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					14
Additional documentation (in libraries, on electronic platforms, field documentation)					6
Preparation for seminars/labs, homework, papers, portfolios and essays					23
Tutorship					7
Evaluations					5
Other activities:					-

3.7 Total individual study hours	55
3.8 Total hours per semester	125
3.9 Number of ECTS credits	5

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	• Understanding of basic concepts of mathematics and use them to problem-solving activities; • Ability to understand and approach problems of modeling nature from other sciences • Ability to work independently and/or in a team in order to solve problems in defined professional contexts
Transversal competencies	• Ability to analyze, synthesize and model phenomena and processes from various fields (economy, science, research, education) using adequate mathematical, statistical, computational and computer science methods; • Improved Matlab programming skills; • Ability to use and maintain educational software for primary education and gymnasium

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.	Exposure: description, explanation, examples, discussion, proofs	
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).	Exposure: description, explanation, examples, discussion, proofs	
3. Random variables and random vectors. Discrete random variables. Probability distribution function. Cumulative distribution function. Properties, examples.	Exposure: description, explanation, examples, discussion, proofs	
4. Discrete probability laws (Bernoulli, binomial, hypergeometric, Poisson, Pascal, geometric). Discrete random vectors. Operations with discrete random variables.	Exposure: description, explanation, examples, discussion of case studies, proofs	
5. Continuous random variables. Probability density function. Continuous probability laws (uniform, normal, Gamma, exponential, Chi-squared, Beta, Student, Cauchy, Fisher). Independent random variables. Functions of continuous random variables.	Exposure: description, explanation, discussion of case studies, proofs	

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).	Exposure: description, explanation, examples, discussion, proofs	
7. Sequences of random variables. Convergence of sequences of random variables. Laws of large numbers. Limit theorems.	Exposure: description, explanation, examples, discussion, proofs, debate	
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.	Exposure: description, explanation, discussion, debate	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.	Exposure: description, explanation, examples, discussion, debate	
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.	Exposure: description, explanation, examples, discussion, proofs	
11. Hypothesis testing. Rejection region. Type I errors. Significance testing and P-values. The Z-test and T (Student)-test for the mean. Examples.	Exposure: description, explanation, examples, discussion, debate	
12. The Chi-square-test for variance. The F-test for the ratio of variances. Tests for the difference of means. Examples. Robust tests.	Exposure: description, explanation, examples, discussion, debate	
13. Type II errors and the power of a test. Most powerful tests and the Neyman-Pearson lemma. Uniformly most powerful tests. Examples.	Exposure: description, explanation, examples, discussion	
14. The Chi-square-test for several characteristics. The Chi-square-test for contingency tables.	Exposure: description, explanation, examples, discussion	

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.	Explanation, discussion, proofs, individual and group work	The seminar is structured as 2 hours per week, every other week
2. Classical probability problems. Geometric probability. Conditional probability. Independent events. Bayes' formula.	Explanation, discussion, examples, individual and group work	
3. Classical probabilistic models.	Explanation, discussion, examples, synthesis, individual and group work	
4. Discrete random variables and random vectors. Operations with discrete random variables.	Explanation, discussion, examples, proofs, individual and group work	
5. Continuous random variables and random vectors. Functions of continuous random variables.	Explanation, discussion, examples, proofs, individual and group work	
6. Numerical characteristics of random variables.	Explanation, discussion, proofs, individual and group work	
7. Inequalities. Sequences of random variables.	Explanation, discussion, proofs, individual and group work	
8.3 **Laboratory**	Teaching methods	Remarks
1. Introduction to Matlab, I.	Description, explanation, discussion, examples, individual and group work	
2. Introduction to Matlab, II.	Description, explanation, discussion, examples, individual and group work	
3. Discrete random variables. Probability distribution function.	Description, discussion, examples, individual and group work	
4. Continuous random variables. Probability density function. CDF and Inverse CDF.	Description, discussion, examples, individual and group work	
5. PDF and CDF of continuous distributions. Random number generators.	Description, discussion, examples, individual and group work	
6. Numerical characteristics of random variables.	Description, discussion, examples, individual work	
7. Overview of Statistics Toolbox features. Samples.	Description, discussion, examples, individual and group work	

8. Descriptive Statistics. Grouped frequency distribution, graphical display of data. Statistical measures.	Description, discussion, examples, individual and group work	
9. Correlation and regression.	Description, discussion, examples, individual and group work	
10. Confidence intervals for one population.	Description, discussion, examples, individual and group work	
11. Confidence intervals for comparing two populations.	Description, discussion, examples, individual and group work	
12. Hypothesis and significance testing for one population.	Description, discussion, examples, individual and group work	
13. Hypothesis and significance testing for comparing two populations.	Description, discussion, examples, individual and group work	
14. Lab exam.	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 pursuing 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	- participation in discussing and solving problems throughout the semester - additional documentation - individual presentation of	25%

	probabilistic or statistical model to various practical problems - problem solving	solutions - solving bonus problems	
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
.....	Lect. Prof. PhD. Sanda Micula	Lect. Prof. PhD. Sanda Micula

Date of approval

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Signature of the head of department

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