Course guide
250567 - METESTCIMA - Statistical Methods in Marine Sciences

Last modified: 22/05/2024

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: BACHELOR'S DEGREE IN MARINE SCIENCE AND TECHNOLOGY (Syllabus 2018). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: JOSE LUIS DIAZ BARRERO

Others: JOSE LUIS DIAZ BARRERO, MATTEO GIACOMINI

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13388. To know and apply the lexicon and concepts of the Marine Sciences and Technologies and other related fields.
13390. Establish a good practice in the integration of common numerical, laboratory and field techniques in the analysis of any problem related to the marine environment.
13394. Address the most relevant processes and their interactions related to their physical / chemical / biological / geological components, applying technical and scientific knowledge and criteria.
13403. Develop a conceptual framework to address the sustainability of the marine environment and the related socio-economic activities at different scales, explaining the effects of climate change.
13405. Carry out calculations, assessments, surveys and inspections in coastal and marine environments, as well as the corresponding technical documents.
13407. Apply the necessary tools to analyze the economic and legal aspects of human actions and the related impacts on the marine environment, including technical advice and representation of companies and administrations.

Generical:
13380. Develop a professional activity in the field of Marine Sciences and Technologies.
13381. Address in a comprehensive manner the analysis and preservation of the marine environment with sustainability criteria.

TEACHING METHODOLOGY

The course consists of 2 hours per week of classroom activity.

Two hours are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

LEARNING OBJECTIVES OF THE SUBJECT

In this subject, statistical methods that allow explaining correlations and dependencies of natural and anthropogenic processes in the sea will be presented, emphasizing fundamental aspects of exploratory statistics such as descriptive analysis of multivariate data, bi-variated distribution, extreme models, principal component analysis, regression models, grouping and classification methods and introduction to Bayesian statistics.

1.- Critically analyze a multivariate database (be it of real, positive, directional or compositional scale) using exploratory (e.g. biplot) and descriptive (e.g. PCAs) techniques.
2.- Establish multiple regression models and simple generalizations of them (e.g. ANOVA). Interpret the diagnoses about the models, as well as critically analyze their predictive uses.
3.- Classify and discriminate large capacity multivariate databases with supervised and unsupervised classification methods, for later analysis and critical interpretation.

This is where students are expected to obtain a vision of real environmental problems in the marine environment from a perspective that combines, on the one hand, chemistry and biology, as well as the mathematical techniques to address these problems (Marine Ecology, Ecosystems and Productive Processes) and, on the other, the tools of chemistry, biology and physics (Marine Pollution, Origin, Transport and Impacts), which are needed to solve common problems in coastal and platform waters.

This subject also includes applied techniques in the visualization, interpretation and resolution of the problems addressed in this same subject.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	30,0	20.00
Self study	90,0	60.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

Topic 1: Review of basic concepts for statistical methods

Description:
Probability distributions. Parameter estimation and hypothesis testing. ANOVA analysis.
Problems on the contents of Lesson 1.
Study of the contents of lesson 1 with the appropriate statistical software.

Specific objectives:
Review the basic concepts required by statistical methods.
Practice with the concepts of Lesson 1.
Practice with statistical software (excel, minitab or R).

Full-or-part-time: 36h
Theory classes: 9h
Practical classes: 4h
Laboratory classes: 2h
Self study : 21h

Topic 2: Linear regression

Description:
Simple and multiple linear regression. Applications.
Problems on the contents of Lesson 2.
Practice on the regression model with the appropriate statistical software.

Specific objectives:
Learn how to obtain and use linear regression models and apply them to practical problems.
Practice with statistical software (excel, minitab or R) on the contents of Lesson 2.
Practice with statistical software (excel, minitab or R).

Full-or-part-time: 28h 47m
Theory classes: 6h
Practical classes: 4h
Laboratory classes: 2h
Self study : 16h 47m

Topic 3: Logistic and polynomial regression

Description:
Logistic and polynomial regression. Analysis of multiple regression models.
Problems on the contents of Topic 3.
Practice on the logistic and polynomial regression model with the appropriate statistical software.

