National University of Science and Technology POLITEHNICA Bucharest

Faculty of Automatic Control and Computers

SYLLABUS

1. Program information

1.1 Higher Education Institution	**National University of Science and Technology POLITEHNICA Bucharest**
1.2 Faculty	**Faculty of Automatic Control and Computer**
1.3 Department	**Computer Science**
1.4 Domain	**Computers and Information Technology**
1.5 Study program	**Artificial Intelligence**
1.6 Study cycle	**Master**
1.7 Teaching language	**English**
1.8 Geographical location of the studies	**Bucharest**

2. Course data

2.1 Course title (ro) (en)			**Reprezentarea cunoștințelor / Knowledge Representation and Reasonig**				
2.2 Course holder			Prof. dr. ing. Adina Magda Florea				
2.3 Seminar/ Laboratory/ Project holder			S.l. dr. ing. Alexandru Sorici				
2.4 Academic year	1	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob[1]
2.8 Type of discipline		DS[2]	2.9 Discipline code		UPB.03.CTI.M.05.E.I.Ob.1		

3. Total estimated time (hours of activity per semester)

3.1 Number of hours per week	4	3.2 course	2	3.3 seminary/ laboratory/ project	2
3.4 Total hours of the curriculum	56	3.5 course	28	3.6 seminary/ laboratory/ project	28
Distribution of time:					ore
Study by manual, course support, bibliography, and notes Additional documentation in the library, on specialized platforms and on the ground Preparing seminars / laboratories / practical works / projects, themes, papers					62
Tutoring					3
Examinations					4
Other activities (if any):					0
3.7 Total hours of individual study	**69**				
3.8 Total hours per semester	**125[3]**				
3.9 Number of ECTS	**5[4]**				

4. Prerequisites (where applicable)

4.1 curriculum	Completing and/or passing the following disciplines: Computer Programming, Data Structures and Algorithms, Linear Algebra, Software Engineering
4.2 learning outcomes	• Good command of a programming language, basic knowledge of Python, Search techniques

[1] *Obligatorie / Opțională / Facultativă – Se va completa conform planului de învățământ.*
[2] *de aprofundare/ de sinteză / complementare – Se va completa conform planului de învățământ..*
[3] *Se va calcula ținând cont că se acordă un credit pentru volumul de muncă care îi revine unui student cu frecvență la zi pentru a echivala 25 de ore de pregătire pentru dobândirea rezultatelor învățării.*
[4] Se va completa conform planului de învățământ.

5. Requirements for the optimal performance of teaching activities (where applicable)

5.1 Lecture	• The course will be taught in an interactive way using presentations and examples • The course will take place in a room equipped with video projector and computer. • Students will have access to the digital support of the course and its bibliography
5.2 seminary/laboratory/ project	• The laboratory will take place in a room equipped with computers and a video projector • Students will have access to the laboratory's digital support and its bibliography • Students will use the computers to solve the practical exercises in the laboratory support

6. General objective of the course

The course offers in-depth knowledge on different models of problem solving based on Artificial Intelligence techniques that are centered on both symbolic and non-symbolic representations of the problem domain. It is designed to offer students the understanding of different knowledge representation models and methods and their use in problem solving.

7. Learning outcomes

Knowledge	• Design and implementation of artificial intelligence-based systems that use knowledge and automatic reasoning • Assimilation of knowledge representation methods and techniques and automatic reasoning specific to each representation model, symbolic and non-symbolic • Use of knowledge representation models in problem solving • Understanding the opportunities offered by automatic knowledge processing; • Ability to program automatic reasoning algorithms; • Understanding the appropriate cases where the studied techniques are useful.
Skills	• Implementation of artificial intelligence-based systems that use knowledge and automatic reasoning • Justify the identified solutions and methods. • Experimentally test the implemented applications. • Argue the identified solutions and methods of resolution. • Formulate conclusions based on the conducted experiments.

Responsibility and autonomy	• Select appropriate bibliographic sources and analyze them. • Adhere to the principles of academic ethics, correctly citing the bibliographic sources used. • Show collaboration with other students and teaching staff in conducting educational activities. • Demonstrate receptiveness to new learning contexts. • Demonstrate autonomy in organizing the learning situation/context or the problem situation to be solved. • Collaborate with other colleagues and teachers in the conduct of teaching activities. • Apply principles of professional ethics/deontology in analyzing the technological impact of the proposed solutions in the field of specialization on the environment. • Demonstrate real-life situation management skills (time management, collaboration vs. conflict).

