ΟΙΚΟΝΟΜΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ

ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

SCHOOL OF INFORMATION SCIENCES AND TECHNOLOGY

DEPARTMENT OF STATISTICS

"MSc. in STATISTICAL DATA SCIENCE"

STUDY GUIDE
ATHENS, ACADEMIC YEAR 2026-27

PART I: INFORMATION ABOUT THE INSTITUTION

CONTACT DETAILS (Name & Address)

ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS (AUEB)

Address:76, Patission Str. GR-10434, Athens

Telephone number: +30-210-8203911

Website: https://www.aueb.gr

e-mail: webmaster@aueb.gr

Facebook: https://www.facebook.com/auebgreece

Twitter: https://twitter.com/aueb

Linkedin: https://www.linkedin.com/school/athens-university-of-economics-and-business/mycompany/

Youtube: https://www.youtube.com/channel/UCPncunqp3bMuAHHeCikhalg

Instagram: https://www.instagram.com/aueb.gr/

ACADEMIC AUTHORITIES

The rectorate authorities consist of the Rector and the Vice Rectors, as per below:

Rector:

Professor Vasilios Vasdekis

Vice Rectors:

Vice Rector for Academic Affairs and Personnel
Professor Leonidas Doukakis

Vice Rector for Research and Lifelong Learning
Professor Georgia Siougle

Vice Rector for Financial Planning and Infrastructure
Associate Professor Eleanna Galanaki

Vice Rector for International Cooperation and Growth
Professor Nancy Pouloudi

School of Information Sciences and Technology
Dean: Professor Vasiliki Kalogeraki
Department of Statistics
Chair: Professor Stylianos Psarakis
Master's Program
Director: Professor Dimitrios Karlis
Contact details
Address: 47A Evelpidon & 33 Lefkados Street, Athens, 113 62, Greece
Telephone number: +30 210 82 03 681
e-mail: masterst@aueb.gr
Website: https://aueb-analytics.wixsite.com/msc-stats/

ACADEMIC CALENDAR

FALL SEMESTER

Classes begin:	September 21, 2026
Classes end:	December 22, 2026
Christmas Holidays:	December 23, 2026 – January 6, 2027

Exam period

Start of Exams:	January 7, 2027
End of Exams:	February 11, 2027

Holidays

October 28, 2026
November 17, 2026
January 30, 2027

SPRING SEMESTER

Classes period A:	February 15, 2027 – March 31, 2027
Classes period B:	April 19, 2027 – June 11, 2027
Easter Holidays:	April 26, 2027 – May 9, 2027

Exam period

Exam period A:	April 1, 2027 – April 16, 2027
Exam period B:	June 14, 2027 – June 30, 2027

Holidays

March 15, 2027
March 25, 2027
May 1, 2027
June 21, 2027

AUEB's OPERATIONAL STRUCTURE

The structure and operation of the Institution is defined by current legislation as in force. The Athens University of Economics and Business is under the supervision of the Ministry of Education, Research and Religious Affairs. Its governing bodies include:

The Governing Council
The Senate
The Rector
The Vice-Rectors
The Executive Director

Until the Governing Council assumes its duties, administration is exercised by the University's Rector's Council

AUEB's ACADEMIC STRUCTURE

The Athens University of Economics and Business is structured by academic units of two (2) levels: a) the Schools, and b) the Departments

Each School is structured by at least two (2) Departments, covers a domain of related scientific areas, and ensures the interdisciplinary approach to teaching and research between its departments. The School is responsible for supervising and coordinating the operation of the Departments and the educational and research work produced, in accordance with the Internal Operating Regulations.

The bodies of the School, according to Law 4957/2022 (A 141) as applicable are: a) the Dean and b) the Dean's Council

The Department is the University's fundamental academic unit and aims to advance a specific field of science, technology, letters and arts through education and research. The Department consists of all the members of the Teaching & Research Staff (DEP), the members of the Special Education Staff (EEP), the members of the Laboratory Teaching Staff (EDIP) and the members of the Special Technical Laboratory Staff (ETEP).

Bodies of the Department according to Law 4957/2022 (A 141) as applicable are: a) the Assembly, b) the Board of Directors, c) the Head/Chair and d) the Deputy Head/Chair.

The Athens University of Economics and Business consists of three Schools & eight Departments:

1. **SCHOOL OF ECONOMIC SCIENCES**

   Department of International and European Economic Studies

   Department of Economics.

2. **SCHOOL OF BUSINESS**

   Department of Management Science and Technology

   Department of Business Administration

   Department of Accounting and Finance

   Department of Marketing and Communication**.**

3. **SCHOOL OF INFORMATION SCIENCE AND TECHNOLOGY**

   Department of Informatics
   Department of Statistics

ADMINISTRATIVE BODIES OF POSTGRADUATE STUDY PROGRAMS

Competent bodies for the organization and operation of the Postgraduate Study Programs are:
a) the Senate,
b) the Assembly of the Department,
c) the Coordinating Committee (CC), and
d) the Director of the Postgraduate Program.

Especially for inter-departmental, inter-institutional and joint programs, the responsibilities of the Department's Assembly are exercised by the Curriculum Committee

UNIVERSITY STAFF

The University staff consists of the following categories:

- TEACHING STAFF:

- Teaching & Research Staff (DEP)
- Emeritus Professors
- Visiting Professors
- Special Education Staff (E.E.P.)
- Laboratory Teaching Staff (E.DI.P.)
- Special Technical Laboratory Staff (E.T.E.P.)
- Auxiliary Teaching Staff
- Teaching Fellows
- Scientific Faculty Members
- Adjunct Instructors
- Secondet Teachers

- **ADMINISTRATIVE STAFF**

SERVICES

The Athens University of Economics and Business provides both administrative and other services (meals, housing, library, sport facilities etc.) aiming at serving both its students and staff. More information on the organization and operation of the University's services can be found on the University΄s website (http://www.aueb.gr/en).

GENERAL DESCRIPTION OF THE UNIVERSITY

The Athens University of Economics and Business (AUEB), as a Higher Educational Institution, is a legal entity governed by public law and supervised by the Ministry of Education, Research and Religious Affairs.
AUEB is, in order of seniority, the third Higher Education Institution of the country and the first in the fields of Economics and Business Administration. Later, the scientific fields of Informatics and Statistics were added. Since its founding, in 1920, AUEB has a rich and noteworthy tradition of significant academic achievements that define the present and create excellent prospects for the future.
The University as a center of excellence, in academic research and teaching, is rated as one of the leading universities in its subject areas in Greece and one of the best internationally. The high level of its scientific staff, the quality in teaching and research, the modern curriculum/courses, but also the high demand of its graduates enhance significantly the University's brand name and reputation, in Greece and abroad.

LIST OF DEGREE PROGRAMMES

Athens University of Economics and Business offers the following Degrees and streams:

A/A	DEPARTMENTS	SPECIALIZATIONS
1.	International and European Economic Studies	1. International Economics and Finance 2. International and European Political Economy
2.	Economics	1. Economic Theory and Policy 2. Business Economics and Finance 3. International and European Economics

3.	Management Science and Technology	1. Operations Research and Business Analytics 2. Operations and Supply Chain Management 3. Software and Data Analysis Technologies 4. Information Systems and Electronic Business 5. Strategy, Entrepreneurship and Human Resources
4.	Business Administration	1. Business Administration 2. Information Systems Management 3. Accounting and Financial Management 4. Marketing
5.	Accounting and Finance	1. Accounting 2. Finance
6.	Marketing and Communication	1. International Management, Innovation and Entrepreneurship 2. Human Resource Management 3. Business Analytics 4. Digital Marketing
7.	Informatics	1. Theoretical Computer Science 2. Computer Systems and Networks 3. Information Systems and Information Security 4. Databases and Knowledge Management 5. Operational Research and Economics of Information Technology 6. Computational Mathematics and Scientific Calculations
8.	Statistics	No specializations are offered

Detailed information about programs and curriculum is provided in each department's study guide and website.

