SCHOOL OF INFORMATION SCIENCES AND TECHNOLOGY

DEPARTMENT OF STATISTICS

MSc. in APPLIED STATISTICS & DATA ANALYTICS

STUDY GUIDE
ATHENS, ACADEMIC YEAR 2024-25

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 Ioannis Ntzoufras
Master's Program
Director: Professor Stylianos Psarakis

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 8, 2024
Break before Christmas Holidays:	December 23, 2024
Classes restart:	January 7, 2025
Classes end:	January 9, 2025

Exam period January 2025

Start of Exams:	January 16, 2025
End of Exams:	January 28, 2025

Holidays
October 28, 2024

SPRING SEMESTER

Classes begin:	February 4, 2025 & May 13, 2025
Break before Easter Holidays:	April 12, 2025
Classes restart:	April 27, 2025
Classes end:	April 10, 2025 & June 6, 2025

Exam period April -May - June 2025

Start of Exams:	April 28, 2025 – May 6, 2025
End of Exams:	June 17, 2025

Holidays
January 30, 2025
March 3, 2025
March 25, 2025
May 1, 2025
June 9, 2025

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 Applied Statistics & Data Analytics.**

Admission requirements

The program accepts university graduates, from Greek or non-Greek higher education institutions that have been recognized from the Hellenic NARIC organization (DOATAP), according to the law 4957/2022. Applicants that have not yet graduated from their universities' must submit a solemn statement of Law No. 1599/86 that if selected for the MSc program, they will have completed their undergraduate studies until the forthcoming September.

Admission criteria/Registration Procedure

The program accepts university graduates, from Greek or non-Greek higher education institutions that have been recognized from the Hellenic NARIC organization (DOATAP), according to the law 4957/2022.

Foreign students must have proficient knowledge of the Greek language (they must either have graduated from the Hellenic high school (lyceum) or have a GAT Greek language certificate).

The program accepts up to forty (40) students per year.

Applicants selection is made according to the provisions of the Law No. 4957/2022 and the program's Academic Regulations as published in the Governmental Gazette No. 5364B(7-12-20).

The Following documents must be submitted with the application, as indicated in the official call for applications:

1. Online application form http://e-graduate.applications.aueb.gr
2. Curriculum Vitae
3. Copies of all University Degrees / Diplomas and Official Transcripts of marks received. Applicants that have not yet graduated from their universities' must submit a solemn statement of Law No. 1599/86 that if selected for the MSc program, they will have completed their undergraduate studies until the forthcoming September.
4. Certified copy of the English language certification verifying good command of the language (at least level B1.
5. Two confidential recommendation letters (for FT applicants only academic references are accepted, while for PT applicants employer's references are also accepted)

6. For non-Greek university degrees recognition by the Hellenic National Academic Recognition Information Centre (DOATAP) is required according to the Law No. 4957/2022.

The applicant's evaluation process has as follows:

The Admissions Committee

a) Compiles a table of all applicants
b) Rejects all applicants that do not meet the minimum prerequisites that have been set by the Departmental Assembly.
c) Calls all eligible applicants for a personal interview with at least two members of the Admissions Committee.
d) Ranks all applicants according to the above mentioned quantitative and qualitative criteria and selects the ones that will be accepted.
e) The final list of accepted applicants is validated by the Departmental Assembly.

Educational and professional goals

The Postgraduate Program in Applied Statistics has as its object the provision of specialized postgraduate knowledge to graduates of Greek and recognized foreign universities in the main fields of Statistics and Probability. In particular, the object of the Program is the education of postgraduate students in the following areas: a) Data analysis, b) Biostatistics, c) Computational Statistics of Big Data, d) Applied Probability.

The program aims to:

1. The creation of specialized scientists in areas that are compatible with the research activity, the corresponding specializations of the undergraduate study program and with the scientific staff of the department.
2. The training of senior executives for companies and organizations in the private and public sector that may cover their needs in for specific applications in data analysis.
3. To promote the University globally, to develop networks of cooperation with the international scientific community and the greatest possible activity within the framework of the opportunities offered in Europe and in the wider world.
4. In the interconnection of the educational process with the needs of the market and the economy in general.

Access to further studies

Access to the PhD Program – 3rd Cycle.

Course structure diagram with credits:

1st Semester *(each student selects all three **(3)** courses)*	**ECTS**
Applied Probability and Statistics	5
Statistical Methods for Data Analytics	5
Programming in Data Analytics	5
Total (1st semester)	**15**
2nd Semester *(each student selects all three **(3)** courses)*	
Optimization Techniques in Data Analytics	5
Statistical Data Modelling	5
Time Series Analysis and Forecasting	5
Total (2nd semester)	**15**
3rd Semester *(each student selects all two **(2)** courses) and courses from the "elective courses" list)*	
Applied Biostatistics	5
Computational Methods in Statistical Data Science	5
Elective Courses (from the list below)	
4th Semester *(each student selects courses from the "elective courses" list)*	
Elective Courses (from the list below)	
***Elective Courses** (each student selects four **(4)** courses from the "elective courses" list below*	
Bayesian Data Analysis	5
Statistical and Machine Learning	5
Censored Data and Survival Analysis	5
Sampling Techniques	5
Statistical Quality Control	5
High Dimensional Statistics and Big Data	5
Design and Analysis of Clinical Trials	5
Inventory Theory and Supply Chain Management	5
Financial Mathematics and Analytics	5
Demographic Techniques	5
Decision Analysis and Game Theory	5
Advanced Programming Tools in Data Science	5
Official Statistics and Index Numbers Methodology	5
Topics in Official Statistics: National Accounts and Survey Data Analysis	5
Total (3rd & 4th semesters)	**30**
5th Semester	
MSc 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 examinations grading scale is set from zero (0) to ten (10), half grades are also awarded. The passing grade is five (5) or higher.

