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	Master
1.6 Program of study / Qualification	Data Science / Master
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Machine Learning 1***			Subject code	**4.00**
2.2 Course responsible / lecturer	Assoc.prof.dr.eng. Raluca Didona Brehar - raluca.brehar@cs.utcluj.ro Prof.dr.eng. Camelia Lemnaru - camelia.lemnaru@cs.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Assoc.prof.dr.eng. Ionel Giosan - ionel.giosan@cs.utcluj.ro As.drd.eng. Jurcă Mihnea - mihnea.jurca@cs.utcluj.ro				
2.4 Year of study	I	2.5 Semester	1	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DA – advanced, DS – speciality, DC – complementary				DS
	Optionality: DI – imposed, DO – optional (alternative), DF – optional (free choice)				DI

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	Introduction to Machine Learning Fundamentals: supervised and unsupervised methods for machine 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	1. Working with advanced mathematical methods and models, engineering and computing specific techniques and technologies. 2. Development of advanced techniques, methods and methodologies in the domains of software design, programming systems and environments and their applications, machine learning and artificial intelligence. 3. Innovative design of machine learning systems and related software and hardware using the specific tools; implementation evaluation and deployment of machine learning pipelines 4. Creative pooling of multidisciplinary knowledge in the field of computers and information technology for research, design, optimization, implementation and testing of theories, algorithms and original methods specific to artificial intelligence and computer vision systems. 5. Perform scientific research, formulate problems, analyse challenges critically, write technical and scientific reports.
6.2 Cross competences	1. Proof of knowledge for the economic, ethical, legal and social context associated with the profession, for correct task identification, schedule of activities, responsible decisions, with the final goal the design, preparation and presentation of a scientific paper. 2. Clear and concise description of professional activity flows, tasks and outcomes obtained by assuming the role of leader / project manager or as a member of a research team, as result of personal skills of domain specific information synthesis, global vision, communication skills with collaborators, ability of task stages identification. 3. Exercising the skill of continuous self-education and demonstrating critical, innovative and research abilities

7. Expected Learning Outcomes

Knowledge	machine learning fundamental concepts machine learning algorithms for classification and clustering machine learning frameworks and libraries 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 machine learning and data analytics pipelines • implement machine learning algorithms from scratch • evaluate the performance of machine learning and data analytics pipelines • deploy machine 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 the process of learning from data, the pipeline steps and the best known techniques associated with each step
8.2 Specific objectives	Understanding and being able to develop and utilise the most important learning algorithms and data pre-processing techniques for data analysis. Operate with known frameworks and software tools for data analysis.

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Introduction.	2	Presentations, discussions	
The learning problem, Linear model example, Error/Noise, Linear Regression	2		
Polynomial Regression, Regularized Regression, Practical Tips for Regression, Metrics	2		
Classification methods. Training/testing, generalisation, bias/variance	2		
Decision Trees	2		
Support Vector Machines, Kernel Methods	2		
Probabilistic methods	2		
Ensemble and cost-sensitive learning	2		
Clustering	2		
Methods for dealing with noisy/incomplete data	2		
Feature selection and transformation	2		
ML Applications in Computer Vision	2		
ML Applications in NLP	2		
Review	2		

Bibliography:

- A-M. S. Yaser, M-I. Malik and L. Hsuan-Tien, "Learning from Data", 2012 (selection of e-chapters available at https://amlbook.com/eChapters.html)
- Caltech C156 - Learning From Data page: https://work.caltech.edu/telecourse.html
- Stanford CS229 - Machine Learning Lecture Notes by Andrew Ng, available at: https://cs229.stanford.edu/notes2022fall/main_notes.pdf

9.2 Applications - Seminars/Laboratory/Project	Hours	Teaching methods	Notes
Introduction to Python (numpy, pandas, matplotlib, seaborn)	2	Presentations, discussions, live coding	
Training and evaluation of a simple model. Evaluation metrics	2		
Building an interpretable model for medical diagnosis	2		
Building an SVM and an NN model for handwritten digit recognition	2		
Ensembling ML models for boosting performance	2		
Data preparation pipeline	2		
Clustering algorithms	2		

Bibliography

- ML1 laboratory guide, M. Jurca and I. Giosan, made available on the lecture moodle page each year
- 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: 01.09.2025	**Responsible**	**Title First name Last name**	**Signature**
	Course	Assoc.prof.dr.eng.Raluca-Didona Brehar,	
		Prof.dr.eng. Camelia Lemnaru	
	Applications	Assoc.prof.dr.eng.Ionel Giosan	
		As.drd.eng. Mihnea Jurcă	

Date of approval in the department 17.09.2025	Head of department, Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council 19.09.2025	Dean, Prof.dr.eng. Vlad Mureșan