SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Automation and Computer Science
1.3 Department	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / Qualification	Computer Science / Engineer
1.7 Form of education	Full time
1.8 Subject code	42.

2. Data about the subject

2.1 Subject name			***Intelligent systems***		
2.2 Course responsible / lecturer			Assoc.prof.dr.eng. Slăvescu Radu Răzvan - Radu.Razvan.Slavescu@cs.utcluj.ro		
2.3 Teachers in charge of applications			Assoc.prof.dr.eng. Slăvescu Radu Răzvan - Radu.Razvan.Slavescu@cs.utcluj.ro		
2.4 Year of study	III	2.5 Semester	6	2.6 Type of assessment (E - exam, C - colloquium, V - verification)	
2.7 Subject category	*DF - fundamentală, DD - în domeniu, DS - de specialitate, DC - complementară*				DS
	DI - Impusă, DOp - opțională, DFac - facultativă				OB

3. Estimated total time

3.1 Number of hours per week	4	of which:	course	2	Seminars	Laboratory	2
3.2 Number of hours per semester	56	of which:	course	28	Seminars	Laboratory	28
3.3 Time budget (per semester)							Hours
a) Manual, lecture material and notes, bibliography							18
b) Supplementary study in the library, online and in the field							5
c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays							10
d) Tutoring							6
e) Exams and tests							5
f) Other activities							0

3.4 Total hours of individual study (suma (3.3(a)...3.3(f)))	44
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	Artificial Intelligence
4.2 Competence	Fundamentals of Computer Programming, Discrete Mathematics, Calculus

5. Requirements (where appropriate)

5.1 For the course	Blackboard, Projector, Computer
5.2 For the applications	Computers with Linux, Specific Software

6. Specific competences

6.1 Professional competences	**C6 –** Design of intelligent systems • **C6.1 –** Describing the components of intelligent systems • **C6.2 –** Usage of specific instruments of the domain for explaining and understanding the functioning of intelligent systems • **C6.3 –** Application of principles and basic methods for the specification of solutions typical problems using intelligent systems • **C6.4 –** Choosing criteria and methods for the evaluation of quality, performance and limits of intelligent systems • **C6.5 –** Development and implementation of professional designs for intelligent systems
6.2 Cross competences	N/A

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

7.1 General objective	Knowledge of representation and reasoning of fundamental problems of inelligent systems.
7.2 Specific objectives	Reasoning under uncertainty, acquisition of knowledge, Machine learning (supervised, unsupervised, reinforcement.)

8. Contents

8.1. Lecture (syllabus)	Teaching methods	Notes
Introduction.	ides, Algorithms, uality of solutions, xceptions, mits in the epresentation of ne real world	
Learning from Examples. Learning decision trees.		
Hypothesis evaluation. Overfitting. Regression and classifcation. Naive Bayes classifier.		
Non-parametric learning. Support Vector Machines. K-Nearest Neighbor. Ensemble Learning.		
Artificial Neural Networks.		
Deep Learning: convolutional neural networks (CNN), recurrent Neural networks (RNN). Regularization.		
Transformers. Attention Mechanism. Language Models. Natural Language Processing with Deep Learning. Information Retrieval. Word-to-vector representation.		
Unsupervised learning. Association mining: frequent set generation, rule generation, compact representation of frequent sets		
Unsupervised learning. Data clustering algorithms. K-means. Hierarchical clustering.		
Making complex decisions: value iteration, policy iteration, partially observable MDP, game theory.		
Reinforcement Learning		
Neuro-symbolic integration. Knowledge in Learning: explanation-based learning, relevant information, Inductive Logic Programming		
BDI Agents: goals, events, plan selection, values.		
Explainable AI. Ethics and responsability.		

Bibliography:

1. Russell, Stuart, and Peter Norvig. "Artificial intelligence: a modern approach (4th edition)." *Essex: Pearson* (2020).
2. Aurelien Geron - Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow, Concepts, Tools, and Techniques to Build Intelligent Systems, 3rd Edition, O'Reilly Media, 2022
3. Tan, Pang-Ning, Michael Steinbach, and Vipin Kumar. *Introduction to data mining*. Pearson Education India, 2016.
4. LeCun, Yann, Yoshua Bengio, and Geoffrey Hinton. "Deep learning." *Nature* 521.7553 (2015): 436-444.
5. Goldberg, Yoav. "A primer on neural network models for natural language processing." *Journal of Artificial Intelligence Research* 57 (2016): 345-420.

8.2 Applications - Seminars / Laboratory / Project	Hours	Teaching methods	Observations

Learning decision trees. Evaluating classification models	2	First assessment Experiments Final assessment	
Learning linear models. Regression. Evaluating regression models	2		
Flow end2end of Machine Learning	2		
Applying Machine Learning methods on a new scenario	2		
Naive Bayes classifier, KNN, ensemble learning, Random Forest	2		
Artificial Neural Networks and training algorithms	2		
Artificial Neural Networks. Loss functions. Train monitoring. Overfitting, Underfitting	2		
Convolutional Neural Networks. Transfer learning	2		
Recurrent Neural Networks	2		
Transformers. Natural Language Processing.	2		
Unsupervised learning. Hierarchical clustering. K-means algorithm	2		
Unsupervised learning. Apriori algorithm	2		
Natural Language Processing. Parse trees. BDI agents	2		
Final assessment	2		

Bibliography:

Various AI instruments on the web.
Machine Learning Notebooks, Hands-on Machine Learning with Scikit-Learn, Keras and TensorFlow
https://github.com/ageron/handson-ml3

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

The textbook chosen for this course is used worldwide by many prestigious universities and is continuously discussed at this level by the university community and companies in the field.

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Problems and specific instruments	Written exam (moodle)	60%
Laboratory	Using and evaluating intelligent instruments	2 milestone evaluations (moodle)	40%

Minimum standard of performance:
The ability to draw specific algorithms. Ability to model realistic scenarios. The ability to propose solutions to identified problems. Ability to meet deadlines.
Calculation of the discipline grade: 40% laboratory + 60% exam
Conditions for participation in the final exam: Laboratory ≥ 5
Promotion conditions: Grade ≥ 5

Date of filling in: 26.02.2025	**Responsible**	**Title First name Last name**	**Signature**
	Course	Assoc.prof.dr.eng. Radu-Răzvan SLĂVESCU	
	Applications	Assoc.prof.dr.eng. Radu-Răzvan SLĂVESCU	

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 Muresan