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	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Masters
1.6 Program of study / Qualification	Data Science / Masters
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Machine Learning 2***			Subject code	**7.1**
2.2 Course responsible / lecturer	Prof. dr. eng. Lemnaru Camelia - camelia.lemnaru@cs.utcluj.ro Assoc. prof. dr. eng. Brehar Raluca-Didona - raluca.brehar@cs.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	As. drd. eng. Jurcă Mihnea - mihnea.jurca@cs.utcluj.ro As. drd. eng. Negru Vlad - vlad.negru@cs.utcluj.ro				
2.4 Year of study	I	2.5 Semester	2	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DF – fundamental, DS – speciality, DC – complementary				DF
	Optionality: DOB – mandatory, DOP – optional (alternative), DFA – optional (free choice)				DOP

3. Estimated total time

3.1 Number of hours per week	3	of which:	Course	2	Seminars	-	Laboratory	1	Project	-
3.2 Number of hours per semester	42	of which:	Course	28	Seminars	-	Laboratory	14	Project	-
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										20
(b) Supplementary study in the library, online and in the field										15
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										13
(d) Tutoring										5
(e) Exams and tests										5
(f) Other activities:										-

3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))	58
3.5 Total hours per semester (3.2+3.4)	100
3.6 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 Curriculum	Advanced Machine Learning Methods: deep learning,
4.2 Competence	Linear algebra, programming, logics, basic statistics

5. Requirements (where appropriate)

5.1. For the course	white/black-board, projector, PC/laptop
5.2. For the applications	white/black-board, projector, PC/laptop

6. Specific competence

6.1 Professional competences	• analyse big data • analyse business processes • analyse decentralised applications • build predictive models • create data models • debug software • define software architecture • define technical requirements • design cloud architecture • design process for blockchain-based systems • develop blockchain innovative architectures • develop software prototype • develop with cloud services • evaluate blockchain architectures • explain blockchain implications • explain distributed ledger technologies principles • identify blockchain innovation opportunities • implement smart contracts • interpret technical requirements • manage cloud data and storage • outline blockchain-based identity management • oversee development of software • perform data cleansing • perform data mining • perform scientific research • provide technical documentation • recognise blockchain application areas • recognise blockchain risks • use data processing techniques • use software design patterns • use software libraries • utilise computer-aided software engineering tools • utilise machine learning
6.2 Cross competences	The graduate: • develop an analytical approach • taking a proactive approach • developing strategies to solve problems • being open minded • coordinate engineering teams

7. Expected Learning Outcomes

Knowledge	• deep learning fundamental concepts • deep learning architectures • deep learning frameworks • data analytics tools • data models • data storage alternatives • data warehouse principles • database management systems (DBMS) • digital data processing methods • algorithms for dealing with unstructured data • statistics • computer programming • software design principles • software libraries

Skills	The student is able to: • create data sets • develop deep learning pipelines • implement deep learning models from scratch • evaluate the performance of deep learning pipelines • deploy deep learning models • establish data processes • manage data • perform dimensionality reduction • interpret technical requirements • use software design patterns • use software libraries • adapt to changes in technological development plans • design user interfaces • implement front-end website designs • use markup languages
Responsibilities and autonomy	The student has the ability to work independently in order to: • develop an analytical approach • take a proactive approach • develop strategies to solve problems • be open minded • coordinate engineering teams

8. Discipline objective (as results from the *key competences gained*)

8.1 General objective	Understanding basic concepts in deep learning, the main types of architectures, training considerations; understanding the basic elements of reinforcement learning
8.2 Specific objectives	Understanding and being able to develop and utilise the most important deep learning and reinforcement learning algorithms. Operate with known frameworks and software tools for deep learning.

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Introduction to Deep Feedforward Networks	2	Presentations, discussions.	
Design and optimization of Neural Networks	2		
Convolutional Neural Networks	2		
Recurrent Neural Networks	2		
Transformer Models	2		
Generative Models – introduction, autoencoders and variational autoencoders	2		
Generative Models - GANs and diffusion models	2		
Foundation Models	2		
Interpretability of Deep Learning Models	2		
Deployment of Deep Learning Models (Quantization, distillation)	2		
Fairness, Bias and Ethics in Machine Learning	2		
Advanced ML Applications in computer vision	2		
Advanced ML Applications in NLP	2		
Review	2		

Bibliography:

- Deep Learning Book, by Ian Goodfellow, Yoshua Bengio and Aaron Courville, https://www.deeplearningbook.org/
- Deep Learning. Foundations and Concepts, Christopher Bishop and Hugo Bishop, Springer Berlin, 2023
- Selected research papers

9.2 Applications - Seminars/Laboratory/Project	Hours	Teaching methods	Notes
Introduction to Python and review of usefull Python packages	2	Presentations, discussions, live coding	
FFN for image classification: design, implementation, optimization	2		
CNN for image classification: design, implementation, optimization	2		
Implementing an RNN for sequence tagging	2		
Autoencoders	2		
Foundation models	2		
Interpretability techniques, deployment aspects	2		

Bibliography

- Selected kaggle.com scripts (https://www.kaggle.com/)

**Se vor preciza, după caz: tematica seminariilor, lucrările de laborator, tematica și etapele proiectului.*

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

The contents of this course are in line with the curricula of top universities around the globe (see bibliography sections). Moreover, the contents of the course cover the most important conceptual and technical aspects needed to develop machine learning solutions at industry level).

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	The ability to solve problems specific to the domain. Course participation and involvement	Final Evaluation	50%
Seminar	-	-	-
Laboratory	The ability to implement and evaluate specific solutions for the proposed problems	Bi-weekly laboratory assessments, final assignment	50%
Project	-	-	-
Minimum standard of performance: Minimum lab grade 5, Minimum final grade: 5			

Date of filling in: 29.04.2026	**Responsible**	**Title First name Last name**	**Signature**
	Course	Prof.dr.eng. Camelia LEMNARU	
		Assoc.prof.dr.eng. Raluca-Didona BREHAR	
	Applications	As.drd.eng. Mihnea JURCĂ	
		As.drd.eng. Vlad NEGRU	

Date of approval in the department	Head of department, Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council	Dean, Prof.dr.eng. Vlad Mureșan