ERASMUS COURSES
DEPARTMENT OF STATISTICS
ACADEMIC YEAR 2020-21

All students should come from Department of Statistics or Department of Mathematics

WINTER SEMESTER

1. Computational Statistics (master course)

D. Karlis
7,5 ECTS credits

Communication with Lecturer
e-mail: karlis@aueb.gr

Prerequisites
Probability, Statistics, Estimation-Hypothesis testing, Linear Modelling, Analysis of Variance.
The course is suitable for students from Statistics departments.

Course contents
R programming, simulation techniques, Monte Carlo methods, numerical methods for stats, smoothing, numerical optimisation, bootstrap, MCMC.

Recommended or required reading

- 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.

2. Actuarial Science II (Reading course)

A. Zimbidis
7 ECTS credits

Communication with Lecturer
e-mail: aaz@aueb.gr

Prerequisites
Basic knowledge of Mathematics, Probability and Statistics.

Course contents

Survival function, Simple mortality table and related functions, force of mortality, laws Classics mortality, actuarial tables and commutation functions, Stochastic approach to Life Insurance. Life annuities with one or more payments annually, Relationship between annuities, life insurance of various kinds, Relationship annuities and insurance, interest rate movements and mortality. Net premiums and gross premiums, concept and process of calculating reserves, Relationship between successive stock price. Tables and Actuarial functions for two or more persons, Contingent actuarial functions..

Recommended or required reading

- Zimbidis A.(2009), «Actuarial Mathematics of Life Insurance»
- Neil A. (1986), «Life Contingencies» Heinemann Professional Publishing
- Etienne De Vylder (1997), "Life insurance : Actuarial Perspectives"
- Kluwer Academic Print

3. Data Analysis (master course)

I. Ntzoufras
7.5 ECTS credits

Communication with Lecturer
e-mail: ntzoufra@aueb.gr

Prerequisites
Statistical Inference, Regression Analysis, Basic knowledge of R.

Course contents
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.

The course is taught in 12 four-hour sessions (9 lectures and 3 labs) which will cover the following topics: Introduction to data analysis and analytics - motivation; Descriptive analysis and Data visualization; Basic principles of Statistical Inference (Estimators, point estimation, interval estimation, hypothesis tests, p-values, data analysis with R (t-tests, χ2, ANOVA, normality tests, tests for equality of variances); Correlation and Simple linear regression, Regression diagnostics; Outliers and influential points; Multiple regression; Collinearity; AIC and BIC; Stepwise variable selection; Ridge regression; Lasso Regression.

Examination
One assignment (50%) and one written examination (50%) with the requirement the grade in the written examination to be higher than 5 (out of 10).

Recommended or required reading

- 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
- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An introduction to statistical learning*. Springer; available at http://www-bcf.usc.edu/~gareth/ISL/
- Rui Miguel Forte (2015). Mastering Predictive Analytics with R Paperback. Packt Publishing

4. Probability and Statistical Inference (master course)

A.Yannacopoulos – N.Demiris
7.5 ECTS credits

Communication with Lecturer

e-mail: ayannaco@aueb.gr & nikos@aueb.gr

Course contents

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, 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.

Recommended or required reading

- R. Ash, Statistical Inference, Dover
- Jacod and Protter, Probability Essentials Springer.
- Berger and Casella, Statistical Inference

SPRING SEMESTER

1. Multivariate Statistical Analysis ADVANCED LEVEL (Reading Course)

D. Karlis
8 ECTS credits

Communication with Lecturer
e-mail: karlis@aueb.gr

Prerequisites
Knowledge of

- Statistical Inference
- Linear Algebra
- Basic knowledge of R

The course has the following parts

- Multivariate descriptive and graphs
- Multivariate normal and related distributions
- Hypotheses tests for multivariate data
- MANOVA
- Multivariate Linear model
- Principal Components Analysis
- Factor Analysis

During the course there are 3-4 projects. The projects need computing in R.

2. Statistical Learning (master course)

I.Papageorgiou
4 ECTS credits

Communication with Lecturer
e-mail: ioulia@aueb.gr

Prerequisites
Attendance only for students from Statistics departments with good knowledge of R, statistical inference, data analysis and Linear algebra.

