

Course guide 2500014 - GECPROBEST - Probability and Statistics

	Last modified: 01/10/202	23
Unit in charge:	Barcelona School of Civil Engineering	
Teaching unit:	751 - DECA - Department of Civil and Environmental Engineering.	
Degree:	BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2020). (Compulsory subject).	
Academic year: 2023	ECTS Credits: 6.0 Languages: Catalan, English	
LECTURER		
Coordinating lecturer:	MARÍA ISABEL ORTEGO MARTÍNEZ	
coordinating letter.		

Others: MARÍA ISABEL ORTEGO MARTÍNEZ, JOSE SARRATE RAMOS

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

14392. Ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculation; differential equations and partial derivatives; numerical methods; numerical algorithmic; Statistics and optimization. (Basic training module)

TEACHING METHODOLOGY

The course is given at 4 lecture hours per week. These lecture hours include theory, problems and laboratory sessions and they are not strictly distinguished. Full size, medium size and small teaching groups are combined, following the teaching program.

Statistics has an eminently applied and computational component. Therefore, practical classes, that are taught in the same classroom, should be followed using a laptop. Specific software is used (R + RStudio, among others).

Students should use the support materials that will be available in the virtual campus ATENEA: updated information about subject organization, contents, scheduling of activities, learning assessment and bibliography.

The main language of instruction will be English/Catalan, depending on the group. Teaching materials may be written in any of the three languages (English/Catalan/Spanish).

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.



LEARNING OBJECTIVES OF THE SUBJECT

Development of the fundamental concepts and methodology of probability and statistics. Application of non-deterministic methods of analysis to civil and environmental engineering problems: probability, descriptive statistics, random variables, statistical inference. Basic use of specific computer software for the application of these methodologies.

1 Ability to perform data analysis of a problem in Civil Engineering using a computer tool that uses the techniques studied.

2 Ability to perform multiple linear regression analysis using computer programs.

3 Ability to perform data simulations and transformation of random variables, as well as the study of distributions.

Knowledge and skills for data representation and processing, including basic knowledge of databases as well as computer programs with engineering applications, as well as statistical concepts. Knowledge of data analysis. Knowledge of regression models, estimation of parameters. Knowledge of probability and uncertainty.

Basic knowledge of point and interval estimation; hypothesis testing.

STUDY LOAD

Туре	Hours	Percentage
Hours large group	30,0	20.00
Guided activities	6,0	4.00
Hours medium group	30,0	20.00
Self study	84,0	56.00

Total learning time: 150 h

CONTENTS

Data exploration

Description:

Scale, support and data transformation. Location and dispersion measures Graphic representations. Sample distribution. Multivariate data. Covariance and linear correlation. Minimum square line fit. Trends

Full-or-part-time: 14h 23m Theory classes: 4h Laboratory classes: 2h Self study : 8h 23m



Elemental Probability

Description:

Definition and properties of probability Total probability theorem and Bayes theorem. Experimental model. Probability calculation

Full-or-part-time: 14h 23m Theory classes: 4h Practical classes: 2h Self study : 8h 23m

Univariate probabilistic models

Description:

Random variable General discrete models. Commonly used discrete models. Continuous models. Frequently used continuous models. Normal distribution. LogNormal and logitNormal distributions Simple transformations of random variables. Model applications

Full-or-part-time: 26h 24m

Theory classes: 8h Practical classes: 3h Self study : 15h 24m

Simulation of random variables

Description:

Elementary simulation methods. Simulation and representation of samples.de mostres. Basic MonteCarlo method.

Full-or-part-time: 4h 48m Laboratory classes: 2h Self study : 2h 48m

Multivariate probabilistic models

Description:

Multivariate probabilistic models Multivariate normal distribution and Central limit theorem

Full-or-part-time: 7h 11m Theory classes: 3h Self study : 4h 11m

Evaluation

Full-or-part-time: 24h Laboratory classes: 10h Self study : 14h



Parameter estimation

Description:

Statistics. Estimators. Method of moments Likelihood of a sample. Maximum likelihood method. Properties of estimators Applications of point parameter estimation. Central limit theorem. Distributions of usual statistics.

Full-or-part-time: 16h 48m Theory classes: 3h Practical classes: 2h Laboratory classes: 2h Self study : 9h 48m

Contrast of statistical hypotheses

Description:

Hypothesis tests Contrasts in normal context Contrasts in Normal context Simulated contrasts. Other contrast statistics

Full-or-part-time: 19h 12m Theory classes: 3h Practical classes: 3h Laboratory classes: 2h Self study : 11h 12m

Multiple linear regression

Description:

Linear regression least squares model. Hypotheses and assessment of the model More Linear Model. ANOVA

Full-or-part-time: 16h 48m Laboratory classes: 7h Self study : 9h 48m



GRADING SYSTEM

The mark of the course is obtained as a weighted average of the marks of the continuous assessment activities.

