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	42.00

2. Data about the subject

2.1	Subject name					***Intelligent Systems***					
2.2	Course responsible / lecturer					Prof. dr. eng Adrian Groza - Adrian.Groza@cs.utcluj.ro Conf. dr. eng. Radu Răzvan Slăvescu - Radu.Razvan.Slavescu@cs.utcluj.ro					
2.3	Teachers in charge of applications					Prof. dr. eng Adrian Groza - Adrian.Groza@cs.utcluj.ro Conf. dr. eng. Radu Răzvan Slăvescu - Razvan.Slavescu@cs.utcluj.ro Conf. dr. eng. Anca Mărginean - Anca.Marginean@cs.utcluj.ro					
2.4	Year of study	III	2.5	Semester	6	2.6	Assessment	Exam	2.7	Subject category	DS/OB

3. Estimated total time

3.1	Number of hours per week	4	of which	course	2		Lab	2
3.2	Number of hours per semester	56	of which	course	28		Lab	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

4 Requirements (where appropriate)

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

6. Specific competences

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
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 intelligent 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
1	Introduction.	Slides, Algorithms, Quality of solutions, Exceptions, Limits in the representation of the real world	
2	Learning from Examples. Learning decision trees.		
3	Hypothesis evaluation. Overfitting. Regression and classifcation. Naive Bayes classifier.		
4	Non-parametric learning. Support Vector Machines. K-Nearest Neighbor. Ensemble Learning.		
5	Artificial Neural Networks.		
6	Deep Learning: convolutional neural networks (CNN), recurrent Neural networks (RNN). Regularization.		
7	Transformers. Attention Mechanism. Language Models. Natural Language Processing with Deep Learning. Information Retrieval. Word-to-vector representation.		
8	Unsupervised learning. Association mining: frequent set generation, rule generation, compact representation of frequent sets		
9	Unsupervised learning. Data clustering algorithms. K-means. Hierarchical clustering.		
10	Making complex decisions: value iteration, policy iteration, partially observable MDP, game theory.		
11	Reinforcement Learning		
12	Neuro-symbolic integration. Knowledge in Learning: explanation-based learning, relevant information, Inductive Logic Programming		
13	BDI Agents: goals, events, plan selection, values.		
14	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 (seminary/lab/project)	Hours	Teaching methods	Observations
1. Learning decision trees. Evaluating classification models	2	First assessment Experiments Final assessment	
2. Learning linear models. Regression. Evaluating regression models	2		
3. Flow end2end of Machine Learning	2		
4. Applying Machine Learning methods on a new scenario	2		
5. Naive Bayes classifier, KNN, ensemble learning, Random Forest	2		
6. Artificial Neural Networks and training algorithms	2		
7. Artificial Neural Networks. Loss functions. Train monitoring. Overfitting, Underfitting	2		
8. Convolutional Neural Networks. Transfer learning	2		
9. Recurrent Neural Networks	2		
10. Transformers. Natural Language Processing.	2		
11. Unsupervised learning. Hierarchical clustering. K-means algorithm	2		
12. Unsupervised learning. Apriori algorithm	2		
13. Natural Language Processing. Parse trees. BDI agents	2		
14. 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	10.1	Assessment criteria	10.2	Assessment methods	10.3	Weight in the final grade
Course		Problems and specific instruments		Written exam (moodle)		60%
Lab		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: 12.06.2024	**Teachers**	**Title First name Last name**	**Signature**
	Course	Prof.dr.eng. Adrian Groza	
	Applications	Prof.dr.eng. Adrian Groza	
		Conf.dr.eng. Radu-Răzvan Slăvescu	
		Conf.dr.eng. Anca Mărginean	

Date of approval in the department 20.20.2024	Head of department, Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council 22.02.2024	Dean, Prof.dr.eng. Mihaela Dînșoreanu