

# Syllabus

## 1. Programme information

1.1. Institution	THE BUCHAREST UNIVERSITY OF ECONOMIC STUDIES
1.2. Faculty	Economic Cybernetics, Statistics and Informatics
1.3. Departments	Department of Economic Informatics and Cybernetics
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

2.1. Name	<b>Machine Learning and Predictive Analytics</b>								
2.2. Code	<b>25.0318IF1.2-0001</b>								
2.3. Year of study	<b>1</b>	2.4. Semester	<b>2</b>	2.5. Type of assessment	<b>Exam</b>	2.6. Status of the discipline	<b>O</b>	2.7. Number of ECTS credits	<b>6</b>
2.8. Leaders	C(C)	<b>prof.univ.dr. STANCU Stelian</b>					stelian.stancu@csie.ase.ro		
	S(S)	<b>prof.univ.dr. STANCU Stelian</b>					stelian.stancu@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) 1.00
	S(S) 2.00
3.3. Total hours from curriculum	42.00 of which
	C(C) 14.00
	S(S) 28.00
3.4. Total hours of study per semester (ECTS*25)	150.00
3.5. Total hours of individual study	108.00
<i>Distribution of time for individual study</i>	
Study by the textbook, lecture notes, bibliography and student's own notes	40.00
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	7.00
Examinations	2.00
Other activities	29.00

## 4. Prerequisites

4.1. of curriculum	<ul style="list-style-type: none"> <li>● Basic Statistics</li> <li>● Nonparametric Statistics</li> <li>● Probability theory and Mathematical Statistics</li> </ul>
4.2. of competences	<ul style="list-style-type: none"> <li>● Statistical software: Excel, RStudio, Python</li> </ul>

### 5. Conditions

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: Excel, RStudio, Python etc

### 6. Acquired specific competences

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	CP2	Uses of data processing techniques
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

7.1. General objective	Providing the necessary tools for the analysis through quantitative methods of investment projects in various fields
7.2. Specific objectives	<p>C1: Acquisition of advanced knowledge of applied statistical analysis concepts, methods, and techniques, including inference, stochastic modeling, econometrics, and Bayesian methods.</p> <p>C2: Deep understanding of the processes of data collection, processing, analysis and interpretation in economic, social and industrial contexts, as well as the integration of interdisciplinary knowledge (data science, machine learning, advanced visualization).</p> <p>C4: Acquisition of AI-specific techniques such as: ML, Deep learning, Big data.</p> <p>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.</p> <p>A3: Ability to use AI techniques such as ML, Neural Networks/Deep Learning to solve problems in different fields, including GIS-based methods</p> <p>RA1: Ability to lead complex analytical projects and make autonomous statistical decisions under uncertainty, in compliance with ethical and data protection principles.</p> <p>RA2: Taking responsibility for continuous professional development and active involvement in multidisciplinary teams, including through consultancy, applied research or innovation activities in the field of data analysis.</p>

### 8. Contents

8.1. C(C)		Teaching/Work methods	Recommendations for students
1	Introductory course - Introduction to ML - Types of ML: Supervised, Semisupervised, Unsupervised and Reinforcement Learning - Base models vs. ensemble models. (C1, A3)	Lecture in the classic system, at the blackboard/video projector in interaction with students. (1 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 1, pp. 1 - 18; [4]

