



Introduction to Probability and Statistics

Course code:	1576
Number of ECTS credits:	6
Semester:	2nd (February-June)
Prerequisites:	None
Recommended components:	Funciones de Una Variable Real I (1588)
Language of instruction:	Spanish (students are allowed to ask questions and write homeworks and exams in English)

Course description

This is an introductory course on univariate probability models with some applications to (descriptive) statistics. We will study the Kolmogorov axiomatic definition of probability spaces and the basic properties of (univariate) random variables. This includes the theoretical notions of expected value (mean), variance, median, quantile, etc. We will also study the basic properties of the most relevant univariate discrete and continuous models such as Binomial, Poisson, Geometric, Normal (Gaussian), Exponential, Weibull, Gamma, etc.

We will study how to solve problems related with these concepts. We will also give an introduction to the free statistical software R which includes how to manage the above mentioned models and how to simulate data from them. We will also give a short introduction to descriptive statistical methods by comparing the theoretical values of a model with the empirical (sample) values obtained from simulated random data sets obtained from it.

Learning outcomes and competences

After completion of this course you will:

1. know the basic probability tools.
2. know the basic concepts associated to a (univariate) random variable.
3. know the basic properties of the most relevant probability models and how to apply them to solve practical problems.
4. know how to manage these models by using the program R.
5. know how to use the basic tools in descriptive statistics by using R.
6. know how to compare the theoretical values of a model and the empirical characteristics of a data set obtained from it.

Course contents

1. Introduction to Combinatorics. *Counting problems. Permutations. Combinations. Pascal's triangle. Newton's Binomial formula. Leibniz's Multinomial formula.*
2. Probability Spaces.
Definitions of probability. The σ -algebra of the events. The Probability function. Probability spaces. Kolmogorov axiomatic definition. Basic properties. Limiting properties.
3. Conditional Probability.
Definition. Basic Properties. The law of total probability. Bayes' formula. Independence of events.
4. Random variables.
Definition of random variable. Distribution function. Discrete distributions. Probability mass function. Absolutely continuous distributions. Probability density function.
5. Expected value.
Expected value of a discrete or continuous random variable. Properties. Moments. Variance. Other characteristics (median, mode, quantiles, skewness and kurtosis coefficients, etc.). Inequalities. Generating functions.
6. Probability models.
Discrete probability models: Binomial, Poisson, Geometric, Hypergeometric, etc. Continuous probability models: Normal (Gaussian), Exponential, Weibull, Gamma, Beta, Student-t, etc.
7. Introduction to descriptive statistics.
Measures associated to a data set: Frequency, mean, covariance, median, quantiles, etc. Graphs associated to a data set: Frequency plots, pie chart plots, histograms, box-plots, etc. Generating random data sets from discrete and continuous models. Monte Carlo Method.

References

Main texts

1. Grinstead, C.M., Snell, J.L. Introduction to probability. American Mathematical Society. 1998.
2. Tijms, H. Understanding Probability. Cambridge University Press. 2008.

Supplementary references

1. Evans, M.J., Rosenthal, J.S. Probabilidad y Estadística. Reverté. 2005.
2. Guillamón, A., Navarro, J. Probabilidad y Estadística. Fundamentos (2ª ed.). DM. 2002.
3. Híbert, Y. Matemáticas generales, probabilidades y estadística. Reverté. 1980.
4. Lipschutz, S., Lipson, M. Probabilidad. Mc Graw Hill. 2004.
5. Mode, EB. Elementos de Probabilidad y Estadística. Reverté. 1982.
6. Navarro, J., Franco, M., Guillamón, A. Probabilidad y Estadística. Problemas. DM. 1999.
7. Zoroa, P., Zoroa, N. Elementos de Probabilidades. DM. 2008.