SYLLABUS

Probabilities

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeș-Bolyai University
1.2. Faculty	Mathematics and Computer Science
1.3. Department	Mathematics
1.4. Field of study	Computer Science
1.5. Study cycle	Bachelor
1.6. Study programme/Qualification	Artificial Intelligence
1.7. Form of education	Full-time

2. Information regarding the discipline

2.1. Name of the discipline	**Probabilities**					Discipline code	**MLE0029**
2.2. Course coordinator				Dr Oana-Andrea Lang			
2.3. Seminar coordinator				Dr Oana-Andrea Lang			
2.4. Year of study	1	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Discipline regime	Compulsory

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

3.1. Hours per week	**4**	of which: 3.2 course	**2**	3.3 seminar/laboratory	**2**
3.4. Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar/laboratory	**28**
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
Learning using manual, course support, bibliography, course notes (SA)					19
Additional documentation (in libraries, on electronic platforms, field documentation)					17
Preparation for seminars/labs, homework, papers, portfolios and essays					15
Tutorship					8
Evaluations					10
Other activities:					-
3.7. Total individual study hours	**69**				
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	Set Theory, Combinatorics

5. Conditions (if necessary)

5.1. for the course	Classroom with blackboard/video projector
5.2. for the seminar /lab activities	Classroom with blackboard/video projector

6.1. Specific competencies acquired [1]

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

Professional/essential competencies	C1.1. Identification of notions, description of theories and use of specific language. C2.3. Application of appropriate theoretical models of analysis for solving given problems. C5.2 Using mathematical arguments to prove mathematical results.
Transversal competencies	CT1 Application of efficient and rigorous working rules, manifest responsible attitudes towards the scientific and didactic fields, respecting the professional and ethical principles.

6.2. Learning outcomes

Knowledge	The student knows: • fundamental notions related to Probability Theory and methods of applying them to areas of science related to Mathematics, Mechanics and Engineering. • how to use at least a programming and editing environment to create attractive mathematical texts with formulas, diagrams and images.
Skills	The student is able to • ensure the formation of skills specific to the Mathematics-related disciplines needed to complete the assignments. • explore some mathematical content independently, drawing on ideas and tools from previous coursework to extend their understanding.
Responsibility and autonomy:	The student has the ability to work independently to • extend mathematical ideas and arguments from previous coursework to a mathematical topic not previously studied. • interpret articles or books from the mathematical literature and incorporate ideas and results from the literature in their written and oral presentations.

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

7.1 General objective of the discipline	• Acquire basic knowledge of Probability Theory, with focus on theoretical aspects, as well as its applications.
7.2 Specific objective of the discipline	• Application of classical probabilistic models to solve real life problems. • Become familiar with classical probability distributions. • Properties of sequences of random variables.

8. Content

8.1 Course	**Teaching methods**	**Remarks**
1. Introduction to Probability Theory. Experiments and events.	Interactive exposure, explanation, conversation, didactical demonstration	

2. Probability function; conditional probability; independence of events.	Interactive exposure, explanation, conversation, didactical demonstration	
3. Sampling with/without replacement.	Interactive exposure, explanation, conversation, didactical demonstration	
4. Random variables; classical discrete probability distributions.	Interactive exposure, explanation, conversation, didactical demonstration	
5. Cumulative distribution function.	Interactive exposure, explanation, conversation, didactical demonstration	
6. Probability density function; classical continuous probability distributions.	Interactive exposure, explanation, conversation, didactical demonstration	
7. Random vectors; joint cumulative distribution function; joint density function.	Interactive exposure, explanation, conversation, didactical demonstration	
8. Functions of random variables; operations with random variables.	Interactive exposure, explanation, conversation, didactical demonstration	
9. Numerical characteristics of random variables: expectation, variance, moments.	Interactive exposure, explanation, conversation, didactical demonstration	
10. Numerical characteristics of random variables: covariance, correlation coefficient.	Interactive exposure, explanation, conversation, didactical demonstration	
11. Moment generating function of a random variable.	Interactive exposure, explanation, conversation, didactical demonstration	
12. Sequences of random variables; types of convergence; laws of large numbers.	Interactive exposure, explanation, conversation, didactical demonstration	
13. Limit theorems.	Interactive exposure, explanation, conversation, didactical demonstration	
14. Review and preparation for the exam.	Interactive exposure, explanation, conversation, didactical demonstration	

Bibliography

- Baron, M., Probability and Statistics for Computer Scientists, 2019
- Klenke, A., Probability Theory: A Comprehensive Course. Springer-Verlag, London, 2008
- Lisei, H., Probability Theory, Casa Cărţii de Ştiinţă, Cluj-Napoca, 2004
- Ross, S., A First Course in Probability, 9th edition, Pearson Education, 2014

8.2 Seminar / laboratory	**Teaching methods**	**Remarks**
1. Combinatorics	Interactive exposure, explanation, conversation, individual and group work	
2. Probability calculus	Interactive exposure, explanation, conversation, individual and group work	
3. Conditional probability	Interactive exposure, explanation, conversation, individual and group work	
4. Classical probabilistic models	Interactive exposure, explanation, conversation, individual and group work	
5. Cumulative distribution function	Interactive exposure, explanation, conversation, individual and group work	

6. Probability density function	Interactive exposure, explanation, conversation, individual and group work	
7. Joint cumulative distribution function; joint density function	Interactive exposure, explanation, conversation, individual and group work	
8. Functions of random variables; operations with random variables	Interactive exposure, explanation, conversation, individual and group work	
9. Numerical characteristics of random variables	Interactive exposure, explanation, conversation, individual and group work	
10. Probability inequalities	Interactive exposure, explanation, conversation, individual and group work	
11. Moment generating function of a random variable	Interactive exposure, explanation, conversation, individual and group work	
12. Sequences of random variables	Interactive exposure, explanation, conversation, individual and group work	
13. Laws of large numbers	Interactive exposure, explanation, conversation, individual and group work	
14. Applications of limit theorems	Interactive exposure, explanation, conversation, individual and group work	

Bibliography

• Grimmett G.R., Stirzaker D.R., One thousand exercises in probability. Oxford University Press, Oxford, 2003.
• Lisei H., Grecksch, W., Iancu, M., Probability: Theory, Examples, Problems, Simulations. World Scientific Publishing, Singapore, 2020.
• Lisei, H., Micula, S., Soos, A., Probability Theory trough Problems and Applications, Cluj University Press, Cluj-Napoca, 2006.

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 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.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	• to acquire the basic principles from Probability Theory • to be able to apply correctly the course concepts on various applications • problem-solving	• Written exam • Coursework	70% 30%
10.5 Seminar/laboratory	• to be able to apply the course	• Continuous observation during the	Extra 10% possible

	concepts to solve problems	semester, active participation in the seminars	
10.6 Minimum standard of performance			
• At least 50% overall.			

11. Labels ODD (Sustainable Development Goals)[2]

	General label for Sustainable Development							
								

Date:
11.04.2025

Signature of course coordinator

O Lang

Signature of seminar coordinator

O Lang

Date of approval:
25.04.2025

Signature of the head of department

Prof. dr. Andrei Mărcuș

[2] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable*.".