SYLLABUS

Fundamentals of Machine Learning

University year **2025-2026**

1. Information regarding the programme

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 of study	*Computer Science*
1.5. Study cycle	*Bachelor*
1.6. Study programme/Qualification	*Computer Science*
1.7. Form of education	*Full time*

2. Information regarding the discipline

2.1. Name of the discipline	*Fundamentals of Machine Learning*					Discipline code	MLE5228
2.2. Course coordinator				Lect. Dr. Bogdan MURSA			
2.3. Seminar coordinator				Lect. Dr. Bogdan MURSA			
2.4. Year of study	2	2.5. Semester	4	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	**5**	of which: 3.2 course	**2**	3.3 seminar/laboratory/project	2lab
3.4. Total hours in the curriculum	70	of which: 3.5 course	28	3.6 seminar/laboratory/project	28
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
Learning using manual, course support, bibliography, course notes (SA)					25
Additional documentation (in libraries, on electronic platforms, field documentation)					29
Preparation for seminars/labs, homework, papers, portfolios and essays					30
Tutorship					7
Evaluations					3
Other activities:					-
3.7. Total individual study hours	94				
3.8. Total hours per semester	150				
3.9. Number of ECTS credits	6				

4. Prerequisites (if necessary)

4.1. curriculum	Algorithms, data structures, statistics
4.2. competencies	Average programming skills

5. Conditions (if necessary)

5.1. for the course	Projector
5.2. for the seminar /lab activities	Computers, specific development environment

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	CE1.1 Description of artificial intelligence concepts and research directions CE1.2 Evaluation of the quality and stability of the obtained solutions and their comparison with the solutions obtained by traditional methods CE1.3 Using artificial intelligence methods, techniques and algorithms to model solutions to classes of problems
Transversal competencies	**CT1.** Application of efficient work rules and responsible attitudes towards the scientific domain, for the creative exploitation of one's own potential according to the principles and rules of professional ethics **CT3.** Use of efficient methods and techniques for learning, information, research and development of abilities for knowledge exploitation, for adapting to the needs of a dynamic society and for communication in a widely used foreign language.

6.2. Learning outcomes

Knowledge	• The graduate knows, understands and applies the basic concepts and the fundamental algorithms of Artificial Intelligence and is able to evaluate them based on metrics. • The graduate knows and understands the concepts and the techniques of knowledge representation and is able to apply them for problem solving.
Skills	• The graduate is able to identify complex issues and examine related issues in order to design several solutions and implement these solutions. • The graduate is able to apply fundamental algorithms of Artificial Intelligence in order to solve real-world problems. • The graduate is able to evaluate, both quantitatively and qualitatively, the performance of intelligent systems.
Responsibility and autonomy:	• The graduate is able to apply architectural templates, design templates and best practices in the field to design highly complex software applications. • The graduate has the necessary skills to apply various methods and tools for analysis and visualizing the results of the used Artificial Intelligence algorithms and techniques. • The graduate has the necessary knowledge to review the literature and use international databases and international digital research libraries.

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

7.1 General objective of the discipline	• Emphasis the proper machine learning methods and techniques for solving real-world problems
7.2 Specific objective of the discipline	• This course is aimed to advance both theoretical and practical aspects of Machine Learning. The course aims to provide an overview of the discipline and its main areas. At the end of the course, students will understand the basic principles of machine learning and associated algorithmic approaches and have knowledge of machine learning applications.

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction to Machine Learning 2. Intelligent systems – Machine Learning (computational intelligence) a. Problem formalisation i. Regression problems ii. Supervised classification problems iii. Unsupervised classification problems b. Supervised learning i. Performance measures ii. Algorithms 1. Least Mean Square Root 2. Descent Gradient 3. Logistic regression 4. Artificial neural networks 5. Convolutional Neural Networks 6. K-nearest neighbour 7. Decision trees 8. Support Vector Machines 9. Bayesian models 10. Evolutionary algorithms c. Unsupervised learning i. Performance measures ii. Algorithms d. Reinforcement learning i. Performance measures ii. Algorithms 1. Q-learning 2. Neural Networks 3. Hybrid systems 4. Real-world intelligent systems 5. information processing that were collected in different domains (medical, biological, financial, psychology, etc) and represented in different modalities: a. Texts b. Images c. Sounds d. Networks / graphs	• Interactive • Presentation • Explanation • Practical examples • Case-study discussions	

Bibliography

1. S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 1995
2. C. Groşan, A. Abraham, Intelligent Systems: A Modern Approach, Springer, 2011
3. M. Mitchell, An Introduction to Genetic Algorithms, MIT Press, 1998
4. A. Hopgood, Intelligent Systems for Engineers and Scientists, CRC Press, 2001
5. T. M. Mitchell, Machine Learning,McGraw-Hill Science, 1997
6. James Kennedy, Russel Eberhart, Particle Swarm Optimisation, Proceedings of IEEE International Conference on Neural Networks. IV. pp. 1942–1948, 1995

7. Marco Dorigo, Christian Blum, Ant colony optimization theory: A survey, Theoretical Computer Science 344 (2005) 243 – 27
8. H.F. Pop, G. Şerban, Inteligenţă artificială, Cluj Napoca, 2004
9. D. J. C. MacKey, Information Theory, Inference and Learning Algorithms, Cambridge University Press, 2003
10. C. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
11. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Eficient solutions for algorithmic problems 2. Introduction to Machine Learning – performance measures 3. Regression problems – Least Mean Square Root 4. Data normalisation 5. Regression problems – descent gradient 6. Classsification problems – logistic regression 7. Regression problems – Artificial Neural Networks 8. Classification problems – Artificial Neural Networks 9. Regression problems – Evolutionary Algorithms 10. Classification problems – Evolutionary Algorithms 11. Clustering 12. Real-world problems – ML-based solutions 13. Development of applications that include intelligent components	• Interactive exposure • Explanation • Conversation Didactical demonstration	

Bibliography

1. S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 1995
2. C. Groşan, A. Abraham, Intelligent Systems: A Modern Approach, Springer, 2011
3. A. Hopgood, Intelligent Systems for Engineers and Scientists, CRC Press, 2001 A. Geron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, https://github.com/ageron/handson-ml

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 curriculum of many universities in the world.
- The results of course are considered by software companies particularly useful and topical, developing needed abilities in modelling and visualization of data.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Knowledge of the basic concepts of the field	Written exam	50%

	Applying the intelligent principles from the course content to solve complex and difficult problems		
10.5 Seminar/laboratory	· Specification, design, implementation and testing of intelligent methods · Effective problem solving with the help of previously implemented methods	Systematic observation of the student while solving the task Practical projects	50%
10.6 Minimum standard of performance			
Each student has to demonstrate that he has reached an acceptable level of knowledge and understanding of the field, that he is able to express the knowledge in a coherent form, that he has the ability to establish certain connections and to use the knowledge in solving some problems. To pass the exam you must: • at least 60% of the laboratory assignments are completed • an evaluation average (written exam, seminar, laboratory) to be above 5			

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

Not applicable.

Date:
30.04.2025

Signature of course coordinator

Lect. Dr. Bogdan MURSA

Signature of seminar coordinator

Lect. Dr. Bogdan MURSA

Date of approval:
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Signature of the head of department

Assoc.prof.phd. Adrian STERCA

[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.*".