SYLLABUS
Academic year 2025-2026

Dean,
Prof. dr. eng. Vasile-Ion Manta

1. Program data

1.1 Higher education institution	"Gheorghe Asachi" Technical University of Iași
1.2 Faculty	Automatic Control and Computer Engineering
1.3 Department	Computers
1.4 Field of studies	Computers and Information Technology
1.5 The cycle of studies[1]	Master
1.6 Study program	Artificial Intelligence

2. Subject data

2.1 Name of the subject / Code				**Explainable and Neuro-Symbolic Learning Methods** (*Metode de învățare explicabile și neuro-simbolice*) / **AI.203**			
2.2 Course coordinator				Prof. dr. eng. Florin Leon			
2.3 Application instructor				Lect. dr. eng. Otilia Zvorișteanu			
2.4 Year of study[2]	2	2.5 Semester[3]	3	2.6 Type of assessment[4]	exam	2.7 Type of subject[5]	DS

3. Estimated total time of daily activities (hours per semester)

3.1 Number of hours per week	2	3.2 lectures	1	3.3a sem.		3.3b laboratory	1	3.3c project	
3.4 Total hours in curriculum[6]	28	3.5 lectures	14	3.6a sem.		3.6b laboratory	14	3.6c project	

Distribution of the time fund[7]	No. hours
Study by textbook, course support, bibliography and notes	33
Additional documentation in the library, on specialist electronic platforms and in the field	20
Preparation of seminars/labs/projects, assignments, reports and portfolios	15
Tutorial[8]	
Examinations[9]	4
Other activities:	

3.7 Total hours of individual study[10]	72
3.8 Total hours per semester[11]	100
3.9 Number of credits	4

4. Prerequisites (where applicable)

4.1 curriculum[12]	
4.2 competences	

5. Conditions (where applicable)

5.1 conducting the lectures[13]	• Blackboard, video projector
5.2 conducting the seminar / laboratory / project[14]	• Laboratory room with computers and Internet access • The Visual Studio (academic license) and PyCharm programming environments

6. Specific competences accumulated[15]

		Number of credits assigned to the subject[16]:	**4**
			Distribution of credits per competences[17]
Professional competences	CP1	Knowledge of advanced concepts of computer science and information technology and the ability to work with these concepts.	0.8
	CP2	Scientific and practical research in the field of artificial intelligence.	0.7
	CP3	Problem solving using artificial intelligence methods and techniques.	0.8
	CP4	Design and development of artificial intelligence systems.	0.7
	CP5	Utilization of artificial intelligence tools and technologies.	0.7
	CP6		
	CPS1		
	CPS2		
al competenc	CT1	Legislation compliant application of the intellectual property rights and of the principles, norms and values of the professional ethics code within their own strategies for rigorous, effective and responsible work.	0.1
	CT2	Application of communication techniques and effective group work; developing empathic interpersonal communication skills and assuming leadership roles/functions	0.1

		in a multi-specialized team.	
	CT3	Creating opportunities for continuous training and the effective utilization of learning resources and techniques for personal development.	0.1
	CTS		

7. Objectives of the subject (resulting from the grid of specific competences accumulated)

7.1 General objective of the subject	Understanding and possibility of practical application of knowledge specific to explainable and neuro-symbolic learning methods
7.2 Specific objectives	The goal of this course is to present the fusion of symbolic and subsymbolic artificial intelligence methods together with interpretable models that bridge the gap between neural networks and human-understandable reasoning.

8. Contents

8.1 Course[18]	Teaching methods[19]	Remarks
1. Overview of Explainable Artificial Intelligence (types of XAI: model-based, input-based, output-based; techniques for generating explanations: saliency maps, rule extraction, model visualization) (2h) ***2. Model-agnostic algorithms I (LIME and SHAP algorithms; application for classification and regression models) (2h)*** ***3. Model-agnostic algorithms II (ELI5 library; layer-wise relevance propagation LRP; application for multi-class classification, sentiment analysis and time-series) (2h)*** ***4. Example-based explanations (counterfactual explanations; adversarial examples; prototypes and criticisms) (2h)*** ***5. Hybrid neuro-symbolic systems (types of NS combinations; examples of algorithms) (2h)*** ***6. Cognitive architectures I (ACT-R, SOAR) (2h)*** ***7. Cognitive architectures II (SPA) (2h)***	Lectures with Powerpoint presentations, explanations and answers to questions	

Course references:

1. Molnar, C. (2022). *Interpretable Machine Learning: A Guide For Making Black Box Models Explainable*, online: https://christophm.github.io/interpretable-ml-book/
2. Mishra P. (2023). Explainable AI Recipes: Implement Solutions to Model Explainability and Interpretability with Python, Apress
3. Rothman, D. (2020). *Hands-On Explainable AI (XAI) with Python: Interpret, visualize, explain, and integrate reliable AI for fair, secure, and trustworthy AI apps*, Packt Publishing
4. Dingli, A., Farrugia, D. (2023). *Neuro-Symbolic AI: Design transparent and trustworthy systems that understand the world as you do*, Packt Publishing
5. O'Reilly, R.C.; Munakata, Y. (2000). *Understanding the Mind by Simulating the Brain*. MIT Press
6. Sun, R. (ed.) (2023). *The Cambridge Handbook of Computational Cognitive Sciences*. Cambridge University Press, second edition

