

**COURSE DESCRIPTION**  
**Probability and Statistics**  
**Academic year 2026-2027**

**1. Programme-related data**

1.1 Higher education institution	<b>Babeş-Bolyai University</b>
1.2 Faculty	<b>Faculty of Mathematics and Computer Science</b>
1.3 Department	<b>Department of Computer Science</b>
1.4 Field	<b>Computer Science</b>
1.5 Level of study	<b>Bachelor</b>
1.6 Degree programme / Qualification	<b>Computer Science</b>
1.7 Form of education	<b>Full-Time</b>

**2. Course-related data**

2.1 Course title	<b>Probability and Statistics</b>		Course code	<b>MLE0031</b>	
2.2 Course coordinator	<b>Prof. Sanda Micula, PhD. Habil.</b>				
2.3 Seminar coordinator	<b>Prof. Sanda Micula, PhD. Habil.</b>				
2.4. Year of study	<b>2</b>	2.5 Semester	<b>3</b>	2.6. Type of assessment	<b>Exam</b>
2.7 Course status	<b>Compulsory</b>		2.8. Course type	<b>Core subject</b>	

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

3.1 Number of hours per week	<b>4</b>	of which: 3.2 course	<b>2</b>	3.3 seminar/laboratory/project	<b>1 sem + 1 lab</b>
3.4 Total hours in the curriculum	<b>56</b>	of which: 3.5 course	<b>28</b>	3.6 seminar/laboratory	<b>28</b>
<b>Time allocation for individual study (IS) and self-taught activities (ST)</b>					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					
<b>3.7 Total hours of individual study (IS) and self-taught activities (ST)</b>					<b>94</b>
<b>3.8 Total hours per semester</b>					<b>150</b>
<b>3.9 Number of credits</b>					<b>6</b>

**4. Prerequisites (where applicable)**

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

**5. Specific conditions (where applicable)**

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

### 6.1. Competencies resulting from the completion of the degree programme (as referred to in the curriculum)<sup>1</sup>

Professional competencies	
Competency code	Competency
PC5	define technical requirements
PC7	design information system
PC8	create process diagram
Transversal competencies	
Competency code	Competency
-	

### 6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)<sup>2</sup>

Learning outcomes targeted by the subject		
Competency code	Knowledge and comprehension	Specific academic skills
PC5	The student/graduate selects, explains and specifies the mathematical foundations applied in computer science, including formal logic, algebra, probability and statistics.	The student/graduate develops interdisciplinary solutions by integrating mathematics with related fields and collaborating effectively with specialist teams.
PC7, PC8	The student/graduate names, gives examples, concludes, specifies, recognizes and critically argues the methods of designing and managing complex IT projects using modern strategies.	The student/graduate develops a collaborative environment and takes responsibility for the successful delivery of projects on time and according to requirements. The student/graduate organizes technical teams and manages the life cycle of software projects.

### 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 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

<sup>1</sup> 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.

<sup>2</sup> 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.

## 8. Contents

8.1 Course	Teaching and learning methods	Remarks <sup>3</sup>
1. Experiments, events, field of events, operations with events. Axiomatic definition of probability. Poincaré's formula. Classical definition of probability.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
2. Conditional probability. Independent events. Total probability formula. Classical probabilistic models (Binomial, Hypergeometric, Poisson, Pascal, Geometric).	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
3. Random variables and random vectors. Discrete random variables. Probability distribution function. Cumulative distribution function. Properties, examples.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
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"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
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"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
6. Numerical characteristics of random variables. Expectation. Variance and standard deviation. Median. Moments (initial, central, absolute).	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
7. Quantiles. Covariance and correlation coefficient. Inequalities (Markov, Chebyshev). Central limit theorem.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
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"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
9. Measures of variation. Correlation and regression. Linear regression, least squares estimation.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
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"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
11. Confidence intervals for comparing two population means and two population variances. Hypothesis testing, basic notions.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	

