**Applied Stochastic Modeling (61204)**

***Instructors: P.BESBEAS***

Core Course, 2nd semester, 3.5 ECTS units

Course level: Graduate (MSc)

Language: Greek/English

**Course Description**

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

*Lecture Syllabus:*

Introduction and examples: Motivation through a range of real examples.

Model fitting by maximum-likelihood: Progression from explicit estimates to non-linear problems. Importance of modelling through example results.

Function optimisation: Modern deterministic and stochastic methods. Newton vs EM.

Computational Likelihood Tools: profile likelihood; use of information criteria; Wald tests, likelihood ratio tests; confidence interval construction.

Fundamental principles of modelling: Parameterisation: staying in range; delta method; orthogonality.

Application to multinomials, mixtures, truncated data.

Simulation techniques: Monte Carlo inference; confidence interval construction; bootstrap;

goodness of fit testing.

Case studies: Hierarchical Models. Capture-recapture. Hidden Markov.

**Prerequisites**

Probability and Inference. Regression. R.

**Target Learning Outcomes**

On successful completion of the module, students will:

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

**Recommended Bibliography**

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

**Teaching and Learning Activities**

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

**Assessment and Grading Methods**

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