30308 - Probability and processes

Información del Plan Docente

Academic Year	2017/18
Faculty / School	110 - Escuela de Ingeniería y Arquitectura
Degree	438 - Bachelor's Degree in Telecomunications Technology and Services Engineering
ECTS	6.0
Year	1
Semester	Second semester
Subject Type	Basic Education
Module	---

1.General information

1.1.Introduction

1.2.Recommendations to take this course

1.3.Context and importance of this course in the degree

1.4.Activities and key dates

2.Learning goals

2.1.Learning goals

2.2.Importance of learning goals

3.Aims of the course and competences

3.1.Aims of the course

3.2.Competences

4.Assessment (1st and 2nd call)

4.1.Assessment tasks (description of tasks, marking system and assessment criteria)

5.Methodology, learning tasks, syllabus and resources

5.1.Methodological overview

The proposed methodology aims at encouraging students for every day work. Concepts are presented sequentially in time from probability models and random variables to random vectors. Thus, the concepts related to stochastic processes constitute the last topic to be covered in this course. In so doing a better understanding of the contents is achieved and at the same time the student's interest is promoted by means of a practical approach based on the use of actual problems and data.

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The general principles of this course are presented in large-group-sessions where a formal description is carried out with applications in standard examples. Classes in computer room deal with both data analysis and modelling of real events. Students completing them will be able to use specific statistical software.

5.2.Learning tasks

The following activities are designed to achieve the expected results

This course comprises five learning blocks:

Block 1: *Data analysis*

Block 2: *One random variable, Probability models*

Block 3: *Two random variables*

Block 4: *Stochastic processes*

Block 4: *Introduction to optimization*

This course corresponds to 6 ECTS equivalent to 150 hours for students developed in both presential activities and non-presential activities whose individual weightings are as follows:

Presential activities:

30 hours (2 hours/week) in large-group sessions

30 hours (2 hours/week) of practical classes in small group sessions. These classes involve problem sets and data analysis.

Non-presential activities:

30 hours for individual study of general principles or ideas and 54 hours devoted to practical tasks.

6 hours for student appraisal.

5.3.Syllabus

*.- INTRODUCTION

Deterministic and random experiments.

Statistical methodology.

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Historical introduction

*.- DESCRIPTIVE STATISTICS

Graphs.

Percentiles.

Statistics of location.

Statistics of dispersion.

Skewness and kurtosis.

Association measures. Correlation coefficient. Smoothing. Linear regression.

*.- SAMPLE SPACES, CONDITIONAL PROBABILITY. INDEPENDENCE

Sample space and events.

The axioms of probability. Consequences

Conditional probability.

Sequential experiments.

Partition of the sample space. Total probability rule

Bayes formula.

Independence of two events. Mutually independent events.

*.- RANDOM VARIABLES. PROBABILITY DISTRIBUTIONS

Definition of random variable.

Distribution function.

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Probability mass function.

Discrete random variable.

Continuous random variable: density function.

V. a. con distribución de probabilidad mixta.

Conditional distribution.

Functions of a random variable.

*.- CHARACTERISTICS OF RANDOM VARIABLES

Expected value of a random variable.

Expected value of a function of a random variable.

Properties of the expected value.

Moments of random variables.

Variance and its properties. Standard deviation

Chebyshev's inequality.

Location measures, percentiles. Dispersión measures. Skewness and kurtosis.

Moment approximation for functions of random variables.

Characteristic function. Moment calculation.

*.- PROBABILITY MODELS

Discrete uniform distribution.

Bernoulli random variable.

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Binomial distribution.

Geometric distribution, memoryless property

Negative binomial distribution.

Poisson distribution. Aproximation to the binomial distribution.

Poisson process.

Exponential distribution, memoryless property.

Gamma distribution.

Interarrival times in the Poisson process: exponential and gamma distributions.

Continuous uniform distribution.

Normal distribution. Aproximations to the binomial and Poisson distributions.

Weibull, Rayleigh and lognormal distributions.

*.- STATISTICS.

Random sampling.

Point estimation.

Confidence intervals.

Test of hypotheses.

Tests on means and proportions.

Tests on variances.

Distribution fitting. Probability plots. Anderson-Darling test

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*.- VECTOR RANDOM VARIABLES

Definition

Joint cumulative distribution function: definition and properties.

Joint probability mass function.

Discrete random variable: definition and set of values.

Jointly continuous random variable: density function on R2.

Marginal pdf: discrete, continuous and mixed.

Conditional distributions: conditional distribution function and conditional pdf.

Independent random variables.

Functions of several random variables. Sums, products and ratios.

Expectation of a function of pair of random variables.

Moments of a pair of random variables. Covariance matrix.

Variance and covariance properties.

Conditional expectation, properties. Independent variables case.

Correlation coefficient, properties.

Regression line.

*.- PAIRS OF RANDOM VARIABLES

Multinomial distribution. Properties .

Bivariate normal distribution: properties, marginal and conditional pdf.

Multivariate normal distribution.

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*.- SEQUENCES OF RANDOM VARIABLES

Convergence in distribution and probability.

Weak law of large numbers.

The central limit theorem.

*.- STOCHASTIC PROCESSES

Definition.

Space state and index set. Classification.

First order cumulative distribution function. Probability mass and probability density functions. Second order joint functions and kth-order functions.

Mean, autocorrelation and autocovariance functions. Properties.

Cross-correlation and cross-covariance.

Independent, uncorrelated and orthogonal process.

Markovian processes.

White noise.

Gaussian processes.

Counting processes.

*.- STATIONARY AND ERGODIC PROCESSES

Stationary versus transient process. Mean and autocorrelation functions.

Strict-sense stationary and kth-order stationary processes. Properties.

Wide-sense stationary random processes.

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Relationship between stationary modes. The Gaussian process case.

Integrals of random processes. Time averages, expectation and variance.

Ergodic processes.

Spectral density function. Response of a linear system to stationary processes.

*.- SOME PROCESS OF INTEREST

Gaussian process.

Random telegraph signal.

Markov processes.

Poisson process.

Introduction to queuing theory.

Time series. ARMA models.

*.- OPTIMIZATION

Introduction, objective functions and restrictions.

Maximum likelihood estimation.

Analysis of the optimum by means of simulation models.

5.4.Course planning and calendar

This course is organized in 4 hours of class per week. Two of them correspond to large-group sessions where the main concepts along with illustrating examples are presented. The other two hours take place in a computer room for small groups, the target being the development of skills in both problem-solving and data analysis.

Every student is supposed to complete several tasks periodically. These tasks are associated to each learning block and are part of the student's appraisal.

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5.5.Bibliography and recommended resources

León-García, Alberto. Probability and random processes for electrical engineering. Pearson Prentice Hall. 3ª edición (2009).

Devore, J.L. Probabilidad y Estadística para Ingeniería y Ciencias. International Thomson Editores. 6ª edición (2005).