Chief Regulations of the University (including academic recognition procedures)
The regulations include, for example:

- The University's Internal Operating Regulations
- The Organization of Administrative Services
- The Regulations for the Operation of Postgraduate and Doctoral Study Programs
- The Internal Regulation for conducting postdoctoral research

AUEB'S ECTS COORDINATOR

The University's ECTS Coordinator is the Quality Assurance Chairperson, who ensures the University's compliance with the principles and rules of the European credit accumulation and transfer systems, supervises compliance and implementation and is responsible for the full recognition and transfer of credit units.

PART II: INFORMATION ON DEGREE PROGRAMS

(A) General Description

Qualification awarded

The Postgraduate Program awards a **Master Degree in Statistical Data Science.**

Admission requirements

The Program is addressed to first degree holders of domestic and foreign Universities/allied Institutions recognized by DOATAP. Graduate students also have the right to apply, who - if accepted - have the opportunity to register after completing their studies until the exam period of September.

Admission/Registration Procedure

Candidates submit their application to the Secretariat of Postgraduate and Doctoral Studies of the School of Information Sciences and Technology. The selection criteria of the candidates are defined in the announcement and include, indicatively: degree, grade in undergraduate courses related to the courses of the Program, scientific works, any work experience, as well as qualitative criteria, such as (indicative): university and department of origin, type research and / or professional experience, knowledge of English, knowledge of another foreign language, personal interview, letters of recommendation from faculty members and / or employers. The selection process for postgraduate students is as follows:

1. The Director of the Program compiles a list of those who have submitted an application and rejects those who do not meet the minimum criteria (e.g. graduate of a non-relevant department, etc.).
2. The Candidate Evaluation Committee invites the remaining candidates for an interview.
3. Internal examinations shall be carried out, if deemed necessary.
4. The candidates are ranked and the Committee makes the final selection.
5. The final list of successful candidates and runners-up is ratified by the Assembly of the Department.

Educational and professional goals

The Postgraduate Studies Program entitled "Postgraduate Diploma (M.Sc.) in Statistical Data Science" has as its object the provision of specialized postgraduate knowledge level to graduates of Greek and recognized foreign universities in the main areas of Statistics and Probability. The object of Program is the education of postgraduate students in the following fields: a) Probability Theory, b) Theory of Statistical Conclusion c) Applied Statistics, d) Computational Statistics, e) Theory and Applications of Stochastic Processes.

Access to further studies

Access to the PhD Program – 3rd Cycle.

Course structure diagram with credits:

In the first semester, a total of four (4) courses are offered (a total of 30 ECTS) which are compulsory for all students. In the second semester, successful attendance is required in two (2) of the three (3) compulsory (C) courses (7.5 ECTS each, total 15 ECTS) and in four (4) elective (E) courses (total 12 ECTS) coming from a list of courses from the three (3) course groups. Also, the successful attendance of short courses (total 2 ECTS) as well as the attendance of research seminars (1 ECTS) are required. In the third semester, students prepare a thesis (30 ECTS).

The course structure diagram with credits for the Academic Year 2026-27 is defined as follows:

Winter Semester 2026-2027 (30ECTS)

1st Semester *(each student selects all four **(4)** courses)*	**ECTS**
Probability and Statistical Inference	7.5
Computational Statistics	7.5
Generalized Linear Models	7.5
Data Analysis	7.5
Total *(1st semester)*	**30**

Spring Semester 2026-2027 (30ECTS)

2nd Semester *(each student selects* two (2) of the three (3) compulsory (C) courses and four (4) elective (E) courses coming from the list of courses from the three (3) course groups.	**ECTS**
Course Group 1: Data Analytics	
Health Data Science (C)	7.5
Advanced Methods in Survey Sampling (E)	3
Statistical Quality Control (E)	3
Topics in Applied Statistics: Statistical Genetics- Bioinformatics (E)	3
Course Group 2: Statistical Data Science	
Statistical Machine Learning (C)	7.5
Bayesian Models in Statistics (E)	3
Applied Stochastic Modeling (E)	3
Topics in Computational Statistics: Data Engineering (E)	3
Course Group 3: Finance and Stochastics	
Financial Analytics (C)	7.5
Probability Theory (E)	3
Stochastic Models in Finance (E)	3
Stochastic Models in Operations Research (E)	3
Advanced Stochastic Processes (E)	3
Total of Courses *(2nd semester)*	**27**
Short Course(s)	2
Research Seminars	1
Total *(2nd semester)*	**30**

3rd Semester	ECTS
Dissertation Thesis	30
TOTAL	**90**

Examination and assessment regulations

The final grade of each course is determined by the respective teachers. The degree may involve individual and group work of students. Participation in the exams on the specific date announced according to the exam schedule is mandatory.

The rating scale is set from zero (0) to ten (10), with grades of the whole or half unit. Leading points are the five (5) and the highest.

Each student can take exams in courses that failed during the September exam period. If a student fails in the September exam then he is entitled to be examined in the next exam of the course and in case of failure he is deleted from the program taking only one certificate of attendance.

To receive the degree must have a promotional degree in all postgraduate courses and a successful examination in the diploma thesis. If this condition is not met within the stipulated deadline, the postgraduate student is entitled to a simple certificate of successful attendance of the courses in which he received a promotional grade and leaves the Program.

(B) Description of individual course units

Probability and Statistical Inference

Instructors: ST.VAKEROUDIS – P.TSIAMYRTZIS

Course Code: 61101

Core Course, 1st semester, 7.5 ECTS units

Course level: Graduate (MSc)

Language: English

Course Description

The aim of the course is to present key topics of probability and distribution theory and to place particular emphasis on statistical inference. Initially, the axiomatic definition of probability is given by using measure theory and its interpretation in the classical/Bayes approach. Then the conditional probability is given, the concept of random variable, conditional expectation and its role as estimator, transformations, moments, moment generating function and characteristic functions. It follows the distribution theory, location/scale families, exponential family and goodness of fit measures. The topics defined in the one-dimensional case are presented for multivariate distributions and furthermore are defined the hierarchical models, the idea of independence, correlation and prediction, while some basic inequalities are given. Next, is the theory of order statistics, convergence (in probably, almost sure and by law), law of large numbers, central limit theorem and delta method. The principle of sufficiency and likelihood and completeness are also given. Finding point estimators (method of moments, maximum probability, Bayes rule) and their evaluation (mean square error, uniformly minimum variance unbiased estimator, Cramer-Rao, Rao-Blackwell, decision theory). Hypothesis testing (likelihood ratio test, Bayesian testing, union-intersection tests) and their evaluation (size and level, p-value, type I and II errors, even more powerful test, Neyman-Pearson lemma, monotone probability ratio, Karlin-Rubin), hypothesis testing and large data, multiple comparisons and corrections. Finally, confidence interval material is covered by finding methods (inverting a test statistic, pivots and Bayes methods), their evaluation (coverage probability) and interpretation.

Prerequisites

Undergraduate probability and calculus of functions of multiple variables.

Target Learning Outcomes

Upon successful completion of the course, students will be able to handle issues related to: probability and distribution theory, principles of sufficiency and likellihood, and statistical inference with emphasis on the presentation of analytical methods of finding and evaluating: point estimators, interval estimators and hypothesis tests (using the Frequentist and the Bayesian approachs).

Recommended Bibliography

- G. Casella and R.L. Berger "Statistical Inference", 2nd edition, Duxbury Advanced Series
- Jacod and Protter Probability essentials 2nd edition Springer

Teaching and Learning Activities

In vivo and online teaching.

Assessment and Grading Methods

Exercises during the semester, essays and written or oral exam.

Computational Statistics

Instructors: D.KARLIS

Course Code: 61102
Core Course, 1st semester, 7.5 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

The aim of the course is to teach how computers can be used and facilitate statistical inference. The students learn the basic principles of simulations and its usage in modern statistical analyses. They also learn how to make statistical inference using the computer and how to apply numerical methods to solve statistical problems like, estimation, calculation of quantities that it is not possible otherwise, the EM algorithm etc. The basic contents of the course are:

- R programming,
- Simulation techniques,
- Monte Carlo methods,
- Marcov Chain Monte Carlo Methods,
- Bootstrap and iys use for inference,
- Numerical methods for statistics,
- Numerical optimization and the EM algorithm.