Course contents
Unsupervised learning: association rules, clustering, self organizing maps Supervised Learning: LDA, QDA, k-nn, penalized LDA Kernel methods and regularization methods (Ridge, Lasso, Elastic Net) Model Assessment and Selection. Big data problems

Recommended or required reading

- 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

3. Introduction to Probability and Statistics using R (Reading Course) ADVANCED LEVEL

D.Karlis, X.X.Penteli
7,5 ECTS credits

Communication with Lecturer
e-mail: karlis@aueb.gr, xpedeli@aueb.gr

Prerequisites
Students should have taken introductory courses in Probability, Statistics and R programming. The course is suitable only for Statistics students

Course Content
Emphasis is given on R programming using ideas from probability and Statistics. So, the course is mainly an R programming course. The curse aims at introducing ideas from Porbbaility and Statistics together with R programming. Such examples is using simulation to show and understand with the Central limit theorem, the law of large numbers, probability as frequency, descriptive statistics and their properties etc

4. Actuarial Science I (Reading course)

A. Zimbidis
7 ECTS credits

Communication with Lecturer
e-mail: aaz@aueb.gr

Prerequisites
Basic knowledge of Mathematics, Probability and Statistics.

Course contents
Uncertainty, Risk, Insurance, Insurance Companies, Actuaries, Insurance Concepts, Products, Actuarial base. Frequency, severity and pricing methodology premium adjustments, Projections and trends for the final payments by using linear and other models. Reserving methods, Analysis of Insurance Data, Triangular methods and olistic methods of reserving, Discounting reserves, and Confidence Intervals. Reinsurance schemes, «Bonus-Malus» and Markov Chains.

Recommended or required reading

- Zimbidis A.(2008) "Actuarial Mathematics of Non-life Insurance"
- Brown R.L , Gottlieb L.R. (2005) -3rd edition
- "Introduction to Ratemaking and Loss Reserving for Property and Casualty Insurance", Actex Publications,
- Mikosch T. (2006) "Non-Life Insurance Mathematics: An Introduction with Stochastic Processes", Springer

5. Financial Econometrics (master course)

I. Vrontos
3.5 ECTS credits

Communication with Lecturer
e-mail: vrontos@aueb.gr

Prerequisites
Statistical Inference, Regression Analysis, Basic knowledge of Matlab.

Course contents
Introduction to Course: Outline of Topics, Basic Econometric Models, Mean-Variance Portfolio Theory (Return and risk, Portfolio diversification, Construction of optimal portfolios, Basic empirical application), Performance Evaluation of Financial Assets (Capital asset pricing model, Treynor measure, Sharpe measure, Jensen's alpha, Multifactor models, Alternative measures, Empirical application), Characteristics of Financial Data (Fat tails, Volatility clustering phenomenon, Leverage effect), Heteroskedasticity Models (ARCH, GARCH and EGARCH models, Properties of time-varying models, Estimation of heteroskedastic models, Empirical application), Multivariate Factor models (Single index models, General multivariate mulifactor model), Multivariate Heteroskedasticity Models (Multivariate ARCH/GARCH models, Constant conditional correlation model, Empirical application)

Recommended or required reading
- Tsay, R.S. (2002). Analysis of Financial Time Series, Wiley
- Elton, E. J., Gruber, M. J., Brown, S. J., and Goetzmann, W. N. (2006). Modern Portfolio Theory and Investment Analysis (7th Ed.), Wiley.
- Sharpe, W., Alexander, G. and Bailey, J. (1995). Investments (5th Ed.), Prentice Hall.

6. Biostatistics (master course)

X.X. Penteli
4 ECTS credits

Communication with Lecturer
xpedeli@aueb.gr

Course contents
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)
Rates of disease: 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
Clinical trials: Definition/ Phases of CTs, Ethics, Standard CTs designs (parallel group, cross-over, control arms, single arms, active control, placebo), Hypotheses/ Aims (superiority, non-inferiority, equivalence, primary secondary), Endpoints / Measurements, Treatments / Interventions, Randomization, Stratification, Blinding, Sample Size, Interim Analyses, Sequential Monitoring

Recommended or required reading

- 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

7. Advanced Stochastic Processes (master course)

N.Fragos
3,5 ECTS credits

Communication with Lecturer

e-mail: nef@aueb.gr

Course contents

Martingales in Discrete and Continuous Time. Brownian Motion: Characterization, Construction and Properties. Quadratic Variation. Ito integration. Properties of Ito integrals, the Ito formula. Stochastic Differential Equations. Existence and uniqueness of solutions. Examples and applications from Insurance, Finance, and Operations Research.

Recommended or required reading

- Fima C. Klebaner (2005). *Introduction to Stochastic Calculus with Applications.* Imperial College Press.
- Bernt Oksendal (2003). *Stochastic Differential Equations, an Introduction with Applications.* Sixth Edition, Springer Verlag.
- J. Michael Steele (2000). *Stochastic Calculus and Financial Applications.* Springer Verlag.