Universitat de Lleida

DEGREE CURRICULUM

GEOESTADÍSTICA I TÈCNIQUES D'OBSERVACIÓ GLOVAL

Coordination: AMÉZTEGUI GONZÁLEZ, AITOR

Academic year 2021-22

Subject's general information

Subject name	GEOESTADÍSTICA I TÈCNIQUES D'OBSERVACIÓ GLOVAL
Code	102461
Semester	1st Q(SEMESTER) CONTINUED EVALUATION
Typology	Degree: Double degree: Bachelor's degree in Forest Engineering and Bachelor's degree in Nature Conservation; Course: 5; Character: OPTIONAL; Modality: Attendance-based
Course number of credits (ECTS)	6
Type of activity, credits, and groups	see table below
Coordination	AMÉZTEGUI GONZÁLEZ, AITOR
Department	AGRICULTURAL AND FOREST ENGINEERING
Important information on data processing	Consult this link for more information.
Language	Catanan and Spanish

Typology:

Degree	Course	Character	Modality
Double degree: Bachelor's degree in Forest Engineering and Bachelor's degree in Nature Conservation	5	OPTIONAL	Attendance-based

Type of activity, credits, and groups:

Activity type	PRAULA	TEORIA
Number of credits	3	3
Number of groups	1	1

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
AMÉZTEGUI GONZÁLEZ, AITOR	aitor.ameztegui@udl.cat	4	
GELABERT VADILLO, PERE JOAN	perejoan.gelabert@udl.cat	2	

Subject's extra information

This course is part of the double degree in Forestry Engineering and Nature Conservation. It is a subject that teaches techniques and methods for statistical analysis, modelling and prediction of spatial processes, as well as the process of downloading, processing and application of some of the main techniques for global observation of the territory.

Geostatistics is a type of statistics used to analyse and predict the values associated with spatial or spatio-temporal phenomena. It incorporates the spatial (and in some cases temporal) coordinates of the data into the analysis. The first geostatistical tools were developed to describe spatial patterns and interpolate values in places where no samples were taken. Modern geostatistical analysis also allows the construction of more accurate interpolation and uncertainty models, incorporating multivariate analysis.

Geostatistics is widely used in many areas of science and engineering, for example to estimate levels of pollutants and determine whether they constitute a threat to health, to spatialise data from non-continuous samples, such as the National Forest Inventory, or to map soil characteristics such as nutrients, salinity, etc., and to relate them to soil yields and to the quality of the soil. And to relate them to the performance of agricultural crops or forestry systems, among many others:

In all these examples, the general context is that there is some phenomenon of interest that occurs in the landscape and that is characterised on the basis of specific samples. Geostatistics is then used to elaborate predictions in the locations not shown. This course introduces the principles of statistical modelling, I of spatial information, and then presents the tools available for a geostatistical analysis of the processes of interest.

Learning objectives

Knowledge objectives

Understand and demonstrate knowledge of:

- The principles of statistical modelling, specifically linear regression analysis and GLMs (generalised linear models).
- The handling, downloading and processing of different sources of spatial information in raster and vector format.
- The theoretical (statistical) concepts behind the main geostatistical tools available.
- The main physical bases of remote sensing, its advantages and limitations for studies of the natural environment, as well as image analysis techniques (visual interpretation and digital processing).
- Analysis techniques and functions for the resolution of particular cases in territorial analysis.

Competences

- CB3. Students have the ability to gather and interpret relevant data (usually within their area of study) in order to make judgements that include a reflection on relevant social, scientific or ethical issues.
- CB4. Students are able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
- CB5. That students have developed those learning skills necessary to undertake further studies with a high

degree of autonomy.
- CT3. Acquire skills in the use of new technologies and information and communication technologies.
- CT5. Acquire essential notions of scientific thought
- CG1. Demonstrate the ability to plan and organise personal work.
- CG4. Understand and express oneself with the appropriate terminology. SC6 Carry out diagnoses of the ecological processes that affect habitats, species, landscapes and ecosystems in order to maintain the ecosystem services that contribute to human well-being.
- CB1. Students will have demonstrated knowledge and understanding in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
- GC2. Develop learning skills to improve their training autonomously.
- GC5. Be able to search for and use available sources of information related to professional activity.
- GC7. Have a critical and innovative spirit.
- GC10. Respect the fundamental rights of equality between men and women, the promotion of Human Rights and the values of a culture of peace and democratic values.
- SC9 Apply the territorial planning tools that guarantee the preservation of ecological connectivity and the persistence of green infrastructures in the management of open spaces, as well as the criteria and indicators of sustainable resource management.
- SC12 Designing, executing and monitoring projects, plans and programmes for the conservation and restoration of biodiversity and geodiversity in all types of ecosystems through the application of appropriate technologies.
- CT1. Acquire an adequate oral and written comprehension and expression of Catalan and Spanish.
- TC2. Acquire a significant command of a foreign language, especially English.

