Course guide
2500014 - GECPROBEST - Probability and Statistics

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: 2022  ECTS Credits: 6.0  Languages: Catalan, Spanish, English

LECTURER
Coordinating lecturer: MARÍA ISABEL ORTEGO MARTÍNEZ
Others: AGUSTIN MEDINA SIERRA, MARÍA ISABEL ORTEGO MARTÍNEZ

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 and medium size 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 Catalan/Spanish/English, depending on the group. The other two languages will also be used. Teaching materials may be written in any of the three languages.

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

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>6,0</td>
<td>4.00</td>
</tr>
<tr>
<td>Self study</td>
<td>84,0</td>
<td>56.00</td>
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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:** 24h
- Theory classes: 8h
- Practical classes: 2h
- Self study: 14h

### 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
Central limit theorem
Applications of multivariate models

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

**Full-or-part-time**: 19h 12m  
Laboratory classes: 8h  
Self study: 11h 12m

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### 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

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### Contrast of statistical hypotheses

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

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

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### Multiple linear regression

**Description:**  
Linear regression model and adjustment for least squares  
Complete linear model. Hypothesis and evaluation of the model.

**Full-or-part-time**: 21h 36m  
Laboratory classes: 9h  
Self study: 12h 36m
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 evaluation tests 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 sum 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 probabilistical 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 who that not reach a minimum 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:

Complementary: