SCHOOL OF INFORMATION SCIENCES AND TECHNOLOGY

DEPARTMENT OF STATISTICS

MSc. in STATISTICS

STUDY GUIDE
ATHENS, ACADEMIC YEAR 2022-23

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 Dimitris Bourantonis

Vice Rectors:

Vice Rector of Academic Affairs and Personnel
Professor Vasilios Vasdekis

Vice Rector of Research and Lifelong Learning
Associate Professor Georgios Lekakos

Vice Rector of Financial Planning and Infrastructure
Professor Konstantinos Drakos

Vice Rector of International Cooperation and Development
Professor Vasilios Papadakis

School of Information Sciences and Technology
Dean: Professor Ioannis Kotidis
Department of Statistics
Chair: Professor Ioannis Ntzoufras
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:	October 3, 2022
Classes end:	December 22, 2022
Break before Christmas Holidays:	December 23, 2022

Exam period January-February 2021

Start of Exams:	January 9, 2023
End of Exams:	January 31, 2023

Holidays

October 28, 2022
November 17, 2022
January 6, 2023
January 30, 2023

SPRING SEMESTER

Classes begin:	February 1, 2023
Break before Easter Holidays:	April 10, 2023
Classes restart:	April 24, 2023
Classes end:	May 26, 2023

Exam period June 2021

Start of Exams:	June 1, 2023
End of Exams:	June 30, 2023

Holidays

February 27, 2023
May 1, 2023
June 5, 2023

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 Statistics.**

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 Statistics" 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, four courses are offered which are compulsory for all students. In the second semester, three courses are offered (Applied Statistics, Computational Statistics, Stochastics). Each group contains five lessons. Students choose two course groups and from each group choose four courses.
The course structure diagram with credits for the Academic Year 2022-23 is defined as follows:

1st Semester *(each student selects all four **(4)** courses)*	**CR**
Probability - Statistics	7.5
Data Analysis	7.5
Computational Statistics	7.5
Generalized Linear Models	7.5
2nd Semester *(each student selects two **(2)** course groups and from each group choose four **(4)** courses.)*	**CR**
Applied Statistics	
Biostatistics	4
Advanced Methods in Survey Sampling	3.5
Statistical Process Control	3.5
Epidemic Models	4
Statistical Genetics- Bioinformatics	3.5
Computational Statistics	
Bayesian Statistics	4
Statistical Learning	4
Statistics for Big Data	3.5
Advanced Stochastic Processes	3.5
Applied Stochastic Modeling	3.5
Stochastics	
Probability Theory	4
Time Series	4
Stochastic Models in Finance	3.5
Financial Econometrics	3.5
Stochastic Models in Operations Research	3.5
3rd Semester	
MSc Thesis	30

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 (61101)

Instructors: ST.VAKEROUDIS – N.DEMIRIS

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.

Data Analysis (61104)

Instructors: I.NTZOUFRAS

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

- Ντζούφρας Ι. & Καρλής Δ. (2015). *Εισαγωγή στον προγραμματισμό και στη στατιστική ανάλυση με R*. Αθήνα: Σύνδεσμος Ελληνικών Ακαδημαϊκών Βιβλιοθηκών. http://hdl.handle.net/11419/2601, ISBN: 978-960-603-449-7
- Ντζούφρας Ι. & Καρλής Δ. (2015). Εισαγωγή στον προγραμματισμό και στη στατιστική ανάλυση με R. Αθήνα: Σύνδεσμος Ελληνικών Ακαδημαϊκών Βιβλιοθηκών. http://hdl.handle.net/11419/2601, ISBN: 978-960-603-449-7
- Φουσκάκης Δ. (2013). *Ανάλυση Δεδομένων με Χρήση της R*. Εκδόσεις Τσότρας. Αθήνα. (Κωδικός Βιβλίου στον Εύδοξο: 33134029).
- Field A, Miles J and Field Z. (2012). Discovering Statistics Using R. Sage Publications. Μεταφρασμένη στα Ελληνικά έκδοση (2021): Ανακαλύπτοντας την Στατιστική με τη Χρήση της R. Εκδόσεις Προπομπός.

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

Computational Statistics (61102)

Instructors: D.KARLIS

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 (61103)

Instructors: V.VASDEKIS

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%).

Biostatistics (61202)

Instructors: X.PEDELI

Core Course, 2nd semester, 4 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

Introduction to epidemiology and epidemiological study designs. Measures of health and disease: Measures of disease frequency (prevalence, incidence), Risk measures (cumulative incidence or risk of disease, incidence rate of disease, odds of disease), Measures of exposure effect (risk ratio, rate ratio, odds ratio, risk difference, rate difference). Cohort studies: Rates, Rate ratio, Test of null hypothesis, Exposures with more than two levels, Stratified analysis of rates – Controlling for confounders. Survival analysis: Censored observations, The lifetable method, The Kaplan-Meier method, The log-rank and other tests for testing survival curves, The Nelson Aalen estimator, Survival regression (Cox's proportional hazard model, Aalen's additive model, Cox's time varying proportional hazard model). Case-control studies: Analysis of case-control studies (prospective/ retrospective approach), Analysis of unmatched case-control studies, Matched case-control studies, Choice of controls in case-control studies.

Prerequisites

Students should have basic knowledge of probability theory and statistics. For the programming assignments of the course, programming experience in R is required.

Target Learning Outcomes

After successfully completing the course, students will be able to:

- recognize the appropriate study design in a medical study, and
- use appropriate measures and statistical methods to help the health scientist in deriving sensible conclusions.

Recommended Bibliography

- Armitage, P.; Berry, G.; Matthews, J.N.S. Statistical Methods in Medical Research; Wiley: Hoboken, NJ, USA, 2002.
- Clayton, D.; Hills, M. Statistical Models in Epidemiology; Oxford University Press: Oxford, UK, 2013.
- Pocock SJ. Clinical trials: a practical approach. Wiley, New York, 2013.

- David W. Hosmer, Jr., Stanley Lemeshow, Susanne May, 2008 Applied Survival Analysis: Regression Modeling of Time to Event Data, 2nd Edition. Wiley Series in Probability and Statistics
- Kenneth J. Rothman, Sander Greenland, Timothy L. Lash, 2012 Modern Epidemiology Third Edition, Lippincott Williams & Wilkins

Teaching and Learning Activities

One three-hour lecture per week, assignment as homework (to be submitted).

Assessment and Grading Methods

The final grade is the weighted average of the final examination grade (80%) and the grade of the assignment to be submitted (20%).

Advanced Methods in Survey Sampling (61203)

Instructors: P.MERKOURIS

Core Course, 2nd semester, 3.5 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

Basic theory of survey sampling in finite populations. Methodology of estimation of parameters of populations and subpopulations. Use of auxiliary information in parameter estimation. Generalized regression and calibration. Variance estimation in complex surveys. Methods of adjustment for non-response and methods of imputation.

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 (2009). Sampling: Design and Analysis. Second Edition, Brooks/Cole, Cengage Learning.
- Sarndal, C-E, Swensson, B., Wretman, J. (1992). Model Assisted Survey Sampling, Springer.

Teaching and Learning Activities

Six weekly three-hour lectures and homework.

Assessment and Grading Methods

Grade of final exam (100%).

Statistical Process Control (61210)

Instructors: ST.PSARAKIS

Core Course, 2nd semester, 3.5 ECTS units
Course level: Graduate (MSc)
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.
- Ταγαράς Γ.(2001) Στατιστικός Έλεγχος Ποιότητας, εκδόσεις ΖΗΤΗ.

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.

Epidemic Models (61228)

Instructors: N.DEMIRIS

Core Course, 2nd semester, 4 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

- Introduction to Stochastic Epidemic Modelling, Stochastic versus deterministic models. Stochastic epidemics in large communities. The Markovian case, Some Exact results. Chain-binomial models.
- Coupling methods. Applications to the early stage of epidemics and the connection with branching processes. The threshold limit theorem, Duration of the Markovian SIR epidemic. Density dependent jump Markov processes.
- Disease Control, Estimation of vaccine efficacy. Estimating vaccination policy.
- Multitype epidemics and multiple age-groups. Household models and population structure. Epidemics and graphs, Random graph interpretation, Epidemics and social networks. Implications for vaccination.
- Bayesian Inference for epidemic models. Inference for ODE models. Approximate inference for stochastic models.
- Applications using data from influenza outbreaks and the SARS-CoV2 pandemic.

Prerequisites

Probability and Statistical Inference. Computational methods.

Target Learning Outcomes

At the end of the course the student will have a basic understanding of disease transmission and the relevant factors which affect it. Disease control techniques and parameter estimation will be possible, including the estimation of the relevant function(al)s such as the disease reproductive rate and the vaccination coverage.

Recommended Bibliography

Andersson H. and Britton T. (2000): *Stochastic epidemic models and their statistical analysis*. Springer Lecture Notes in Statistics, 151. Springer-Verlag, New York.

Teaching and Learning Activities

Classroom teaching (or via teleconference). Practicals on the computational inference techniques.

Assessment and Grading Methods

Exercises during the course. A large study based on analyzing real epidemic data and oral presentation at the end of the course.

Statistical Genetics - Bioinformatics (61229)

Instructors: D.PAPASTAMOULIS

Core Course, 2nd semester, 3.5 ECTS units
Course level: Graduate (MSc)
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 University 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 expression 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.

Bayesian Statistics (61206)

Instructors: I.NTZOUFRAS

Core Course, 2nd semester, 4 ECTS units
Course level: Graduate (MSc)
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.

Statistical Learning (61208)

Instructors: I.PAPAGEORGIOU

Core Course, 2nd semester, 4 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

A range of statistical learning methods is studies. For supervised learning and classification problem: Methods of Linear Discriminant Analysis (LDA), Quadratic Discriminant Analysis (QDA), k-nn and decision trees. For unsupervised learning: clustering (hierarchical, optimization clustering, model-based), data reduction methods. Model Assessment and Selection.

Prerequisites

Multivariate Analysis, 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, classification and clustering. They will be able to interpret the results and assess the methodologies' performance.

Recommended Bibliography

- Hastie, Tibshirani and Friedman (2009) Elements of Statistical Learning, 2nd edition Springer
- James, Witten, Hastie and Tibshirani (2011) Introduction to Statistical Learning with applications in R, Springer
- B. S. Everitt, S. Landau, M. Leese, and D. Stahl (2011) Cluster Analysis, Fifth Edition, Wiley

Teaching and Learning Activities

Face to face teaching covering theory and practice. The practicals are implemented with R.

Assessment and Grading Methods

Written exam and projects.

Statistics for Big Data (61209)

Instructors: D.KARLIS

Core Course, 2nd semester, 3.5 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

The era of big data has led to paradigm shift in statistical methods. New challenges and new problems have occurred due to the abundance of data. The aim of the present course is to discuss the changes on the statistical methods and how the huge volume of data affects the classical statistical methods, while at the same time, how the new problems occurring can be solved via «state of the art» new statistical methodologies. We have selected some methods and problems to exploit showing the new potential and the new dynamics of statistical science towards new problems. Topics that we cover relate to: new challenges in Statistics, Regression for Big Data, Regularization problems, Multiplicity problems and Statistical analysis in networks.

Prerequisites

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

Target Learning Outcomes

The target of the course is to show the needs and challenges produced by the big data era and how statistical methodologies can handle them . After completing the course, the students will be able to:

- understand the new challenges and problems due to the abundance of data
- apply new techniques defined to handle problems with big data
- implement the new methods using R

Recommended Bibliography

- C. Giraud (2015). Introduction to High-Dimensional Statistics. Philadelphia: Chapman and Hall/CRC.
- T. Tony Cai, Xiaotong Shen, ed. (2011). High-dimensional data analysis. Frontiers of Statistics. Singapore: World Scientific.
- P. Bühlmann and S. van de Geer (2011). Statistics for high-dimensional data: methods, theory and applications. Heidelberg; New York: Springer.
- T. Hastie, R. Tibshirani and R. Friedman (2009) Elements of Statistical Learning, Springer.
- E. D. Kolaczyk (2014) Statistical Analysis of Network Data with R. Springer

Teaching and Learning Activities

Course lasts 6 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%). There will be two small assignments and a team project.

Advanced Stochastic Processes (61212)

Instructors: M.ZAZANIS

Core Course, 2nd semester, 3.5 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

Review of useful notions from Probability Theory. Conditional Expecation. Martingales in discrete time (Filtrations, Martingales, Games of Chance, 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). Brownian Motion (Definition and basic properties, Increments of Brownian Motion, sample paths, Doob's maximal L2 Inequality for Brownian motion). Ito Stochastic Calculus (Ito Stochastic Integral: Definition, Properties of the Stochastic Integral, Stochastic Differential and Ito Formula, Stochastic Differential Equations).

Prerequisites

Probability Theory (probability measures, random variables, expectation, independence, conditional probability, laws of large numbers. Calculus (limits, series, the notion of continuity, differentiation, the Riemann integral). Basic knowledge of Lebegue Integral.

Target Learning Outcomes

- The students, after attending this course, will know the notion of martingale, which plays an important role in financial and actuarial applications.
- They will also be familiar with the Optional Stopping Theorem and Applications.
- They will be familiar with the notion of Brownian Motion, with stochastic calculus and with stochastic differential equations (with applications in various scientific fields).

Recommended Bibliography

- Z. Brzezniak, T. Zastawniak, Basic Stochastic Processes, Springer,1998.
- S. Karlin, A. M. Taylor, A Second Course in Stochastic Processes, Academic Press, 1981.

Teaching and Learning Activities

In class, assignments, presentations.

Assessment and Grading Methods

Written Examination. Assignments.

Applied Stochastic Modeling (61204)

Instructors: P.BESBEAS

Core Course, 2nd semester, 3.5 ECTS units
Course level: Graduate (MSc)
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.

Probability Theory (61211)

Instructors: H.PAVLOPOULOS

Core Course, 2nd semester, 4 ECTS units
Course level: Graduate (MSc)
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.
- **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.

- 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

Remote Teaching (Tuesday 12:00-15:00) by implementing a combination of tools available via AUEB e-class and Microsoft-Teams platforms.

Assessment and Grading Methods

Homework Assignments (50%) + Final Written Exam (50%).

Time Series (61201)

Instructors: E.IOANNIDIS

Core Course, 2nd semester, 4 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

The notion of stationarity, definition and properties of the autocovariance function of a stationary time series, test for white noise, Parametric and non-parametric estimation and elimination of the components of a time series, method of differences, statistical properties of the sample mean, estimates of the auto-correlation function and properties of their distribution, linear time series, prediction of a stationary time series and the partial auto-correlation function, Autoregressive moving average (ARMA) models for stationary time series, linear time series representation of an ARMA model and conditions for causality and invertibility, theorem of Wold, calculation of the ACF and the PACF of an ARMA model, estimating the parameters of an AR(p), asymptotic properties, efficiency, estimating the order of an ARMA model: AIC. Time series with a Unit root kai the Dickey-Fuller test. The spectral density of a stationary time series: definition, properties and interpretation. The spectral density of ARMA processes. Estimating the spectrum: the smoothed periodogram, statistical properties.

Prerequisites

Basic knowledge of mathematical calculus, Linear algebra and Probability theory. Knowledge of Estimating and Testing and Linear Models and ability to apply them in data analysis. Basic knowledge of the R programming language.

Target Learning Outcomes

Understand in depth the concepts, models and methods described in the syllabus: capability to respond to relevant theoretical questions and exercises. The ability to apply the methods taught in real data analysis.

Recommended Bibliography

- Brockwell, P.J. and R.A. Davis (1996): *Introduction to Time Series and Forecasting*, Springer Verlag
- Brockwell, P.J. and R.A. Davis (1991): *Time Series: Theory and Methods*, *2nd Edition*, Springer Verlag.
- Hamilton, J.D. (1994) : *Time Series Analysis*, Princeton University Press.

- Koopmans, L.H. (1974): *The Spectral Analysis of Time Series*, Academic Press.
- Brillinger, R. D. (1981): *Time Series: Data Analysis and Theory*, Holden Day.

Teaching and Learning Activities

One three-hour lecture per week and a one-hour per-week lecture in data analysis of time series with R. Study exercises and data analysis exercises with R as homework.

Assessment and Grading Methods

The final grade is the grade of the written (or/and oral) final examination increased by a percentage of 1.5 proportional to the performance in exercises to be submitted, provided that the final examination grade is at least 4/10. Otherwise, the final grade equals the final examination grade.

Stochastic Models in Finance (61213)

Instructors: A.YANNACOPOULOS

Core Course, 2nd semester, 3.5 ECTS units
Course level: Graduate (MSc)
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.

Financial Econometrics (61207)

Instructors: I.VRONTOS

Core Course, 2nd semester, 3.5 ECTS units
Course level: Graduate (MSc)
Language: English

Course Description

This course provides a broad introduction to the theory and empirical analysis of advanced econometric models in financial applications such as construction of optimal portfolios, evaluating managers' performance, and forecasting financial returns. Multi-factor models are introduced, which can be used to estimate the expected returns of financial assets, and univariate and multivariate heteroscedasticity models (ARCH/GARCH), which can be used to model the variations and covariances/correlations of financial returns. Indicative examples of the application of these advanced statistical and econometric models and techniques are (a) the construction of optimal portfolios, (b) the evaluation of the performance of the various mutual fund or hedge fund investment managers, (c) forecasts of financial series, e.g. stock returns.

Prerequisites

None.

Target Learning Outcomes

The aim of this module is to provide students with advanced statistical and econometric skills required to analyze empirical problems in finance. After successfully completing the course, students will be able to:

- interpret the concepts of return and risk in financial markets
- model the expected returns of financial assets
- model the variances and covariances/correlations of financial returns
- use advanced econometric tools to analyze models used in financial applications
- 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

- 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.
- Tsay, Ruey S. (2010). Analysis of Financial Time Series, New York: Wiley.
- Vrontos, I.D. (2016) Financial Econometrics, Lecture Notes (In Greek).
- Selected papers.

Teaching and Learning Activities

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

Assessment and Grading Methods

The final grade is the average of the final examination grade (weight 80%) and the grade of the study and programming exercises to be submitted (weight 20%), provided that the final examination grade is at least 5/10. Otherwise, the final grade equals the final examination grade.

Stochastic Models in Operations Research (61214)

Instructors: E.KYRIAKIDIS

Core Course, 2nd semester, 3.5 ECTS units
Course level: Graduate (MSc)
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.

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/webmail-manual

- **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.

- **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/el/lib/content/amea-atoma-me-idiateires-anages.

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/content/erasmus-programme

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/el/content/student-associations).

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/el/content/organizations-and-associations-of-students-and-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/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/el/content/dia-vioy-mathisi-kedivim-opa).