Universidad Zaragoza

Academic Year/course: 2021/22

30308 - Probability and processes

Syllabus Information

Academic Year: 2021/22
Subject: 30308 - Probability and processes
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 581 - Bachelor's Degree in Telecomunications Technology and Services Engineering
ECTS: 6.0
Year: 2
Semester: First semester
Subject Type: Basic Education
Module:

1. General information

2. Learning goals

3. Assessment (1st and 2nd call)

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The proposed methodology aims at encouraging students for everyday 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.

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 computing classes deal with both data analysis and modeling of real events. Students completing them will be able to use specific statistical software.

4.2. Learning tasks

The following activities are designed to achieve the expected results

This course comprises five learning blocks:

- Block 1: *Descriptive data analysis*
- Block 2: *Random variables*
- Block 3: *Random vectors*
- Block 4: *Data analysis. Inference*
- Block 5: *Stochastic processes*

This course corresponds to 6 ECTS equivalent to 150 hours developed as follows:

Group 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.

Individual activities:

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

4.3. Syllabus

The course will address the following topics:

BLOCK 1. DESCRIPTIVE DATA ANALYSIS

1.- Descriptive Statistics

Graphs.

Frequency. Percentiles.

Measures of location, dispersion, Skewness and kurtosis.

BLOCK 2. RANDOM VARIABLES

2.- Probability

Deterministic and random experiments.

Sample space and events.

Conditional probability.

Independent events.

3.- Random variables

Definition of the random variable.

Distribution function.

Discrete random variable.

Continuous random variable: density function.

Conditional distribution.

Functions of random variables.

The expected value of a random variable.

Moments of random variables.

Moment approximation for functions of random variables.

Characteristic function.

4. Probability models

Discrete uniform distribution.

Bernoulli random variable and related distributions: binomial, geometric.

Poisson distribution.

Exponential distribution.

Gamma distribution.

Poisson Process.

Continuous uniform distribution.

Normal distribution. Aproximations to the binomial and Poisson distributions.

Weibull, Rayleigh and lognormal distributions.

BLOCK 3. RANDOM VECTORS

5. Random vectors.

Definition

Joint cumulative distribution function: definition and properties.

Joint probability mass function.

Marginal and conditional distributions.

Independent random variables.

Functions of bivariate random variables.

Moments of bivariate random variables.

Covariance matrix and correlation.

Conditional expectation. Properties.

Regression line.

6.- Multivariate distributions

Multinomial distribution.

Bidimensional and n-dimensional normal distribution.

BLOCK 4. DATA ANALYSIS. INFERENCE

7.-Introduction to statistical inference

The sequence of random variables.

Convergence in distribution and probability.

Weak law of large numbers.

The central limit theorem.

Random sampling.

Point estimation.

Maximum likelihood estimation.

Confidence intervals.

Test of hypotheses.

Tests on means, variances and proportions.

Distribution fitting. Probability plots.

BLOCK 5. STOCHASTIC PROCESSES

8. 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.

Independent, uncorrelated and orthogonal process.

Strict-sense and wise sense stationary processes.

Time averages, expectation and variance.

Ergodic processes.

Mean ergodic processes.

Spectral density function.

Linear functions of stationary processes.

9.- Usual processes

White noise.

Gaussian processes.

Markovian processes.

Counting processes.

Random telegraphic signal.

Queueing theory.

4.4. 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 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 with each learning block and are part of the student?s appraisal.

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=30308