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250123 - PROBESTAD - Probability and Statistics

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering

Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering

Academic year: 2018

Degree: BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2017). (Teaching unit Compulsory)

ECTS credits: 7,5 Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: MARÍA ISABEL ORTEGO MARTÍNEZ

Others: MARIA CAMINO TEOFILA BALBUENA MARTINEZ, MARÍA ISABEL ORTEGO MARTÍNEZ

Degree competences to which the subject contributes

Specific:

3048. Ability to solve the types of mathematical problems that may arise in engineering. Ability to apply knowledge of: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial derivatives; numerical methods; numerical algorithms; statistics and optimisation.

3049. Ability to select resources from knowledge of: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial derivatives; numerical methods; numerical algorithms; statistics and optimisation. All with a view to solving the types of mathematical problems that may arise in engineering

3054. Students will acquire basic knowledge of the use and programming of computers, operating systems, databases and applications for engineering.

Transversal:

592. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

595. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

599. EFFECTIVE USE OF INFORMATION RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.

602. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

584. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Teaching methodology

The course is given at 5 lecture hours per week. These lecture hours include theory, problems and laboratory sessions and they are not strictly distinguished.

Statistics has an eminently applied and computational component. Therefore, practical classes, that are taught in the same classroom, should be followed using a laptop.

Support materials will be available in the virtual campus ATENEA: contents, scheduling of activities, learning assessment and bibliography.

Learning objectives of the subject

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Students will acquire the skills to analyse, represent and process data, including basic knowledge of databases and computer software with applications in engineering. They will also learn to solve problems of uncertainty and statistics.

Upon completion of the course, students will have acquired the ability to: 1. Carry out a data analysis of a civil engineering problem using a computer tool that employs the techniques studied. 2. Carry out a multiple linear regression analysis using computer software. 3. Carry out data simulations and transformations of random variables, as well as studies of distributions.

Data analysis; Regression models, parameter estimation; Probability and uncertainty; Random variables: definition and interpretation; Operations on random variables; Probability models: Bernoulli, Poisson and other distributions; Asymptotic probabilistic models that start with the normal distribution and end with transformations of the normal distribution; Estimation of return period; Parameter estimation, method of maximum likelihood, interval estimation; Hypothesis testing and goodness-of-fit testing; Bayesian estimation and statistical analysis of regression models

Study load

Total learning time: 187h 30m	Hours large group:	32h	17.07%
	Hours medium group:	16h	8.53%
	Hours small group:	27h	14.40%
	Guided activities:	7h 30m	4.00%
	Self study:	105h	56.00%

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Content

Elements of probability

Learning time: 16h 48m

Theory classes: 3h
Practical classes: 2h
Laboratory classes: 2h
Self study : 9h 48m

Description:
Frequency and axiomatic probability. Joint probability, marginal and conditional. Theorem of total probability and Bayes
Effective interpretation and calculation of experimental results
Combinatorics and probability exercises

Data exploration

Learning time: 19h 12m

Theory classes: 5h
Laboratory classes: 3h
Self study : 11h 12m

Description:
Qualitative variables, discrete, continuous. Scale and measures of difference of continuous variables. Measures of location and dispersion.
Logarithmic transformations, logistic and quadratic. Averages and variability.
Representation of the sampling distribution. Histograms.
Representation. Calculation and interpretation of correlation.
Linear fit and prediction. Cyclic and polynomic trend

Univariate probability models

Learning time: 43h 12m

Theory classes: 9h
Practical classes: 5h
Laboratory classes: 4h
Self study : 25h 12m

Description:
Definition. Probability distribution. Continuous and discrete variables. Density and probability function. Moments.
Bernoulli distribution, binomial, geometric, hypergeometric. Poisson
Representation of discrete probability functions
Exponential,gamma and beta distributions. Central limit theorem and normal distribution. Asymptotic extremal models: GPD and GEVD
Transformation methods. Log-normal and logistic-normal distribution. Chi2
Representation of densities and continuous distributions
Point processes in time (Bernoulli and Poisson). Return periods

