SYLLABUS

1. Information on the study programme

1.1. Higher education institution	West University of Timisoara
1.2. Faculty	Mathematics and Computer Science
1.3. Department	Computer Science
1.4. Study program field	Computer Science
1.5. Study cycle	PhD
1.6. Study programme / Qualification	Doctoral School in Mathematics and Computer Science/ Computer Science

2. Information on the course

2.1. Course title			Topics of Machine Learning				
2.2. Lecture instructor			Daniela Zaharie				
2.3. Seminar / laboratory instructor							
2.4. Study year	1	2.5. Semester	1	2.6. Examination type		2.7. Course type	

3. Estimated study time (number of hours per semester)

3.1. Attendance hours per week	1	out of which: 3.2 lecture	1	3.3. seminar / laboratory	-
3.4. Attendance hours per semester	12	out of which: 3.5 lecture	12	3.6. seminar / laboratory	0

Distribution of the allocated amount of time*	**hours**
Study of literature, course handbook and personal notes	80
Supplementary documentation at library or using electronic repositories	54
Preparing for laboratories, homework, reports etc.	40
Exams	6
Tutoring	8
Other activities…	0

3.7. Total number of hours of individual study	188
3.8. Total number of hours per semester	200
3.9. Number of credits (ECTS)	8

4. Prerequisites (if it is the case)

4.1. curriculum	Artificial Intelligence, Numerical Calculus, Programming, Probability and Statistics, Operations Research
4.2. competences	Knowledge of numerical algorithms, statistics, artificial intelligence, optimization and programming abilities

5. Requirements (if it is the case)

5.1. for the lecture	Lecture room with whiteboard and projector – support materials available on Google Classroom (code i6l4dv6)
5.2. for the seminar / laboratory/ individual activity	

6. Specific acquired competences

Professional competencies	• Understanding the main concepts in machine learning • Ability to identify the machine learning methods for a specific problem • Ability to implement and validate a machine learning algorithm • Ability to analyze and compare machine learning methods
Transversal competencies	• Ability to search for relevant literature • Ability to conduct research activity and to prepare reports on a given topic • Team work ability

7. Course objectives

7.1. General objective	Providing knowledge on constructing data-driven models, on learning algorithms, and on related optimization methods
7.2. Specific objectives	(1) to present computational aspects of machine learning; (2) to identify the techniques appropriate to a given problem; (3) to use software tools that are specific for machine learning; (4) to implement efficient and scalable learning algorithms;

8. Content

8.1. Lecture	**Teaching methods**	**Remarks, details**
L1-2. Reminder on mathematical tools and basics of Machine Learning (supervised and unsupervised learning models).	Discourse, conversation, illustration by examples	[4] - ch 2,3,5 [6], [1] - ch 9, [2] – ch 2, [3] – ch 2,3,4,5,6, 14
L3-4. Ensemble Models. Bagging. Boosting. Stacking.	Discourse, conversation, illustration by examples	[3] - ch 8,9,10, 15,16
L7-8. Deep Learning Models. Convolutional Neural Networks. Autoencoders. Attention Mechanisms. Generative Adversarial Networks.	Discourse, conversation, illustration by examples	[4] – ch 6-12 [5]
L9-10. Recurrent Neural Networks. Graph Neural Networks	Discourse, conversation, illustration by examples	
L11-12. Reinforcement Learning and Deep Reinforcement Learning. Hyper-parameter optimization. Neural architecture search.	Discourse, conversation, illustration by examples	[1] – ch 11, [7], [8]
Recommended literature 1. S. Marsland, Machine Learning. An Algorithmic Approach, Chapman & Hall, 2015 2. K.P. Murphy, Machine Learning. A Probabilistic Perspective, MIT Press, 2012		

3. T. Hastie, R. Tibshirani, J. Friedman, The Elements of Statistical Learning. Data Mining, Inference, and Prediction. Springer, 2017
4. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016
5. A. Zhang, Z.C. Lipton, M. Li, A.J. Smola, Dive into Deep Learning, 2020
6. J. Brownlee; Basics of Linear Algebra for Machine Learning, 2018
7. S. Luke: Essentials of Metaheuristics, Lulu, second edition, 2013, available for free at http://cs.gmu.edu/~sean/book/metaheuristics/
8. J. Brownlee: Clever Algorithms. Nature-inspired Programming Recipes, 2011, available at http://www.CleverAlgorithms.com
9. J. Zhou et al., Graph neural networks: A review of methods and applications, AI Open, Volume 1, 2020, Pages 57-81, https://doi.org/10.1016/j.aiopen.2021.01.001
10. V. Francois-Lavet et al, An Introduction to Deep Reinforcement Learning, 2018, https://arxiv.org/pdf/1811.12560.pdf
11. Rick Muller, *A crash course in Python for scientists*, https://nbviewer.jupyter.org/gist/rpmuller/5920182
12. A. Muller, S. Guido, Introduction to Machine Learning with Python, O'Reilly, 2016
13. Scikit-learn: Machine Learning in Python, https://scikit-learn.org/stable/
14. TensorFlow - https://github.com/tensorflow/tensorflow
15. Keras - https://keras.io/guides/
16. PyTorch - https://pytorch.org/

8.2. Seminar / laboratory	**Teaching methods**	**Remarks, details**

Recommended literature:
1.

9. Correlations between the content of the course and the requirements of the professional field and relevant employers.

The content covers recent topics in Machine Learning

10. Evaluation

Activity	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in the final mark
10.4. Lecture	● Ability to solve a real-world problem using a machine learning method ● Usage of software tools and implementation of machine learning algorithms	Project presentation (report, software implementation, oral presentation)	100%
10.5. Seminar / laboratory			
10.6. Minimum needed performance for passing			

- Knowledge of the main concepts used in machine learning and understanding of the way in which machine learning methods can be used in practice
- Ability to identify the machine learning model which is appropriate for solving a real-world problem.
- Implementation of at least one machine learning algorithm (by using specific software tools).

Date of completion	Signature (lecture instructor)	Signature (seminar instructor)
28.09.2023	prof.dr. Daniela Zaharie	

Date of approval	Signature (director of the department/ doctoral school)