

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF INFORMATION SCIENCES & TECHNOLOGY		
ACADEMIC UNIT	DEPARTMENT OF STATISTICS		
LEVEL OF STUDIES	1st Cycle (UNDERGRADUATE)		
COURSE CODE	6125	SEMESTER	6 th
COURSE TITLE	Computational Statistics and Simulation		
INDEPENDENT TEACHING ACTIVITIES		WEEKLY TEACHING HOURS	CREDITS
Lectures		4	7
Workshops			
Labs		2	
COURSE TYPE	Elective – General Background		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	https://www.dept.aueb.gr/en/stat/content/computational-statistics-and-simulation-7-ects		

(2) LEARNING OUTCOMES

Learning outcomes
Upon successful completion of the course, students will be able to: • Understand the fundamental principles of stochastic simulation and the role of randomness in statistical inference. • Generate pseudorandom numbers and random variables from basic probability distributions. • Apply Monte Carlo methods to approximate expected values, probabilities, and integrals. • Use variance reduction techniques to improve the efficiency of simulations. • Apply bootstrap and randomization methods for statistical estimation and hypothesis testing. • Develop and implement Markov Chain Monte Carlo (MCMC) algorithms for statistical and Bayesian analysis problems. • Evaluate the convergence and reliability of simulation-based estimators using appropriate diagnostic tools. • Present, document, and interpret simulation results clearly.
General Competences

(3) SYLLABUS

Generation of uniform random variables: congruential generators, tests of random numbers, methods for generating random variables. Inverse transform method, rejection method, composition method, other methods. Methods for specific distributions.

Variance reduction techniques and Monte Carlo integration: importance sampling, antithetic random variables, control variates.

Generation of dependent random variables: order statistics, exponential spacings, multivariate normal distribution, Poisson process, Markov chains, Markov random fields, Gibbs sampler. Markov Chain Monte Carlo. Particle filtering.

Bootstrap: the basic idea. Nonparametric and parametric bootstrap. Standard errors and confidence intervals using bootstrap. Hypothesis testing. Bootstrap for linear regression. Bootstrap for complex data structures, block bootstrap.

Jackknife and other resampling schemes.

Randomization-based hypothesis testing. Exact and approximate tests. Estimation of the p-value. ANOVA, tests of correlation, tests for contingency tables, Fisher's exact test.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY <i>Face-to-face, Distance learning, etc.</i>	Face-to-face	
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	YES	
TEACHING METHODS	Activity	Semester workload
	Lectures	55
	Studying and Analyzing Bibliography	30
	Tutorial	40
	Project	25
	Assignment	25
	Course Total	175
STUDENT PERFORMANCE EVALUATION	Assignment: 40% Written Assignment (Project): 60% Information is available at eclass	

(5) ATTACHED BIBLIOGRAPHY

- Δελλαπόρτας, Π. (1994). Στοχαστικά Μοντέλα και Προσομοίωση. Σημειώσεις παραδόσεων, τμήμα Στατιστικής, Οικονομικό Πανεπιστήμιο Αθηνών. Διαθέσιμες στη διεύθυνση <http://www.stat-athens.aueb.gr/~ptd/simulation.ps>.
- Devroye, L. (1986). Non-Uniform Random Variable Generation, Springer-Verlag, New York.
- Ripley, Brian D. (1987). Stochastic Simulation, John Wiley, New York.
- Robinson, S. (2004). Simulation: The Practice of Model Development and Use, Wiley, Chichester, UK.
- Robert, C., Casella, G. (2010). Introducing Monte Carlo Methods with R. Springer