

COURSE DESCRIPTION
Probability Theory and Statistics
Academic year 2026-2027

1. Programme-related data

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	Computer and Information Technology
1.5 Level of study	Bachelor
1.6 Degree programme / Qualification	Information Engineering
1.7 Form of education	Full-Time

2. Course-related data

2.1 Course title	Probability Theory and Statistics		Course code	MLE0090	
2.2 Course coordinator	Prof. Sanda Micula, PhD. Habil.				
2.3 Seminar coordinator	Prof. Sanda Micula, PhD. Habil.				
2.4. Year of study	2	2.5 Semester	3	2.6. Type of assessment	Exam
2.7 Course status	Compulsory		2.8. Course type	Core subject	

3. Total estimated time (hours per semester of teaching activities)

3.1 Number of hours per week	4	of which: 3.2 course	3	3.3 seminar/laboratory/project	1 lab
3.4 Total hours in the curriculum	56	of which: 3.5 course	42	3.6 seminar/laboratory	14
Time allocation for individual study (IS) and self-taught activities (ST)					hours
Learning from textbooks, course materials, bibliography, and notes (IS)					25
Additional research in the library, on subject-specific electronic platforms, and on-site					15
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					25
Tutoring (professional guidance)					9
Examinations					20
Other activities					
3.7 Total hours of individual study (IS) and self-taught activities (ST)					94
3.8 Total hours per semester					150
3.9 Number of credits					6

4. Prerequisites (where applicable)

4.1. curriculum-related	<ul style="list-style-type: none"> • Mathematical Analysis • Algebra
4.2. skills-related	<ul style="list-style-type: none"> • Logical thinking • Average logical programming skills

5. Specific conditions (where applicable)

5.1. course-related	<ul style="list-style-type: none"> • Lecture room with large blackboard and video projector
5.2. seminar/laboratory-related	<ul style="list-style-type: none"> • For lab: Laboratory with computers having Matlab installed

6.1. Competencies resulting from the completion of the degree programme (as referred to in the curriculum)¹

Professional competencies	
Competency code	Competency
PC2	align software with system architectures
PC5	design information system
Transversal competencies	
Competency code	Competency
-	

6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)²

Learning outcomes targeted by the subject		
Competency code	Knowledge and comprehension	Specific academic skills
PC2, PC5	<p>The graduate has adequate knowledge of the use of integrated development environments in order to create large-scale complex applications.</p> <p>The graduate has knowledge of programming, mathematics, engineering and technology and has the skills to use them in creating complex computer systems.</p>	<p>The graduate has the ability to develop, design and create new applications, systems or products using best practices in the field of computer science.</p>

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Acquire basic knowledge of Probability Theory and Mathematical Statistics, with main focus on applications
2. Become familiar and be able to work with various probabilistic and statistical models
Specific academic skills
1. Ability to perform statistical analysis of data
2. Ability to use statistical features of various mathematical software

8. Contents

8.1 Course	Teaching and learning methods	Remarks ³
1. Experiments, events, field of events, operations with events. Axiomatic definition of probability.	<ul style="list-style-type: none"> Interactive exposure Explanation 	

¹ The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes. If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

² The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

³ For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

Poincaré's formula. Classical definition of probability.	<ul style="list-style-type: none"> • Conversation • Didactical demonstration 	
2. Conditional probability. Independent events. Total probability formula. Classical probabilistic models (Binomial, Hypergeometric, Poisson, Pascal, Geometric).	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
3. Random variables and random vectors. Discrete random variables. Probability distribution function. Cumulative distribution function. Properties, examples.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
4. Discrete probability laws (Bernoulli, Binomial, Hypergeometric, Poisson, Negative Binomial, Geometric). Discrete random vectors. Operations with discrete random variables.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
5. Continuous random variables. Probability density function. Continuous probability laws (Uniform, Normal, Gamma, Exponential, Chi-square, Student, Fisher). Independent random variables. Functions of continuous random variables.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
6. Numerical characteristics of random variables. Expectation. Variance and standard deviation. Median. Moments (initial, central, absolute).	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
7. Quantiles. Covariance and correlation coefficient. Inequalities (Markov, Chebyshev). Central limit theorem.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
8. Descriptive statistics. Data collection. Graphical display of data. Frequency distribution, histograms, stem-and-leaf plots. Parameters of a statistical distribution. Measures of central tendency.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
9. Measures of variation. Correlation and regression. Linear regression, least squares estimation.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
10. Statistical inference. Sample theory. Samples. Sample functions (sample mean, sample variance, sample moments). Estimation theory, basic notions. Confidence intervals for estimating the population mean and the population variance.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
11. Confidence intervals for comparing two population means and two population variances. Hypothesis testing, basic notions. Rejection region. Type I errors. Significance testing and P-values.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
12. Tests for the parameters of one population. Tests for comparing the parameters of two populations. Examples. Robust tests. Summary of hypothesis testing.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
13. Properties of point estimators. Unbiased and minimum variance estimators. Fisher's information. Absolutely correct estimators. The	<ul style="list-style-type: none"> • Interactive exposure • Explanation 	

