# Syllabus

## 1. Programme information

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| 1.1. Institution | THE BUCHAREST UNIVERSITY OF ECONOMIC STUDIES |
| 1.2. Faculty | Economic Cybernetics, Statistics and Informatics |
| 1.3. Departments | Department of Applied Mathematics |
| 1.4. Field of study | Cybernetics and statistics |
| 1.5. Cycle of studies | Master Studies |
| 1.6. Education type | Full-time |
| 1.7. Study programme | Applied data analytics |
| 1.8. Language of study | English |
| 1.9. Academic year | 2025-2026 |

## 2. Information on the discipline

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|---|---|---|---|---|---|---|---|---|---|
| 2.1. Name | **Soft Computing** | | | | | | | | |
| 2.2. Code | **25.0318IF1.2-0002** | | | | | | | | |
| 2.3. Year of study | **1** | 2.4. Semester | **2** | 2.5. Type of assessment | **Test** | 2.6. Status of the discipline | **O** | 2.7. Number of ECTS credits | **6** |

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|---|---|---|---|
| 2.8. Leaders | C(C) | **prof.univ.dr. AGAPIE Alexandru- Licinius** | alexandru.agapie@csie.ase.ro |
| | C(C) | **prof.univ.dr. GIUCLEA Marius** | marius.giuclea@csie.ase.ro |
| | S(S) | **prof.univ.dr. AGAPIE Alexandru- Licinius** | alexandru.agapie@csie.ase.ro |
| | S(S) | **prof.univ.dr. GIUCLEA Marius** | marius.giuclea@csie.ase.ro |

## 3. Estimated Total Time

| | | | |
|---|---|---|---|
| 3.1. Number of weeks | 14.00 | | |
| 3.2. Number of hours per week | 3.00 | of which | |
| | | C(C) | 2.00 |
| | | S(S) | 1.00 |
| 3.3. Total hours from curriculum | 42.00 | of which | |
| | | C(C) | 28.00 |
| | | S(S) | 14.00 |
| 3.4. Total hours of study per semester (ECTS*25) | 150.00 | | |
| 3.5. Total hours of individual study | 108.00 | | |
| *Distribution of time for individual study* | | | |
| Study by the textbook, lecture notes, bibliography and student's own notes | 35.00 | | |
| Additional documentation in the library, on specialized online platforms and in the field | 15.00 | | |
| Preparation of seminars, labs, assignments, portfolios and essays | 15.00 | | |
| Tutorials | 10.00 | | |
| Examinations | 3.00 | | |
| Other activities | 30.00 | | |

## 4. Prerequisites

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| 4.1. of curriculum | ● Basic Algebra<br>● Probability Theory and Mathematical Statistics |
| 4.2. of competences | ● Statistical software: Excel |

## 5. Conditions

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| for the C(C) | The lectures will be held in rooms with Internet access and multimedia teaching equipment |
| for the S(S) | The seminars will be conducted in rooms with computers which have appropriate software. |

## 6. Acquired specific competences

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| PREFESSIONAL | CC2 | STEM (science, technology, engineering, mathematics) skills – understanding the mathematical foundations of AI, statistical methods of data analysis applied in AI techniques. |
| PREFESSIONAL | CP1 | Applies statistical analysis techniques |
| PREFESSIONAL | CP3 | Performs data analysis |
| PREFESSIONAL | CP5 | Identifies of statistical patterns |
| PREFESSIONAL | CT1 | Demonstrates an understanding of mathematical terms and concepts and applies basic mathematical principles and processes for interpreting data and facts. |
| PREFESSIONAL | CT3 | Lists simple instructions for a computer system to solve problems or perform tasks at a basic level, with appropriate guidance if necessary. |

