

SYLLABUS

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

2. Information regarding the discipline

2.1 Name of the discipline	Machine Learning						
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 Type of discipline	Compulsory
2.8. Code of the discipline	MME8042						

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	1 sem+1 pr
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 seminar/laboratory	28
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					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	
5.2. for the seminar /lab activities	Laboratory with computers; high level programming language environment (.NET or any Java environment a.s.o.)

6. Specific competencies acquired

Professional competencies	<ul style="list-style-type: none"> Advanced ability to approach, model and solve phenomena and problems using machine learning techniques. Ability to approach and solve complex problems using various techniques of computational intelligence.
Transversal competencies	<ul style="list-style-type: none"> Ethic and fair behavior, commitment to professional deontology Team work capabilities; able to fulfill different roles Professional communication skills; concise and precise description, both oral and written, of professional results. Good English communication skills

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

7.1 General objective of the discipline	<ul style="list-style-type: none"> To provide an introduction to the basic principles, techniques, and applications of Machine Learning.
7.2 Specific objective of the discipline	<ul style="list-style-type: none"> 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.

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction in Machine Learning. <ul style="list-style-type: none"> Issues in Machine Learning Designing a learning system Example 	<ul style="list-style-type: none"> Interactive exposure Explanation Conversation Didactical demonstration 	
2. Statistical foundations <ul style="list-style-type: none"> Event space and Probability function Elementary Information Theory Examples 	<ul style="list-style-type: none"> Interactive exposure Explanation Conversation Didactical demonstration 	
3. Decision Tree learning <ul style="list-style-type: none"> Decision tree representation ID3 learning algorithm Statistical measures in decision tree learning: entropy, information gain Issues in DT learning Applications 	<ul style="list-style-type: none"> Interactive exposure Explanation Conversation Didactical demonstration 	

4. Artificial Neural Networks <ul style="list-style-type: none"> • Neural Network representations • Appropriate problems for Neural Network Learning • Perceptrons • Multilayer Networks and the Backpropagation algorithm • Advanced topics in Artificial Neural Networks 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
5. Support Vector machines <ul style="list-style-type: none"> • Main idea • Linear SVMs • Non-linear SVMs • Applications 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
6. Bayesian learning <ul style="list-style-type: none"> • Specific problems • Bayes theorem • Naive Bayes Classifier 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
7. Instance based learning <ul style="list-style-type: none"> • <i>k</i>-Nearest Neighbor learning • Locally weighted regression • Radial basis functions • Case based reasoning • Applications 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
8. Unsupervised Learning <ul style="list-style-type: none"> • Cluster analysis • Self organizing maps • Hebbian learning • Applications 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
9. Reinforcement Learning <ul style="list-style-type: none"> • The reinforcement learning task • Markov Decision Processes • Q-learning • Temporal Difference learning • Applications 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
ML research reports presentation	<ul style="list-style-type: none"> • Interactive exposure • Conversation • Oral assessment 	
Bibliography <ol style="list-style-type: none"> 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 lab is structured as 2 hours classes every

		second week
1. Administration of labs. Survey of the sources of information available on Internet and Intranet	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation 	
2. Survey of the sources of information available on Internet and Intranet; choosing the paper topic and scheduling the presentation.	<ul style="list-style-type: none"> • Documentation • Explanation • Conversation 	
<i>The first software project (Project 1) will be developed using an open source ML software. The second project (Project 2) will be fully implemented, without using existing ML environments.</i>		
3. Installation of ML software; description of the programming software used, including used features	<ul style="list-style-type: none"> • Lab assignment • Explanation • Conversation 	
4. Problem definition	<ul style="list-style-type: none"> • Lab assignment • Explanation • Conversation 	
5. Project 1 demonstration and comments about the solution; problem definition for Project 2	<ul style="list-style-type: none"> • Lab assignment • Explanation • Conversation 	
6. Comments about the solution and problem analysis for Project 2	<ul style="list-style-type: none"> • Lab assignment • Explanation • Conversation 	
7. Design documentation; the electronic version of the source code, test files and any other files required to test Project 2. Project 2 demonstration	<ul style="list-style-type: none"> • Lab assignment • Explanation • Conversation 	
Bibliography <ol style="list-style-type: none"> 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 Czubala, 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

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	<ul style="list-style-type: none"> • 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%
	<ul style="list-style-type: none"> • The correctness and completeness of the 	Oral assessment	

	accumulated knowledge.		
10.5 Seminar/lab activities	<ul style="list-style-type: none"> • A software project developed using an open source ML software 	Evaluation of the project (documentation and demonstration)	15%
	<ul style="list-style-type: none"> • A software project fully implemented, without using existing ML environments. 	Evaluation of the project (software implementation, documentation and demonstration)	35%
10.6 Attendance	<ul style="list-style-type: none"> • Class (course, lab) attendance 		10%
10.7 Minimum performance standards			
<ul style="list-style-type: none"> • 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 these 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. 			

Date

Signature of course coordinator

Signature of seminar coordinator

Prof. dr. Gabriela Czibula

Prof. dr. Gabriela Czibula

Date of approval

Signature of the head of department

Assoc. Prof. dr. Sterca Adrian