8.2a Seminar	Teaching methods[20]	Remarks

8.2b Laboratory	Teaching methods[21]	Remarks
1. LIME algorithm (2h) ***2. SHAP algorithm (2h)*** ***3. Layer-wise relevance propagation (LRP) (2h)*** ***4. Using the ELI5 library (2h)*** ***5. Working with the Neural Engineering Framework (NEF) (6h)***	General and individual explanations, individual computer work	

8.2c Project	Teaching methods[22]	Remarks

Applications (laboratory) references:

1. Molnar, C. (2022). *Interpretable Machine Learning: A Guide For Making Black Box Models Explainable*, online: https://christophm.github.io/interpretable-ml-book/

2. Mishra P. (2023). Explainable AI Recipes: Implement Solutions to Model Explainability and Interpretability with Python, Apress
3. O'Reilly, R.C.; Munakata, Y. (2000). *Understanding the Mind by Simulating the Brain*. MIT Press

9. Corroboration of the contents of the subject with the expectations of representatives of the epistemic community, professional associations and representative employers in the field related to the program[23]

An "Explainable and Neuro-Symbolic Learning Methods" course directly addresses the IT industry's demand for transparent AI systems, as the industry seeks interpretable AI solutions due to ethical, regulatory, and practical concerns. By combining subsymbolic principles with symbolic AI, this course prepares professionals to develop models that not only perform effectively but also provide comprehensible explanations for their decisions.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods		10.3 Weight in the final grade
10.4a Exam	Acquired theoretical and practical knowledge (quantity, correctness, accuracy)	Periodic tests[24]:		50% (minimum 5)
		Homework:		
		Other activities[25]:		
		Final evaluation:	100%	
10.4b Seminar	Frequency/relevance of interventions or responses	Record of interventions, portfolio of works (references, scientific summaries)		
10.4c Laboratory	Knowledge of equipment, how to use specific tools; evaluation of tools or achievements, processing and interpretation of results	• Practical demonstrations • Oral answers • Written questionnaires		50% (minimum 5)
10.4d Project	The quality of the completed project, the correctness of the project documentation, the justification of the chosen solutions			
10.5 Minimum performance standard[26]: grade 5 in the exam and laboratory work				

Date of completion,
4 December 2023

Signature of course coordinator,
Prof. dr. eng. Florin Leon

Signature of application instructor,
Lect. dr. eng. Otilia Zvorișteanu

Date of approval in the department,
7 December 2023

Director of department,
Assoc. prof. dr. eng. Andrei Stan

[1] *Bachelor / Master*
[2] *1-4 for Bachelor's, 1-2 for Master's*
[3] *1-8 for Bachelors, 1-3 for Masters*
[4] *Exam, colloquium or VP A/R – from the curriculum*
[5] *DF - fundamental subject, DID - subject in the field, DS - specialized subject or DC - complementary subject - from the education plan*
[6] *It is equal to 14 weeksx number of hours from point 3.1 (similar for 3.5, 3.6abc)*
[7] *The lines below refer to the individual study; the total is completed at point 3.7.*
[8] *Between 7 and 14 hours*
[9] *Between 2 and 6 hours*
[10] *The sum of the values on the previous lines, which refer to the individual study.*
[11] *The sum of the number of hours of direct teaching activity (3.4) and the number of hours of individual study (3.7); must be equal to the number of credits allocated to the subject (point 3.9)x 25 hours per credit.*
[12] *Mention the subjects that must be passed previously or equivalent*
[13] *Blackboard, video projector, flipchart, specific teaching materials, etc.*
[14] *Computing technique, software packages, experimental stands, etc.*
[15] *Competencies from the G1 and G1bis Grids of the study program, adapted to the specifics of the subject, for which credits are allocated (www.rncis.ro or the faculty website)*
[16] *From the education plan*
[17] *The credits allocated to the subject are distributed on professional and transversal competences according to the specifics of the subject*
[18] *Chapter and paragraph headings*
[19] *Exposition, lecture, blackboard presentation of the studied issue, use of video projector, discussions with students (for each chapter, if applicable)*

[20]*Discussions, debates, presentation and/or analysis of papers, solving exercises and problems*
[21]*Practical demonstration, exercise, experiment*
[22]*Case study, demonstration, exercise, error analysis, etc.*
[23]*The connection with other subjects, the usefulness of the subject on the labor market*
[24]*The number of tests and the weeks in which they will be held will be specified.*
[25]*Scientific circles, professional competitions, etc.*
[26]*The minimum performance standard from the competences grid of the study program is customized to the specifics of the subject, if applicable.*