A student who fails a course is re-examined in the following examinations' period. If a student fails in the following examinations' period then he is entitled to be examined in the next exam of the course and in case of failure he is dropped from the program and is only entitled to a certificate for courses successfully attended.

In order to be awarded the Master's degree, students must achieve passing grades in all courses as well as the Master's dissertation in the designated time period. If not, then students are dropped from the program, and are only entitled to a certificate for courses successfully attended.

(B) Description of individual course units

Applied Probability and Statistics (m62110p)

Instructors: E.KYRIAKIDIS – ST.VAKEROUDIS

Core Course, 1st semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
Random Experiment. Sample Space. Axioms of Kolmogorov. Properties of Probabilities. Law of total probability. Bayes's Rule. Discrete and Continuous random variables. Expected value and variance of random variables. Moment generating function. Characteristic function. Binomial distribution. Geometrical Distribution. Poisson Distribution. Hypergeometrical Distribution. Uniform Distribution. Exponential Distribution. Normal Distribution. Central Limit Theorem. Law of Large Numbers. Independence of random variables. Multidimensional random variables. Estimator of unknown parameter. Unbiased Estimator. Consistent Estimator. Sufficient Estimator. Rao-Blackwell Estimator. Cramer-Rao lower bound. Method of maximum likelihood. Methods of moments.

Prerequisites
Knowledge of Calculus and of Linear Algebra.

Target Learning Outcomes
- The students will be able to compute probabilities of events, expected values and variances of discrete and continuous random variables. They will also be able to apply the central limit theorem and find estimates of unknown parameters.
- The students will be able to solve realistic problems that are related with random experiments.

Recommended Bibliography
- S. M. Ross, "A first course in Probability"
- G. Roussas, "Statistical Inference"

Teaching and Learning Activities
In Class, distant learning.

Assessment and Grading Methods
Written final exam, Assignments.

Statistical Methods for Data Analytics (m62111p)

Instructors: I.VRONTOS – ST.PSARAKIS

Core Course, 1st semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description

This course has two parts. In the first one the basic theory of confidence intervals and hypothesis testing is presented while in second part the basic theory of statistical models is examined.
In the first part the basic theory of the construction and interpretation of confidence intervals for means, proportions and variances for one and two populations both for normal and non-normal data is presented. The basic theory statistical hypothesis testing for population parameters such as means, proportions, variances as well comparison of parameters of two populations the level of significance, the p-value, the power of the test and the determination of sample size is examined.
In the second part the course introduces and presents the fundamental theory of statistical models, methods, and techniques, which are necessary in the research and empirical data analysis. The theory of regression models, single and multiple linear regression, is presented. The variable/model selection problem, the use of dummy variables, and the problem of multicollinearity are examined. Emphasis is given on the application of the theory, estimation of the model parameters, examination of the assumptions of residuals using diagnostic tests, and the interpretation of results. The theory and empirical application of the analysis of variance are introduced and presented in detail. The underline theory, methods and models are implemented to empirical data and problems using the statistical package R.

Prerequisites

Applied Probability – Estimation.

Target Learning Outcomes

The aim of this course is to provide students with the learning of using appropriate statistical methods, models and techniques required for data analysis. After successfully completing the course, students will be able to:

- Know and apply the appropriate methodology, to construct confidence intervals that will contain the unknown parameters with the desirable probability
- Perform hypothesis testing in various problems
- Learn the fundamentals in statistical inference allowing them to understand which type of analysis is necessary and how it can be correctly implemented
- Estimate the parameters of statistical models
- Conduct hypothesis testing and construct confidence intervals for model parameters
- Estimate regression models, construct predictions and interpret the results of the analysis appropriately
- Apply, using the R package, statistical models to empirical problems and applications

Recommended Bibliography

- Draper N, Smith H (1998) Applied Regression Analysis 3rd Edition Wiley
- Montgomery D (2012) Introduction to Linear regression Analysis, 5th Edition Wiley.
- Montgomery D. and Runger GC (2018) Applied Statistics and Probability for Engineers 7th Edition Wiley
- Weisberg, S. (2005). Applied Linear Regression, 3rd edition, Wiley
- Fox, J., and Weisberg, S. (2011). An R Companion to Applied Regression, 2nd edition, SAGE Publications Inc.

Teaching and Learning Activities
One three-hour lecture per week and study exercises as homework (some to be submitted).

Assessment and Grading Methods
90% Written examination. 10% project/assignment based on simulated data applying the methodologies and techniques described during the course accompanied with short scientific report.

Programming in Data Analytics (m62112p)

Instructor: P.BESBEAS

Core Course, 1st semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
The course provides an introduction to modern applied statistics and elementary programming via the statistical programming language R. The course provides an inclusive guide to R, developing a skill set to efficiently perform technical computations, whilst at the same time covering a variety of statistical techniques to analyse data, ranging from standard material like descriptive statistics, estimation, and hypothesis testing to intermediate methods like linear regression, model selection and diagnostics.

Prerequisites
Applied Probability – Estimation. Hypothesis Testing – Linear Models.