Prerequisites
The course implies a good prior knowledge of statistics. Basic knowledge of programming in R is required.

Target Learning Outcomes
Upon completion of the course the students will be able

- To use the computer for statistical inference
- To simulate various phenomena and stochastic models based on different distributions
- To solve statistical problems that involve numerical methods with the use of computer
- To write R code for all the above

Recommended Bibliography

- Venables, W.N., Ripley, B.D. (2002). Modern Applied Statistics with S (4th edn). Springer Crawley, M.J. (2002). Statistical Computing: An introduction to data analysis using S-Plus. Wiley
- Robert, C.P. and Casella, G. (2010). Introducing Monte Carlo Methods with R, Springer.
- Efron, B. and Tibshirani, R.J. (1993). An Introduction to the Bootstrap, Chapman & Hall.
- Davison, A.C. and Hinkley, D.V. (1997) Bootstrap Methods and Their Applications. Cambridge University Press, Cambridge.

- Gilks, W.R., Richardson, S. and D.J. Spiegelhalter, (1996) Markov Chain Monte Carlo in Practice, Chapman & Hall, NY

Teaching and Learning Activities
Course lasts 12 3-hours lectures (one each week). Every week there will be exercises as homework (some to be submitted).

Assessment and Grading Methods
The final grade is the weighted average of the final examination grade (weight 70%) and the three assignment/projects (weight 30%).

Generalized Linear Models

Instructor: V.VASDEKIS

Course Code: 61103
Core Course, 1st semester, 7.5 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

Introduction to statistical modeling, exponential family of distributions, part of a GLM, binomial data, logit models, contingency tables, log-linear models, Poisson models, overdispersion, normal data, Gamma data, polynomial-ordinal regression models, linear mixed models, GEE models, GLMM models. All applications include the use of the R language.

Prerequisites

Students should have basic knowledge of mathematical calculus, linear algebra, and probability theory.

Target Learning Outcomes

Upon successful completion of the course, students are expected to understand if the nature of their data allows application of a generalized linear model (knowledge and understanding). They should also be able to define the appropriate generalized linear model to the data at hand (application). They should be able to fit this model and interpret the results of analysis (skill). Finally, they should be able to explain to scientists of other disciplines the results of their analysis (synthesis).

Recommended Bibliography

- Agresti (2013). Categorical data analysis, Wiley Atkinson (1985). Plots, transformations and regression, Oxford university Press Carroll and Ruppert (1988). Transformation and weighting in regression, Chapman and Halλ Chatterjee and Price (1977). Regression analysis by example, Wiley.
- Christensen R. (1998). Analysis of variance, design and regression. Chapman and Hall. Collett, D. (1991) Modelling Binary data, Chapman and Hall Cook and Weisberg, S. (1982). Residuals and Influence in regression, Chapman and Hall
- Dobson, A., Barnett, A.G (2008). An introduction to generalized linear models, Chapman and Hall. Draper and Smith (1981). Applied regression analysis, Wiley.
- Fitzmaurice, Laird and Ware (2004). Applied longitudinal data analysis, Wiley. Hedeker and Gibbons (2006). Longitudinal data analysis.

- McCullagh, P and Nelder, J.A. (1989) Generalized Linear Models, Chapman and Hall. Montgomery, D.C. (1989) Design and Analysis of Experiments, Wiley
- Montgomery, D.C., Peck, E.A. and Vining, G.G. (2001). Introduction to linear regression analysis. Wiley. Ryan (1997). Modern regression methods, Wiley. Weisberg, S. (1985) Applied Linear Regression, Wiley Venables W.N. and Ripley B.D (1999) Modern Applied Statistics with S-Plus, Springer

Teaching and Learning Activities

One three-hour lecture per week, one one-hour laboratory, study exercises as homework (some to be submitted).

Assessment and Grading Methods

The final grade is the weighted average of the final examination grade (70%) and the grade of the study exercises to be submitted (30%).

Data Analysis

Instructor: I.NTZOUFRAS

Course Code: 61104
Core Course, 1st semester, 7.5 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

Primary aim of this course is the understanding and the application of statistical method in real life problems of various scientific fields such as Management, Marketing, Psychology, Medicine, Sports and Social Sciences. Focus is given on the review of parametric and non-parametric hypothesis tests for one and two samples (t-tests και Wilcoxon tests), analysis of variance and regression models. Emphasis is given in the implementation of all methods using R and in problem solving. Interesting real-life datasets and problems are analyzed during this course with aim to provoke their attention and motivate them. Finally, the students are introduced to the basic principles of scientific report writing and story telling either in the form of a written report or in form of oral presentation.

Prerequisites

Students should have good knowledge of estimation and statistical inference. It is also useful to have basic knowledge of the statistical language R and to be familiar with the statistical theory of regression.

Target Learning Outcomes

Upon completion of the course, students will be able to:

1) To manipulate and analyze data in R
2) To perform basic hypothesis tests
3) To build and interpret regression models

To write statistical reports in a professional way.

Recommended Bibliography

- Diez, D., Barr, C., & Cetinkaya-Rundel, M. (2012). *OpenIntro statistics* (Second. Edition). Free Open Book; available at http://www.openintro.org/stat/textbook.php
- Fox J. & Weisberg H.S. (2011). *An R Companion to Applied Regression.* 2nd edition. SAGE Publications Inc.
- Faraway, J. (2002). *Practical regression and ANOVA using R;* available at http://cran.r-project.org/doc/contrib/Faraway-PRA.pdf
- Ntzoufras I. & Karlis D. (2015). Introduction to programming and statistical analysis with R. Athens: Association of Hellenic Academic Libraries. http://hdl.handle.net/11419/2601, ISBN: 978-960-603-449-7.

- Fouskakis D. (2013). Data Analysis Using R. Tsotras Publications. Athens. (Book code in Eudoxos: 33134029).
- Field A, Miles J and Field Z. (2012). Discovering Statistics Using R. Sage Publications. Translated into Greek edition (2021): Discovering Statistics Using R. Propompos Publications.

Teaching and Learning Activities

- Introductory motivational talk about the value and the fun part of Statistics.
- Introductory videos (for R, for interpretation of Statistics by David Spiegelhalter, for the necessity of statistics in our daily life).
- Teaching in a classroom and computer labs.
- Laboratory exercises conducted during an extended lab session.
- Online game Kahoot (all together in the room - online version and asynchronously - offline).
- Guess the correlation game.
- Introductory course in R

Assessment and Grading Methods

- 25% project/assignment accompanied with long scientific report
- 25% project/assignment on high dimensional problem accompanied with short scientific report and oral presentation (focus is given on the latter)
- 50% Written examination (mostly multiple choice with 3-4 open questions)
- Three (3) optional lab assignments (small size)
- One (1) optional R exercise

HEALTH DATA SCIENCE

Instructor: N.DEMIRIS

Course Code: 61231
Course Type: Compulsory of Course Group 1
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 7,5
Language: English

Course Description

This course has the following content

Basic concepts in survival analysis, definitions, hazard and survival functions, relationships, parametric methods, likelihood function, Exponential and Weibull Models, applications in R

Non-parametric methods: Kaplan-Meier estimator, Greenwood and Nelson-Aalen estimator, graphical goodness of fit, log rank test.

Regression models, Cox proportional hazards, Survival Analysis theory, counting processes, applications in R

Martingale/Deviance/Schoenfeld residuals. Heterogeneity and frailty models, LASSO and elastic net, hyperparameter selection via cross-validation, applications in glmnet

Non-proportional hazards models, additive hazards, accelerated failure time, proportional odds, competing risks and (non-)identifiability, multi-state models

Prospective and retrospective studies, (non)interventional, AR, RR and OR, equivalence of OR. Screening tests, PPV/NPV and sensitivity/specificity

Clinical trial design and analysis, protocol, sample size calculations, phase I, MTD, 3+3 design, Phase II, safety and efficacy, phase III. Real world vs (and/or) randomised data.