Specific objectives:
Analyze non-linear multiple regression models.
Practice with statistical software (excel, minitab or R) on the contents of Lesson 3.
Practice with statistical software (excel, minitab or R) the contents of Lesson 3.

Full-or-part-time: 28h 47m
Theory classes: 6h
Practical classes: 4h
Laboratory classes: 2h
Self study : 16h 47m

Lesson 4: Bayesian Statistics. Statistics of extremes and time series

Description:
Introduction to Bayesian statistics. Statistics of extremes and time series.
Problems on the contents of Lesson 4.
Practice the contents of Lesson 4 with the appropriate statistical software.

Specific objectives:
Learn the concepts of Bayesian statistics, statistics of extremes and time series.
Practice with statistical software (excel, minitab or R) on the contents of Lesson 4.
Practice with statistical software (excel, minitab or R) the contents of Lesson 4.

Full-or-part-time: 36h
Theory classes: 9h
Practical classes: 4h
Laboratory classes: 2h
Self study : 21h

Evaluations

Full-or-part-time: 14h 23m
Laboratory classes: 6h
Self study : 8h 23m

GRADING SYSTEM

Two exams are held throughout the semester:
* EP1 = Partial Exam 1, weight = 50% of the grade for the subject.
* EP2 = Partial Exam 2, weight = 50% of the grade for the subject. If the grade obtained (EP1 + EP2) / 2 exceeds the approved one, that is, it is greater than or equal to 5 points out of 10, then the subject is approved per course. Otherwise, you have to go to the reevaluation exam. The re-evaluation (R) will consist of a single exam covering the entire course content. The maximum grade for the re-evaluation will be five (5.0) and the final grade for the course will be the maximum grade between the ordinary evaluation and the re-evaluation exam.
-Mark EP1=0.25*Theory+0.25*Practical Exercises+0.5*Problems.
-Mark EP1=0.25*Theory+0.25*Practical Exercises+0.5*Problems.
-Mark R=0.25*Theory+0.25*Practical Exercises+0.5*Problems.

EXAMINATION RULES.

Failure to perform a laboratory assessment activity in the scheduled period will result in a mark of zero in that activity.

BIBLIOGRAPHY

Basic:
- Kottegoda, N.T.; Rosso, R. Applied statistics for civil and environmental engineers [on line]. Second Edition. Oxford: Wiley-Blackwell, 2008 [Consultation: 28/10/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=428240. ISBN 978-1-4051-7917-1.
- Ang, A.H-S.; Tang, W.H. Probability concepts in engineering: emphasis on applications in civil & environmental engineering. 2nd ed. New York: Wiley, 2007. ISBN 9780471720645.
- Chatterjee, S.; Hadi, A.S. Regression analysis by example. 5th ed. Hoboken, New Jersey: Wiley, 2012. ISBN 9780470905845.
- Dobson, Annette J G. Barnett. An introduction to generalized linear models. 4th. Boca Raton, FL: Chapman & Hall/CRC Taylor & Francis Group, 2018. ISBN 9781138741515.
- Peter K. Dunn Gordon K. Smyth. Generalized Linear Models With Examples in R [on line]. New York, NY: Springer, 2018 [Consultation: 18/01/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6311738. ISBN 9781441901187.
- Brockwell, P. J.; Davis, R. A.. Introduction to time series and forecasting [on line]. 2nd ed. New York: Springer, 2002 [Consultation: 08/11/2023]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/b97391. ISBN 9780387953519.

Complementary:
- Maindonald, J.; Braun, J. Data analysis and graphics using R: an example-based approach. 3rd ed. Cambridge: Cambridge University, 2010. ISBN 9780521762939.
- Castillo, E. [et al.]. Extreme value and related models with applications in engineering and science. Hoboken, New Jersey: John Wiley & Sons, 2005. ISBN 047167172X.