Target Learning Outcomes
On successfully completing the module students will be able to
- demonstrate proficiency in the use of computing utilities and the statistical package R;
- show judgement in the application of R;
- make effective and well-considered use of R
- use suitable statistical methods to analyse data
- use information technology effectively for introductory data analysis including data retrieval.

Recommended Bibliography

- J. Verzani. Using R for Introductory Statistics (2nd edition, CRC Press, 2014)
- Crawley M. J. The R Book, Wiley 2009
- Chatfield, C. Problem–solving: a statistician's guide. London, Chapman and Hall. 1995
- Cox, D.R. and Snell E.J. Applied Statistics: Principles and Examples (Chapman Hall statistics text series) 1987.

Teaching and Learning Activities
24 hours of lectures and terminal classes.
75 hours independent study.

Assessment and Grading Methods
Assessment: The unit is assessed by a combination of examination and continuous assessment.
Continuous Assessment: Open book written assessment completed in independent study hours.
Examination: A final written examination in the examination period.

Optimization Techniques in Data Analytics (m62113p)

Instructors: A.YANNACOPOULOS – M.ZAZANIS

Core Course, 2nd semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek Greek (or English if foreign students attend)

Course Description
The course introduces the basic concepts and analytic and computational techniques of Optimization theory with an emphasis in data analytics and machine learning and its applications in various fields covered in the present MSc.
Techniques are covered from linear and integer programming, convex optimization, duality methods, stochastic optimization, non smooth programming as well as computational algorithms such as e.g. gradient methods, stochastic gradient schemes, Newton and quasi Newton schemes etc. with applications in concrete models in data science.

Prerequisites
None.

Target Learning Outcomes
Upon successful completion of the course, students will learn the fundamental concepts and techniques of the theory of Optimization and they will be able to apply these techniques in the context of problems in data science.

Recommended Bibliography
- S. Boyd and Vanderberghe, Convex optimization, Cambridge University Press
- J. Nocedal, Numerical Optimization, Springer.
- D. Kravvaritis and A. N. Yannacopoulos, Variational Methods in Nonlinear Analysis with applications in Optimization and PDEs. De Gruyter, Chapters 4 and 5.
- Α. Ν. Γιαννακόπουλος, Βελτιστοποίηση και εφαρμογές, Σημειώσεις μαθήματος

Teaching and Learning Activities
In vivo or by distance teaching, computational applications.

Assessment and Grading Methods
Essays and mini projects within the term.

Statistical Data Modeling (m62114p)

Instructors: V.VASDEKIS

Core Course, 2nd semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
The principles of statistical modeling, experimental design, and the use of regression techniques for data following an exponential family distribution are presented. The R language is used for statistical modeling. Regression techniques for analyzing binary or binomial data, Poisson data, and data exhibiting overdispersion are introduced. Models for continuous data, categorical data with multiple categories and ordinal variables are also discussed. Emphasis is placed on predicting new observations and the ability to separate subpopulations as supervised learning techniques.

Prerequisites
Students should have basic knowledge of mathematical calculus 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, interpret the results of analysis and provide predictions of future observations (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 Hall
- 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.
- 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, 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%).

Time Series Analysis and Forecasting (m62115p)

Instructors: I.VRONTOS – A. LIVADA

Core Course, 2nd semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
This course provides the theory and practice of time series analysis and related forecasting techniques. It introduces the deterministic type of models and the classical decomposition of a given time series into its components: trend, seasonal, cyclical and irregular component. The course presents and describes different methods and models for estimating and forecasting trend, seasonal and cyclical effects. Alternative seasonal adjustment techniques are also discussed. It also presents linear filters and exponential smoothing techniques for the trend estimation. Forecasts with Holt, Holt and Winters, Gardner and Mckenzie models are also discussed. It also introduces the basic theory of stationary processes (characteristics of stationary and non-stationary time series and unit root testing), it describes and presents analytically stochastic time series models, ARMA models in particular, and the Box-Jenkins methodology for ARIMA models. The course introduces the class of conditional heteroscedastic models (ARCH/GARCH), and presents practical time series forecasting techniques. Illustrative examples applying time series models/techniques to actual economic and financial data are also presented using R package and the econometric package Eviews. The empirical analysis consists of (a) unit root testing to exchange rate series and financial series, e.g. stocks and indices, and (b) modeling and forecasting economic/financial time series..

Prerequisites
Students should have basic knowledge of statistics and linear models.

Target Learning Outcomes
The aim of this course is to provide students with the learning of using appropriate time series models and techniques required for the analysis of time series data. After successfully completing the course, students will be able to:

- know deterministic time series modeling

- know alternative decomposition models
- know forecasting techniques for trend estimation
- know forecasting techniques for data seasonal adjustment
- know business cycles estimation techniques
- know the basic concepts of stationary processes
- have learned the ARMA stochastic time series models
- have learned about the time-varying ARCH/GARCH volatility models
- be able to apply the Box-Jenkins methodology in empirical applications
- be able to model and forecast time series data
- know how to implement time series analysis using R and Eviews

