SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş-Bolyai University**
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	**Bachelor**
1.6 Study programme / Qualification	**Computer Science**

2. Information regarding the discipline

2.1 Name of the discipline	**Probability Theory and Statistics**						
2.2 Course coordinator	**Lect. Prof. PhD. Sanda Micula**						
2.3 Seminar coordinator	**Lect. Prof. PhD. Sanda Micula**						
2.4. Year of study	**2**	2.5 Semester	**3**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Compulsory**

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

3.1 Hours per week	5	Of which: 3.2 course	2	3.3 seminar/laboratory	1 sem + 2 lab
3.4 Total hours in the curriculum	70	Of which: 3.5 course	28	3.6 seminar/laboratory	42
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					20
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					23
Tutorship					7
Evaluations					20
Other activities:					-

3.7 Total individual study hours	80
3.8 Total hours per semester	150
3.9 Number of ECTS credits	6

4. Prerequisites (if necessary)

4.1. curriculum	• Mathematical Analysis • Algebra
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
5.2. for the seminar /lab	• For seminar: room with large blackboard

activities	• For lab: Laboratory with computers having Matlab installed

6. Specific competencies acquired

Professional competencies	C4.1 Defining basic concepts, theory and mathematical models C4.2 Interpretation of mathematical models C4.3 Identifying the appropriate models and methods for solving real-life problems C4.5 Embedding formal models in applications from various areas
Transversal competencies	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 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, with main focus on applications
7.2 Specific objective of the discipline	• Become familiar and be able to work with various probabilistic and statistical models • Ability to perform statistical analysis of data • Ability to use statistical features of various mathematical software

8. Content

8.1 **Course**	Teaching methods	Remarks
1. Experiments, events, field of events, operations with events. Axiomatic definition of probability. Poincaré's formula. Classical definition of probability.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
2. Geometric probability. Buffon's needle problem. Conditional probability. Independent events. Total probability formula, Bayes' formula. Classical probabilistic models (binomial, multinomial, hypergeometric, Poisson, Pascal, geometric).	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
3. Random variables and random vectors. Discrete random variables. Probability distribution function. Cumulative distribution function. Properties, examples.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
4. Discrete probability laws (Bernoulli, binomial, hypergeometric, Poisson, Pascal, geometric). Discrete random vectors. Operations with discrete random variables.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
5. Continuous random variables. Probability density function. Continuous probability laws	• Interactive exposure • Explanation	

(uniform, normal, Gamma, exponential, Chi-squared, Beta, Student, Cauchy, Fisher). Independent random variables. Functions of continuous random variables.	• Conversation • Didactical demonstration	
6. Numerical characteristics of random variables. Expectation. Variance. Moments (initial, central, absolute). Covariance and correlation coefficient. Quantile, median, quartiles. Inequalities (Hölder, Schwartz, Cauchy-Buniakovski, Minkowsky, Markov, Chebyshev).	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
7. Sequences of random variables. Convergence of sequences of random variables. Laws of large numbers. Limit theorems.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
8. Descriptive statistics. Data collection. Graphical display of data. Frequency distribution and histograms. Parameters of a statistical distribution. Measures of central tendency. Measures of variation. Correlation and regression. Linear regression.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	Video projector presentation
9. Sample theory. Samples. Sample functions (sample mean, sample variance, sample moments). Estimation theory. Unbiased estimators. Confidence intervals for estimating the population mean and the population variance. Confidence intervals for comparing two population means and two population variances.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
10. Estimation theory. Properties of point estimators. Sufficient statistics. Likelihood function. The Rao-Blackwell theorem and minimum variance estimators. Fisher's information. Absolutely correct estimators. Methods of estimation. The method of moments estimator, the method of maximum likelihood estimator.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
11. Hypothesis testing. Rejection region. Type I errors. Significance testing and P-values. The Z-test and T (Student)-test for the mean. Examples.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
12. The Chi-square-test for variance. The F-test for the ratio of variances. Tests for the difference of means. Examples. Robust tests.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
13. Type II errors and the power of a test. Most powerful tests and the Neyman-Pearson lemma. Uniformly most powerful tests. Examples.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
14. The Chi-square-test for several characteristics. The Chi-square-test for contingency tables.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
Bibliography		

1. Micula, S., Probability and Statistics for Computational Sciences, Cluj University Press, 2009.
2. Agratini, O., Blaga, P., Coman, Gh., Lectures on Wavelets, Numerical Methods and Statistics, Casa Cartii de Stiinta, Cluj-Napoca, 2005.
3. Blaga, P., Calculul probabilitatilor si statistica matematica. Vol. II. Curs si culegere de probleme, Universitatea "Babes-Bolyai" Cluj-Napoca, 1994.
4. Blaga, P., Statistica prin Matlab, Presa Universitara Clujeana, Cluj-Napoca, 2002.
5. Blaga, P., Radulescu, M., Calculul probabilitatilor, Universitatea "Babes-Bolyai" Cluj-Napoca, 1987.
6. Feller, W., An introduction to probability theory and its applications, Vol.I-II, John Wiley, New York, 1957, 1966.
7. Iosifescu, M., Mihoc, Gh., Theodorescu, R., Teoria probabilitatilor si statistica matematica, Editura Tehnica, Bucuresti, 1966.
8. 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.

