**COURSE SYLLABUS**

***MACHINE LEARNING***

1. **Program identification details**

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| 1.1 Higher education institution | „Ovidius” University of Constanta |
| 1.2 Faculty | Faculty Mathematics and Computer Science |
| 1.3 Department | Mathematics and Computer Science |
| 1.4 Field of studies | **Computer Science** |
| 1.5 Cycle of studies (degree) | Master |
| 1.6 Degree program/qualification | **Cyber Security and Machine Learning** |
| 1.7 Academic year | 2022-2023 |

1. **Course identification details**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 2.1 Course title | | | **Machine Learning** | | | | |
| 2.2 Course code | | | **FMI.CSML.I.1.02** | | | | |
| 2.3 Instructor | | | Assoc. Prof. Pelican Elena | | | | |
| 2.4 Teaching assistant | | | Assoc. Prof. Pelican Elena | | | | |
| 2.5 Year | I | 2.6 Semester | 1 | 2.7. Evaluation type | E | 2.8 Course type \*/\*\* | DAP/DI |

*\* DF – fundamental course, DD – field course, DS – specialty course, DC – complementary course, DAP – advanced study course, DSI – synthesis course, DCA – advanced knowledge course.*

*\*\* DI – mandatory course; DO – optional course.*

1. **Estimated workload (hours per semester)**

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| --- | --- | --- | --- | --- | --- | --- |
| 3.1 Number of teaching hours/week | | 4 | of which:  3.2 course | 2 | 3.3 applications*\*\*\** | 2 |
| 3.4 Total of teaching hours within the program/semester | | 56 | of which:  3.5 lecture | 28 | 3.6 seminar | 28 |
| **3.7 Student workload for individual study** | | | | | | 119 |
| ***Distribution of workload*** | | | | | | [hours] |
| Individual study of texbooks, handbooks/reader, bibliography and notes | | | | | | 40 |
| Additional research (library, electronic resources, fieldwork) | | | | | | 20 |
| Homework (preparing seminar presentations, portfolios, critical essays, research papers, etc.) | | | | | | 50 |
| Individual consultations (optional) | | | | | | 4 |
| Evaluations / exams | | | | | | 5 |
| Other activities | | | | | | 0 |
| **3.8 Total hours per semester** | *175* | |  |  |  |  |
| **3.9 Number of credits** | 7 | |  |  |  |  |

*\*\*\* S - seminar; L - laboratory; P – project*

1. **Prerequisites (if any)**

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| 4.1 Curriculum-related | Linear Algebra, Calculus, Statistics, Optimizations, Fundamental Algorithms, Data Structures |
| 4.2 Skills-related | Python Programming |

1. **Requirements (if any)**

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| 5.1. For running the course | Lecture Room/Lecture Hall |
| 5.2. For running the seminar / laboratory /project  *\*The type is to be chosen according to the discipline* | Computer Laboratory |

**6 . Acquired specific skills**

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| --- | --- |
| Professional skills | Students must be able to deeply understand the methods and features of important classes of machine learning algorithms, as well as the advantages and drawbacks of the main solutions in the field, but also their impact on the performance of the system/ application. |
| Cross-cutting skills | Autonomous completion of complex tasks, and also detection and solving related problems during development and deployment the application.  Efficient development of activities organized in an interdisciplinary group and development of empathic capacities for interpersonal communication, relationships and collaboration with various groups. |

1. **Course goal and objectives**

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| 7.1 The general objective of the course | Introduction of the principles and mechanisms of machine learning. |
| 7.2 Specific objectives | In-depth understanding of the principles of machine learning algorithms.  The ability to correctly interpret the results obtained by applying machine learning models, according to the performance scores corresponding to the studied problem.  Ability to implement specific algorithms, to use specific software tools and to modify them as required.  Development of software applications based on algorithms in this field. |

