ADVANCED STATISTICAL METHODS

Basic Information

This is a course, which contributes to MSc award in Biology

Course period	From February 1st till June 1st, and from September 1st till February 1st, 2 semesters
Study credits	6 ECTS credits
Duration	216 hours
Language of instruction	English
Academic requirements	- BSc degree in Biology, Chemistry, Physics or Environmental Sciences or equivalent (transcript of records), - Good command of English (certificate or other official document)

Course Description

«Advanced statistical methods» is an extensive course, which is designed to advance a student's ability to apply the advanced statistical methods to the medical problems. It provides the necessary mathematical and modelling background for the ability to create the statistical models and to apply them to the medical data.

The most important part of this course is advanced statistical modelling. It provides the basic background, which is required for the variety of the statistical analysis of the medical problems.

The Statistics in medicine part provides the important information about the application of the theoretical models directly to the various medical data. This part also includes the clinical trials statistics, which is necessary topic for the students, who is planning to become the academic researcher in the future.

The course is designed to cover a wide range of possible areas of biology and medicine. Grading this course will help the future specialist to construct and develop the explanation of the observed phenomena.

Course Aims

- To help students study new discipline or to ameliorate the existing knowledge in coding.
- To assist students to perform the high-level statistical analysis.
- To give students the understanding of how to ameliorate the analysis as a whole.
- To introduce the basic principles of Bayesian statistics and Bayesian networking.
- To give an introduction of clinical trials statistics.

Course Objectives

The course has been designed to:

- ensure that students are familiar with basic and advanced statistical routines.
- give students the knowledge and skills of the interval estimations, applied to the medical data sets.
- give students an appreciation of the Bayesian statistical methods.
- provide students with the skills of the Bayesian networking for the drugs combination assessment.
- provide students with the basic routines of clinical trials statistics.
- make students know and understand the principles of the statistical shape analysis in application to the medical trials.

Learning Outcomes of the Course

By the end of the course, the students will be able to:

- create statistical models on the advanced level,
- perform the assessment of drug interaction and clinical trials of drugs,
- use the Bayesian methods and Bayesian networking in the analysis
- apply the Life-time analysis.

Course (module) Structure

Learning Activities	Hours
Lectures	32
Practice sessions / Seminars,	64
Self-study Assignments	120
Final Exam (including preparation)	-
Total study hours	**216**

Course Outline

Week	Lectures	Practice session / Assignments	Hours
• Semester 2			
1-6	Advanced Statistics Fundamentals	• Likelihood estimations • Bootstrap Confidence intervals • Life time analysis • Home assignment No 1	(7/14/33)
7-14	Advanced Statistical Modelling	• Bayesian factor analysis • Dependent variables models • Moving average models • Models of ordered data • Home assignment No 2	(7/14/33)
	Pass/Fail Exam		
Semester 3			
1-18	Statistics in Medicine	• Assessment of drug interactions • Clinical trials statistics • Bayesian Network for health checkups • Statistical shape analysis in medicine • Home assignment No 3	(18/36/54)
	Pass/Fail Exam		

Course Instructors and Tutors, Contact Information

Instructor	Contact Information
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Assessment

The final exam is an individual problem in the form of a simulated experimental dataset. The student must demonstrate the abilities in:

• creation likelihood estimation with the bootstrapping technique (20 points maximum),

• Bayesian functional analysis and Bayesian networking analysis (40 points maximum),

• clinical trials analysis (40 point maximum).

Grade policy:

A (excellent work)	91-100 %
B (above average work)	81-90 %
C (average work)	71-80 %
D (below average work)	50-70 %
F (failed work)	<50 %

Core reading

1. Chen, D.G. et al. (2016) *Advanced Statistical Methods in Data Science*. Springer, Singapore.
2. Chen, D.G. et al. (2017) *New Advances in Statistics and Data Science*. Springer, Cham.
3. Minguez, R. et al. (eds.) (2008) *Advances in Mathematical and Statistical Modeling*. Birkhäuser Boston.
4. Borgelt, C. et al. (2013) *Towards Advanced Data Analysis by Combining Soft Computing and Statistics*. Springer, Berlin, Heidelberg.
5. Torelli, N., Pesarin, F. and Bar-Hen, A. (2013) *Advances in Theoretical and Applied Statistics*. Springer, Berlin, Heidelberg.

6. Ciaccio, A., Coli, M. and Ibanez, J.M.A. (2012*) Advanced Statistical Methods for the Analysis of Large Data-Sets*. Springer, Berlin, Heidelberg.
7. Holmes, D.E. and Jain, L.C. (2018) *Advances in Biomedical Informatics*. Springer, Cham.
8. Husmeier, D., Dybowsky, R. and Roberts, S. (2005) *Probabilistic Modeling in Bioinformatics and Medical Informatics*. Springer, London.