## 7. Objectives of the discipline

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| 7.1. General objective | Providing the necessary tools for the analysis through quantitative methods<br>of investment projects in various fields |
| 7.2. Specific objectives | C1. Applies statistical analysis techniques<br>C2. Uses of data processing techniques<br>C3. Performs data analysis<br>C5. Identifies of statistical patterns<br>A1: Development and implementation of statistical models and artificial intelligence algorithms for the analysis of complex data, using programming environments such as R, Python and SQL.<br>A2: Application of exploratory and predictive data analysis techniques, including time series analysis, spatial econometrics and big data, with the purpose of substantiating strategic decisions in public and private organizations.<br>A3: Ability to use AI techniques such as ML, Neural Networks/Deep Learning to solve problems in different fields, including GIS-based methods<br>RA1: Ability to lead complex analytical projects and make autonomous statistical decisions under uncertainty, in compliance with ethical and data protection principles.<br>RA3: Continuous development of professional skills in accordance with technology trends and business environment |

## 8. Contents

| 8.1. C(C) | | Teaching/Work methods | Recommendations for students |
|---|---|---|---|
| 1 | Introduction:<br>Presenting the objectives and competences to be achieved during the course. Specifying the methods and tools to be used, as well as the requirements and the evaluation standards during the course and at the final evaluation. Rehearsing the basic probabilistic notions used in evolutionary algorithms.<br>2H<br>Expected learning outcomes: C1, C2, C3, C5, A1, A2, A3, RA1, RA3 | Lecture based on multimedia presentations and interaction with students. | The study of the documents uploaded on online.ase.ro |
| 2 | Discrete and continuous random variables involved in evolutionary algorithms. Random number generators. Stochastic processes. Markov chains. Martingales.<br>10H<br>Expected learning outcomes: C1, C2, C3, C5, A1, A2, A3, RA1, RA3 | Idem | Introduction to stochastic models pp. 1-11. Lanturi Markov finite si aplicatii, pp. 13-55, 68-102, 104-126. |
| 3 | Evolutionary algorithms on finite space – genetic algorithms. Definition, theory and applications.<br>6H<br>Expected learning outcomes: C1, C2, C3, C5, A1, A2, A3, RA1, RA3 | Idem | Evolutionary algorithms: modeling and convergence, pp. 1-21 |
| 4 | Evolutionary algorithms on continuous n-dimensional space – evolution strategies. Definition, theory and applications.<br>6H<br>Expected learning outcomes: C1, C2, C3, C5, A1, A2, A3, RA1, RA3 | Idem | • THEORY OF (1+1) ES ON SPHERE REVISITED |
| 5 | Fuzzy sets. Operations with fuzzy sets.<br>Fuzzy logic and Approximate reasoning.<br>Fuzzy ssystems, fuzzy numbers and applications.<br>2H<br>Expected learning outcomes: C1, C2, C3, C5, A1, A2, A3, RA1, RA3 | Idem | Fuzzy sets. FUZZY SETS, UNCERTAINTY, AND INFORMATION |
| 6 | Final revision.<br>2H<br>Expected learning outcomes: C1, C2, C3, C5, A1, A2, A3, RA1, RA3 | Idem | Idem |

***Bibliography***


- A. Agapie, • EVOLUTIONARY ALGORITHMS – MODELING AND CONVERGENCE, Academiei, Bucuresti, 2007, România
- A. Agapie, O. Solomon, L. Badin, • THEORY OF (1+1) ES ON SPHERE REVISITED, IEEE Transactions on Evolutionary Computation , 2022, doi: 10.1109/TEVC.2022.3217524
- A. Agapie, O. Solomon, M. Giuclea, •THEORY OF (1+1) ES ON THE RIDGE, IEEE Transactions on Evolutionary Computation, 2022
- A. Agapie, • SPHERICAL DISTRIBUTIONS USED IN EVOLUTIONARY ALGORITHMS, Mathematics, 9(23), 3098, 2021, doi.org/10.3390/math9233098
- G. Klir, T. Folger, • FUZZY SETS, UNCERTAINTY, AND INFORMATION, Prentice-Hall International Edition, 1998
- M. Giuclea, T. Sireteanu, G. Ghita, • METODE DE INTELIGENȚĂ COMPUTAȚIONALĂ CU APLICAȚII LA SISTEME DINAMICE, Bren, Bucuresti, 2008, România
- C. Popescu, M. Giuclea, • A MODEL OF MULTIPLE LINEAR REGRESSION, Proceedings of the Romanian Academy, Series A, vol. 8, nr. 2, pg.137-144, Bucuresti, 2007, România
- M. Giuclea, C. C. Popescu, • ON STATISTICAL PATTERN WITH FUZZY DATA, Journal of Economic Computation and Economic Cybernetics Studies and Research, vol. 43, nr. 4, Bucuresti, 2009, România
- C. C. Popescu, M. Giuclea, • ON CRITICAL PATH WITH FUZZY WEIGHTS, Journal of Economic Computation and Economic Cybernetics Studies and Research, vol. 52, nr. 4, Bucuresti, 2018, România
- M. Iosifescu, N. Limnios, G. Oprisan, Introduction to stochastic models, Wiley, London, 2007, Marea Britanie
- C.V. Negoita, Fuzzy sets , New Falcon, Tempe, 2000, Statele Unite ale Americii
- M. Iosifescu, Lanturi Markov finite si aplicatii, Editura Tehnica, Bucuresti, 1977, România

