Statistics for Environmental Sciences

Educational subject description sheet

Basic information

Field of study Joint Bachelor in Sustainability	**Education cycle** 2025/26
Speciality Environmental & Life Sciences	**Subject code** UJ.WPAJBSELSS.840.16544.25
Organizational unit Faculty of Law and Administration	**Lecture languages** english
Study level first cycle (joint degree programme)	**Subject related to scientific research** Yes
Study form full-time degree programme	**Disciplines** Earth sciences and the environment, Maths
Education profile General academic	**ISCED classification** 0542 Statistics
Mandatory obligatory	**USOS code**

Subject coordinator	Piotr Szwedo
Lecturer	Maria Eugenia de León González, Felix May, Esther Gómez Mejia, Fatima Martin Hernandez

Period Semester 3	**Examination** graded credit **Activities and hours** Discussion class: 45	**Number of ECTS points** 5.0

Goals

C1	This course is dedicated to imparting the foundational principles and the most prevalent statistical tools for the treatment and statistical analysis of a data set. This includes grounding in the most basic statistical concepts such as descriptive statistics, and progressing with probability, hypothesis testing, relation and difference tests, linear models, variance analysis, and experimental design. The objective is for students to acquire statistical tools to support, discuss, and make decisions in the field of sustainability.

Subject's learning outcomes

Code	Outcomes in terms of	Effects	Examination methods
Knowledge – Student knows and understands:			
W1	advanced statistical methodologies and data analysis techniques to address intricate challenges within the realm of Sustainability.	JBS_K1_W07	written credit, credit with grade
W2	the theoretical keystones, scientific-technical principles of data analysis, and fundamental statistics as applied to the field of Sustainability.	JBS_K1_W07	written credit, credit with grade
W3	the rules for the assessment of the validity and reliability of theoretical postulations and practical outcomes through the application of suitable statistical tools.	JBS_K1_W07	written credit, credit with grade
Skills – Student can:			
U1	utilize sophisticated computational software for the dissection and interpretation of complex datasets, thereby facilitating problem-solving in the Sustainability sector	JBS_K1_U03	written credit, credit with grade
U2	compose comprehensive reports, substantiated arguments, strategic plans, programs, or projects of a scientific and technical nature pertinent to the field of Sustainability.	JBS_K1_U01, JBS_K1_U02, JBS_K1_U03	written credit, credit with grade
Social competences – Student is ready for:			
K1	to integrate theoretical acumen and practical proficiency to tackle complex scientific-technical challenges of significant societal interest within the Sustainability domain.	JBS_K1_K05	written credit, credit with grade

Calculation of ECTS points

Activity form	Activity hours*	
Discussion class	45	
tasks solving	20	
preparation for classes	20	
preparation for the exam	65	
Student workload	**Hours** 150	**ECTS** 5.0

* hour means 45 minutes

Study content

No.	Course content	Subject's learning outcomes
1.	Lecture: What is statistics and why is it needed? Types of variables: numerical and categorical. Organization of information in data tables Practice: Getting started with statistical software. Reading data into the software. Extract columns and rows	W1, U1
2.	Lecture: Exploratory data analysis: Central parameters: means, medians. Dispersion: Standard deviation. Quantiles. Practice: Calculate numeric summary statistics for variables and for groups of variables	W2, U1
3.	Lecture: Data visualization: Histograms, boxplots, bar, and line diagrams Practice: Create these plots in software and export graphics for presentation	W2, U1
4.	Lecture: Random variables and probability functions: prob. density, prob. mass and cumulative probability. The normal distribution Practice: Calculate probabilities from a given normal distribution	W1, W2, U1
5.	Lecture: Discrete distribution: Poisson and Binomial inference Practice: Simulate random numbers from a given distribution and calculate probabilities from a given distribution	W1, W2, U1
6.	Lecture: Theory of hypothesis testing: Null and alternative hypothesis, P-value, Type I and Type II errors (false positive, false negative). Comparison of means (related and unrelated), one-tailed and two-tailed test, rejection of observations. Practice: Test for equal means: t-test, Wilcox-test	W3, U1, K1
7.	Lecture: Tests for equal variances and association between numeric variables (correlation test) or categorical variables (Chi2-test) Practical: Implement all these tests in statistical software	W1, W2, U1
8.	Lecture: Intro to linear models: Dependent and independent variables. Simple linear regression. Practice: Run simple linear regression in software	W1, W2, U1
9.	Lecture: One-way analysis of variance (ANOVA) and analysis of covariance (ANCOVA). Additive vs. interactive effects Practice: Fit and analyse ANOVA and ANCOVA in software	W1, W2, W3, U1
10.	Lecture: More complex linear models. Multiple regression and multi-way ANOVA Practice: Fit and analyse complex linear models	W1, W2, W3, U1
11.	Lecture: Model selection: AIC based comparisons, caution of p-Hacking, data-dredging	W1, W2, W3
12.	Experimental and Sampling design. Types of design, replication, blocking, randomized sampling, stratified random sampling. Optimization. Response Surface Analysis	W1, W2, W3
13.	Experimental and sampling design 1: General principles: Replication and randomization Practical: Generate experimental designs using random number generation	W1, W2, W3, U1

No.	Course content	Subject's learning outcomes
14.	Experimental and sampling design 2: Blocking. Randomized sampling, Stratified random sampling Practical: Generate advanced designs	W1, W2, W3, U1
15.	Discussion & presentation session	U2, K1

Course advanced

Teaching methods :

conversation lecture, lecture with multimedia presentation, solving tasks, practicals

Activities	Examination methods	Credit conditions
Discussion class	written credit, credit with grade	Accumulated points garnered from the practical assignments disseminated during the course duration constitute 40% of the final academic grade. The final exam contributes to 40% of the cumulative grade. Accumulated points garnered from the evaluative rubric constitute 20% of the final academic grade.

Entry requirements

None

Literature

Obligatory

1. Rencher, Alvin C., and Christensen, William F. Methods of Multivariate Analysis, John Wiley & Sons, Incorporated, 2012. Miller, James N., and Miller C. Jane. Statistics and Chemometrics for Analytical Chemistry, Pearson, 2010. Rawlings, John O., Pantula, Sastry G., and Dickey, David A. Applied Regression Analysis: A Research Tool, Springer, 2001.

Effects

Code	Content
JBS_K1_K05	The graduate can defend the importance of scientific data and methods as a basis for decision-making.
JBS_K1_U01	The graduate can critically analyse academic literature, formulate research questions and conduct research under supervision.
JBS_K1_U02	The graduate can present and report knowledge, methodologies, ideas, problems and solutions, clearly and comprehensively, in different forms destined for different audiences – including discussions and debates which require defending a substantiated opinion, as well as conversations in a foreign language at the CEFR B2 level.
JBS_K1_U03	The graduate can apply adequate methods and tools, including selected IT tools, to solve problems related to data collection, analysis, and management in the context of sustainability.
JBS_K1_W07	The graduate can apply the theory and methodology of disciplines included in the selected specialisation track to sustainability-related problems, taking into consideration practical limitations such as protection of intellectual property.