

Academic Year: (2022 / 2023)

Review date: 30-05-2022

Department assigned to the subject: Statistics Department

Coordinating teacher: CASCOS FERNANDEZ, IGNACIO

Type: Compulsory ECTS Credits : 3.0

Year : 4 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Probability (Year 2 - Semester 2)

Statistics (Year 3 - Semester 1)

Stochastic Processes (Year 4 - Semester 1) - at least partial knowledge

DESCRIPTION OF CONTENTS: PROGRAMME

1. Random numbers (Monte Carlo techniques)
 - 1.1 Probability and inference refresher
 - 1.2 Statistical validation techniques
 - 1.3 (Pseudo)random number generation
 - 1.4 Approximation of probabilities and volumes
 - 1.5 Monte Carlo integration
2. Simulating random variables and vectors
 - 2.1 Inverse transform
 - 2.2 Acceptance-rejection
 - 2.3 Composition approach
 - 2.4 Multivariate distributions
 - 2.5 Multivariate normal distribution
3. Discrete event simulation
 - 3.1 Poisson processes
 - 3.2 Gaussian processes
 - 3.3 Single- and multi-server Queueing systems
 - 3.4 Inventory model
 - 3.5 Insurance risk model
 - 3.6 Repair problem
 - 3.7 Exercising a stock option
4. Efficiency improvement (variance reduction) techniques
 - 4.1 Antithetic variables
 - 4.2 Control variates
 - 4.3 Stratified sampling
 - 4.4 Importance sampling
5. MCMC
 - 5.1 Markov chains
 - 5.2 Metropolis-Hastings
 - 5.3 Gibbs sampling
6. Introduction to the bootstrap
 - 6.1 The bootstrap principle
 - 6.2 Estimating standard errors
 - 6.3 Parametric bootstrap
 - 6.4 Bootstrap Confidence Intervals
 - 6.5 Bootstrap Hypothesis Tests

LEARNING ACTIVITIES AND METHODOLOGY

- Lectures and problem sessions with a computer: introducing the theoretical concepts and developments with examples, and solving problems: 25 on-site hours
- Homework: 49 non on-site hours
- Evaluation sessions (continuous evaluation and final exam): 5 on-site hours
- Specific exam preparation: 49 non on-site hours

ASSESSMENT SYSTEM

100% of the course grade will be obtained by continuous evaluation:

- Simulation project: 35%
- Classroom presentation of the simulation project: 10%
- Resampling project: 25%
- Classroom problems: 30%

The students that do not follow the continuous evaluation will be allowed to write a final exam with a total weight of 60%.

Any student that has not followed the continuous evaluation process has the right to take an extraordinary exam with a total weight of 100% of the course grade. Alternatively, she/he can complete a Simulation project (35%) with its presentation (10%) and a Resampling project (25%) with its presentation (5%) having a total weight of 75%.

% end-of-term-examination:	0
% of continuous assessment (assignments, laboratory, practicals...):	100

BASIC BIBLIOGRAPHY

- Bradley Efron, Robert Tibshirani An introduction to the Bootstrap, Chapman & Hall, 1993
- Sheldon M. Ross Simulation, Academic Press, 2013 (5th ed)

ADDITIONAL BIBLIOGRAPHY

- Christian P. Robert, George Casella Introducing Monte Carlo methods with R, Springer, 2010