CRM+adaptive designs, Simon 2-stage design, Bayesian and historical/synthetic controls

Meta analysis, systematic reviews, fixed effects, heterogeneity, random effects, publication bias, funnel plots, indirect treatment comparisons and network meta analysis, example applications in health economics using ICER, INB and CEAC.

Evidence synthesis and conflict diagnostics

Introduction to Epidemic models, main results, vaccination and control.

Basic stochastic models, branching processes and coupling, functional LLN and CLT, connections between the different types of model.

Inference for chain binomial models using MCMC. Inference for deterministic models using HMC.

Heterogeneity, multiple age-groups, contact matrices, epidemics among households.

Epidemics on networks

Prerequisites

Probability and Statistical Inference, Computational Statistics

Target Learning Outcomes

At the end of the course students will have knowledge of the basic principles, methods and implementation tools of the main data science techniques that are being used in the analysis of health data.

Recommended Bibliography

No single textbook covers the material presented. There will be lecture notes and course code from books in Biostatistics, Survival Analysis and Epidemic models as well as relevant research papers

Teaching and Learning Activities

Classroom teaching and assignments.

Assessment and Grading Methods

The main course assessment will be based upon assignments that will be prepared, given as reports and presented on an individual basis.

Advanced Methods in Survey Sampling

Instructor: I. PAPAGEORGIOU

Course Code: 61203
Course Type: Elective of Course Group 1
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 3
Language: English

Course Description

The module refers to the problem of inference for survey populations adopting the design-based approach. Topics include:
Basic theory of survey sampling in finite populations. A brief presentation of basic sampling designs and methodology for estimation of parameters of populations.
Use of auxiliary information to introduce weights and improve statistical errors. Methods include ratio and regression estimation, probability proportional to size and calibration.
Variance estimation in complex surveys. Methods of adjustment for non-response.

Prerequisites

Basic knowledge of Statistics.

Target Learning Outcomes

Upon completion of the course, the students will be able to identify the type of the statistical problem in real survey sampling situations, as well as to choose and apply in any case the appropriate methodology. Furthermore, they will be able to evaluate the quality of the results of the chosen methodology.

Recommended Bibliography

- Lohr, S.L (2021). Sampling: Design and Analysis. Third edition. Chapman and Hall/CRC.
- Lu, Y. and Lohr, S.L. (2022) R Companion for Sampling Design and Analysis. Third edition.
- Lumley, T. (2010) Complex Surveys: A Guide to Analysis Using R. Wiley.

Teaching and Learning Activities

Six weekly three-hour lectures and homework/projects.

Assessment and Grading Methods

Grade of final exam (70%) and projects during the teaching weeks (30%) .

Statistical Quality Control

Instructor: ST.PSARAKIS

Course Code: 61210
Course Type: Elective of Course Group 1
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 3
Language: English

Course Description

Definition of quality. Basics on quality and statistical quality control. An introduction to Acceptance sampling and Design of Experiments. Cause and effect chart and Pareto chart. The philosophy of statistical process control. Control charts for variables and attributes. Individual control charts. EWMA and CUSUM charts Capability indices. Control charts for autocorrelated data. Introduction to multivariate control charts. Basics of six sigma methodology.

Prerequisites

Students should have good knowledge of estimation and statistical inference. It is also useful to have basic knowledge of the statistical language R.

Target Learning Outcomes

The student after the course will acquire the skills needed to deal with problems improving the quality of products or services using statistical methods.

Recommended Bibliography

- Montgomery D (2019) Introduction to Statistical Quality Control, 8th Edition Wiley.
- Qiu P. (2013) Introduction to Statistical Process Control, CRC Press.
- Tagaras G.(2001) Statistical Quality Control, ZHTH press.

Teaching and Learning Activities

One three-hour lecture per week, one one-hour laboratory, study exercises as homework (some to be submitted).

Assessment and Grading Methods

85% Written examination.
15% project/assignment based on simulated data applying the methodologies and techniques described during the course accompanied with short scientific report.

Topics in Applied Statistics: Statistical Genetics - Bioinformatics

Instructor: P.PAPASTAMOULIS

Course Code: 61234
Course Type: Elective of Course Group 1
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 3
Language: English

Course Description

Modern biology is a data-rich science. This course will expose the students to high-throughput biological datasets (such as microarrays, RNA-Seq, ChIP-Seq) and present the main inferential tools to deal with challenges they impose to the statistician. These methods include techniques for:

- controlling the False Discovery Rate in multiple testing (such as the Benjamini-Hochberg procedure)
- modelling high-throughput count data (multifactorial designs, generalized linear models)
- performing differential expression analysis in microarray and RNA-Sequencing data
- taking into account heterogeneity in sizeable data (mixture models)
- fitting (frequentist or Bayesian) models specifically designed for estimating gene and tran- script expression given a known genome/transcriptome annotation and (big) datasets of short nucleotide reads

Prerequisites

This course is tailored to a statistically trained audience. More specifically:

- Prerequisites
- Estimation/Hypothesis Testing theory
- (Generalized) Linear Models

Some basic knowledge on:

- Computational Statistics
- Bayesian Inference
- R programming

Students will also benefit from the following courses (not required):

- Bayesian Statistics
- Statistical Learning
- Statistics for Big Data

Target Learning Outcomes

After completing the course, the students will:

- know the basic statistical challenges in bioinformatics
- properly deal with large scale hypothesis testing
- learn many novel statistical ideas and methods developed in the last 20 years, such as hybridizations of Bayesian and frequentist data analysis
- put their hands on many different types of data that modern biologists have to deal with, including microarrays, RNA-Seq, chip-Seq and single cell measurements
- know how to apply the relevant methods using R and Bioconductor.

Recommended Bibliography

- Holmes, Susan and Wolfgang Huber. Modern Statistics for Modern Biology. Cambridge Uni- versity Press, 2019
- Efron, Bradley. Large scale inference: Empirical Bayes Methods for Estimation, Testing and Prediction. Cambridge University Press, 2010
- Gentleman, Robert, et al., eds. Bioinformatics and computational biology solutions using R and Bioconductor. Springer Science & Business Media, 2006
- McLachlan, Geoffrey and David Peel. Finite Mixture Models. Wiley Series in Probability and Statistics, 2000
- Benjamini, Yoav and Hochberg, Yosef. Controlling the false discovery rate: a practical and powerful approach to multiple testing. Journal of the Royal statistical society: series B, 1995
- Dudoit, Sandrine and Shaffer, Juliet Popper and Boldrick, Jennifer C. Multiple hypothesis testing in microarray experiments. Statistical Science, 2003
- Robinson MD, McCarthy DJ, Smyth GK. edgeR: a Bioconductor package for differential expres- sion analysis of digital gene expression data. Bioinformatics, 2010
- Love MI, Huber W, Anders S. Moderated estimation of fold change and dispersion for RNA-seq data with DESeq2. Genome Biology, 2014
- Li, B., Dewey, C.N. RSEM: accurate transcript quantification from RNA-Seq data with or without a reference genome. BMC Bioinformatics, 2011
- Glaus, P, Honkela, A, Rattray, M. Identifying differentially expressed transcripts from RNA-seq data with biological variation. Bioinformatics, 2012
- Hensman, J, Papastamoulis, P, Glaus, P, Honkela, A, Rattray, M. Fast and accurate approx- imate inference of transcript expression from RNA-seq data. Bioinformatics, 2015
- Lönnstedt, Ingrid and Speed, Terry. Replicated Microarray data. Statistica sinica, 2002
- Smyth, G.K. Linear models and empirical Bayes methods for assessing differential expression in microarray experiments. Statistical applications in genetics and molecular biology, 2004

Teaching and Learning Activities

The computational aspects of this course will be implemented in R, a free software environment for statistical computing and graphics. R can be downloaded at https://www.r-project.org and installed on all types of environments (Windows, Mac, Linux). The R programming language will be enhanced by the specialized method

packages from the Bioconductor project https://www.bioconductor.org, such as limma, DeSeq2, edgeR, BitSeq, rsem-EBSeq. Supplementary command line tools (such as Bowtie2) will also be used.

