

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	Intelligent Systems

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

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1 sem
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6 seminar/laboratory	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					30
Additional documentation (in libraries, on electronic platforms, field documentation)					40
Preparation for seminars/labs, homework, papers, portfolios and essays					40
Tutorship					7
Evaluations					16
Other activities:					
3.7 Total individual study hours		133			
3.8 Total hours per semester		175			
3.9 Number of ECTS credits		7			

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

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"> • Understanding the concepts, methods and models used in Machine Learning. • Understanding the principles, design, implementation and validation of learning systems. • Learning to conduct incipient original research in machine learning.
Transversal competencies	<ul style="list-style-type: none"> • The ability to apply machine learning techniques in solving real world problems. • Responsible execution of lab assignments, research and practical reports. • Application of efficient and rigorous working rules. • Manifest responsible attitudes toward the scientific and didactic fields. • Respecting the professional and ethical principles.

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 	<ul style="list-style-type: none"> • Interactive exposure • Explanation 	

<ul style="list-style-type: none"> Learning • Perceptrons • Multilayer Networks and the Backpropagation algorithm • Advanced topics in Artificial Neural Networks 	<ul style="list-style-type: none"> • 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 (1) <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. Bayesian learning (2) <ul style="list-style-type: none"> • Bayesian Belief Networks • EM algorithm • Examples 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
8. Instance based learning (1) <ul style="list-style-type: none"> • k-Nearest Neighbor learning • Locally weighted regression • Applications 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
9. Instance based learning (2) <ul style="list-style-type: none"> • Radial basis functions • Case based reasoning 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
10. Unsupervised Learning (1) <ul style="list-style-type: none"> • Cluster analysis • Self organizing maps 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
11. Unsupervised Learning (2) <ul style="list-style-type: none"> • Hebbian learning • Applications 	<ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Didactical demonstration 	
12. 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 	
13. ML research reports presentation	<ul style="list-style-type: none"> • Interactive exposure • Conversation 	
14. ML research reports presentation	<ul style="list-style-type: none"> • Interactive exposure • Conversation 	
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 seminar 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; chosing 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 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

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)	20%
	<ul style="list-style-type: none"> The correctness and completeness of the accumulated knowledge. 	Written exam (in the regular session)	40%
	<ul style="list-style-type: none"> Class attendance 	4 unmotivated absences are accepted, but each unmotivated absence other than those specified above are penalised	10%
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)	15%
10.6 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

30.04.2013

Signature of course coordinator

Prof. dr. Gabriela Czibula

Signature of seminar coordinator

Prof. dr. Gabriela Czibula

Date of approval

Signature of the head of department

Prof. dr. Bazil Pârv