

## COURSE DESCRIPTION

### Probability 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 Science                            |
| 1.5. Level of study                   | Bachelor                                    |
| 1.6. Degree programme / Qualification | Computer Science (English)                  |
| 1.7. Form of education                | Full-Time                                   |

#### 2. Course-related data

|                          |                                         |               |                  |                         |                |
|--------------------------|-----------------------------------------|---------------|------------------|-------------------------|----------------|
| 2.1. Course title        | <b>Probability and Statistics</b>       |               |                  | Course code             | <b>MLE0031</b> |
| 2.2. Course coordinator  | Assoc. Prof. PhD Habil. Hannelore Lisei |               |                  |                         |                |
| 2.3. Seminar coordinator | Assoc. Prof. PhD Habil. Hannelore Lisei |               |                  |                         |                |
| 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 | 2  | 3.3. seminar/laboratory  | 1+1          |
| 3.4. Total of hours in the curriculum                                                     | 56 | of which: 3.5. course | 28 | 3.6. seminar/ laboratory | 28           |
| <b>Time allocation for individual study (IS) and self-taught activities (ST)</b>          |    |                       |    |                          | <b>hours</b> |
| Learning from textbooks, course materials, bibliography, and notes (IS)                   |    |                       |    |                          | 30           |
| Additional research in the library, on subject-specific electronic platforms, and on-site |    |                       |    |                          | 20           |
| Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays  |    |                       |    |                          | 27           |
| Tutoring (professional guidance)                                                          |    |                       |    |                          | 11           |
| Examinations                                                                              |    |                       |    |                          | 6            |
| Other activities                                                                          |    |                       |    |                          | -            |
| <b>3.7. Total hours of individual study (IS) and self-taught activities (ST)</b>          |    |                       |    | 94                       |              |
| <b>3.8. Total hours per semester</b>                                                      |    |                       |    | 150                      |              |
| <b>3.9. Number of credits</b>                                                             |    |                       |    | 6                        |              |

#### 4. Prerequisites (where applicable)

|                         |                                                                                    |
|-------------------------|------------------------------------------------------------------------------------|
| 4.1. curriculum-related | Mathematical Analysis, Algebra                                                     |
| 4.2. skills-related     | Computation of limits and integrals, Set Theory, Combinatorics, Python programming |

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

|                                 |                                       |
|---------------------------------|---------------------------------------|
| 5.1. course-related             | Lecture room, laptop, video projector |
| 5.2. seminar/laboratory-related | Seminar/laboratory room, computers    |

### 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 |
| PC10                      | use software libraries        |
| Transversal competencies  |                               |
| Competency code           | Competency                    |
| TC2                       | Solve problems                |
| TC3                       | Think analytically            |
| TC4                       | Schedule and organize         |

### 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 applies, evaluates, and proposes mathematical methods for modeling, simulating and solving computer science problems.                                                                                                                                                                                                                                                                 |
| PC10                                      | The student/graduate selects, describes, analyzes and explains modern programming paradigms, including functional, object-oriented and parallel programming, using current languages and frameworks. | The student/graduate designs, plans, builds, develops scalable software applications, and efficiently uses hardware and software resources.                                                                                                                                                                                                                                                                |
| CT2, CT3, CT4                             | The student/graduate has the knowledge necessary to understand and solve complex problems, and to plan and organize advanced processes in various fields.                                            | <p>The graduate is able to identify complex problems and examine related issues to develop solving options and implement solutions.</p> <p>The graduate has the ability to apply general rules to specific problems and produce relevant solutions.</p> <p>The graduate is able to combine diverse information to formulate solutions and generate ideas for developing new products and applications.</p> |

### 7. Subject-specific learning outcomes

| Knowledge and comprehension                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. The student has acquired the fundamental concepts specific to the discipline: probability, random variables/random vectors, distribution function, probability density function, expected value, variance, point estimation, confidence intervals, and statistical hypothesis testing. |

<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.

|                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2. Students are able to appropriately use existing software tools and to interpret theoretical results in practical applications.                             |
| <b>Specific academic skills</b>                                                                                                                               |
| 1. The student is able to apply mathematical methods from probability theory and statistics to model, analyze, and solve problems specific to various fields. |
| 2. The student is able to use the Python programming language for applications in probability and statistics.                                                 |

## 8. Contents

| 8.1. Course                                                                                                                  | Teaching and learning methods                                            | Remarks <sup>3</sup> |
|------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|----------------------|
| 1. Random experiments, random events, the axiomatic definition of probability                                                | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 2. Conditional probability, the law of total probability, Bayes' formula, independent events                                 | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 3. Random variables, classical discrete distributions                                                                        | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 4. Distribution function, probability density function, classical continuous distributions                                   | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 5. Distribution function and probability density function of a random vector                                                 | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 6. Operations on random variables, independent random variables                                                              | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 7. Numerical characteristics associated with random variables: expected value, variance, covariance, correlation coefficient | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 8. Almost sure convergence, the Strong Law of Large Numbers                                                                  | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 9. Descriptive statistics, representation and processing of statistical data; relative frequencies, absolute frequencies     | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 10. Sampling theory                                                                                                          | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 11. Estimation methods: the maximum likelihood method; the method of moments                                                 | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 12. Confidence intervals for the mean, confidence intervals for the variance                                                 | Interactive exposure, explanation conversation, didactical demonstration |                      |
| 13. Tests for statistical hypotheses: the Z-test, the Student's t-test, the variance test                                    | Interactive exposure, explanation conversation, didactical demonstration |                      |