Assessment and Grading Methods

There will be a total of 2 homework assignments that will contribute ≈ 50% in the final grade. The remaining ≈ 50% will be determined by the final exam.

Statistical Machine Learning

Instructors: I.KOSMIDIS – X.PEDELI

Course Code: 61232
Course Type: Compulsory of Course Group 2
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 7,5
Language: English

Course Description

A range of statistical and machine learning methods will be described for supervised and unsupervised learning problems. Unsupervised learning: clustering (hierarchical, partition clustering, k-means and its variants, model-based clustering), data reduction methods. Model Assessment and Selection. Supervised learning: Methods of Linear Discriminant Analysis (LDA), Quadratic Discriminant Analysis (QDA), k-nn, decision trees, random forests, SVM, naïve Bayes and others. Cross-validation methods. Statistics for big data problems, new approaches. Regularizations. Statistical methods for networks. Smoothing approaches in regression.

Prerequisites

Statistical Inference

Target Learning Outcomes

Upon completion of the course, students will have the knowledge and the skills

- to implement statistical methods aiming to deal with the problem of data dimension reduction,
- to apply classification models/algorithms and access their performance
- to apply clustering and access its performance
- to be familiar with new methodologies developed to deal with big data.

Recommended Bibliography

- T. Hastie, R. Tibshirani and R. Friedman (2009) Elements of Statistical Learning, Springer.
- Witten, J, Hastie, T. and Tibshirani, R. (2011) Introduction to Statistical Learning with applications in R, Springer
- C. Giraud (2015). Introduction to High-Dimensional Statistics. Philadelphia: Chapman and Hall/CRC.
- E. D. Kolaczyk (2014) Statistical Analysis of Network Data with R. Springer

Teaching and Learning Activities

Course lasts 12 3-hours lectures (one each week). Every week there will be exercises as homework (some to be submitted). There will be also a team project.

Assessment and Grading Methods

The final grade is the weighted average of the final examination grade (80%) and the assignment/projects (20%).

Bayesian Models in Statistics

Instructor: I.NTZOUFRAS

Course Code: 61206
Course Type: Elective of Course Group 2
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 3
Language: English

Course Description

This course will provide the introduction to the Bayesian approach in statistics both from the theoretic and the computational perspective using R and WinBUGS.
The course syllabus includes:
Bayesian inference. Conjugate Analysis. Simulation and random number generation. Markov models and hidden Markov (MCMC) methods. Metropolis-Hastings algorithm, Gibbs sampling. Introduction to WinBUGS. Bayesian inference for Regression and GLMs. Hierarchical models. Bayesian model and variable selection.

Prerequisites

The students should have a good quantitative and computational background. Specifically, knowledge in the fields of calculus, probability/distribution theory, statistical modelling and R programming will be necessary for this course.

Target Learning Outcomes

Upon completion of the course, students will be able to:

1) Understand the basic theory and philosophy of Bayesian Statistics
2) Understand the basic notions of Bayesian computation
3) Analyze data using WinBUGS
4) Build models (glm and hierarchical) in WinBUGS
5) Perform Bayesian variable selection using WinBUGS and BAS package in R.

Recommended Bibliography

- Ntzoufras, I. (2009). Bayesian Modeling Using WinBUGS. Wiley. Hoboken. USA.
- Carlin B. and Louis T. (2008), Bayes and Empirical Bayes Methods for Data Analysis. 3rd Edition, London: Chapman and Hall.

- Gelman A., Carlin J.B., Stern H.S., Dunson, D.B., Vehtari, A. and Rubin D.B. (2013). Bayesian Data Analysis. Third Edition. Chapman and Hall/CRC.
- P. Dellaportas and P. Tsiamyrtzis, “Introduction to Bayesian Statistics” (in Greek)

Teaching and Learning Activities

- Live teaching in a lecture room or computer labs
- Informal labs for using R and WinBUGS/OpenBUGS/JAGS
- Evaluation of current knowledge using Kahoot web game
- Interim optional exercises
- Personalized assignment/project

Assessment and Grading Methods

The course is examined by a big project/assignment that contributes 100% of the final grade. The students can break the final outcome/assignment in smaller landmark exercises (optional) that will help him to construct the final project report.

Applied Stochastic Modeling

Instructor: P.BESBEAS

Course Code: 61204
Course Type: Elective of Course Group 2
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 3
Language: English

Course Description

The aim of this module is to present modern statistical methods and associated theory for the construction, fitting and evaluation of statistical stochastic models. Highlighting modern computational methods, the module provides students with the practical experience of scientific computing in applied statistics through a range of interesting real-world applications from the natural and social sciences. In more complex situations this will mean using optimisation routines to obtain maximum likelihood estimates for the parameters. You will also learn how to take advantage of advanced likelihood tools, and simulation techniques, for inference. The module is a blend of descriptions of statistical methods, and the associated computational algorithms needed to perform the methods. The programming language R is used to illustrate the statistical computing algorithms, in the context of fitting models to data.

Lecture Syllabus:

Introduction and examples: Motivation through a range of real examples.
Model fitting by maximum-likelihood: Progression from explicit estimates to non-linear problems. Importance of modelling through example results.
Function optimisation: Modern deterministic and stochastic methods. Newton vs EM.
Computational Likelihood Tools: profile likelihood; use of information criteria; Wald tests, likelihood ratio tests; confidence interval construction.
Fundamental principles of modelling: Parameterisation: staying in range; delta method; orthogonality.
Application to multinomials, mixtures, truncated data.
Simulation techniques: Monte Carlo inference; confidence interval construction; bootstrap;
goodness of fit testing.
Case studies: Hierarchical Models. Capture-recapture. Hidden Markov.

Prerequisites

Probability and Inference. Regression. R.

Target Learning Outcomes

On successful completion of the module, students will:

- Appreciate the importance of computing for modern statistical analysis.
- Appreciate the breadth and importance of modern statistical methods.
- Be able to describe a number of practical areas where statistical modelling is of importance.
- Have enhanced their computer skills.
- Have encountered a range of complex data.
- Have an appreciation of how probability models may be formulated for atypical data sets.
- Have a good understanding of how likelihood-based classical procedures operate in practice.
- Have experience of running a wide range of modern statistical procedures through running computer programs in R.

Recommended Bibliography

Morgan, BJT 2009 Applied Stochastic Modelling, 2nd Edition. Chapman and Hall

Teaching and Learning Activities

18 hours of lectures and terminal classes. 60 hours independent study.

Assessment and Grading Methods

The unit is assessed by continuous assessment. Continuous Assessment: This will consist of several open book written assessments started in the terminal sessions and completed in independent study hours. These consist of questions on numerical problems along with R computing problems which test the learning outcomes.

Topics in Computational Statistics: Data Engineering

Instructor: K.P.PANOUSIS

Course Code: 61235
Course Type: Elective of Course Group 2
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 3
Language: English

Course Description

The course lays proper foundations in Data Engineering with emphasis on Statistical and Data Science applications. We will begin with basic SQL concepts such as queries, joins and aggregation as well as fundamental databases and in-memory analytics notions. In addition, we will introduce standard Python syntax, modules, data types and structures, operations control flow and input/output operations and database connectivity. Then, topics from the entire data lifecycle will be covered including data ingestion, transformation, loading, visualization, modeling, deployment, update, monitoring, maintenance, and documentation. More advanced or modern subjects with software engineering flavor such as parallelism, cloud computing, error handling, testing and version control will also be sampled for exposition.

Prerequisites

None

Target Learning Outcomes

Upon completion of the course, students will

- Understand the principles of data engineering and their significance on statistical analysis.
- Have a solid foundation in SQL and Python programming.
- Comfortably perform standard data engineering tasks with focus on statistical modeling.
- Have hands on experience on in-memory computing technologies.