8. Teaching methods

Based on the analysis of students' learning characteristics and their specific needs, the teaching process employs methods such as expository teaching (lectures, presentations), conversation-interactive approaches as well as action-based methods (problem-solving and discovery-based learning within homework assignments).

Teaching activities involve lectures focus on understanding the principles and techniques of knowledge representation and reasoning in Artificial Intelligence. Students are supported in practicing discovery-based learning by solving and then discussing homework assignments.

Active listening, presentation, explanation, and assertive communication skills of students are exercised through discussions with the students for assessing progress in developing their project, discuss encountered issues, clarify necessary concepts through concrete examples.

09. Content

LECTURE

Chapter	*Content*	*no. of hours*
I	Introduction to knowledge represenation for artificial intelligence	2
II	Semantic knowledge representation: Description Logics (DL)	2
III	Semantic knowledge representation: OWL	2
IV	Probabilistic graphical models – Bayesian networks (BN)	4
V	Probabilistic graphical models – Learning in BN	4
VI	Expectation Maximization (EM)	2
VII	Probabilistic graphical models – Hidden Markov Models (HMM)	4
VIII	Probabilistic graphical models – Learning in HMM	2
IX	Basic principles of Large Language Models (LLM)	2
X	Using LMM in problem solving	4
	Total:	**28**

Bibliography:

1. *A.M. Florea, Knowledge Representation and Reasoning, electronic course support,* https://curs.upb.ro/2023/course/view.php?id=4669
2. *Artificial Intelligence: A Modern Approach* (4rd Edition) by Stuart Russell and Peter Norvig Prentice Hall, 2020 http://aima.cs.berkeley.edu/
3. *Probabilistic Graphical Models. Principles and Techniques* by Daphne Koller and Nir Friedman, MIT Press, 2009, https://mitpress.mit.edu/books/probabilistic-graphical-models

4. https://tinyurl.com/y6zbpua3
5. A number of papers from scientific literature that students have to read

SEMINARY/LABORATORY/ PROJECT		
Chapter	*Content*	*no. of hours*
1.	Presentation of laboratories and requirements, protocols	2
2.	Use of Description Logics fro modeling and problem solving	2
3.	Use of OWL language fro building an application	2
4.	Inferences in BN, separability, variable elimination, Junction Trees	4
5.	Learning algorithm implementation in BN	4
6.	Implementing EM for BN	2
7.	Solving the first 2 problems of HMM	4
8.	Implement learning in HMM (EM for HMM)	2
9.	Using a LLM fro solving 2 specific problems	2
10.	Prompt engineering exercises	4
	Total:	**28**

Bibliography:

1. *A.M. Florea, Knowledge Representation and Reasoning, suport de curs electronic,* https://curs.upb.ro/2023/course/view.php?id=4669
2. *Artificial Intelligence: A Modern Approach* (4rd Edition) by Stuart Russell and Peter Norvig Prentice Hall, 2020 http://aima.cs.berkeley.edu/
3. *Probabilistic Graphical Models. Principles and Techniques* by Daphne Koller and Nir Friedman, MIT Press, 2009, https://mitpress.mit.edu/books/probabilistic-graphical-models

10. Assessment

Activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Lecture	Correctness of problem solving	Written exam	30 points
	Midterm exam	Written exam	20 points
	Class activity (bonus points)	Tests	10 points
10.5 Seminar / Laboratory / Project	Correctness of solving laboratory work and homeworks	Individual evaluation	50 points
10.6 Conditions for passing			
Obtaining minimum 50% from each category.			

Date

Course holder
Prof. dr. ing. Adina Magda Florea

Applications holder
S.l.. dr. ing. Alexandru Sorici

Date of approval in the department

Department director
Prof. dr. Emil Slusanschi

National University of Science and Technology
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Faculty of Automatic Control and Computers

Date of approval in the Faculty Council

Dean
Prof. dr. ing. Mihnea Moisescu