

Advanced statistical methods (syllabus)

Instructor	Contact Information
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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 the introduction in clinical trials statistics.

Course objectives

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

Learning outcomes

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

- create the 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.

Outline of content

Week	Lectures	Practice session / Assignments	Hours
1-3	Advanced Statistics Fundamentals	<ul style="list-style-type: none"> o Likelihood estimations o Bootstrap Confidence intervals o Life time analysis o Home assignment No 1 	<ul style="list-style-type: none"> 2 2 2 20
4-7	Advanced Statistical Modelling	<ul style="list-style-type: none"> o Bayesian factor analysis o Dependent variables models o Moving average models o Models of ordered data o Home assignment No 2 	<ul style="list-style-type: none"> 2 2 2 2 20
8		Exam	2
9-15	Statistics in Medicine	<ul style="list-style-type: none"> o Assessment of drug interactions o Clinical trials statistics o Bayesian Network for health checkups o Statistical shape analysis in medicine o Home assignment No 3 	<ul style="list-style-type: none"> 2 2 2 40
16		Exam	2

Assessment and assessment method

The 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 %

Recommended 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., Dybowski, R. and Roberts, S. (2005) *Probabilistic Modeling in Bioinformatics and Medical Informatics*. Springer, London.