Recommended Bibliography

- Brockwell, P.J. and R. A. Davies (1998,2008). Introduction to Time Series and Forecasting, Springer Texts in Statistics, 2nd edition
- Hamilton, James D. Time Series Analysis. Princeton, New Jersey: Princeton University Press, 1994.
- Enders, Walter. Applied Econometric Time Series. New York: Wiley, 2010.
- 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.
- Jarrett J. "ΜΕΘΟΔΟΙ ΠΡΟΒΛΕΨΕΩΝ", Gutenberg
- Gujarati, Damodar N. Basic Econometrics. New York: McGraw-Hill, 2008.
- Ngai Hang Chan (2010)Time Series applications to Finance with R and Splus, Wiley, 2nd edition
- 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.
- Tsay, Ruey S. Analysis of Financial Time Series. New York: Wiley, 2010.
- Wooldridge, Jeffrey. Introductory Econometrics: A Modern Approach. South-Western College Publishing, 2009.
- Granger, C.W.J. and Paul Newbold. Forecasting Economic Time Series. San Diego, CA: Academic Press, 1986.
- https://otexts.com/fpp3/ R.J. Hyndman and G. Athanasopoulos Forecasting: Princilpes and Practice
- Dimeli, S. (2014) Modern Methods of Time Series Analysis, AUEB

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.

Applied Biostatistics (m62116p)

Instructor: X.PEDELI

Core Course, 3rd semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description

The course discusses different medical/ epidemiological study designs and a comparative approach to them with an emphasis on differences/similarities, advantages/disadvantages. Measures of risk and relative risk: the relationship between them, as appropriate for the type of study and the theory of their estimation interspersed with examples. Confounding effects: definition, implications for estimating the relationship between exposure and disease, accounting for confounders (standardization, stratification, Mantel Haenzel estimator, modifying effects, McNemar). Diagnostic tests: sensitivity and specificity, overall accuracy, positive and negative predictive value, ROC curves.

Regression models to investigate the relationship between exposure and disease: logistic regression, relationship of logistic regression to contingency tables, estimation and prediction, interactions, application of logistic regression models to case-control studies, matching, conditional logistic regression. Analysis of person-time data: incidence rate and cumulative incidence, one- and two-sample inference, incidence rate ratio, inference for stratified data, introduction to survival analysis (the concept of censoring, types of censoring, survival function, hazard function and cumulative hazard function, life table, Kaplan Meier and Nelson Aalen methods to estimate the survival function, log-rank and Wilcoxon tests to compare two groups).

Using the R CRAN statistical software to implement the taught methods.

Prerequisites

Probability, Statistics and computational methods.

Target Learning Outcomes

At the end of the course each student will become familiar with the basic types of medical study and the appropriate method of statistical analysis by study, including their practical application.

Recommended Bibliography

- Lecture notes
- 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.
- Hosmer, D.W. Jr., Lemeshow, S., May, S. Applied Survival Analysis: Regression Modeling of Time to Event Data, 2nd Edition. Wiley Series in Probability and Statistics, 2008.
- Rosner, B. Fundamentals of Biostatistics. 8th ed. Boston MA: Cengage Learning, 2016.
- Rothman, K.J., Greenland, S., Lash, T.L. Modern Epidemiology, Third Edition, Lippincott Williams & Wilkins, 2012.

Teaching and Learning Activities
Weekly lectures and exercises.

Assessment and Grading Methods
Written exam and assignment.

Computational Methods in Statistical Data Science (m62117p)

Instructors: P.BESBEAS

Core Course, 3rd semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
The course aims to develop a broad and thorough knowledge of modern statistical computing techniques, to enable use of advanced statistical modelling and inference methods in practice.
In more complex situations this will mean using numerical optimisation routines to obtain maximum likelihood estimates for the model parameters, and modern computational power to simulate distributional properties of estimators and test statistics. The course also considers how to evaluate such stochastic models. Outline syllabus includes: Numerical function optimisation. Numerical maximum likelihood and likelihood tools for inference.
Simulation techniques. Inferences using Monte-Carlo and resampling methods. The methods are implemented in the statistical programming language R, and illustrated using detailed real examples.

Prerequisites
- Applied Probability – Estimation.
- Hypothesis Testing – Linear Models.
- Statistical Applications using R.

Target Learning Outcomes
On successfully completing the module students will be able to:
- demonstrate systematic understanding of computational statistics
- demonstrate the capability to deploy established approaches accurately to analyze and solve problems in the following areas: function optimization, numerical aspects of maximum likelihood estimation, simulation methods and Monte Carlo, resampling
- apply a range of computational statistics methods, showing good judgment in the selection and application of tools and techniques
- write R programs for complex applications, making effective and well-considered use of R

Recommended Bibliography

- Rizzo, Maria. 2014. Statistical Computing with R. Chapman and Hall.
- Voss, Jochen. 2013. An introduction to statistical computing: A simulation-based approach. Wiley.
- Eubank, R. and A. Kupresanin. 2011. Statistical Computing in C++ and R. Chapman and Hall.
- Givens, Geof and Hoeting, Jennifer. 2012. Computational Statistics. Wiley.
- Gentle, James. 2009. Computational Statistics. Springer.
- Martinez, Wendy and Martinez, Angel. 2015. Computational Statistics Handbook with Matlab. Chapman and Hall.
- Gentle, James. 2013. Elements of Computational Statistics. Springer.

Teaching and Learning Activities
24 hours of lectures and terminal classes. 75 hours independent study.

Assessment and Grading Methods
Assessment: The unit is assessed by a combination of examination and continuous assessment.
Continuous Assessment: Open book written assessment completed in independent study hours.
Examination: A final written examination in the examination period

Bayesian Data Analysis (m62213p)

Instructor: **I. Ntzoufras**

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
This course provideσ an introduction to the Bayesian statistics and data analysis both from the theoretic and the computational perspective using R and WinBUGS/STAN. The course syllabus includes Bayesian inference, conjugate Analysis, simulation and random number generation, Markov chain Monte Carlo (MCMC) methods, Introduction to WinBUGS/STAN, Bayesian inference for Regression and GLMs, Hierarchical models, Bayesian model and variable selection. All methods are used to analyze real datasets and cases.

