SYLLABUS

Machine learning

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeş-Bolyai University of Cluj-Napoca
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	Master
1.6. Study programme/Qualification	High performance computing and Big Data Analytics
1.7. Form of education	Full time

2. Information regarding the discipline

2.1. Name of the discipline	**Machine learning**					Discipline code	**MME8042**
2.2. Course coordinator					Prof. PhD Czibula Gabriela		
2.3. Seminar coordinator					Prof. PhD Czibula Gabriela		
2.4. Year of study	1	2.5. Semester	1	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	**4**	of which: 3.2 course	**2**	3.3 seminar/laboratory/project	**1 sem+ 1 pr**
3.4. Total hours in the curriculum	56	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)					20
Additional documentation (in libraries, on electronic platforms, field documentation)					30
Preparation for seminars/labs, homework, papers, portfolios and essays					28
Tutorship					6
Evaluations					10
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	Artificial Intelligence
4.2. competencies	Programming skills

5. Conditions (if necessary)

5.1. for the course	Classroom with a projector
5.2. for the seminar /lab activities	

6.1. Specific competencies acquired [1]

Professional/essential competencies	• Capability of analysis and synthesis; • Understanding and acquisition of methods of modeling, optimization, analysis of massive datasets, and data visualization techniques; • Efficient modeling and solving real-life problems.
Transversal competencies	• Etic and fair behavior, committment to professional deontology; • Team work capabilities; able to fulfil different roles.

6.2. Learning outcomes

Knowledge	The student knows: • the basic principles, techniques, and applications of Machine Learning; • ethical and deontological norms and rules in scientific research.
Skills	The student is able to: • use novel algorithms, software infrastructures and methodologies for the purpose of processing (store, retrieve, analyze) large amounts of data; • handle (extremely) large amounts of digital data in various formats (text, video, financial, medical, etc.).
Responsibility and autonomy:	The student has the ability to work independently to: • develop applications and services for various business domains based on the results of big data analysis; • translate academic knowledge into a professional, economic, social and ethical context.

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

7.1 General objective of the discipline	To provide the principles, techniques, and applications of Machine Learning.
7.2 Specific objective of the discipline	• To cover the principles, design, implementation and validation of learning programs which improve their performance on some set of tasks by experience. • To offer a broad understanding of machine learning algorithms and their use in data-driven knowledge discovery and program synthesis. • To offer an understanding of the current state of the art in machine learning in order to conduct original research in machine learning.

[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.

8. Content

8.1 Course	Teaching methods	Remarks
1. **Introduction in Machine Learning.** • Issues in Machine Learning • Designing a learning system • Examples	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
2. Statistical foundations • Event space and Probability function • Elementary Information Theory • Examples	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
3. Decision Tree learning • Decision tree representation • ID3 learning algorithm • Statistical measures in decision tree learning: entropy, information gain • Issues in DT learning • Applications	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
4. Artificial Neural Networks • Neural Network representations • Appropriate problems for Neural Network Learning • Perceptrons • Multilayer Networks and the Backpropagation algorithm • Advanced topics in Artificial Neural Networks	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
5. Support Vector machines • Main idea • Linear SVMs • Non-linear SVMs • Applications	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
6. Bayesian learning • Specific problems • Bayes theorem • Naive Bayes Classifier	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
7. Instance based learning • *k*-Nearest Neighbor learning • Locally weighted regression • Radial basis functions • Case based reasoning • Applications	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
8. Unsupervised learning • Cluster analysis	• Interactive exposure • Explanation • Conversation	

• Self organizing maps • Hebbian learning • Applications	• Didactical demonstration	
9. Reinforcement Learning • The reinforcement learning task • Markov Decision Processes • Q-learning • Temporal Difference learning • Applications	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
ML research reports presentation	• Interactive exposure • Conversation • Oral assessment	
Bibliography 1. Mitchell, T., Machine Learning, McGraw Hill, 1997 2. Russell, J.S, Norvig, P., Artificial Intelligence- A Modern Approach, Prentice- Hall, Inc., New Jersey, 1995 3. Sutton, R.S., Barto, A.G., Reinforcement learning, The MIT Press Cambridge, Massachusetts, London, England, 1998 4. Gabriela Czibula, Sisteme inteligente. Instruire automata, Ed. Risoprint, Cluj-Napoca, 2008 5. Manning, C., Schutze, H., Foundations of Statistical NLP, MIT Press, 2002 6. Cristiani, N., Support Vector and Kernel Machines, BIOwulf Technologies, 2001 7. Nillson, N., Introduction to Machine Learning, Stanford University, 1996		
8.2 Seminar / laboratory	Teaching methods	Remarks
		The activity is structured as 2 hours classes every
1. Administration of labs. Survey of the sources of information available on Internet and Intranet	• Interactive exposure • Explanation • Conversation	
2. Survey of the sources of information available on Internet and Intranet; choosing the paper topic and scheduling the presentation.	• Documentation • Explanation • Conversation	
A software project will be fully implemented, without using existing ML environments.		
3. Problem definition	• Lab assignment • Explanation • Conversation	
4-5. Comments about the solution, problem analysis and related work	• Lab assignment • Explanation • Conversation	
6-7. Design documentation; the electronic version of the source code, test files and any other files required to test the software project. Project 2demonstration	• Lab assignment • Explanation • Conversation	
Bibliography 1. Mitchell, T., Machine Learning, McGraw Hill, 1997 2. Sutton, R.S., Barto, A.G., Reinforcement learning, The MIT Press Cambridge, Massachusetts, London, England, 1998 3. Gabriela Czibula, Sisteme inteligente. Instruire automata, Ed. Risoprint, Cluj-Napoca, 2008		

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 content of the discipline is consistent with the similar disciplines from other Romanian universities and universities from abroad, as well as with the requirements that potential employers would have in the machine learning field.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade

10.4 Course	A theoretical research report on a learning technique, based on some recent research papers should be prepared and presented	Evaluation of the research report (a written paper of about 10 pages and an oral presentation)	40%
	The correctness and completeness of the accumulated knowledge.	Oral assessment	
10.5 Seminar/laboratory	A software project implemented using a ML framework	Evaluation of the project (software implementation, documentation and demonstration)	15%
	A software project fully implemented, without using existing ML environments.	Evaluation of the project (software implementation, documentation and demonstration)	25%
10.6 Activity	Class attendance (elctures, labs) and activity		15%
10.7 Minimum standard of performance			
• Each student has to prove that (s)he acquired an acceptable level of knowledge and understanding of the Machine Learning domain, that (s)he is capable of stating this knowledge in a coherent form, that (s)he has the ability to establish certain connections and to use the knowledge in solving different problems. • Successful passing of the exam is conditioned by the final grade that has to be at least 5.			

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

Not applicable.

Date:

03.04.2025

Signature of course coordinator

Prof. PhD Gabriela CZIBULA

Signature of seminar coordinator

Prof. PhD Gabriela CZIBULA

Date of approval:

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*.”.