There will be continuous assessment activities of different types, performed individually and in groups. These activities are additive and have a training character, being carried out during the academic year (both in and out of the classroom).

The exams consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge, and a part with a set of application exercises.

The final qualification of the subject is obtained by weighted average of the marks of different assessment activities:

Each of the partial exams will consist of two parts, one for assessment of concepts (Theoretical questions) and the other for assessment of applications (Problems).

1. Assessment of concepts: the assimilation of concepts is evaluated through theoretical questions in which both the knowledge of the subject and the capacity for rigor in written expression are valued. The mark of this part is the arithmetic mean of the marks of the two partial exams.

2. Applications to practical cases. The mark of this part is the arithmetic mean of the marks of the two partial exams.

The first partial will correspond approximately to the Probability part of the subject and the second to the Statistics part (non-strict division, depending on the calendar). The second partial exam includes the concepts of the first (the subject's syllabus is cumulative).

3. Course project. The project is assessed considering the assimilation of statistical and probabilistic methods taught in class, such as the use of computing and representation tools. Other transversal competencies, such as working in a group or expression are also considered in the assessment.

4. Bibliographic research of Applications of Statistics to Civil Engineering. The effort and ability to collect technical and scientific information is assessed, as well as the understanding of the contents and applications of probabilistic modeling and statistics.

5. Self-assessment questionnaires. Several questionnaires are carried out on the subject. For each questionnaire, the materials taught in class in the period prior to the questionnaire are considered.

6. Other activities.

The final grade for the subject (out of 10) is obtained by the weighted sum of the evaluations of each of the five described blocks. The weighted values of the assessment items are

- 1. Conceptual evaluation: 2.0 points
- 2. Applications to practical cases: 3.5 points
- 3. Course project evaluation: 3.0 points
- 4. Bibliographical research of applications of Statistics to Civil Engineering: 0.5 points
- 5. Self-assessment quizzes and other activities: 1.0 point

Criteria for re-evaluation qualification and eligibility: Students whose marks have not reached a minimun of five and have a score strictly greater than zero in the assessment activities will have the opportunity of carrying out a re-evaluation exam during the period specified in the academic calendar. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests.

EXAMINATION RULES.

The materials and resources to carry out the tests (calculator, forms ...) will be determined for each exam session. Information will be posted on Atenea.

BIBLIOGRAPHY

Basic:

- Kottegoda, N.T.; Rosso, R. Applied statistics for civil and environmental engineers [on line]. 2nd ed. Oxford: Blackwell, 2008 [Consultation: 28/10/2020]. Available on: <u>https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=428240</u>. ISBN 9781405179171.

- Devore, J.L. Probabilidad y estadística para ingeniería y ciencias. 9a ed. México: Cengage Learning, 2016. ISBN 9786075228280.

- Ross, S.M. Introduction to probability and statistics for engineers and scientists. 5th ed. Oxford: Elsevier Academic Press, 2014. ISBN 978012394811-3.

- DeGroot, M.H.; Schervish, M.J. Probability and statistics. 4th ed. Boston: Pearson, 2012. ISBN 9780321709707.

- 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.



Complementary:

- Kabacoff, R.I. R in action: data analysis and graphics with R. 2nd ed. Shelter Island, [New York]: Manning, 2015. ISBN 9781617291388.

- Pawlowsky-Glahn, V. [et al.] (eds.). Modeling and analysis of compositional data: theory and applications [on line]. Hoboken, N.J.: Wiley, 2015 [Consultation: 26/07/2021]. Available on: <u>https://onlinelibrary.wiley.com/doi/book/10.1002/9781119003144</u>. ISBN 9781119003144.

- Castillo, E. [et al.]. Extreme value and related models with applications in engineering and science. Hoboken, New Jersey: John Wiley & Sons, 2005. ISBN 047167172X.

- Canavos, G.C. Probabilidad y estadística : aplicaciones y métodos. México [etc.]: McGraw Hill, 1988. ISBN 9684518560.

- Mood, A. M; Graybill, F.A; Boes, D.C. Introduction to the theory of statistics. 3rd. McGraw-Hill, 1974. ISBN 0070428646.