Universitat Autònoma de Barcelona

2020/2021

Probability

Code: 104386
ECTS Credits: 6

Degree	Type	Year	Semester
2503740 Computational Mathematics and Data Analytics	FB	1	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Prerequisites

This subject is of the second semester of the first year. As prerequisites, we specially mention

- Calculus in One Variable, subject of first semester, although also
- Introduction to Programming, also of the first semester.

It is also very necessary that the student reaches throughout the semester the contents of the subject

Calculus in Various Variables, which is taken simultaneously.

Objectives and Contextualisation

What has in common a draw of the lottery, a clinical trial to experimentally evaluate the efficacy and/or safety of a new medical treatment, the weather forecast of rain in a specific area, the management of the inventory of a company, the transmission of genes from parents to children, the estimate of the size of the whale population, an epidemiological study on the incidence of a certain disease, the inspection of batches of products that a company manufactures to verify their quality, an experiment to study the effect of pressure and temperature on the result of a certain chemical reaction, or the effect of the use of different fertilizers in the agricultural production of a farm, ...?

These are real situations in which chance intervenes.

To study them and to be able to extract reliable conclusions, we must use a suitable mathematical model. This model is provided by the Probability, which is the mathematical theory that allows modeling random phenomena, that is, situations where chance acts.

The objective of this subject is to introduce the theory of Probability as a mathematical theory that studies the models that allow to deal with randomness. The topics that will be introduced and will be developed in this subject include basic contents of the theory of Probability (development of the mathematical model for random phenomena), although without using advanced elements of the Measure Theory that correspond to a deeper study of matter. But the emphasis will be on applications, when trying to find the best possible probabilistic model in a given real situation and, by using it appropriately, with the tools we will learn throughout the course,

to extract valuable information, knowledge, and reach useful conclusions, because this is the objective that is sought when modeling is done.

Competences

- Apply a critical spirit and rigour for the validation or rejection of your own arguments and those of others.
- Demonstrate a high capacity for abstraction and translation of phenomena and behaviors to mathematical formulations.
- Formulate hypotheses and think up strategies to confirm or refute them.
- Make effective use of bibliographical resources and electronic resources to obtain information.
- Relate new mathematical objects with other known objects and deduce their properties.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Using criteria of quality, critically evaluate the work carried out.
- Work cooperatively in a multidisciplinary context assuming and respecting the role of the different members of the team.

Learning Outcomes

1. "Explain ideas and mathematical concepts pertinent to the course; additionally, communicate personal reasonings to third parties."
2. Apply a critical spirit and rigour for the validation or rejection of your own arguments and those of others.
3. Contrast, if possible, the use of calculation with the use of abstraction in solving a problem.
4. Describe the concepts and mathematical objects pertaining to the subject.
5. Develop autonomous strategies for solving problems such as identifying the ambit of problems within the course, discriminate routine from non-routine problems, design an a priori strategy to solve a problem, evaluate this strategy.
6. Evaluate the advantages and disadvantages of using calculation and abstraction.
7. Identify the essential ideas in the demonstration of ceratin basic theorems and know how to adapt these to obtain other results.
8. In an orderly and accurately manner, draft brief mathematical texts (exercises, resolution of theoretical questions, etc.).
9. Make effective use of bibliographical resources and electronic resources to obtain information.
10. Read and understand a mathematical text at the current level of the course.
11. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
12. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
13. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
14. Using criteria of quality, critically evaluate the work carried out.
15. Work cooperatively in a multidisciplinary context, taking on and respecting the role of the distinct members in the team.

Content

1. Modeling randomness: the probabilistic model.

- Random phenomena and probability spaces.
- Properties of the Probability. Probability and Odds.
- Counting elements of a set: some combinatorics.
- Conditioned probability and independence of events.
- The Formula of Total Probability and the Bayes' Formula.
- Evidence Evaluation and Bayes Formula: The Odds Ratio.

2. Random variables.

- Introduction. Distribution function of a random variable.
- Discrete random variables. Probability function. Examples
- (Absolutely) continuous random variables. Density function. Examples.
- Functions of a random variable.
- Independence of random variables.

3. Mathematical Expectation, Variance and Moments.

- Expectation of discrete random variables.
- Expectation of (absolutely) continuous random variables.
- Expectation and independence of random variables.
- Variance of a random variable.
- Covariance of two random variables. The (Pearson) correlation coefficient.
- Moments of a random variable. Txevixev inequality.
- Moment generating function.

