overall goals</td><td colspan="3">Independent work on a GI topic using scientific methods and presentation of results</td></tr>
<tr><td>1</td><td>Courses</td><td colspan="3">• Master thesis seminar (2 CP)
• Master thesis including defense (28 CP)</td></tr>
<tr><td></td><td>Competences and learning outcomes</td><td colspan="3">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.</td></tr>
<tr><td></td><td>Syllabus</td><td colspan="3">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.</td></tr>
<tr><td></td><td>Teaching methodologies</td><td colspan="3">The thesis is supervised by a main supervisor of the hosting Institution (ifgi or ISEGI 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.</td></tr>
<tr><td></td><td>Grading</td><td colspan="3">The module is graded by the defense (25 %) and the Master thesis (75 %).</td></tr>
<tr><td>2</td><td>Requirements for participation</td><td colspan="3">Recognition of 60 credit points of this Master program</td></tr>
<tr><td rowspan="4">3</td><td rowspan="4">Workload, requirements for awarding credit points, grading system</td><td>Course name</td><td>Exam</td><td>30 credit points</td></tr>
<tr><td>Master thesis seminar</td><td>No</td><td>2</td></tr>
<tr><td>Master thesis including defense</td><td>Yes</td><td>28</td></tr>
<tr><td colspan="3">National grading system:
Can be transferred to other national grading systems and ECTS</td></tr>
<tr><td>4</td><td>Duration and frequency of module offer</td><td colspan="3">Each semester</td></tr>
<tr><td>5</td><td>Teachers</td><td colspan="3">Prof. Huerta, Dr. Brox, Prof. Painho, N.N.</td></tr>
<tr><td>6</td><td>In charge of module</td><td colspan="3">Prof. Huerta, Dr. Brox, Prof. Painho</td></tr>
</table>