Course guide
200131 - TP - Probability Theory

Unit in charge: School of Mathematics and Statistics
Teaching unit: 749 - MAT - Department of Mathematics.
Degree: BACHELOR'S DEGREE IN MATHEMATICS (Syllabus 2009). (Compulsory subject).
Academic year: 2023 ECTS Credits: 7.5 Languages: Catalan

LECTURER
Coordinating lecturer: MARCOS NOY SERRANO
Others:
Primer quadrimestre:
MARCOS NOY SERRANO - M-A, M-B
MIQUEL ORTEGA SÁNCHEZ COLOMER - M-A, M-B
JUAN JOSÉ RUE PERNA - M-A, M-B

REQUIREMENTS
It is recommended to take this course after completing the first two years of the Mathematics degree. In particular, those not having taken Real Analysis yet will have to cover some gaps by their own (references will be supplied).

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CE-2. Solve problems in Mathematics, through basic calculation skills, taking in account tools availability and the constraints of time and resources.
2. CE-3. Have the knowledge of specific programming languages and software.
3. CE-4. Have the ability to use computational tools as an aid to mathematical processes.

General:
5. CB-1. Demonstrate knowledge and understanding in Mathematics that is founded upon and extends that typically associated with Bachelor's level, and that provides a basis for originality in developing and applying ideas, often within a research context.
6. CB-2. Know how to apply their mathematical knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader or multidisciplinary contexts related to Mathematics.
7. CB-3. Have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements.
8. CG-1. Show knowledge and proficiency in the use of mathematical language.
10. CG-3. Have the ability to define new mathematical objects in terms of others already know and ability to use these objects in different contexts.
11. CG-4. Translate into mathematical terms problems stated in non-mathematical language, and take advantage of this translation to solve them.
12. CG-6 Detect deficiencies in their own knowledge and pass them through critical reflection and choice of the best action to extend this knowledge.

Transversal:
4. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

TEACHING METHODOLOGY
(See the Catalan version of this guide.)
LEARNING OBJECTIVES OF THE SUBJECT

There are two main objectives: (1) to present Probability Theory as a rich, attractive and useful tool in modeling random phenomena and (2) to provide the necessary background in probability for other subjects in the Degree of Mathematics.

The particular goals of the subject are the achievement by the students of the following aspects:

* To know the notion of probability and its main properties.
* To know the basic discrete and continuous probability models.
* To use the concept of random variable in formalizing and solving problems in probability.
* To know the concept of moments of a random variable and the main results associated to this notion.
* To know the notion of convergence of random variables, particularly the Central Limit Theorem and the Laws of Large Numbers.

STUDY LOAD

<table>
<thead>
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<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tr>
<td>Hours large group</td>
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<td>Self study</td>
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<td>60.00</td>
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Total learning time: 187.5 h

CONTENTS

**Probability spaces**

Description:

**Full-or-part-time:** 25h 30m
Theory classes: 6h
Practical classes: 4h
Self study: 15h 30m

**Random variables**

Description:

**Full-or-part-time:** 25h 30m
Theory classes: 6h
Practical classes: 4h
Self study: 15h 30m
Discrete random variables

Description:
Discrete variables. Probability function.
Probability generating function. Sums of random variables.
Models of Discrete Random Variables.
Conditional distributions. Conditional Expectation.
Ramification processes (Galton-Watson trees)
Random walks.

Full-or-part-time: 26h 30m
Theory classes: 6h
Practical classes: 5h
Self study: 15h 30m

Continuous random variables

Description:
Density Probability Function.
Models of Continuous Random Variables.
Joint distributions. Marginal distributions.
Conditional distributions and mixtures.
Multivariate Normal distribution.
Transformations of continuous variables.

Full-or-part-time: 27h 30m
Theory classes: 6h
Practical classes: 6h
Self study: 15h 30m

Characteristic functions

Description:
Moment Generating Function.
Characteristic Function. Inversion theorem.

Full-or-part-time: 21h 30m
Theory classes: 5h
Practical classes: 2h 30m
Self study: 14h

Convergence of Random Variables

Description:
Modes of convergence
Laws of large numbers
Convergence in distribution. The Central Limit Theorem.

Full-or-part-time: 35h 30m
Theory classes: 9h
Practical classes: 4h
Self study: 22h 30m
GRADING SYSTEM

(See the Catalan version of this guide.)

BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Hyperlink:
- The Probability Web (Teaching resources)
  - http://www.mathcs.carleton.edu/probweb/probweb.html - Chance
- The R Project for Statistical Computing
  R is a free software environment for statistical computing and graphics.
  http://www.r-project.org/