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/STAN
4) Build models (glm and hierarchical) in WinBUGS/STAN
5) Perform Bayesian variable selection using WinBUGS/STAN and 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/STAN
- Evaluation of current knowledge using quizizz 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 and Machine Learning (m62214p)

Instructor: I.PAPAGEORGIOU

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description

Module refers to methods fo extracting information from data with the use of statistical and computer aids. A wide range of methods are included aiming to deal with the problem of clustering, data dimension reduction, such as principal components analysis, classification, and factor analysis. Methods included in the module belong to either statistical or machine learning scientific area. The presentation of the methods includes the methodological background, their implementation in R and how to interpret and assess the derived information.

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 classification, data dimension reduction, factor analysis 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.

Censored Data and Survival Analysis (m62215p)

Instructor: N.DEMIRIS

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
The survival and hazard functions are presented along with the likelihood function and its use in parametric and non-parametric (Kaplan-Meier) estimation. The concept of censored data is explicitly considered and modelled. Time to event data are analysed using parametric and semi-parametric approaches. The Cox proportional hazards model is utilised and appropriate residuals, including martingale, deviance and Schoenfeld are defined. The lasso-based extensions are defined and illustrated using the glmnet package. An introduction to competing risks and multi-state models concludes the course.

Prerequisites
Probability, Statistics and computational methods.

Target Learning Outcomes
Each student will become familiar with the basic principles of survival data, the Kaplan-Meier estimator, the concept of censoring and parametric modelling. They will be able to use the Cox model, select its variables and assess the model via the appropriate residuals.

Recommended Bibliography
Lecture notes and the "Applied Survival Analysis: Regression Modeling of Time-to-Event Data" Book by David W. Hosmer, Stanley Lemeshow, and Susanne May.

Teaching and Learning Activities
Weekly lectures and assignments. Detailed presentation of the relevant R code.

Assessment and Grading Methods
70% of the grade will be based on the final assignment which is based on the analysis of real time to event data and 30% of the grade is based on the assignments.

Sampling Techniques (m62216p)

Instructor: I.PAPAGEORGIOU

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
The module includes a presentation of

- Basic sampling techniques for probability sampling. The presentation includes implementation of each sampling method and estimation of population parameters. Specialized R packages for illustration.
- Methods for improving the estimation: using auxiliary information, sampling proportional to size. Illustration via packages in R.

Practical problems during the implementation of sampling surveys

- Methods to approximately calculate the estimation of variance for the obtained estimates in complex sampling designs.
- Non-response. How to identify the type of and how to treat non-response. Imputation and re-weight methods. Implementation in R.

Prerequisites
Probability, Estimation, Statistical inference.

Target Learning Outcomes
Upon completion of the course, students will have the knowledge and the skills to implement sampling techniques to collect data for a sampling survey and derive statistical results with respect to population parameters. Moreover, to make use either previous or auxiliary information to improve statistical properties of the derived estimates. Students will have the technical skills to recognize the type of and treat the non-response in a survey.

Recommended Bibliography

- Barnett, V. (2002). Sample survey: Principles and methods. 3rd Edition, London: Arnold.
- Cochran, W. G. (1977). Sampling techniques (3rd Edition). New York: John Wiley and Sons
- Fink, A. (2013). *How to Conduct Surveys: A Step-by-Step Guide.* 5th Edition. Sage Publications.
- Groves, R.M. Floyd, J., Fower, Jr., Couper, M.P., Lepkowski, J.M., Singer, E., & Tourangeau, R. (2009). *Survey Methodology*. 2nd Edition, Wiley-Blackwell.
- Levy, P.S. and Lemeshow, S. (1999). *Sampling of Populations. Methods and Applications* (3rd Edition). New York: John Wiley and Sons.
- Lohr S. L. (2010). Sampling: Design and analysis (2nd Edition). Pacific Grove, CA: Duxbury Press.

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.

Statistical Quality Control (m62217p)

Instructor: ST.PSARAKIS

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
Definition of quality. Basics on statistical quality control and reliability. An introduction to Acceptance sampling and Design of Experiments. Metrology and reliable measurements. 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. Control chart for Big Data. 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 of controlling and improving the quality and the reliability 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.

Teaching and Learning Activities
One three-hour lecture per week and study exercises as homework (some to be submitted).

Assessment and Grading Methods
70% Written examination.
30% project/assignment based on simulated data applying the methodologies and techniques described during the course accompanied with short scientific report.

High Dimensional Statistics and Big Data (m62218p)

Instructor: P.PAPASTAMOULIS

Elective Course,3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
Modern statistical applications deal with the analysis of high-dimensional datasets. However, inference is extremelly challenging due to the curse of dimensionality: as the number of variables increases, the data may become quite noisy and it is difficult to separate the actual underlying information. The course will present modern statistical techniques particularly suited to problems with high dimensionality, such as:
- Large scale hypothesis testing
- Statistical applications in bioinformatics
- Applications of (generalized) linear models in big data problems
- Regularization techniques (LASSO, Ridge regression)
- Classification and model-based clustering for multivariate data with dimensionality reduction techniques
- Statistical network analysis

Prerequisites
- Essential
  – Hypothesis Testing - Linear Models

– Generalized Linear Models
- Some basic knowledge on
  – Computational Statistics
  – R programming
- Students will also benefit from the following courses (not required)
  – Applied Bayesian Statistics
  – Statistical Learning

Target Learning Outcomes
After completing the course, the students will:
- know the challenges that big data impose to the statistician
- properly deal with large scale hypothesis testing
- put their hands on many different types of data from cutting edge research areas such as bioinformatics and network analysis
- learn many novel statistical ideas and methods developed in the last 20 years
- know how to apply the relevant methods using R and Bioconductor.