Subject contents

The course is structured in four main blocks, in addition to an introductory block. Each of the blocks and the contents that will be developed in them are presented below, including the practical exercises that the students will have to carry out:

BLOCK 0: PRESENTATION AND INTRODUCTION TO R

BLOCK 1: REGRESSION ANALYSIS

1. Simple and multiple linear regression

- Linear correlation
- Fundamentals of linear regression
- Simple and multiple linear regression with R

PRACTICE 1: Linear regression with R

- Normality and other assumptions of linear regression

2. Regression with generalised linear models

- Poisson regression
- Logistic regression
- Binomial regression

PRACTICE 2: Generalised linear regression analysis

BLOCK 2: SPATIAL REGRESSION

3. Working with spatial data with R

Working with vectors

- Working with raster files

- Loading and processing multiple rasters
- Spatial properties
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4.Spatial Regression

- Dependent variable construction
- Load independent variables
- Spatial prediction

PRACTICE 3: Spatial regression analysis

BLOCK 3: GEOSTATISTICS AND SPATIAL INTERPOLATION

5. Introduction to geostatistics

- Types of representation and information: discrete and continuous data.
- Spatial autocorrelation. Moran's I
- Variograms and semi-variograms

PRACTICE 4: Construction and interpretation of spatial autocorrelation

6. Point pattern analysis

- Centrography
- Density-based analysis
- Distance-based analysis
- First and second order effects

PRACTICE 5: Point pattern analysis

7. Spatial interpolation methods

- Nearest Neighbour Interpolation (NNI)
- Inverse distance weighting (IDW)
- Krigging

PRACTICE 6: Spatial interpolation of discrete data

BLOCK 4: GLOBAL OBSERVATION TECHNIQUES

8. Global Forest Characterisation

- Global Ecosystem Dynamics Investigation (GEDI) sensor data processing
- Statistical description of the tree stand with Global Ecosystem Dynamics Investigation (GEDI)

PRACTICE 7: Characterisation of trees in the Pyrenees

9. Time series analysis

- Elements of the series (noise, seasonality and trend)
- Trend analysis

PRACTICE 8: Time series analysis

10. Global Forest Whatch

- Global Forest Whatch

PRACTICE 9: Global Forest Canopy Height, 2019 validation with GEDI data

Methodology

The course is based on a combination of theoretical expositions, where the necessary concepts and methods are presented, with practical sessions. Practical activities include tutored classroom exercises and individual work sessions.

Development plan

According to the calendar and timetable established by the Directorate of Studies of the ETSEA.

Evaluation

Procedure	Núm of tests	Weighting
First test (5-nov 15h)	1	25%
Second test (24-ene 15h)	1	25%
Practices	9	50%

The subject is evaluated according to the following weighting:

- Theoretical part: 50% of the final grade
- Practical part: 50% of the final grade
- Calculation of the overall grade of the course: Partial Ex. 1 x 0.25 + Partial Ex. 2 x 0.25 + Practicals x 0.5
- In order to pass the course, an overall mark equal to or higher than 5.0 must be obtained, and each of the following conditions must be fulfilled:
  - THEORETICAL PART: In order to pass the subject, a mark ≥ 4.0 must be obtained in the theoretical part. This is independent of the practical part mark. In other words, the practicals do not count until the above minimum requirement is met.
  - PRACTICAL PART: The minimum mark to pass the practical part is 5.0. The practical part consists of 9 practicals. In order to pass the course, a mark ≥ 5.0 must be obtained in at least five of the practicals.

NOTE: Each practical will have a **specific due date**. Late submission of practicals and/or reports will be penalised with -30% of the mark for the practical delivered after the deadline. Partial or total copying or plagiarism will result in a failing grade for the practice.

Bibliography

- Baddeley, Turner (2015) Spatial Point Patterns: Methodology and Applications with R. Routledge.
- Cohen, Warren B., Zhiqiang Yang, Sean P. Healey, R. Kennedy, and Noel Gorelick. "A LandTrendr Multispectral Ensemble for Forest Disturbance Detection." *Remote Sensing of Environment*, 2018. https://doi.org/10.1016/j.rse.2017.11.015.
- Dubayah, Ralph, James Bryan Blair, Scott Goetz, Lola Fatoyinbo, Matthew Hansen, Sean Healey, Michelle Hofton, et al. "The Global Ecosystem Dynamics Investigation: High-Resolution Laser Ranging of the Earth's Forests and Topography." *Science of Remote Sensing*, 2020. https://doi.org/10.1016/j.srs.2020.100002.
- Kennedy, R., Z. Yang, and W. B. Cohen. "Detecting Trends in Forest Disturbance and Recovery Using Yearly Landsat Time Series: 1. LandTrendr - Temporal Segmentation Algorithms." *Remote Sensing of Environment*, 2010. https://doi.org/10.1016/j.rse.2010.07.008.
- Kennedy, R., Z. Yang, N. Gorelick, J. Braaten, L. Cavalcante, W. B. Cohen, and S. Healey. *Implementation of the LandTrendr Algorithm on Google Earth Engine*. *Remote Sensing*, 2018. https://doi.org/10.3390/rs10050691.
- Kennedy, R., Zhiqiang Yang, Warren B. Cohen, Eric Pfaff, Justin Braaten, and Peder Nelson. "Spatial and Temporal Patterns of Forest Disturbance and Regrowth within the Area of the Northwest Forest Plan." *Remote Sensing of Environment*, 2012. https://doi.org/10.1016/j.rse.2011.09.024.

- Pebesma, EJ; Bivand R, Gómez-Rubio V. 2008 Applied Spatial Data Analysis with R.
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