SYLLABUS

1. Information regarding the programme

1.1 Higher education	Babeş-Bolyai University
institution	
1.2 Faculty	Faculty of Mathematics and Computer Science
1.3 Department	Department of Computer Science
1.4 Field of study	Computer Science
1.5 Study cycle	Master
1.6 Study programme /	Data Bases (Baze de date)
Qualification	

2. Information regarding the discipline

2.1 Name of the discipline Statistical Computational Methods							
2.2 Course coordinatorAssoc. Prof. PhD. Sanda Micula							
2.3 Seminar coordinator				Assoc. Prof. PhD. Sanda Micula			
2.4. Year of	1	2.5	1	2.6. Type of	Ε	2.7 Type of	Optional
study		Semester		evaluation		discipline	

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3	1
				seminar/laboratory	
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6	14
				seminar/laboratory	
Time allotment:					
Learning using manual, course support, bibliography, course notes					36
Additional documentation (in libraries, on electronic platforms, field documentation)					
Preparation for seminars/labs, homework, papers, portfolios and essays					30
Tutorship					14
Evaluations					18
Other activities:					-
3.7 Total individual study hours108					

3.8 Total hours per semester	150
3.9 Number of ECTS credits	6

4. Prerequisites (if necessary)

4.1. curriculum	Probability and Statistics
4.2. competencies	Logical thinking
	 Average logical programming skills

5. Conditions (if necessary)

5.1. for the course	• Lecture room with large blackboard and video projector, laptop, beamer
5.2. for the seminar /lab	• For seminar: Laboratory with computers having Matlab installed

6. Specific competencies acquired

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Professional competencies	C4.3 Identifying the appropriate models and methods for solving real-life problems C4.4 Using simulations in order to study and elaborate models and evaluate their performance
76	CT1 Ability to conform to the requirements of organized and efficient work, to develop a responsible approach towards the academic and scientific fields, in order to make the most of one's own creative potential, while obeying the rules and principles of professional ethic
Transversal competencies	CT3 Using efficient methods and techniques for learning, information, research and developing capabilities for using knowledge, for adapting to a dynamic society and for communicating in Romanian and in a worldwide spoken language

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• Acquire basic knowledge of Probability Theory and Mathematical Statistics applications and models
7.2 Specific objective of the discipline	 Ability to use Monte Carlo methods and simulations for solving real- life problems and perform statistical analysis of data Become familiar and be able to work with various probabilistic and statistical models Ability to use statistical features of various mathematical software

8. Content

8.1 Course	Teaching methods	Remarks
 Review of Probability and Statistics. Probability space. Rules of probability. Conditional probability. Probabilistic models. Random variables and random vectors. 	 Interactive exposure Explanation Conversation Didactical demonstration 	
2. Common discrete and continuous distributions. PDF and CDF. Examples, applications, properties.	 Interactive exposure Explanation Conversation Didactical demonstration 	
 Random samples. Sample functions. Estimators. Confidence intervals. Hypothesis and significance testing. 	Interactive exposureExplanationConversation	
 4. Computer simulations and Monte Carlo methods. MC methods and random number generators. Discrete methods. Examples. 	 Interactive exposure Explanation Conversation Description 	
5. Inverse transform and discrete inverse transform method. Rejection method. Special methods. Examples.	 Interactive exposure Explanation Conversation Didactical demonstration 	