4. Sequences of random variables.

- Types of convergence.
- Laws of large numbers (LLN).
- The central limit theorem (TCL).

IMPORTANT: To include the gender perspective in the teaching of this subject, we have reviewed the possible androcentric biases and questioned hidden gender assumptions and stereotypes.
This revision involves including in the contents of the subject, as far as possible, knowledge produced by women scientists, often forgotten, seeking the recognition of their contributions, as well as that of their works in the bibliographical references.

Methodology

In this subject, it is not made the classic distinction in the face-to-face activities of: classes of theory, of problems and of practices with computer, but they will be combined according to the teaching needs in each moment, thanks to the facility that supposes the fact that students bring their own computer in class.

In this way, the teacher will introduce the concepts and examples, while when appropriate, the problems will be worked on in class, or the statistical software and R programming language will be used to carry out some practice related to the topic that is being studied in class. The aim is to use a comprehensive system that incorporates the three classical aspects of face-to-face activities in an optimal manner to facilitate student learning and achieve the objectives set, while making the class as participatory as possible, following the principle that you only learn what you are trying to do.

IMPORTANT: Given the situation caused by covid19, it is likely that part of the teaching of the subject will be done virtually. The information in this regard and the instructions for the good follow-up of the subject will be published in the teaching space (Aula Moodle) within the UAB Virtual Campus: http://cv.uab.cat.

Students can communicate with the teacher via email, always sent from the institutional address @ e-campus.uab.cat.

IMPORTANT: To work more comfortably with R, it is recommended to use the RStudio interface: it is free, "open source" and works with Windows, Mac and Linux.
https://www.rstudio.com/

REMARK: Although we have already discussed the gender perspective in teaching in previous sections, we go further by reviewing the teaching methodology and the interactions between students and teachers. In this sense, a participatory teaching methodology will be implemented, where an egalitarian, less hierarchical classroom environment is generated, avoiding stereotyped examples in gender and sexist vocabulary, with the aim of developing critical reasoning and respect for diversity and plurality of ideas, people and situations, it will be more favorable to the integration and full participation of the students.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Problems in the classroom	15	0.6	2, 14, 6, 3, 4, 5, 1, 13, 12, 11, 8, 15, 9
Theory in the classroom	30	1.2	2, 4, 5, 1, 7, 10, 13, 12, 11, 8, 9
Type: Supervised			
Practical sessions	11	0.44	2, 14, 6, 3, 4, 5, 1, 13, 12, 11, 8, 15, 9
Type: Autonomous			
Personal work	85	3.4	2, 14, 6, 3, 4, 5, 1, 7, 10, 13, 12, 11, 8, 15, 9

Assessment

The evaluation of this subject will consist of:

Continued avaluation:

• Two continuous assessment tests (PAC), with a weight of 20% each (total = 40%)

Exam: the exam will have a total weight of 60% and will consist of two parts:

• Problem examination (EProb), with 50% weight.
• Examination of practices with R (EPract), with a 10% of weight.

Therefore, Grade1 = 0.2 * PAC1 + 0.2 * PAC2 + 0.5 * Eprob + 0.1 * EPract.

If Grade1> = 5, the student passes the subject. Otherwise, you have the opportunity to take the recovery exam, which does NOT serve to improve your grade.

Recovery exam (ERec): worth 80% of the grade. The practice exam with R will be worth the remaining 20% of the grade.

Therefore, Grade2 = 0.8 * ERec + 0.2 * EPract

The FINAL GRADE will be Grade1 for students such that Grade1> = 5, and will be the maximum between Grade1 and Grade2 otherwise.

IMPORTANT: in order for any test (PAC or exam) to be taken into account in the calculation of the grade of the subject (Grade or Final Grade), at least a 3.5 out of 10 in the 'evaluation of the test.
Otherwise, the test will score as a 0 on the calculation.

If a student presents at least one of the two PACs, or takes one of the exams, he/she will be considered as Presented; otherwise, their rating will be "Not evaluable". For a student who is considered Presented, the mark of any evaluable test to which it is not presented will be a 0.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Continuous Assessment Test, PAC1	0.20	2	0.08	2, 14, 6, 3, 5, 1, 10, 13, 12, 11, 8, 15, 9
Continuous Assessment Test, PAC2	0.20	2	0.08	2, 6, 3, 4, 5, 1, 7, 10, 13, 12, 11, 8, 9
Exam	0.60	5	0.2	2, 6, 3, 4, 5, 1, 7, 10, 13, 12, 11, 8, 9

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