Recommended Bibliography

- McKinney, Wes. Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.", 2012.
- Fangohr, Hans. Python for Computational Science and Engineering. Online Resource 2022
- Crickard, Paul. Data Engineering with Python: Work with massive datasets to design data models and automate data pipelines using Python. Packt Publishing Ltd, 2020.

- Beaulieu, Alan. Learning SQL: master SQL fundamentals. " O'Reilly Media, Inc.", 2009.
- Tanimura, Cathy. *SQL for Data Analysis*. " O'Reilly Media, Inc.", 2021.

Teaching and Learning Activities

The course is delivered in six weekly 3-hour lectures. Every week homework will be assigned (some to be submitted). A team project will also be assigned.

Assessment and Grading Methods

The final grade is the weighted average of the final examination grade (50%) and the assignment/projects (50%).

Financial Analytics

Instructor: I.VRONTOS

Course Code: 61233
Course Type: Compulsory of Course Group 3
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 7,5
Language: English

Course Description

This module provides a broad introduction to the theory and empirical analysis of econometric models to financial applications. Statistics/Econometrics is concerned with the systematic study of empirical financial problems using observed data. The aim of the course is to develop the relevant econometric tools for analyzing empirical problems in finance such as optimal portfolio construction, performance evaluation, and risk management among several others. It presents and introduces the multifactor model, the basic theory of stationary processes, the Autoregressive Moving Average (ARMA) models and develops analytically the Box-Jenkins methodology for the empirical analysis of financial time series models. The course introduces the class of conditional heteroscedastic models (ARCH/GARCH/EGARCH) and presents estimation and forecasting techniques for practical implementation. It introduces the multivariate factor models, as well as the multivariate heteroscedasticity models for the analysis of time-varying volatilities and covariances/correlations. It describes analytically several empirical financial problems such as portfolio construction, performance evaluation and risk management. Illustrative examples applying econometric models and techniques to actual financial and economic data are also presented using the R package. The empirical analysis consists of (i) unit root testing to exchange rate series and financial series, e.g. stocks and indices, (ii) modeling and forecasting financial return series, (iii) performance evaluation of fund investments, e.g. mutual and hedge fund investment returns, (iv) optimal portfolio construction, and (v) estimating and forecasting risk measures.

Prerequisites

The students should have a basic statistical background. Specifically, basic knowledge in the fields of probabilities and distributions will be necessary for this course.

Target Learning Outcomes

The aim of this module is to provide students with advanced statistical and econometric skills required to analyze empirical financial problems. On completion of this module, students will be able to:

- Implement statistical and econometric models and techniques for the analysis of financial time series
- use advanced econometric estimation techniques and tools to analyze models used in financial applications
- model the expected returns of financial assets
- model the variances and covariances/correlations of financial returns
- interpret the concepts of return and risk in financial markets
- forecast financial returns
- assess the performance of portfolio managers
- understand modern portfolio theory
- solve mean-variance optimization problems

- estimate the risk of financial assets

Recommended Bibliography

Recommended textbooks:

- Hamilton, James D. *Time Series Analysis*. Princeton, New Jersey: Princeton University Press, 1994.
- Enders, Walter. *Applied Econometric Time Series*. New York: Wiley, 2010.
- Tsay, Ruey S. (2010). *Analysis of Financial Time Series*, New York: Wiley.
- Cowpertwait, Paul S.P., and Metcalfe V. Andrew. *Introductory Time Series with R*. New York: Springer Texts in Statistics, 2009.
- Cryer, Jonathan D., and Chan Kung-Sik. *Time Series Analysis with Applications in R.* Springer Texts in Statistics, 2010.
- Elton, E.J., Gruber, M.J., Brown, S.J., and Goetzmann W.N. (2014). *Modern Portfolio Theory and Investment Analysis*, 9th edition, Wiley.
- Sharpe, W.F., Alexander, G.J, and Bailey, J.V. (1999). *Investments*, 6th edition, Prentice-Hall.
- Vrontos, I.D. (2016) *Financial Econometrics*, Lecture Notes (In Greek).

Other Useful textbooks:

- Gujarati, Damodar N. *Basic Econometrics*. New York: McGraw-Hill, 2008.
- Harvey, Andrew. *Time Series Models*. Cambridge: MIT Press, 1993.
- Hendry, David F. *Dynamic Econometrics*. Oxford: Oxford University Press, 1995.
- Pindyck, R.S. and D.L. Rubenfeld. *Econometric Models and Economic Forecasts*. New York: McGraw-Hill, 1991.
- Shumway, Robert H. and David S. Stoffer. *Time Series Analysis and Its Applications with R Examples*. New York: Springer Texts in Statistics, 2011.
- Wooldridge, Jeffrey. *Introductory Econometrics: A Modern Approach*. South-Western College Publishing, 2009.
- Engle, Robert F. and C.W.J. Granger (eds.). *Long-Run Economic Relationships: Readings in Cointegration*. Oxford: Oxford University Press, 1992.
- Granger, C.W.J. and Paul Newbold. *Forecasting Economic Time Series*. San Diego, CA: Academic Press, 1986.
- Banerjee Anindya, Juan Dolado, J.W. Galbraith, and David F. Hendry. *Co-integration, Error Correction, and the Econometric Analysis of Non-Stationary Data*. Oxford: Oxford University Press, 1993.

Teaching and Learning Activities

One three-hour lecture per week, study of the model theory, empirical applications in R package, programming exercises as homework (some to be submitted) and assignments.

Assessment and Grading Methods

The final grade is the weighted average of the final examination grade (weight 80%) and the grade of two homework assignments that will be submitted (weight 20%). Please note that one needs to pass the final exam, i.e. the final examination grade is at least 5/10 (independently of the grades in the homework assignments) in order not to fail the course.

Probability Theory

Instructor: M.ZAZANIS

Course Code: 61211

Course Type: Elective of Course Group 3

Course Level: Graduate (MSc)

Year of Study: A'

Semester: 2nd

ECTS: 3

Language: English

Course Description

The course provides a measure theoretic approach to probability theory according to Kolmogorov's Axioms, with emphasis on construction of probability spaces by the Caratheodory-Lebesgue Extension Theorem, on properties of the Expected (Mean) Value of a random variable as Lebesgue integral in its probability space and in the Borel real-line, on modes of Stochastic Convergence (*almost surely, in probability, in law, in p-th order mean*) and related Limit Theorems (*laws of large numbers, central limit theorems, continuity properties of expectation and probability*), on Lebesgue Decomposition to discrete and continuous components of probability measures on the Borel real-line, on the Radon-Nikodym Theorem and on properties of Conditional Expectation of a random variable with respect to a given σ-algebra of events.

Prerequisites

Calculus, Introduction to Probability, Introduction to Mathematical Analysis.

Target Learning Outcomes

After completing the course, students should be able to construct Probability Spaces, to calculate Expected (Mean) Value of a random variable by Lebesgue integration with respect to the induced probability distribution on the Borel real line, to discern among different notions of Stochastic Convergence and to implement them properly via pertinent significant theorems (e.g. monotone and dominated convergence theorems, laws of large numbers, central limit theorems) applied in both probability theory as well as in mathematical statistics.

Recommended Bibliography

- **Textbook:**
  Rosenthal, J.S. (2006): *A First Look at Rigorous Probability Theory*, 2nd Edition, World Scientific.

- Ross, S. M. (2007): A Second Course in Probability, Boston, MA.

- **Suggested Supplementary Bibliography:**

- Billingsley, P. (1995): *Probability and Measure*, 3rd Edition, John Wiley & Sons, New York.
- Chung, K.-L. (1974): *A Course in Probability Theory*, Academic Press, San Diego.
- Grimmet, G. R. and Stirzaker, D. R. (1992): Probability and Random Processes, 2nd Edition, Clarendon Press, Oxford.
- Roussas, G.G. (2005): *An Introduction to Measure-Theoretic Probability,* Elsevier Academic Press.
- Capinski, M. and Kopp P.E. (2004): *Measure, Integral, and Probability*, 2nd Edition, Springer.
- Durrett, R. (1996): *Probability: theory and examples*, Duxbury, Belmont.
- Port, S.C. (1994): *Theoretical Probability for Applications*, John Wiley & Sons, New York.
- Leadbetter, R, S. Cambanis and V. Pipiras (2014): *A Basic Course in Measure and Probability – Theory for Applications*, Cambrige University Press.