 6. Accuracy of an MC study. Estimating probabilities, means, variances. Size of an MC study. Other applications of MC methods. 7. Stochastic processes. Definitions, classifications. Markov processes and Markov chains. Transition probability matrix. Properties, examples. 8. Steady-state distribution. Regular Markov 	 Interactive exposure Explanation Conversation Didactical demonstration Interactive exposure Explanation Conversation Description Interactive exposure 			
chains. Periodic Markov chains. Simulation of Markov chains.	ExplanationConversationDidactical demonstration			
 Counting processes. Binomial and Poisson counting processes. Gamma-Poisson formula. Simulation of counting processes. Examples. 	 Interactive exposure Explanation Conversation Didactical demonstration 			
10. Queuing systems . Basic notions, main components, Little's law. Bernoulli single- server QS. Systems with limited capacity.	 Interactive exposure Explanation Conversation 			
11. M/M/I QS. Evaluation of a system's performance. Examples.	 Interactive exposure Explanation Conversation Didactical demonstration 			
 12. Multiserver QS's. Bernoulli k-server and M/M/k QS's. M/M/∞ QS's. Simulation of QS's. 	 Interactive exposure Explanation Conversation 			
 Statistical inference. Nonparametric tests, Chi-square-tests, Wilcoxon tests. Bootstrapping. Applications, examples, simulations. 	 Interactive exposure Explanation Conversation Description 			
 Regression and correlation. Fitting models. Analysis of variance (ANOVA), prediction. Examples. 	 Interactive exposure Explanation Conversation Didactical demonstration 			
 Bibliography Micula, S., Probability and Statistics for Computational Sciences, Cluj University Press, 2009. Baron, M., Probability and Statistics for Computer Scientists, CRC Press, Taylor and Francis, Boca Raton, FL, 2014. Milton, J.S., Arnold, J. C., Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, 3rd Edition. McGraw-Hill, New York, 1995. Gentle, J. E., Elements of Computational Statistics, Springer-Verlag, New York, 2002. Matloff, N., From Algorithms to Z-Scores: Probabilistic and Statistical Modelling in Computer Science, Orange Grove Texts Plus, Gainesville, FL, 2009. Gentle, J. E., Hardle, W., Mori, Y., Handbook of Computational Statistics, Springer, Heidelberg, 2004. 				
8.2 Seminar /Laboratory	Teaching methods	Remarks		
1. Random variables and applications.	Interactive exposureExplanationConversation	The seminar is structured as 2 hours per week, every other week		
2. Computer simulations of discrete random variables. Discrete methods.	Interactive exposureExplanation			

	 Conversation Individual and group work
 Computer simulations of random variables and Monte Carlo studies. Inverse transform method, rejection method, special methods. 	 Interactive exposure Conversation Synthesis Individual and group work
 Markov chains. Applications and simulations. 	 Interactive exposure Explanation Conversation Individual and group work
 Counting processes. Bernoulli and Poisson counting processes. Applications and simulations. 	 Interactive exposure Explanation Conversation Individual and group work
 Queuing systems. Examples and simulations. 	 Interactive exposure Explanation Conversation Individual and group work
7. Statistical inference. Applications and simulations.	 Interactive exposure Explanation Conversation Description Individual and group work

Bibliography

- 1. Baron, M., Probability and Statistics for Computer Scientists, CRC Press, Taylor and Francis, Boca Raton, FL, 2014.
- 2. Blaga, P., Statistica prin Matlab, Presa Universitara Clujeana, Cluj-Napoca, 2002.
- 3. Lisei, H., Micula, S., Soos, A., Probability Theory trough Problems and Applications, Cluj University Press, 2006.
- 4. Milton, J.S., Arnold, J. C., Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, 3rd Edition. McGraw-Hill, New York, 1995.
- 5. Gentle, J. E., Elements of Computational Statistics, Springer-Verlag, New York, 2002.
- 6. Matloff, N., From Algorithms to Z-Scores: Probabilistic and Statistical Modelling in Computer Science, Orange Grove Texts Plus, Gainesville, FL, 2009.

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- The course gives students solid statistical background for computational intelligence.
- The knowledge and skills acquired in this course give students a foundation for launching a career in scientific research.
- The statistical analysis abilities acquired in this course are useful in any career path students may choose.

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the			
10.4 Course	 acquire the basic principles in Computational Statistics, with emphasis on simulations and Monte Carlo studies; be able to apply correctly the course concepts on various applications and problem 	Written exam on problems only (a sheet with the main formulas is available)	grade (%) 60%			
10.5 Seminar/Lab activities	 be able to apply course concepts and techniques on practical problems be able to implement course concepts and algorithms in Matlab be able to solve numerical statistical problems in Matlab 	 participation in discussing, solving and implementing problems throughout the semester individual presentation of solutions lab exam (numerical statistical applications and simulations) 	40%			
10.7 Minimum performance standards						
A grade of 5 or above (on a scale from 1 to 10) on <u>each</u> activity mentioned above (written test, seminar/lab evaluation)						

Date	Signature of course coordinator	Signature of seminar coordinator
4.05.2017	Assoc. Prof. PhD. Sanda Micula	Assoc. Prof. PhD. Sanda Micula

Date of approval

Signature of the head of department

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