2	Data Collection and Preprocessing in Machine Learning <ul style="list-style-type: none"> <li>- Sources of data</li> <li>- Collecting the data</li> <li>- Preprocessing the data. (C1, C2, A3)</li> </ul>	Lecture based on multimedia presentations and interaction with students. (1 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 2, pp. 19 - 52; [4]
3	Performance metrics in Machine Learning <ul style="list-style-type: none"> <li>- The confusion matrix</li> <li>- True-positive rate &amp; True-negative rate</li> <li>- Accuracy, Precision and Recall</li> <li>- F Score</li> <li>- ROC Curve etc. (C1, A3)</li> </ul>	Lecture based on multimedia presentations and interaction with students. (1 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 3, 4, pp. 53 - 143; [4]
4	Supervised Learning Algorithms (I) <ul style="list-style-type: none"> <li>- K Nearest Neighbors <ul style="list-style-type: none"> <li>- Distances: Euclidean, Hamming, Minkowski</li> <li>- Mathematical approach</li> </ul> </li> <li>- Naïve Bayes <ul style="list-style-type: none"> <li>- prior and posterior probabilities</li> <li>- Bayes' Theorem</li> <li>- Mathematical concepts</li> </ul> </li> <li>- Linear Regressionatematicice</li> <li>- Regresia liniară. ( C2, C4, A3)</li> </ul>	Lecture based on multimedia presentations and interaction with students. (1 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 5, 6, pp. 145 - 222; [4]
5	Supervised Learning Algorithms (II) <ul style="list-style-type: none"> <li>- Random Forest <ul style="list-style-type: none"> <li>- Theory and mathematical concepts related to RF</li> <li>- Entropy in the context of RF</li> </ul> </li> <li>- Suport Vector Machines (SVM) <ul style="list-style-type: none"> <li>- Mathematical Approach</li> <li>- Discussion upon hyperplanes and kernels</li> </ul> </li> <li>- Decision Trees. (C1, C2, A3)</li> </ul>	Lecture based on multimedia presentations and interaction with students. (1 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 7, pp. 223 - 259; [4]
6	Unsupervised Learning Algorithms (I) <ul style="list-style-type: none"> <li>- Cluster analysis</li> <li>- Hierarchical clustering. (C2, C4, A3)</li> </ul>	Lecture based on multimedia presentations and interaction with students. (1 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 8, 9, pp. 259 - 314; [4]
7	Unsupervised Learning Algorithms (II) <ul style="list-style-type: none"> <li>- K-means clustering</li> <li>- Determining the optimal number of clusters <ul style="list-style-type: none"> <li>- the elbow method</li> <li>- average silhouette method</li> <li>- the gap statistics method. (C1, A3)</li> </ul> </li> </ul>	Lecture based on multimedia presentations and interaction with students. (1 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 10, pp. 315 - 350; [4]

8	<p>Reinforcement Learning</p> <ul style="list-style-type: none"> <li>- Markov Decision Process (MDP)</li> <li>- Bellman Equations</li> <li>- Dynamic Programming. (C1, C2, C4)</li> </ul>	<p>Lecture based on multimedia presentations and interaction with students. (1 h)</p>	<p>Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 11, pp. 353 - 382; [4]</p>
9	<p>Text analytics in ML</p> <ul style="list-style-type: none"> <li>- Introduction to text analytics</li> <li>- Natural Language Understanding (NLU)</li> <li>- Natural Language Processing (NLP)</li> <li>- Natural Language Generation (NLG). (C1, A3)</li> </ul>	<p>Lecture based on multimedia presentations and interaction with students. (1 h)</p>	<p>Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 12, pp. 383 - 423; [4]</p>
10	<p>Deep Neural Networks in ML</p> <ul style="list-style-type: none"> <li>- Development of feed-forward neural networks</li> <li>- Development of recurrent neural networks</li> <li>- Implementing Boltzman Machine Deep Neural Networks (DNNs). (C2, C4, A2)</li> </ul>	<p>Lecture based on multimedia presentations and interaction with students. (1 h)</p>	<p>Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 13, pp. 425 - 470; [4]</p>
11	<p>Convolutional Neural Networks in ML</p> <ul style="list-style-type: none"> <li>- Foundations of CNN</li> <li>- Multi-class image classification problems using CNN. (C1, C4, A2, A3)</li> </ul>	<p>Lecture based on multimedia presentations and interaction with students. (1 h)</p>	<p>Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 14, pp. 471 - 517; [4]</p>
12	<p>Ensemble methods in ML - Bagging and boosting (I)</p> <ul style="list-style-type: none"> <li>- Introduction to ensemble learning, in a bagging-boosting context</li> <li>- Bootstrapping</li> <li>- Selection of the best technique: bagging or boosting. (C1, C2, A2, A3)</li> </ul>	<p>Lecture based on multimedia presentations and interaction with students. (1 h)</p>	<p>Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 15, pp. 517 - 567; [4]</p>
13	<p>Ensemble methods in ML - Bagging and boosting (II)</p> <ul style="list-style-type: none"> <li>- Similarities and differences between bagging and boosting</li> <li>- Bagging used in classification and regression</li> <li>- AdaBoost used in classification and regression. (C4, A2, A3)</li> </ul>	<p>Lecture based on multimedia presentations and interaction with students. (1 h)</p>	<p>Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 16, pp. 567 - 618; [4]</p>

14	Ensemble methods in ML – Stacking (III) - Building a stacking algorithm/model, by combining more basic models. (C1, A2, A3)	Lecture based on multimedia presentations and interaction with students. (1 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 17, 18, pp. 619 - 694; [4]
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### ***Bibliography***