Recommended Bibliography
[1] Christophe Giraud (2015). Introduction to High-Dimensional Statistics. Philadelphia: Chapman and Hall/CRC
[2] Tony Cai, Xiaotong Shen, eds. 2011. High-dimensional data analysis. Frontiers of Statistics. Singapore: World Scientific
[3] Hastie, R. Tibshirani and R. Friedman (2009). Elements of Statistical Learning. Springer
[4] Efron, Bradley. Large scale inference: Empirical Bayes Methods for Estimation, Testing and Prediction. Cambridge University Press, 2010
[5] McLachlan, G. and Peel, D (2000). Finite Mixture Models. Cambridge University Press, 2010
[6] Wasserman, S. and G. Robins (2005). An introduction to random graphs, dependence graphs, and p⋆ . Models and methods in social network analysis.
[7] Hoff, P. D., A. E. Raftery, and M. S. Handcock (2002). Latent space approaches to social network analysis. Journal of the american Statistical association.

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 will be a weighted average of 2 or 3 assignments combined with a presentation/oral examination.

Design and Analysis of Clinical Trials (m62219p)

Instructor: V.VASDEKIS

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
Principles of Clinical Trials (CT), trials types, CT protocol, blinding, randomization methods, sample size, ITT, PP, TR populations, covariate adjustment, cross-over trials, analysis of repeated measures data, linear mixed models, GEE models, introduction to meta-analysis.

Prerequisites
Students should have basic knowledge of mathematical calculus, probability theory and generalized linear models.

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

- write the statistical parts of a CT protocol,
- find the appropriate size of a CT,
- randomize patients into experimental groups,
- analyze clinical trials data,
- perform a basic meta-analysis using statistical techniques.

Recommended Bibliography

- Everitt, B.S. and Pickles, A. (1999). Statistical Aspects of the Design and Analysis of Clinical Trials, Imperial College Press.
- Chow, S-C. and Liu, J-P. (2013). Design and Analysis of Clinical Trials, Wiley.
- Fitzmaurice, G.M., Laird, N. and Ware, J. (2004). Applied longitudinal data analysis, Wiley.
- Whitehead, A. (2002). Meta-Analysis of Controlled Clinical Trials. Wiley.

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

Assessment and Grading Methods
The final grade is the weighted average of the final examination grade (60%) and the grade of the study exercises to be submitted (40%).

Inventory Theory and Supply Chain Management (m62211p)

Instructors: E.KYRIAKIDIS - M.ZAZANIS

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description

Components of Inventory Models (cost of ordering, holding cost, shortage cost, backlogging, salvage cost, discount rate, lead time, continuous inspection of inventory, periodic inspection of inventory). Deterministic Continuous-Review Models (The basic EOQ Model, EOQ model with planned shortages, EOQ Model with quantity discounts, the role of Just-in-Time). A Deterministic Periodic-Review Model. Deterministic Multiechelon Inventory Models for Supply Chain Management. A Model for a Serial Multiechelon System. A Stochastic Cintinuous-Review Model. Safety Stock. The policy (s,S).

Prerequisites

Basic Knowledge of Probability and Calculus.

Target Learning Outcomes

Students after attending the course will be able to:

- Construct appropriate mathematical models for optimal inventory control in a wholesale or retail store as well as in a production system.
- To find the optimal order quantity as well as the time at which the order should be placed, if the inventory is continuously inspected, there is a constant rate of demand of the inventory and shortages of the inventory are not allowed.
- To find the optimal order quantity as well as the time at which the order should be placed, if the inventory is continuously inspected, there is a constant rate of inventory demand, and inventory shortages are allowed.
- To determine the optimal inventory policy in the case where the inventory is inspected periodically and the demands in different periods are not equal.
- To find the optimal order quantity and safety stock in the case where inventory is continuously inspected and the inventory demand is stochastic.
- To find the optimal order quantity and safety stock in the case where the stock is inspected at equidistant times and the stock demand is stochastic.
- To find the critical values s and S that characterize the optimal inventory policy (s,S) in one period problems with stochastic inventory demand.

Recommended Bibliography

S. Axsater, Inventory Control, 3rd Edition, Springer, 2015
F. S. Hillier and G. J. Lieberman, Introduction to Operations Research, 11th Edition, McGraw-Hill, 2019.
S. M. Ross, Applied Probability Models with Optimization Applications, Dover, 1992.

Teaching and Learning Activities
One three hour lecture per week and home study exercises.

Assessment and Grading Methods
Written examination and/or essays and mini projects within the term.

Financial Mathematics and Analytics (m62220p)

Instructor: A.YANNACOPOULOS

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
The aim of this course is to introduce students to financial mathematics with data analytics within the Python econsystem.