Rao-Cramer inequality. Efficient estimators. Methods of estimation (method of moments, method of maximum likelihood). Examples.	<ul style="list-style-type: none"> • Conversation • Didactical demonstration 	
14. Type II errors and the power of a test. Most powerful tests and the Neyman-Pearson lemma. Uniformly most powerful tests. Examples.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	

Bibliography

1. Micula, S., Probability and Statistics for Computational Sciences, Cluj University Press, 2009.
2. Baron, M., Probability and Statistics for Computer Scientists, 3rd edition, CRC Press, Taylor and Francis, Boca Raton, FL, 2019.
3. 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.
4. Blaga, P., Calculul probabilitatilor si statistica matematica. Vol. II. Curs si culegere de probleme, Universitatea "Babes-Bolyai" Cluj-Napoca, 1994.
5. Feller, W., An introduction to probability theory and its applications, Vol. 1, 3rd edition, WSE Wiley, New York, 2008.
6. DeGroot, M. H., Schervish, M. J., Probability and Statistics, Addison-Wesley, Boston, 2012.

8.2 Laboratory	Teaching and learning methods	Remarks
1. Introduction to Matlab.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Individual and group work 	The lab is structured as 2 hours per week, every other week
2. Estimating probability by computer simulations.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Individual and group work 	
3. Discrete random variables. PDF and CDF.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Individual and group work 	
4. Continuous random variables. PDF, CDF and Inverse CDF.	<ul style="list-style-type: none"> • Interactive exposure • Synthesis • Conversation • Individual and group work 	
5. Descriptive Statistics. Statistical measures. Correlation and regression.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Individual and group work 	
6. Confidence intervals and tests for the mean and variance.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Individual and group work 	
7. Confidence intervals and tests for the difference of means and ratio of variances.	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Individual work 	

Bibliography



















1. Micula, S., Probability and Statistics for Computational Sciences, Cluj University Press, 2009.
2. Baron, M., Probability and Statistics for Computer Scientists, 3rd edition, CRC Press, Taylor and Francis, Boca Raton, FL, 2019.
3. Blaga, P., Statistica prin Matlab, Presa Universitara Clujeana, Cluj-Napoca, 2002.
4. Lisei, H., Micula, S., Soos, A., Probability Theory trough Problems and Applications, Cluj University Press, 2006.

5. 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. Evaluation

Activity type	9.1 Evaluation criteria ⁴	9.2 Evaluation methods ⁵	9.3 Percentage of final grade
9.4 Course	<ul style="list-style-type: none"> - acquire the basic principles in Probability Theory and Mathematical Statistics; - be able to apply correctly the course concepts on various applications - 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 	<p>Written exam</p> <ul style="list-style-type: none"> - participation in discussing and solving problems throughout the semester - additional documentation 	<p>70%</p> <p>15%</p>
9.5 Laboratory	<ul style="list-style-type: none"> - be able to implement course concepts and algorithms in Matlab - be able to solve numerical statistical problems in Matlab 	<ul style="list-style-type: none"> - participation in discussing and solving problems throughout the semester - individual presentation of solutions 	15%
9.6 Minimum standard for passing			
<ul style="list-style-type: none"> ➤ A grade of 5 or above (on a scale from 1 to 10) on each of the three activities mentioned above (written test, problem solving, lab evaluation) 			

10. SDG labels (Sustainable Development Goals)⁶

 <input type="radio"/> Sustainable Development Generic Label									
 1 FĂRĂ SĂRĂCIE	 2 FOAMEȚE ZERO	 3 SĂNĂȚATE ȘI BUNĂSTĂRE	 4 EDUCĂȚIE DE CALITATE	 5 EGALITATE DE GEN	 6 APĂ CURĂȚĂ ȘI SĂNĂȚATE	 7 ENERGIE CURĂȚĂ ȘI LA PREȚURI ACCESIBILE	 8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ	 9 INDUSTRIE, INOVĂȚIE ȘI INFRASTRUCTURĂ	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	X
 10 INEGALITĂȚI REDUSE	 11 ORĂȘE ȘI COMUNITĂȚI DURABILE	 12 CONSUM ȘI PRODUCȚIE RESPONSABILĂ	 13 ACȚIUNE CLIMATICĂ	 14 VIAȚĂ ACVATICĂ	 15 VIAȚĂ TERESTRĂ	 16 PAȚE, JUSTIȚIE ȘI INSTITUȚII EFICIENTE	 17 PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR	No label applies	

⁴ The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

⁵ Both final evaluation methods and ongoing evaluation strategies should be established.

⁶ Select a single label which, according to the [Implementation of SDG labels in the academic process](#), best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: "No label applies."

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Date

Signature of course coordinator

Signature of seminar coordinator

5.05.2026

Prof. Sanda Micula, PhD. Habil.

Prof. Sanda Micula, PhD. Habil.

Date of approval

Signature of the head of department

Prof. dr. Andrei Mărcuș