SYLLABUS

1.   Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Faculty of Automation and Computer Science
1.3	Department	Automation
1.4	Field of study	CYBER PHYSICAL SYSTEMS
1.5	Cycle of study	Master of Science
1.6	Program of study/Qualification	System Engineering
1.7	Form of education	Full time
1.8	Subject code	3.00

2.   Data about the subject

2.1	Subject name	Machine Learning				
2.2	Subject area	System Engineering				
2.2	Course responsible/lecturer	S.l. dr. ing. Vlad-Cristian Miclea				
2.3	Teachers in charge of seminars	S.l. dr. ing. Vlad-Cristian Miclea				
2.4 Year of study	1	2.5 Semester	1	2.6 Assessment		E
2.7 Subject category	Formative category					DA
	Optionality					DI

3.   Estimated total time

3.1 Number of hours per week	3	of which	3.2 Course	2	3.3 Seminar	0	3.3 Laborator	1	3.3 Proiect	0
3.4 Total hours in the curriculum	42	of which	3.5 Course	28	3.6 Seminar	0	3.6 Laborator	14	3.6 Proiect	0

3.7 Individual study:	
(a) Manual, lecture material and notes, bibliography	15
(b) Supplementary study in the library, online and in the field	14
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	23
(d) Tutoring	3
(e) Exams and tests	3
(f) Other activities	0

3.8 Total hours of individual study (summ (3.7(a)…3.7(f)))	58
3.9 Total hours per semester (3.4+3.8)	100
3.10 Number of credit points	4

4.   Pre-requisites (where appropriate)

4.1	Curriculum	N/A
4.2	Competence	Computer programming, Probability Theory

5.   Requirements (where appropriate)

5.1	For the course	N/A
5.2	For the laboratory	Attendance at the laboratory is mandatory.

6. Specific competences

Professional competences	C1. Designing intelligent systems using machine learning mechanisms; C2. Applying fundamental methods and principles for specifying solutions for learning problems in the context of automation systems C3. Choosing criteria and methods for the evaluation of quality and performances of machine learning systems C4. Using domain-specific tools for explaining the operation of machine learning systems
Cross competences	N/A

7. Discipline objectives (as results from the *key competences gained*)

7.1	General objective	Knowledge, understanding and use of concepts related to machine learning
7.2	Specific objectives	Knowledge, understanding and use of proper formulation methodologies for machine learning systems; Knowledge, understanding and use of the specific operations of a machine learning system: data pre-processing, dimensional reduction, feature selection, building the prediction model, selection of the optimum model, performance analysis; Understanding and use of machine learning methods using statistical approaches, support vectors, simple classifiers and neural networks.

8. Contents

8.1. Lecture (syllabus)	Number of hours	Teaching methods	Notes
1. Intorduction in ML	2	Exposition using oral presentations supported by multimedia tools; discussions, questioning	
2. Data, models, metrics for ML (1)	2		
3. Data, models, metrics for ML (2)	2		
4. Linear regression	2		
5. Logistic regression and Classification	2		
6. Support Vector Machine	2		
7. Perceptron and Neural Networks	2		
8. Loss functions and optimizations	2		
9. Convolutional neural networks (part 1) – deep learning theory	2		
10. Convolutional neural networks (part 2) – backpropagation	2		

	Number of hours	Teaching methods	Notes
11. Convolutional neural networks (part 3) – object detection	2		
12. Convolutional neural networks (part 4) – segmentation	2		
13. Principal Component Analysis	2		
14. K-Means clustering	2		

Bibliography

1. Convolutional Neural Networks for Visual Recognition, http://cs231n.stanford.edu, 2022
2. K. Murphy, "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012
3. J. Kelleher, "Deep Learning", The MIT Press, 2019
4. Giuseppe Ciaburro, "MATLAB for Machine Learning", Packt Publishing Limited, 2017

8.2. Laboratory	Number of hours	Teaching methods	Notes
1. Introduction – ML in Matlab	2	Case studies, presentation of various methods and procedures for prediction, training and evaluation of ML models	
2. Linear regression for data prediction	2		
3. Classification for data prediction	2		
4. Convolutional neural networks – common architectures	2		
5. Convolutional neural network – prediction	2		
6. Convolutional neural network – training a simple CNN (1)	2		
7. Convolutional neural network – training a simple CNN (2)	2		

Bibliography

1. Convolutional Neural Networks for Visual Recognition, http://cs231n.stanford.edu, 2022
2. Giuseppe Ciaburro, "MATLAB for Machine Learning", Packt Publishing Limited, 2017
3. Deep learning in Matlab, https://www.mathworks.com/help/deeplearning/ug/deep-learning-in-matlab.html, 2022

9. **Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field**

This course presents a practical way of combining fundamental and practical aspects used in the field of machine learning for master students with expertise in automation. The subject content is correlated with the specific curricula of other Universities, in Romania and abroad. The subject's activities are meant to make the students familiar with the applications and the research directions of the field. The themes of the laboratory correspond to some applications of many companies in Cluj-Napoca (Bosch, Siemens, Arobs etc) and abroad.

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	Knowledge of theoretical aspects and ability to solve problems	Oral exam, based on a course project (CP) and theory questions (T)	60%
10.5 Laboratory	Elaboration of a CNN-based project	Laboratory evaluation based on the project (LP), evaluated orally	40%
10.6 Minimum standard of performance			
LP>=5, CP>=5; N=0.4*LP+0.3*CP+0.3*T.			

Date of filling in: 09.03.2023		Title Surname Name	Signature
	Lecturer	S.l. dr. ing. Vlad-Cristian Miclea	
	Teachers in charge of application	S.l. dr. ing. Vlad-Cristian Miclea	

Date of approval in the department of Computer Science _____	Head of department Prof.dr.ing. Rodica Potolea
Date of approval in the faculty of Automation and Computer Science _____	Dean Prof.dr.ing. Liviu Miclea