| 8.2. S(S) | | Teaching/Work methods | Recommendations for students |
|---|---|---|---|
| 1 | Examples and applications of random variables and stochastic processes.<br>6H<br>Expected learning outcomes: C1, C2, C3, C5, A1, A2, A3, RA1, RA3 | Seminar based on multimedia presentations and interaction with students. | Introduction to stochastic models pp. 1-11 Lanturi Markov finite si aplicatii, pp. 13-55, 68-102, 104-126. |
| 2 | Genetic algorithms on finite space: case studies.<br>4H<br>Expected learning outcomes: C1, C2, C3, C5, A1, A2, A3, RA1, RA3 | Idem | Evolutionary algorithms: modeling and convergence, pp. 1-21 |
| 3 | Genetic algorithms on continuous space: case studies.<br>2H<br>Expected learning outcomes: C1, C2, C3, C5, A1, A2, A3, RA1, RA3 | Idem | • THEORY OF (1+1) ES ON SPHERE REVISITED |
| 4 | Examples and problems related to fuzzy systems. Applications of fuzzy numbers in dynamic systems.<br>2H<br>Expected learning outcomes: C1, C2, C3, C5, A1, A2, A3, RA1, RA3 | Idem | Fuzzy sets. FUZZY SETS, UNCERTAINTY, AND INFORMATION |

***Bibliography***


- A. Agapie, • EVOLUTIONARY ALGORITHMS – MODELING AND CONVERGENCE, Academiei, Bucuresti, 2007
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- C.V. Negoita, Fuzzy sets, New Falcon, Tempe, 2000, Statele Unite ale Americii
- M. Iosifescu, Lanturi Markov finite si aplicatii, Editura Tehnica, Bucuresti, 1977, România


## 9. Corroboration of the contents of the discipline with the expectations of the representatives of the epistemic community, of the professional associations and representative employers in the field associated with the programme

The proposed course and seminar topics are consistent with national and international literature, as well as employers' requirements both in terms of theoretical knowledge and software packages used.

## 10. Assessment

| Type of activity | Assessment criteria | Assessment methods | Percentage in the final grade |
|---|---|---|---|
| 10.1. C(C) | Attendance at course and seminars and involvement in discussing issues | Number of course and seminar attendance and answers. | 10.00 |
| 10.2. S(S) | Project | Mark at project | 40.00 |
| 10.3. Final assessment | Written test | Mark at the test | 50.00 |
| 10.4. Modality of grading | Whole notes 1-10 | | |

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| 10.5. Minimum standard of performance | Achievement of 50% of the total number of points corresponding to the discipline (seminar and final examination).<br>To obtain the minimum passing score, the student can accumulate at least 4 points from the exam subjects corresponding to the following topics:<br>- discrete and continuous random variables;<br>- fuzzy systems<br>having the possibility to complete the score from the other exam subjects. |

Date of listing,
04/28/2026

Signature of the discipline leaders,

Date of approval in the department

Signature of the Department Director,