<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.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                          |                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|-------------------------------------------------------------------|
| 14. Test for the independence of two discrete characteristics, goodness-of-fit test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Interactive exposure, explanation conversation, didactical demonstration |                                                                   |
| Bibliography <ul style="list-style-type: none"> <li>• Baron, M., Probability and Statistics for Computer Scientists, 3rd edition, CRC Press, Taylor and Francis, Boca Raton, FL, 2019.</li> <li>• Feller, W., An Introduction to Probability Theory and Its Applications, Vol. 1, 3rd edition, Wiley, New York, 2008.</li> <li>• DeGroot, M. H., Schervish, M. J., Probability and Statistics, Addison-Wesley, Boston, 2012.</li> <li>• Lisei H., Grecksch, W., Iancu, M., Probability: Theory, Examples, Problems, Simulations. World Scientific Publishing, Singapore, 2020.</li> <li>• Micula, S., Probability and Statistics for Computational Sciences, Cluj University Press, Cluj-Napoca, 2009.</li> <li>• 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> </ul> |                                                                          |                                                                   |
| <b>8.2. Seminar/ laboratory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Teaching and learning methods</b>                                     | <b>Remarks</b>                                                    |
| <b>Seminar</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                          | The seminar is organized as a 2-hour session every other week.    |
| S1. Review: elements of combinatorics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                          |                                                                   |
| S2. Classical probability, conditional probability, independent events                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                          |                                                                   |
| S3. Discrete random variables. discrete probability distributions (Bernoulli distribution, Poisson distribution, hypergeometric distribution)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                          |                                                                   |
| S4. Continuous random variables; continuous probability distributions (uniform distribution, normal distribution, exponential distribution)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                          |                                                                   |
| S5. Estimation theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                          |                                                                   |
| S6. Maximum likelihood method, method of moments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                          |                                                                   |
| S7. Confidence intervals, tests for statistical hypotheses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                          |                                                                   |
| <b>Laboratory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                          | The laboratory is organized as a 2-hour session every other week. |
| L1. Mathematical applications using the Python programming language                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Problem formulation, modeling, algorithm design                          |                                                                   |
| L2. Probability of an event; pseudo-random numbers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Problem formulation, modeling, algorithm design                          |                                                                   |
| L3. Classical discrete distributions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Problem formulation, modeling, algorithm design                          |                                                                   |
| L4. Classical continuous distributions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Problem formulation, modeling, algorithm design                          |                                                                   |
| L5. Numerical characteristics of random variables                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Problem formulation, modeling, algorithm design                          |                                                                   |
| L6. Representation and processing of statistical data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Problem formulation, modeling, algorithm design                          |                                                                   |
| L7. Laboratory test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | individual work                                                          |                                                                   |

## Bibliography

- Baron, M., Probability and Statistics for Computer Scientists, 3rd edition, CRC Press, Taylor and Francis, Boca Raton, FL, 2019.
- Feller, W., An Introduction to Probability Theory and Its Applications, Vol. 1, 3rd edition, Wiley, New York, 2008.
- DeGroot, M. H., Schervish, M. J., Probability and Statistics, Addison-Wesley, Boston, 2012.
- Lisei, H., Grecksch, W., Iancu, M., Probability: Theory, Examples, Problems, Simulations. World Scientific Publishing, Singapore, 2020.
- Lisei, H., Micula, S., Soos, A., Probability Theory through Problems and Applications, Cluj University Press, Cluj-Napoca, 2006.

## 9. Evaluation

| Type of activity                                                                                                                                                                                                                                                                                                                                                                                                | 9.1 Evaluation criteria <sup>4</sup>                                                       | 9.2 Evaluation methods <sup>5</sup>                                                                           | 9.3 Percentage in the final grade |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-----------------------------------|
| 9.4. Course                                                                                                                                                                                                                                                                                                                                                                                                     | Apply the concepts introduced in the course to analyze and solve practical problems.       | Written exam                                                                                                  | 70%                               |
| 9.5. Seminar/ laboratory                                                                                                                                                                                                                                                                                                                                                                                        | Knowledge of the basic concepts presented in the course and the ability to solve problems. | Seminar: Participation in problem discussions and problem-solving activities throughout the semester          | 10%                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                            | Laboratory: Participation in problem discussions and problem-solving activities throughout the semester; test | 20%                               |
| 9.6 Minimum standard for passing                                                                                                                                                                                                                                                                                                                                                                                |                                                                                            |                                                                                                               |                                   |
| Knowledge of the definitions, principal concepts, and elementary notions of Probability Theory and Statistics. The student should be able to perform simple reasoning and calculations (operations with events; operations with random variables; means, variances, and sample moments; sampling from a normal population; verification of the properties of estimators; construction of confidence intervals). |                                                                                            |                                                                                                               |                                   |
| The minimum passing grade is 5.                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                            |                                                                                                               |                                   |

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

|                                                                                     |                                                                                     |                                       |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------|
|  |  | Sustainable Development Generic Label |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------|

<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.

<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."

|                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                   |                                                                                    |                                                                                     |                                                                                     |                                                                                     |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |   |  |  |  |
|  |  |  |  |  |  |  |  | No label applies                                                                    |
|  |  |  |  |  |   |  |  |  |

Date of entry  
25.09.2026

Signature of course coordinator  
  
Assoc. Prof. PhD Habil. Hannelore Lisei

Signature of seminar coordinator

Date of approval in the department  
25.09.2026

Signature of the head of department  
  
Prof. PhD Andrei Mărcuș