Probability

Academic Year: (2024 / 2025) **Review date: 24-04-2024**

Department assigned to the subject: Statistics Department

Coordinating teacher: STRZALKOWSKA-KOMINIAK , EWA

Type: Compulsory ECTS Credits : 3.0

Year : 1 Semester : 1

OBJECTIVES

The course Objectives are:

1. Understand the fundamental concepts of probability and random experiments.
2. Analyze events and calculate probabilities using various techniques.
3. Explore conditional probability and apply Bayes' formula.
4. Recognize independence in random events and perform combinatorial analysis.
5. Define discrete random variables and analyze their properties.
6. Examine different discrete probability distributions (Binomial, Geometric, Poisson, etc.).
7. Introduce continuous random variables and study their characteristics.
8. Analyze continuous probability distributions (Uniform, Exponential, Normal, etc.).
9. Understand and work with random vectors, including joint, marginal, and conditional distributions.
10. Investigate properties of random vectors, including independence and transformations.
11. Explore the concepts of sums, mixtures, and random samples.
12. Analyze the concept of order statistics in random samples.
13. Study the properties of expectation, covariance, conditional expectation, and variance.
14. Examine moment generating functions.
15. Explore limit theorems such as Markov and Chebyshev inequalities.
16. Understand convergence in probability, almost sure convergence, and convergence in distribution.
17. Apply the Central Limit Theorem to analyze the behavior of sample means.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Random experiments
1.1 Events
1.2 Probability
1.3 Conditional probability
1.4 Bayes' formula
1.5 Independence
1.6 Combinatorics
2. Discrete random Variables
2.1 Definition of random variable
2.2 Probability mass function and cumulative distribution function
2.3 Mean, variance, and quantiles
2.4 Binomial, Geometric, Poisson, Negative Binomial, and Hypergeometric distributions
3. Continuous random variables
3.1 Density mass function and cumulative distribution function
3.2 Mean, variance, and quantiles
3.3 Transformations of a random variable
3.4 Uniform, Exponential, Normal, Gamma, and Beta distributions
4. Random vectors
4.1 Joint distributions, marginal distributions, and conditional distributions
4.2 Independence
4.3 Transformations of random vectors
4.4 Multivariate Normal and Multinomial distributions

4.5 Sums of random variables
4.6 Mixtures
4.7 General concepto of random variable
4.8 Random sample
4.9 Order statistics
5. Properties of the expectation
5.1 Expectations of sums of random variables
5.2 Covariance
5.3 Conditional expectation
5.4 Conditional variance
5.5 Moment generating function
6. Limit Theorems
6.1 Markov and Chebishev inequalities
6.2 Weak Law of Large Numbers (convergence in probability)
6.3 Strong Law of Large Numbers (almost sure convergence)
6.5 Central Limit Theorem (convergence in distribution)

LEARNING ACTIVITIES AND METHODOLOGY

TRAINING ACTIVITIES OF THE STUDIES PROGRAM

AF1	Theory class
AF2	Exercises class
AF4	Lab class
AF5	Office hours
AF6	Group office hours
AF7	Individual student's work
AF8	In-class assessment activities

Activity Code	Total nb hours	Total in-class nb hours	% in-class hours
AF1	33	33	100
AF2	15	15	100
AF4	15	15	100
AF5	12	12	100
AF6	30	0	0
AF7	115,5	0	0
AF8	4,5	4,5	100
COURSE TOTAL	225	75	33

TEACHING METHODOLOGIES USED IN THIS COURSE

MD1	Teacher class presentations with visual support to present the main contents of the course.
MD3	Exercises and case studies to be solved individually or in group

ASSESSMENT SYSTEM

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

Partial in-class exams: 50%
Final exam: 50%

In the extraordinary assessment (2nd call, june) final grade will be calculated as:
MAX (0.5*continuous assessment grade + 0.5*june's exam grade, june's exam grade)

BASIC BIBLIOGRAPHY

- Sheldon Ross A First Course in Probability, Pearson Prentice Hall, 2010

ADDITIONAL BIBLIOGRAPHY

- Charles M. Grinstead Grinstead and Snell's Introduction to Probability, University Press of Florida, 2009

- Dimitri P. Bertsekas, John N.Tsitsiklis Introduction to Probability, Athena Scientific, 2008