Universidad Zaragoza

Academic Year/course: 2024/25

27016 - Probability

Syllabus Information

Academic year: 2024/25
Subject: 27016 - Probability
Faculty / School: 100 - Facultad de Ciencias
Degree: 453 - Degree in Mathematics
647 - Degree in Mathematics
ECTS: 6.0
Year: 3
Semester: First semester
Subject type: Compulsory
Module:

1. General information

It is a course dedicated to the study of random variables in uncertain environments and the construction of stochastic models that represent real-life situations.

Basic knowledge of linear algebra and mathematical analysis (calculus in one and multiple variables) is required. As it is a continuation of the *Introduction to Probability and Statistics* course, it is crucial to have taken it beforehand.

2. Learning results

- Distinguish deterministic phenomena from random phenomena. Understand the statistical paradigm used to study random phenomena: the probability space.
- Construct the appropriate probability space for the study of a random phenomenon. Calculate probabilities. Understand and interpret the concepts of stochastic dependence and independence. Calculate probabilities in both dependent and independent situations.
- Define and understand the meaning of discrete and continuous random variables, both unidimensional and multidimensional, and the functions that characterize them. Understand their utility in calculating probabilities. Know and calculate the main characteristics of a distribution.
- Understand and apply the basic concepts of convergence of sequences of random variables and some laws of large numbers.
- Know the central limit theorem, understand its meaning, and use it appropriately.
- Use acquired knowledge to construct models that solve situations where randomness is essential.

3. Syllabus

Block 1. Random vectors.

1. General random vectors. Definition. Cumulative distribution function. Transforms of random vectors. Types of random vectors.
2. Discrete random vectors. Probability distributions: joint, marginal, condicional. Independent random variables.
3. Continuous random vectors. Probability distributions: joint, marginal, conditional. Independent random variables. Differentiable transform of a continuous random vector.
4. Moments and properties of random vectors. Moments. Moment generating functions. Reproductive property.
5. Some multivariate probability distributions. Multinomial distribution and Multivariate Normal distribution.
6. Correlation and least mean square principle. Correlation coefficient. Schwarz's inequality. Functional relationships between two random variables and the least mean square principle.

Block 2. Stochastic convergence, law of large numbers and central limit theorem.

1. Convergence of sequences of random variables. Convergence in probability. Almost sure convergence. Convergence in distribution. Convergence in the Lp-norm. Properties and relationships between the types of convergence.
2. Laws of large numbers. Weak laws of large numbers. Strong laws of large numbers. Central limit theorem for independent and identically distributed random variables. General central limit theorem.

4. Academic activities

Master classes: 30 hours.
Problem solving: 30 hours.
Study: 84 hours.
Assessment tests: 6 hours.

5. Assessment system

The course consists of two blocks, B1 and B2, which are evaluated independently. The grade for the first call will be obtained as the average of the grades for B1 and B2.

The grade for B1 can be obtained through a mid-terl exam that will be held at the end of the block's classes. Additionally, on the official assessment date, there will be a second exam for B1. Students who have obtained at least a 4.5 in the first B1 exam will not have to take the second exam; if they choose to take it, the B1 grade will be the higher of the two grades. The grade for B2 will be obtained through an exam on the official assessment date.

The assessment in the second call will consist of a single exam that will cover the entire course material.

6. Sustainable Development Goals

4 - Quality Education
5 - Gender Equality
8 - Decent Work and Economic Growth