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Random variables simulation

Learning time: 12h

Theory classes: 1h
Laboratory classes: 4h
Self study : 7h

Description:
Method of inverse distribution function. Discrete simulation.
Continuous simulation models. QQ and PP plots . Monte Carlo Method

Multivariate probability models

Learning time: 19h 12m

Theory classes: 5h
Practical classes: 3h
Self study : 11h 12m

Description:
Joint, conditional and marginal distribution. Mean and covariance. Linear approximation of random variables.
Joint normal density, conditionals and marginals.
Multinomial distribution and other examples

Parameter estimation

Learning time: 16h 48m

Theory classes: 3h
Practical classes: 2h
Laboratory classes: 2h
Self study : 9h 48m

Description:
Samples. Estimation by the method of moments. Concept of likelihood function. Maximum likelihood estimation.
Properties of estimators.
Examples of estimation.
Graphical estimation of parameters. Irregular cases.

Hypothesis testing

Learning time: 24h

Theory classes: 2h
Practical classes: 4h
Laboratory classes: 4h
Self study : 14h

Description:
Decision rules. Errors type I and II. Power.
Tests on mean and variance of normal populations. Distributions t, chi2, F
Simulation of null hypothesis and estimation of p-value

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Multiple linear regression	Learning time: 19h 12m Theory classes: 4h Laboratory classes: 4h Self study : 11h 12m

Description:
Regression model and its extensions. Least squares fit. Common hypothesis of the model
First example. F-test on regression. T Test on coefficients. Normal residuals.
Multiple regression. ANOVA. Using factors.

Summative assessment	Learning time: 9h 36m Laboratory classes: 4h Self study : 5h 36m

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Qualification system

The rating of the subject is obtained by sum of scores of five assessments with different content.

1. Conceptual assessment. Assimilation of concepts is evaluated through theoretical questions concerning both subject knowledge and proper writing ability.

2. Applications to practical cases. Contains two assessments with applications of probability and with applications of statistics.

3. Laboratory evaluation. The assimilation of statistical methods and synthesis of information using computer and representation tools is evaluated. It refers to the contents given in lab-practical sessions.

4. Literature search of applications of statistics to civil engineering. It evaluates the effort and ability to collect technical and scientific information on probabilistic modeling and statistics applications as well as understanding their content.

5. Self-assessment questionnaires. Several questionnaires are proposed on the subject topics covered during the semester.

The final score of a maximum of 10 is obtained by the weighted sum of the scores for each of the five assessment elements. The weighted values of the elements are

1. Conceptual assessment: 1.5 points
2. Applications to case studies: 4.5 points
3. Laboratory evaluation: 2.5 point
4. Literature search of applications of statistics to Civil Engineering: 0.5 points
5. Self-assessment questionnaires: 1 point

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly performed all evaluation activities will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. 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. Those students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

Regulations for carrying out activities

Materials and resources for the carrying out the examinations (calculator, official cheat sheets...) will be established for each exam.

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Bibliography

Basic:

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Freund, J.E.; Miller, I.; Miller, M. Estadística matemática con aplicaciones. 6a ed. México: Prentice Hall, 2000. ISBN 9701703898.

Ross, S.M. Introduction to probability and statistics for engineers and scientists. 4th ed. Amsterdam: Elsevier, 2009. ISBN 9780123704832.

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:

Horra, J. de la. Estadística aplicada. 3a ed. Madrid: Díaz de Santos, 2003. ISBN 8479785543.

Pawlowsky-Glahn, V [et al.]. Modeling and analysis of compositional data [on line]. Hoboken, N.J.: Wiley, 2015 [Consultation: 04/04/2019]. Available on: <https://onlinelibrary.wiley.com/doi/book/10.1002/9781119003144>. ISBN 9781119003144.

Arriaza Gómez, A.J. ... [et al.]. Estadística Básica con R y R-Commander. Cádiz: Servicio de Publicaciones UCA, 2008. ISBN 9788498281866.

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

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

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

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