1. **Contents**

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| --- | --- | --- |
| **8.1 Lecture** | **Teaching methods** | **Number of hours** |
| 1. Motivation. Overview. Types of learning; types of problems. Performance scores. 2. Supervized learning.   Linear and polynomial regression (uni- and multi-variate regression). LSS Problems: gradient-like methods, regularization methods. Logistic regression.  Decision tree. Random forest. Support vector machines.   1. Unsupervised learning.   Clustering algorithms: k-means and k-means-like algorithms, hierarchical clustering.  Visualization and dimension reduction techniques. Principal Component Analysis (PCA). t-SNE technique.  Independent Component Analysis (ICA).   1. Reinforcement learning 2. Deep learning.   Artificial neural network arhitecture.  Feedforward and backpropagation algorithms.  Types of optimizers.  Convolutional neural networks (CNNs).  Other types of neural networks (RNNs, GANs). | Interactive methods of teaching-learning  Problematization  The active and interactive methods  Methods which contribute to the development of critical thinking  Interaction, problematization, Dialogue  Information synthesizing/ essentialising  Problematization  Independent and cooperative learning  Generalization  Conversation Argumentation | 2 hours    8 hours  6 hours  4 hours  8 hours |
| **Bibliography:**   1. C. Bishop – Pattern Recognition and Machine Learning, Springer, 2006 2. T. Hastie, R. Tibshirani, J. Friedman - The Elements of Statistical Learning. Data Mining, Inference, and Prediction, Second Edition, Springer 2009 3. I. Goodfellow, Y. Bengio, A. Courville – Deep Learning, MIT Press, 2016 4. C.C. Aggarwal, C.K. Reddy - Data Clustering, CRC Press, 2014 5. M. Emre Celebi - Partitional Clustering Algorithms, Springer, 2014 6. L.Ciortuz, A. Munteanu, E. Badarau – Exerciții de învățare automată, Ed. Univ. Al.I.Cuza, Iasi, 2015. 7. [S. Theodoridis](https://www.amazon.com/s/ref=rdr_ext_aut?_encoding=UTF8&index=books&field-author=Sergios%20Theodoridis), [K. Koutroumbas](https://www.amazon.com/s/ref=rdr_ext_aut?_encoding=UTF8&index=books&field-author=Konstantinos%20Koutroumbas), [Pattern Recognition, Fourth Edition](https://www.amazon.com/dp/1597492728/ref=rdr_ext_tmb) (Hardcover), Academic Press, 2009 8. [I.H. Witten](https://www.amazon.com/Ian-H.-Witten/e/B000AP76WK/ref=dp_byline_cont_book_1), [E..Frank](https://www.amazon.com/s/ref=dp_byline_sr_book_2?ie=UTF8&text=Eibe+Frank&search-alias=books&field-author=Eibe+Frank&sort=relevancerank), [M.A. Hall](https://www.amazon.com/s/ref=dp_byline_sr_book_3?ie=UTF8&text=Mark+A.+Hall&search-alias=books&field-author=Mark+A.+Hall&sort=relevancerank), [C.J. Pal](https://www.amazon.com/s/ref=dp_byline_sr_book_4?ie=UTF8&text=Christopher+J.+Pal&search-alias=books&field-author=Christopher+J.+Pal&sort=relevancerank), Data Mining, Fourth Edition: Practical Machine Learning Tools and Techniques (Morgan Kaufmann Series in Data Management Systems) 3rd Edition, Elsevier, 2011 9. Lecture and Lab Notes uploaded in the corresponding channel in MS Teams | | |

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| **8.2 Applications\* (Laboratory / project)**  *\*The type is to be chosen according to the discipline* | **Teaching methods** | **Number of hours** |
| 1. Motivation. Overview. Types of learning; types of problems. Performance scores. 2. Supervized learning.   Linear and polynomial regression (uni- and multi-variate regression). LSS Problems: gradient-like methods, regularization methods. Logistic regression.  Decision tree. Random forest. Support vector machines.   1. Unsupervised learning.   Clustering algorithms: k-means and k-means-like algorithms, hierarchical clustering.  Visualization and dimension reduction techniques. Principal Component Analysis (PCA). t-SNE technique.  Independent Component Analysis (ICA).   1. Reinforcement learning 2. Deep learning.   Artificial neural network arhitecture.  Feedforward and backpropagation algorithms.  Types of optimizers.  Convolutional neural networks (CNNs).  Other types of neural networks (RNNs, GANs). | Interactive methods of teaching-learning  Problematization  The active and interactive methods  Methods which contribute to the development of critical thinking  Interaction, problematization, Dialogue  Information synthesizing/ essentialising  Problematization  Independent and cooperative learning  Generalization  Conversation Argumentation | 2 hours    8 hours  6 hours  4 hours  8 hours |
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**9. Correlation between the content of the course and the needs/expectations of the epistemic community, professional associations and/or significant employers relevant for the program**

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| Preparing students to practice in the field of computer science and to meet the requirements of IT companies, especially for a profession in the field of cybersecurity and machine learning. |

**10. Evaluation**

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| Type of activity | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 Percentage of final grade |
| 10.4 Course | Active participation |  | 10% |
| 10.5 Applications\*  (Seminar/Laboratory / Project)  *\*The type is to be chosen according to the discipline* | Active participation, quizzes |  | 10% |
| Homeworks | 20% |
|  |  | Examination (2 Projects) | 60% |
| 10.6 Minimum standard of achievement for the acquisition of the ECTS credits | | | |
| Know how to solve a regression problem; K-means algorithm and PCA; the backpropagation algorithm for neural networks and CNN architecture. | | | |

Date of completion Course Instructor, Teaching Assistant,

September 20, 2022 Assoc. Prof. Pelican Elena Assoc. Prof. Pelican Elena

Date of approval in the Department Head of Department

Setember 27, 2022 Assoc. Prof. Puchianu Crenguta

Dean,

Assoc. Prof. Nicola Aurelian