UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Probability

2526-1-E4104B004

Learning objectives

1. Knowledge and understanding
By the end of the course, students will have acquired a solid foundation in probability theory, with a particular focus on the measurement of uncertainty in decision-making processes. They will understand the mathematical rules underpinning a coherent system for quantifying uncertainty, as well as the properties and limitations of the most commonly used probabilistic models. These theoretical competencies provide an essential basis for data analysis and for further academic study in the quantitative disciplines.
2. Applying knowledge and understanding
Students will be able to apply the knowledge acquired to identify and describe the essential elements of a random process, and to construct probabilistic models suited to various decision-making contexts. They will be able to use these models to derive quantitative indicators that support informed decisions and will understand how probability theory serves as a foundation for statistical models, particularly in the context of inferential data analysis. The application of knowledge will be both theoretical and problem-oriented.
3. Making judgements
Throughout the course, students will develop independent judgement skills, allowing them to critically assess the appropriateness and coherence of a probabilistic model in relation to the problem under analysis. They will be able to reflect on the limitations of the assumptions made and to interpret the results with awareness, making decisions and evaluations based on a sound quantitative foundation. This analytical mindset will be valuable in both academic and professional settings.
4. Communication skills
Students will develop the ability to communicate clearly and accurately the concepts learned, using appropriate technical language consistent with the terminology of probability and statistics. They will be able to present and discuss probabilistic models and their results effectively, both in written and oral form, and to adapt their communication to different audiences, whether specialists or non-specialists. These skills will support effective communication in group work, teaching, and scientific dissemination.
5. Learning skills
Finally, the course aims to foster strong independent learning abilities. Students will be able to further explore advanced topics in probability and statistics autonomously, to approach more advanced courses with confidence, and to stay up to date with developments in quantitative tools. These lifelong learning skills will be essential both

for continuing academic studies and for adapting to evolving professional environments.

Contents

Probability and its rules. Random variables. Main distributions. Random vectors. Limit theorems.

Detailed program

Combinatorics. Events and their algebra. Probability measures. Rules of probability. Assignment of a probability measure. Conditional probabilities. Bayes theorem. Independent events. Random variables. Cumulative distribution function, probability function, density function. Summary of a random variable: expected value, variance, percentiles, moments. Moment generating function. Distribution of functions of a random variable. Relevant discrete distributions: Bernoulli, binomial, Poisson, geometric, negative binomial, hypergeometric. relevant continuous distributions: uniform, normal, negative exponential, gamma, chi-squared. Bivariate and multivariate random variables. Functions of random vectors. Limit theorem of probability theory: law of large numbers, central limit theorem.

Prerequisites

There are no propaedeutic exams; however, familiarity with the subjects of the courses of Analisi Matematica I and Statistica I is highly recommended. Specifically, students must be familiar with limits, series, integrals and the main summaries (both numerical and graphical) of datasets.

Teaching methods

The course is taught by 63 hours of in-person lessons and practical sessions (exercises).

Tutoring is also provided in preparation to exams.

Assessment methods

The exam consists of a written test, containing both exercises 'open' questions about theory, and of a compulsory oral test. Only students with a grade of at least 18/30 can take the oral test.

Questions about theory aim at testing knowledge and understanding of the rules of probability and of the main probabilistic models. Exercises aim at testing the ability to analyze a random process, the ability to choose a suitable probabilistic model and the ability to derive synthetic indicators from the model. Moreover, both questions about theory and exercises aim at testing the ability to report results in a suitable technical language.

Textbooks and Reading Materials

The textbook is :

Ross, S. M. “*Calcolo delle probabilità (terza edizione italiana)*”, Maggioli, 2016.

Reference to the textbook is crucial to attend lessons and practical sessions. Additional materials are provided by the e-learning website.

Semester

II semester (III and IV cycle)

Teaching language

Italian

Sustainable Development Goals

QUALITY EDUCATION