8.2 **Seminar**	Teaching methods	Remarks
1. Euler's Gamma and Beta functions. Properties.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	The seminar is structured as 2 hours per week, every other week
2. Classical probability problems. Geometric probability. Conditional probability. Independent events. Bayes' formula.	• Interactive exposure • Explanation • Conversation • Individual and group work	
3. Classical probabilistic models.	• Interactive exposure • Conversation • Synthesis • Individual and group work	
4. Discrete random variables and random vectors. Operations with discrete random variables.	• Interactive exposure • Explanation • Conversation • Individual and group work	
5. Continuous random variables and random vectors. Functions of continuous random variables.	• Interactive exposure • Explanation • Conversation • Didactical demonstration • Individual and group work	
6. Numerical characteristics of random variables.	• Interactive exposure • Explanation • Conversation • Didactical demonstration • Individual and group work	
7. Inequalities. Sequences of random variables.	• Interactive exposure • Explanation • Conversation • Didactical demonstration • Individual and group work	
8.3 **Laboratory**	Teaching methods	Remarks
1. Introduction to Matlab, I.	• Interactive exposure • Explanation • Conversation • Individual and group work	
2. Introduction to Matlab, II.	• Interactive exposure • Explanation	

	• Conversation • Individual and group work	
3. Discrete random variables. Probability distribution function.	• Interactive exposure • Explanation • Conversation • Individual and group work	
4. Continuous random variables. Probability density function. CDF and Inverse CDF.	• Interactive exposure • Explanation • Conversation • Individual and group work	
5. PDF and CDF of continuous distributions. Random number generators.	• Interactive exposure • Explanation • Conversation • Individual and group work	
6. Numerical characteristics of random variables.	• Interactive exposure • Explanation • Conversation • Individual and group work	
7. Overview of Statistics Toolbox features. Samples.	• Interactive exposure • Conversation • Synthesis • Individual and group work	
8. Descriptive Statistics. Grouped frequency distribution, graphical display of data. Statistical measures.	• Interactive exposure • Explanation • Conversation • Individual and group work	
9. Correlation and regression.	• Interactive exposure • Explanation • Conversation • Individual and group work	
10. Confidence intervals for one population.	• Interactive exposure • Explanation • Conversation • Individual and group work	
11. Confidence intervals for comparing two populations.	• Interactive exposure • Explanation • Conversation • Individual and group work	
12. Hypothesis and significance testing for one population.	• Interactive exposure • Explanation • Conversation • Individual and group work	
13. Hypothesis and significance testing for comparing two populations.	• Interactive exposure • Explanation • Conversation • Individual and group work	
14. Overview of statistical methods	• Interactive exposure • Explanation • Conversation • Individual work	
Bibliography 1. Micula, S., Probability and Statistics for Computational Sciences, Cluj University Press, 2009.		

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.

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 follows the ACM and IEEE Curriculum Recommendations for Computer Science majors;
- The course exists in the studying program of all major universities in Romania and abroad;
- 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;

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	- acquire the basic principles in Probability Theory and Mathematical Statistics; - be able to apply correctly the course concepts on various applications - problem solving	Written exam on problems only (a sheet with the main probabilistic and statistical formulas is available)	50%
10.5 Seminar activities	- be able to apply course concepts and techniques on practical problems - be able to choose and apply the right probabilistic or statistical model to various practical problems - problem solving	- participation in discussing and solving problems throughout the semester - additional documentation - individual presentation of solutions - solving bonus problems	25%
10.6 Lab activities	- be able to implement course concepts and algorithms in Matlab - be able to solve numerical statistical problems in Matlab	- participation in discussing and solving problems throughout the semester - lab exam (numerical statistical applications)	25%
10.7 Minimum performance standards			
➢ A grade of 5 or above (on a scale from 1 to 10) on each of the three activities mentioned above (written test, seminar evaluation, lab evaluation)			

Date	Signature of course coordinator	Signature of seminar coordinator
...28.04.2015.....	Lect. Prof. PhD. Sanda Micula	Lect. Prof. PhD. Sanda Micula

Date of approval	Signature of the head of department
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