- [1] Goodfellow, I., Bengio, Y., & Courville, A. (2016)., Deep Learning, MA: MIT Press., 2016, Statele Unite ale Americii
- [2] Raschka, S., & Mirjalili, V., Python Machine Learning (3rd ed.), UK: Packt Publishing, Birmingham, 2019, Marea Britanie
- [3] Shalev-Shwartz, S., & Ben-David, S, Understanding Machine Learning: From theory to algorithms., Cambridge University Press, Cambridge, UK, 2014, Marea Britanie
- [4] Cadre didactice titulare, Suporturi curs, online.ase.ro, România

8.2. S(S)		Teaching/Work methods	Recommendations for students
1	Discussion on different packages used for building ML algorithms - Training, test and validation subsets - Python/R practical applications. (A2, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 1, pp. 1 - 18; [4]
2	Data Preprocessing in Machine Learning - Application using a real dataset in Python/R - Collecting the data - Importing libraries for data preprocessing - Finding missing data, correct framing of data types, outlier treatment. (A3, RA1, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 2, pp. 19 - 52; [4]
3	Performance metrics in Machine Learning - Application on the metric evaluation of a model's performances, using Python/R. (A2, A3, RA1, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 3, 4, pp. 53 - 143; [4]
4	Supervised Learning Algorithms (I) - Case study-based Python/R application. (A2, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 5, 6, pp. 145 - 222; [4]

5	Supervised Learning Algorithms (II) - Case study-based Python/R application. (A2, A3, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 7, pp. 223 - 259; [4]
6	Unsupervised Learning Algorithms (I) - Case study-based Python/R application. (A2, A3, RA1, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 8, 9, pp. 259 - 314; [4]
7	Unsupervised Learning Algorithms (II) - Case study-based Python/R application. (A2, A3, RA1)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 10, pp. 315 - 350; [4]
8	Reinforcement Learning - Case study-based Python/R application. (A2, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 11, pp. 353 - 382; [4]
9	Text analytics in ML - Case study: building a chatbot in Python for highlighting the concepts of NLU, NLP and NLG. (A3, RA1)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 12, pp. 383 - 423; [4]
10	Deep Neural Networks in ML - Development of feed-forward and recurrent deep neural networks in Python/R - Introduction to Keras and Tensorflow (Python) and neuralnet and nnet (R). (RA1, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 13, pp. 425 - 470; [4]

11	Convolutional Neural Networks in ML - Building a visual recognition task using Keras in Python. (A3, RA1, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 14, pp. 471 - 517; [4]
12	Ensemble learning - Case studies - AdaBoost and Bagging application in regression using Python/R - AdaBoost and Bagging application in classification using Python/R - Random Forest regression and classification application using Python/R. (A2, A3, RA1, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 15, pp. 517 - 567; [4]
13	Ensemble learning - Case studies - Building a stacking model by combining four basic models in Python/R - Model stacking using Random Forest in Python/R (A2, A3 RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 16, pp. 567 - 618; [4]
14	Project Presentation. (RA1, RA2)	Applications and Case Studies in specialized software: Python/R. (2 h)	Reading the course material and the bibliographic references mentioned in the handout, as well as those mentioned in the course material. The analyzed topic can be found in the bibliographic references: [2] Chap. 17, 18, pp. 619 - 694; [4]

### ***Bibliography***

- [1] Goodfellow, I., Bengio, Y., & Courville, A. (2016)., Deep Learning, MA: MIT Press., 2016, Statele Unite ale Americii
- [2] Raschka, S., & Mirjalili, V., Python Machine Learning (3rd ed.), UK: Packt Publishing, Birmingham, 2019, Marea Britanie
- [3] Shalev-Shwartz, S., & Ben-David, S, Understanding Machine Learning: From theory to algorithms., Cambridge University Press, Cambridge, UK, 2014, Marea Britanie
- [4] Cadre didactice titulare, Suporturi de seminar, online.ase.ro, 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 interventions Teste	10.00

10.2. S(S)	PROJECT	Written	30.00
10.3. Final assessment	Written exam		60.00
10.4. Modality of grading	Whole notes 1-10		
10.5. Minimum standard of performance	Presentation of the project during the seminar. The project can be done alone or in groups of up to 4 master's students. To pass the exam, the student must obtain at least a grade of 5 from the cumulative score from the Course and Seminar.		

Date of listing,  
04/28/2026

Signature of the discipline leaders,

Date of approval in the  
department

Signature of the Department Director,