Introduction to quantitative theoretical and practical techniques, tools and methods of financial mathematics and financial and risk analytics, introduction to the structure of financial markets and the nature of financial assets, data and modeling, asset pricing models, derivative products, bonds, portfolio theory and introduction to risk management techniques. Computational methods and techniques for the above using the Python ecosystem.
Short introduction to the Python ecosystem using scripts supplied by the instructor (no prior knowledge of python required).

Prerequisites
None.

Target Learning Outcomes
To familiarize students with quantitative and computational techniques for financial market analytics as well as with the Python ecosystem

Recommended Bibliography
- Hull, J. C. (2015) Options, Futures, and Other Derivatives, 9th edition, Pearson
- McDonald, R. L. (2013), Derivatives Markets, 9th edition, Prentice Hall
- Shreve, S. (2005), Stochastic calculus for finance Vols. I and II, Springer
- Γιαννακόπουλος Α. (2014) Στοχαστικά Χρηματοοικονομικά (σημειώσεις)
- A.N.Yannacopoulos, Course notes and computational material
- Simone Calogero, A first course in Option pricing Theory, SIAM, 2023

Teaching and Learning Activities
In vivo or by distance teaching, computational applications.

Assessment and Grading Methods
Essays and mini projects within the term.

Demographic Techniques (m62221p)

Instructor: A. KOSTAKI

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
Demographic events and measures. Age-specific rates, exposed-to-risk population and probabilities of vital events, Standardization techniques, Data sources. Modelling mortality: The life table and single decrement processes. Stochastic investigation of life table functions. Statistical hypothesis testing for choosing model life tables to represent a mortality pattern. Modelling mortality: Parametric models, Nonparametric techniques. Mortality forecasting. Multiple decrement processes. Fertility measures. Modelling fertility: Parametric models, nonparametric techniques. Forecasting fertility. Population projections and forecasting of population dynamics.

Prerequisites
Students should have good knowledge of Descriptive Statistics

Target Learning Outcomes
The students after attending successfully the course will be able, using the appropriate methodology, to analyse demographic data, official statistics and provide population projections.

Recommended Bibliography
- Statistical Demography and Forecasting (Springer Series in Statistics) by Juha Alho and Bruce Spencer ISBN-13: 978-0387235301
- Applied Mathematical Demography (Statistics for Biology and Health) Softcover reprint of hardcover 3rd ed. by Nathan Keyfitz , Hal Caswell ISBN-13: 978-144191977

Teaching and Learning Activities
One three-hour lecture per week and individual project

Assessment and Grading Methods
Written examination (60%) and individual project (40%).

Decision Analysis and Game Theory (m62210p)

Instructors: E.KYRIAKIDIS – M.ZAZANIS

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
Decision processes, decision criteria, a priori criterion, a posteriori criterion, decision trees, utility, Von Neumann utilities, games, strategies, stable games, unstable games solution by linear programming, dominance.

Prerequisites
Probabilities, Linear Algebra.

Target Learning Outcomes
The students will be taught decision processes, decision criteria, apriori criterion, aposteriori criterion, utility. They will be able to construct decision trees. They will also be able to solve find the optimal solution of a game using linear programming.

Recommended Bibliography

- E. Mageirou, Games and Decisions, Editions Kritiki, 2012.
- K. Milolidakis, Game Theory: Mathematical Models of Conflict and Cooperation, Editions Sophia, 2009.
- P. Morris, Introduction to Game Theory, Springer-Verlag, 1994.
- F. S. Hillier and G. J. Lieberman, Introduction to Operations Research, 11th Edition, Mc Graw-Hill, 2021.

Teaching and Learning Activities
Lectures in classroom. Theory and Exercises.

Assessment and Grading Methods
Written Exams.

Advanced Programming Tools in Data Science

Instructors: P.BESBEAS, P.PAPASTAMOULIS

Course Code: m62222p

Course Type: Elective

Course Level: Graduate (MSc)

Year of Study: B'

Semester: 3rd or 4th semester

ECTS: 5

Language: Greek (or English if foreign students attend)

Course Description

Data Science refers to the scientific study of data. The module brings together two eminent programming tools for analysing data: Python and R.

The first component of the module will introduce students to Python, a programming language that has become the leading choice for scientific computing. Students will learn how to use Python in order to perform a range of statistical analyses for modern Data Science. You'll learn the latest versions of pandas, NumPy and Jupyter in the process.

The second component of the module consists of advanced data manipulation techniques and efficient coding in R. We will combine data engineering libraries with web scraping applications. Then we are going to speed up R by integrating with C++, something that can be extremely advantageous when writing source code for computationally demanding problems. Finally, we will extend R by creating our own package.

Prerequisites

Familiarity with the R programming language.

Target Learning Outcomes

- Develop skills for choosing the right tool between Python and R for your data
- Use the Jupyter notebook and IPython shell for exploratory computing
- Take advantage of basic and advanced features in NumPy
- Get started with data analysis tools in the pandas library
- Use flexible tools to load and manipulate data
- Create informative visualizations with matplotlib
- Utilise Python for advanced scientific computing
- Data engineering: dplyr, tidy
- Web scraping html, css, rvest, selector gadget, rselenium
- Integrating R and C++
  - basics of bridging R with other languages
  - Rcpp (and related) packages

- Creating extensions with R.