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

Rejection region. Type I errors. Significance testing and P-values.		
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"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
13. Properties of point estimators. Unbiased and minimum variance estimators. Fisher's information. Absolutely correct estimators. The Rao-Cramer inequality. Efficient estimators. Methods of estimation (method of moments, method of maximum likelihood). Examples.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
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"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> </ul>	
<b>Bibliography</b> <ol style="list-style-type: none"> <li>1. Micula, S., Probability and Statistics for Computational Sciences, Cluj University Press, 2009.</li> <li>2. Baron, M., Probability and Statistics for Computer Scientists, 3<sup>rd</sup> edition, CRC Press, Taylor and Francis, Boca Raton, FL, 2019.</li> <li>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.</li> <li>4. Blaga, P., Calculul probabilitatilor si statistica matematica. Vol. II. Curs si culegere de probleme, Universitatea "Babes-Bolyai" Cluj-Napoca, 1994.</li> <li>5. Feller, W., An introduction to probability theory and its applications, Vol. 1, 3<sup>rd</sup> edition, WSE Wiley, New York, 2008.</li> <li>6. DeGroot, M. H., Schervish, M. J., Probability and Statistics, Addison-Wesley, Boston, 2012.</li> </ol>		
<b>8.2 Seminar</b>	<b>Teaching and learning methods</b>	<b>Remarks</b>
1. Euler's Functions. Properties. Counting, Outcomes, Events.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> </ul>	The seminar is structured as 2 hours per week, every other week
2. Classical Probability. Rules of Probability. Conditional Probability. Independent Events.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Individual and group work</li> </ul>	
3. Probabilistic models.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Conversation</li> <li>• Synthesis</li> <li>• Individual and group work</li> </ul>	
4. Discrete random variables and discrete random vectors.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Individual and group work</li> </ul>	
5. Continuous random variables and continuous random vectors.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> <li>• Individual and group work</li> </ul>	
6. Numerical characteristics of random variables.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> <li>• Individual and group work</li> </ul>	

7. Inequalities. Central Limit Theorem. Point Estimators.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Didactical demonstration</li> <li>• Individual and group work</li> </ul>	
<b>8.3 Laboratory</b>	<b>Teaching and learning methods</b>	<b>Remarks</b>
1. Introduction to Matlab.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Individual and group work</li> </ul>	The lab is structured as 2 hours per week, every other week
2. Estimating probability by computer simulations.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Individual and group work</li> </ul>	
3. Discrete random variables. PDF and CDF.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Individual and group work</li> </ul>	
4. Continuous random variables. PDF, CDF and Inverse CDF.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Synthesis</li> <li>• Conversation</li> <li>• Individual and group work</li> </ul>	
5. Descriptive Statistics. Statistical measures. Correlation and regression.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Individual and group work</li> </ul>	
6. Confidence intervals and tests for the mean and variance.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Individual and group work</li> </ul>	
7. Confidence intervals and tests for the difference of means and ratio of variances.	<ul style="list-style-type: none"> <li>• Interactive exposure</li> <li>• Explanation</li> <li>• Conversation</li> <li>• Individual work</li> </ul>	
<b>Bibliography</b> <ol style="list-style-type: none"> <li>1. Micula, S., Probability and Statistics for Computational Sciences, Cluj University Press, 2009.</li> <li>2. Baron, M., Probability and Statistics for Computer Scientists, 3<sup>rd</sup> edition, CRC Press, Taylor and Francis, Boca Raton, FL, 2019.</li> <li>3. Blaga, P., Statistica prin Matlab, Presa Universitara Clujeana, Cluj-Napoca, 2002.</li> <li>4. Lisei, H., Micula, S., Soos, A., Probability Theory through Problems and Applications, Cluj University Press, 2006.</li> <li>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.</li> </ol>		

## 9. Evaluation



















Activity type	9.1 Evaluation criteria <sup>4</sup>	9.2 Evaluation methods <sup>5</sup>	9.3 Percentage of final grade
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<sup>4</sup> 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.

<sup>5</sup> Both final evaluation methods and ongoing evaluation strategies should be established.

9.4 Course	- acquire the basic principles in Probability Theory and Mathematical Statistics; - be able to apply correctly the course concepts on various applications	<b>Written exam</b>	<b>70%</b>
9.5 Seminar/lab	- 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	- participation in discussing and solving problems throughout the semester - additional documentation	<b>15%</b>
	- 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 - individual presentation of solutions	<b>15%</b>
9.6 Minimum standard for passing			
A grade of 5 or above (on a scale from 1 to 10) on <b>each</b> of the three activities mentioned above (written test, seminar evaluation, lab evaluation)			

## 10. SDG labels (Sustainable Development Goals)<sup>6</sup>

	<input type="radio"/>	Sustainable Development Generic Label						
								
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<b>X</b>
								No label applies
<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"/>

Date

9.04.2026

Signature of course coordinator

Prof. Sanda Micula, PhD. Habil.

Signature of seminar coordinator

Prof. Sanda Micula, PhD. Habil.

<sup>6</sup> 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."

Date of approval

Signature of the head of department

Prof. dr. Andrei Mărcuș