SYLLABUS

Artificial Intelligence and Machine Learning for Connected Systems

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	**Babeș 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	**Master**
1.6. Study programme/Qualification	**Artificial Intelligence for Connected Industries**
1.7. Form of education	**Full time**

2. Information regarding the discipline

2.1. Name of the discipline	**Artificial Intelligence and Machine Learning for Connected Systems**					Discipline code	**MME8213**
2.2. Course coordinator				**Lect. Dr. Bogdan MURSA**			
2.3. Seminar coordinator				**Lect. Dr. Bogdan MURSA**			
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 lab + 1 project
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)	32
Additional documentation (in libraries, on electronic platforms, field documentation)	32
Preparation for seminars/labs, homework, papers, portfolios and essays	36
Tutorship	5
Evaluations	14
Other activities:	-

3.7. Total individual study hours	**119**
3.8. Total hours per semester	**175**
3.9. Number of ECTS credits	**7**

4. Prerequisites (if necessary)

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

5. Conditions (if necessary)

5.1. for the course	Projector

5.2. for the seminar /lab activities	For the laboratory activity it is needed a computer with high processing speed and a Python programming environment are needed.

6.Specific competencies acquired [1]

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 compar solutions obtained by traditional methods **CE1.3** Using artificial intelligence methods, techniques and algorithms to model soluti 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 **CT2**. Efficient conduct of activities organized in an interdisciplinary group and development of empathic capacity of interpersonal communication, networking and collaboration with diverse groups **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.

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

7.1 General objective of the discipline	• The main objective of this course is to present the basic concepts related to machine learning (ML) projects, to introduce the main ML models and algorithms, and how to apply them in connected systems.
7.2 Specific objective of the discipline	• The course addresses both theoretical and practical aspects of machine learning (ML) and aims to provide an overview of the discipline and its main areas. By the end of the course, students will understand the basic principles of machine learning, the associated algorithmic approaches, and will have knowledge about the applications of machine learning in connected systems.

8. Content

[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.

8.1 Course	Teaching methods	Remarks
1. Introduction to AI & ML - General overview of AI and ML, history, key concepts, and applications.	• Interactive exposure • Presentation • Explanation • Practical examples • Case-study discussions	
2. Practical Skills and Linear Regression- Fundamentals of linear regression and associated algorithms.		
3. Supervised Learning in Classification Problems I		
4. Supervised Learning in Classification Problems II		
5. Dimensionality Reduction - Concepts of dimensionality reduction, importance in ML.		
6. Unsupervised Learning - Introduction to unsupervised learning, key algorithms.		
7. Artificial Neural Networks - Fundamentals of neural networks.		
8. Deep Neural Networks (DNN) - Advanced neural networks, introduction to deep learning.		
9. Training Enhancement Techniques - Ensembles, boosting, bagging, techniques for improving DNN performance.		
10. Applications in Connected Systems - Practical applications of machine learning in connected systems, case studies.		
11. Scalable ML Architectures in the Context of Big Data Connected Systems.		
12. Review and Practical Topics Discussion - Review of key concepts, Q&A session.		
13 & 14. Final Project Presentations.		

Bibliography

1. S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 1995
2. C. Groșan, 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. Șerban, Inteligență 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 https://www.deeplearningbook.org/
12. D. J. Watts, P. S. Dodds, M. E. J. Newman. Identity and Search in Social

Networks. Science, 296, 1302-1305, 2002.

8.2 Seminar / laboratory	Teaching methods	Remarks
The goal is to use specific ML tools and methods in real applications involving connected systems. Each student will work in a team to implement a project that aims to model a solution using ML technology in a real-world connected systems problem. To achieve these objectives, the seminar/laboratory activity (2 hours every 2 weeks) has the following structure: 1. **Introduction** o Exploring AIML applications in connected systems. o Familiarizing with datasets and specific tools. o Interactive exposure, explanation, conversation, didactical demonstration. 2. **Data Analysis and Visualization Techniques** o Applying preprocessing techniques and algorithms in the context of real datasets, understanding advantages and disadvantages. o Discovering visualization methods. 3. **Connected Systems and Big Data** o Investigating data scalability in Big Data problems. o Working with real data from connected systems. 4. **ML Solution Modeling Project in Connected Systems I** o Specifying a project theme.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	

○ Choosing the dataset. 5. **ML Solution Modeling Project in Connected Systems II** ○ Exploring datasets. ○ Exploring techniques to improve the training results of an ML model. 6-7. **ML Solution Modeling Project in Connected Systems III** ○ Analyzing results. ○ Preparing project presentations.		
Bibliography 1. S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 1995 2. C. Groșan, A. Abraham, Intelligent Systems: A Modern Approach, Springer, 2011 3. A. Hopgood, Intelligent Systems for Engineers and Scientists, CRC Press, 2001 4. 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 studying program of all major universities abroad;

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)

10.4 Course	Understanding the basic concepts of the field Applying intelligent principles from the course content to solve complex and difficult problems	Written exam / research paper and presentation	50%
10.5 Seminar/lab activities	Specifying, designing, implementing, and testing intelligent methods Effectively solving problems using the previously implemented methods	Project implementation and presentation	50%
10.6 Minimum performance standards			
Each student should obtain minimum 5 for the written exam /research paper and presentation, as well as for the final grade.			

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

Not applicable.

Date:
15.04.2025

Signature of course coordinator

Lect. Dr. Bogdan MURSA

Signature of seminar coordinator

Lect. Dr. Bogdan MURSA

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.*".