Indicative Reading

- Randall L. Eubank, Ana Kupresanin, “Statistical Computing in C++ and R”, Chapman & Hall/CRC, 2023
- H. Wickham, “Advanced R”, Second Edition (Chapman & Hall/CRC The R Series), 2019
- M. Dawson, “Python Programming for the Absolute Beginner”, 3rd edition, 2011, Cengage, ISBN 9781435455009
- A.B. Downey, Think Python, 2nd edition, 2015, O'Reilly, ISBN: 9781491939369
- M. Lutz, Learning Python, 5th edition, 2013, ISBN: 9781449355715
- W. McKinney, Python for data analysis, 2013, O'Reilly, ISBN: 9781449323622
- Friedrich Leisch (2009). Creating R packages: a tutorial. R-developer core team.
- Eddelbuettel D, François R (2011). “Rcpp: Seamless R and C++ Integration.” *Journal of Statistical Software*, **40**(8), 1–18. doi:10.18637/jss.v040.i08.
- Eddelbuettel D (2013). *Seamless R and C++ Integration with Rcpp*. Springer, New York. doi:10.1007/978-1-4614-6868-4, ISBN 978-1-4614-6867-7.
- Eddelbuettel D, Balamuta J (2018). “Extending R with C++: A Brief Introduction to Rcpp.” *The American Statistician*, **72**(1), 28-36. doi:10.1080/00031305.2017.1375990.
- Hadley Wickham, Mine Çetinkaya-Rundel, Garrett Grolemund (2023). R for Data Science, 2nd Edition. ISBN: 9781492097402

Teaching and Learning Activities

Classroom teaching and assignments.

Contact hours

- Total contact hours: 24
- Private study hours: 76
- Total study hours: 100

Assessment and Grading Methods

Combination of (i) weekly assignments, (ii) assessment, and (iii) final exam.

Official Statistics and Index Numbers Methodology *(m62223p)*

Instructor: A. LIVADA

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course description

Purpose of this course is the students to understand the methodology and principles of the official national and international statistics as well as to understand theory and applications on the index numbers.

Students will be introduced to some of the basic principles of the European Statistical System through the statistical laws and rules which apply in the EU and they will familiarize themselves with data management issues (transmission, release, metadata) and the harmonization of European Statistics.

Also, students will also be trained in the creation and use of simple and composite (unweighted & weighted) index numbers. Students will understand criteria for selecting index number formula, selecting and changing the base period, selecting the proper goods and services, chaining and indices as well as sampling and heterogeneity errors. Applied index numbers in Greece and Europe will be studied, such as CPI with reference to HES.

Target Learning Outcomes

Upon completion, students will have the knowledge and familiarity with methodology, principles and use of the national and international official statistics. They will also have the technical skills to estimate and evaluate index numbers which are necessary for the every day life using the correct data set and statistical package.

Recommended Bibliography

- Holt D. (2008), "Official Statistics, public policy and public trust", JRSS A,171,2, 323-346.
- OECD (2008) "Handbook on Constructing Composite Indicators – Methodology and the User guide"
- Tzortzopoulos P., Livada A, (2010) "Numerical Indices: Theory and Applications", AUEB, Athens
- http://europa.eu/pol/index_en.ht

Teaching and Learning Activities

Face to face teaching covering theory and lab-courses.

Assessment and Grading Methods

Written exam and projects.

Special Topics in Official Statistics: National Accounts and Survey Data Analysis (m62224p)

Instructor: A.THANOPOULOS

Elective Course, 3rd or 4th semester, 5 ECTS units

Course level: Graduate (MSc)

Language: Greek (or English if foreign students attend)

Course Description
The purpose of the course is to develop students' understanding on the way in which the Official Statistics are compiled regarding sources, methods, and the quality framework (eg. European Statistics Code of Practice). Students will also learn the basic concepts of macroeconomic theory and to calculate national accounting figures. For this purpose, empirical applications from the preparation of National Accounts according to the European System of National and Regional Accounts (ESA 2010) as well as examples of design of sample surveys in accordance with the European Regulation on Business Statistics will be used. In addition, students are trained in machine learning techniques for dealing with official statistics issues using R programming language.

Target Learning Outcomes
Upon completion, students will have the knowledge and technical skills to meet the strict quality framework of Institutions that produce official statistics.

Recommended Bibliography
- European Statistics Code of Practice: https://ec.europa.eu/eurostat/web/quality/european-statistics-code-of-practice
- European System of National and Regional Accounts (ESA 2010): https://ec.europa.eu/eurostat/web/esa-2010/overview
- Regulation on European business statistics: Regulation EBS
- ELSTAT., 2021. The Greek Economy [digital publication every 15 days] Piraeus: Hellenic Statistical Authority. Available: https://www.statistics.gr/en/the-greek-economy
- Abel, A. B., Bernanke, B., & Croushore, D. D., 2021, *Macroeconomics*. Harlow, England: Pearson.
- Kuhn, M., & Johnson, K., 2016, *Applied predictive modeling*. New York: Springer.
- Provost, F., & Fawcett, T., 2013, *Data science for business*. Sebastopol: O'Reilly.

Teaching and Learning Activities
Face to face teaching covering theory and lab-courses.

Assessment and Grading Methods
Written exam and projects.

DISSERTATION THESIS (m62109p)

Core Course, 5th semester

ECTS units: 30

Course level: Graduate (MSc)

Language: Greek or 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 Hypotheses Development, 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.

Reference

McCullagh, P. (2023). *Ten projects in applied statistics*. Springer Nature.

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.

Use of Information and Communications technology

Yes

Teaching Methods

For each thesis there is one supervisor that has to guide the student for any problem that may occur, provide additional help on the bibliography but also supports the student during all the period.

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).