Teaching and Learning Activities

Teaching of Theory in classroom. Solutions of excercises.

Assessment and Grading Methods

Homework Assignments (20%) + Final Written Exam (80%).

Stochastic Models in Finance

Instructor: A.YANNACOPOULOS

Course Code: 61213
Course Type: Elective of Course Group 3
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 3
Language: English

Course Description

This course aims in introducing students in stochastic modeling in finance and the use of stochastic models in the description and forecast of prices of various assets such as stocks and indices, pricing of derivative products and bonds as well as their use in portfolio selection and risk management, focusing on models which are widely used in theory and practice. The course introduces fundamental concepts and analytic as well as computational methodologies such as for example martingale pricing methods, stochastic differential equations, simulation methods and estimation methods for financial models.

Prerequisites

None.

Target Learning Outcomes

Familiarize the students with the use and construction of stochastic models for finance, as well as with the necessary analytic and computational methods which are used in finance and risk management both in academic as well as in real business environments.

Recommended Bibliography

- Shreve, S. (2005), Stochastic calculus for finance, Springer
- Yannacopoulos A. (2014) Stochastic finance (notes)

Teaching and Learning Activities

In vivo and by distance learning, computational applications.

Assessment and Grading Methods

Exercises during term and final project.

Stochastic Models in Operations Research

Instructor: E.KYRIAKIDIS

Course Code: 61214
Course Type: Elective of Course Group 3
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 3
Language: English

Course Description
Poisson Process (definition, examples). Non-homogeneous Poisson process (definition examples). Simple birth-death process (definition, transient probabilities, probability of annihilation of population). Queueing theory. Little formula. Queue M/M/1 (transient probabilities, limiting probabilities). Exponential model of a queueing system with one server and finite capacity. Queue M/M/k with finite capacity. Queue M/M/k with inifinite capacity. Networks of queues (open systems). Networks of queues (open systems). Queue M/G/1 (formula of Pollaczek-Khintchine). Ουρά M/G/1 with bulk arrivals. A stochastic models for inventory control. The policy (s,S). Renewal processes with cost (examples).

Prerequisites
Basic knowledge of probability

Target Learning Outcomes
The students will be able to compute various quantities of interest as the stationary probabilities of a stochastic process, the mean number of customers in a queueing systems.
They will also be able to find the optimal policy for the control of a stochastic system.
They will be able to compute the long-run expected average cost of a renewal process.

Recommended Bibliography
- S. M. Ross, An introduction to Probability Models
- H. C. Tijms, A First Course in Stochastic Models.

Teaching and Learning Activities
In class, assignments, presentations.

Assessment and Grading Methods
Written Examination. Assignments.

Advanced Stochastic Processes

Instructor: ST.VAKEROUDIS

Course Code: 61212

Course Type: Elective of Course Group 3
Course Level: Graduate (MSc)
Year of Study: A'
Semester: 2nd
ECTS: 3
Language: English

Course Description

Reminder on basic knowledge of probability and Stochastic Processes. Conditional Expectation. Discrete Time Martingales (Filtrations, Martingales, Random Games, Stopping Times, Optional Stopping Theorem). Martingale Inequalities and Convergence (Doob's Martingale Inequalities, Doob's Martingale Convergence Theorem, Uniform Integrability and L1 Convergence of Martingales). Poisson Process, Compound Poisson Process, Queueing Theory. Brownian motion (Definition and basic properties, sample paths, Doob's L2 Maximal Inequality for Brownian motion). Itô's Stochastic Calculus (Itô's Stochastic Integral, Properties of Stochastic Integral, Itô's Formula, Stochastic Differential Equations).

Prerequisites

Probability Theory (probability measures, random variables, independence, expectation, conditional probability, Moment Generating function, Characteristic function, Law of Large Numbers, Central Limit Theorem), Basic Stochastic Processes, Calculus (limits, series, continuity, derivative, Riemannian integral), Basic knowledge of Lebesgue Integral.

Target Learning Outcomes

- The students, after following (and successful examination of) this course will understand the notion of Martingales which plays a crucial role in Financial and Actuarial applications.
- Moreover, they will learn applications of the Optional Stopping Theorem.
- They will study the Poisson Process and the Brownian motion, and they will get familiarised with Stochastic Calculus and Stochastic Differential Equations (with applications in Finance and in other fields).

Recommended Bibliography

- P. Billingsley, Probability and measure, Wiley, 1979.
- Z. Brzezniak, T. Zastawniak, Basic Stochastic Processes, Springer,1998.
- S. Karlin, A. M. Taylor, A Second Course in Stochastic Processes, Academic Press, 1981.

- D. Revuz, M. Yor, Continuous Martingales and Brownian motion, Springer Science & Business Media, 2013.

Teaching and Learning Activities

In class (In person) lectures, Exercises, Assignments, Presentations.

Assessment and Grading Methods

Final exam, Assignments.

DISSERTATION THESIS

Core Course, 3rd semester
ECTS units: 30
Course level: Graduate (MSc)
Language: English

Course Description

The dissertation thesis (DT) consists of the writing by the student of a research essay where the existing bibliography is studied, methodologies are studied and if needed they adopt to the current problem, research hypotheses are formulated, relevant data are collected and processed, empirical results are recorded and conclusions are drawn.
The content of the DT includes, indicatively, some of the following sections: Summary, Introduction, Literature review, Research methodology, Description of the data, Empirical results, Simulations to support the findings, Summary and conclusions, Bibliography, Appendices.

Prerequisites

For the preparation of the DT, it is required that the courses of the Msc Program have been completed.

Target Learning Outcomes

The DT aims to give the opportunity to the student to develop and apply research methodologies in real data to topics of scientific interest related to the studies of the Msc program. The goal is for the student to delve deeper into the topic under consideration, study the existing literature, develop his critical thinking by formulating appropriate research hypotheses, collect and analyze appropriate empirical data and acquire skills of investigation and derivation of substantiated conclusions.
General skills expected from a student are the following
• To be able to search, analyze and synthesize data and information, using the necessary technologies.
• To be able to generate new research ideas and methodologies.
• To be able to use existing methodologies and tools but also to create new ones.
• To promote free creative and inductive thinking.
• To be able to develop research skills commensurate with the completion of a master's degree
• To enable the creation of a coherent and logically substantiated text that demonstrates competence in research and the ability to work independently
• Be able to address issues of research design, methodology, ethics and theoretical arguments
• To be able to develop skills in independent research.

Recommended Bibliography

- Regulations about the Master thesis in the MSc in Statistics program.
- Guidelines for the thesis and related templates.

Assessment and Grading Methods

The evaluation of the DT is based on a series of evaluation criteria and its overall scientific merit. Indicatively, some of the questions evaluated are the following:

- Is the research question and its significance in science described?
- Is the purpose of the research presented?
- Are the research framework and methodology briefly mentioned?
- Are research findings summarized?
- Is the significance of the research question and research motivation clearly presented?
- Is the research question connected to the existing literature?
- Is there a need for further investigation of the research question?
- Is the case to be investigated and the objective of the work clearly presented and described?
- Is the work relevant to the curriculum?
- Is the relevant terminology understood by the student and is it used correctly?
- Has the content and organization of the literature review been clearly presented?
- Is the literature cited relevant to the research question?
- Does the review analyze, synthesize, compare and evaluate relevant research?
- Is the specific methodology adequately justified concisely and clearly?
- Is the entire research summarized in a comprehensible manner, its main points stated and the main conclusions presented pointing out any restrictions that apply?
- Are any suggestions for future research mentioned?
- Has the DT regulation as defined by the PMS been observed?
- Is the style of the write-up formal, is terminology used correctly, is repetition avoided and is it consistent?
- Is the text clear, concise and to the point with no grammatical or spelling errors?
- Does the student during the presentation of the DT show mastership on the problem that he presents? Can he answer the questions of the examining committee?

The DE is evaluated by a **three-member examination committee** made up of the supervisor and two other faculty members or lecturers at the program as the valid regulations describe. The student must present the DE before the examining committee.

PART III: INFORMATION FOR THE STUDENTS

GENERAL STUDENT INFORMATION

The Athens University of Economics and Business provides not only high-quality education but also high-quality student services. The adoption of the Presidential Decree 387/83 and Law 1404/83 defines the operation, organization, and administration of Student Clubs at Universities, which aim at improving the living conditions of the students and enhance their social and intellectual wellbeing through engagement and socialization initiatives.
To fulfill this objective the University ensures the required infrastructure for housing, meals, and sports activities through the operation of a student restaurant, reading rooms, library, organization of lectures, concerts, theatrical performances, and excursions in Greece and abroad. Further in this context, the University supports the development of international student relations, organizes foreign language classes, computer/software literacy classes, and courses in modern Greek as a foreign language for foreign students and expatriated Greek students.
Detailed information on meals, housing, fitness, foreign languages, cultural activities, scholarships, financial aid, is provided on the website of AUEB's Student Club at https://lesxi.aueb.gr/

Electronic Services

A significant number of procedures related to both attendance and student care are carried out electronically through applications of the University or the Ministry of Education and Religious Affairs. All applications are accessible with the same codes (username & password).

- **E-mail account:**

Detailed instructions for using the Webmail Service are provided at https://www.aueb.gr/el/content/odigies-gia-office-365-email.

- **Electronic Secretariat (Student Register)**

The Electronic Secretariat application is the information system through which students can be served by the Department's Secretariat via the web.

- **Wireless network**

Using their personal codes, students have access to a wireless network in all areas of the Athens University of Economics and Business buildings/campus: : https://www.aueb.gr/en/content/wi-fi-connection.

- **E-Learning Platform – ECLASS**

The Open eClass platform is an integrated Electronic Course Management System and is the proposal of the Academic Internet (GUnet) to support Asynchronous Distance Education Services.
Instructions are provided at https://eclass.aueb.gr/info/manual.php

Medical Services, Insurance / Healthcare

Undergraduate, postgraduate and PhD students at the University who have no other medical and hospital care are entitled to full medical and hospital care in the National Health System with coverage of the relevant costs by the National Health Service Provider. A psychiatric counseling service also operates at the University, staffed with a physician specializing in the treatment of mental health issues.
More information at https://www.aueb.gr/en/content/health-care.

Services/Facilities to Students with Special Needs

The Athens University of Economics and Business ensures the facilitation of students with special needs, through the design, implementation, and environmental adaptations, for access to the university building facilities. In the main building there are specially configured lifting machines, ramps, and elevators. There are also special regulations for conducting exams for students with special needs.
The Athens University of Economics and Business has established a Committee for Equal Access for people with disabilities and people with special educational needs. The Commission is an advisory body and submits recommendations to the competent bodies for the formulation and implementation of the policy of equal access for persons with disabilities and persons with special educational needs.

Through the Library services, students with physical disabilities are granted electronic access to the recommended Greek bibliography of the courses taught at the University. In this context, the Association of Greek Academic Libraries (SEAB) has developed a multimodal electronic library called AMELib.
More information is available at https://www.aueb.gr/en/lib/content/users-additional-needs.

Library and Study Rooms

The Library & Information Center of the University operates at the University's main building. The AUEB Library is a member of the Hellenic Academic Libraries Association (Heal-LINK), the European Documentation Centers Europe Direct and the Economic Libraries Cooperation Network (DIOBI).
Three Documentation Centers operate within the library:

- The European Documentation Center
- The Organization for Economic Cooperation and Development (OECD) Documentation Center
- The Delegation Center of the World Tourism Organization (WHO)

The library contributes substantially both to meeting the needs for scientific information of the academic community and to supporting studying and research. The library provides access to:

- printed collection of books and scientific journals,
- course books used in modules,
- collection of electronic scientific journals& books
- postgraduate theses and doctoral theses that are produced in Athens University of Economics and Business and deposited in digital form at the PYXIDA institutional repository
- sectoral studies
- statistical series by national and international organizations
- audiovisual material
- information material (encyclopedias, dictionaries)
- databases on the topics used by the University
- printed collections of other academic libraries

The library lends all its printed collections, except for magazines and statistical series, in accordance with its internal rules of operation. The Library and Information Center offers reading rooms, computer workstations for visitors, photocopiers and printing machines, and interlibrary loan of books and journal articles from other academic libraries that are members of its network. More information at https://www.aueb.gr/en/library.

International Programs and Information on International Student Mobility

Athens University of Economics and Business is actively involved in the Erasmus+ Program since 1987 promoting cooperation with universities, businesses, and international organizations of the European Union (EU) as well as in the mobility of students, teaching, and administrative staff.
In addition, strengthening its internationalization objectives, it creates new opportunities through the Erasmus+ International Mobility Program. Within this framework, mobility scholarships are granted through the State Scholarships Foundation (SSF) to incoming and outgoing students of the three study cycles, according to the funding approved each year by the State Scholarship Foundation for the University. Outgoing students have the possibility to spend a period of study at a Partner Institution outside the EU with full academic recognition through the application of the ECTS credits system https://www.aueb.gr/en/erasmus.

Connecting with the Job Market and Entrepreneurship

D.A.STA.O.P.A. (https://www.aueb.gr/el/dasta) is the administrative unit of the University that plans, coordinates and implements the actions of the Athens University of Economics and Business in the following areas:

a) development of entrepreneurship and innovation

b) connecting students and graduates with the labor market

c) connecting the academic community with businesses

d) student internship programs and,

e) supporting research utilization actions

Student Associations

Various student clubs and associations are active within the community of the Athens University of Economics and Business

(https://www.aueb.gr/en/content/student-clubs).

Alumni Network

Adhering to a long tradition of educating future top executives in the economic, social, and political life of the country, AUEB is proud that thousands of its graduates hold leading positions in companies, organizations, research institutes and universities in Greece and abroad. Understanding the importance of developing and strengthening the bond with its graduates, AUEB created its Alumni network including a platform https://alumni.aueb.gr where all graduates of the University can register. The main objectives of the Network are the connection of the graduates with their colleagues and former fellow students, and diffusion of information about activities, services, and events in and around the University that concern them. Additional information on Clubs and Alumni Associations is available on the website https://www.aueb.gr/en/content/alumni.

Volunteer Program

Within the framework of its strategies, the "AUEB Volunteers" Volunteering Program was launched in September 2017. The aim of the Program is to highlight important social issues and the value of participation and practical contribution, but also to raise community awareness regarding the 17 UN Sustainable Development Goals. Actions are developed around two pillars: (a) actions addressed to AUEB's Community, which have as their main objective the maintenance of the quality of the University's infrastructure based on their aesthetics and functionality, and (b) actions addressed to Greek society. (https://auebvolunteers.gr/).

Quality Assurance

The Athens University of Economics & Business implements a quality assurance policy to continuously improve the quality of its study programs, research activities and administrative services, and upgrade the academic and administrative processes and the University's operations. The Quality Assurance Unit (MODIP) operating at AUEB coordinates and supports evaluation processes. Particularly the quality assurance of the educational process is achieved using the module/teaching evaluation questionnaire completed by AUEB students. (https://aueb.gr/en/modip).

Training and Lifelong Learning Center

The Center for Training and Lifelong Learning **(KEDIVIM)** is an AUEB unit which ensures the coordination and interdisciplinary cooperation in the development of training programs, continuing education, training and in general lifelong learning, which complement, modernize and/or upgrade knowledge, competences, and skills, acquired from formal education, vocational education and initial vocational training systems or from work experience, facilitating integration or reintegration in the labor market, job security and professional and personal development.

(https://www.aueb.gr/en/content/kedivim-opa).