COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Applied Electronics and Information Engineering**
1.4 Domain of studies	Computers and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Information Engineering

2. Date despre disciplină

2.1 Course name (ro) (en)				Inteligență artificială 1 Artificial Inteligence			
2.2 Course Lecturer				Prof. Dr. Corneliu Nicolae FLOREA			
2.3 Instructor for practical activities				S.l Dr. Ing Andrei RACOVITEANU; As. Drd. Andreea NITU			
2.4 Year of studies	3	2.5 Semester	II	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		D	2.9 Course code	04.D.06.O.015		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	3	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	14
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					27
Tutoring					0
Examinations					6
Other activities (if any):					0

3.7 Total hours of individual study	33.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	1. Data structures and algorithms 2. Special mathematics 3. Linear algebra
4.2 Results of learning	1. programming, 2. general knowledge of algebraic calculation

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	The course will take place in a room equipped with both a projector and a classic blackboard
5.2 Seminary/ Laboratory/Project	The lab will take place in a room equipped with computers that have installed a Python-based environment (such as Anaconda)

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

The study of the basic principles of artificial intelligence, respectively machine learning. Training skills for measuring and evaluating structures with autonomous decision in order to realize reliable artificial learning pipeline under conditions of uncertainty. Introduction to basic methods for artificial learning, training, optimization, data, cost function, classification, regression, intelligent agent. Preparation of notions specific to machine learning.

The applications aim to enhance the student's understanding of the concepts taught in the course. Also, the application classes aim to enrich the students' understanding of the practical importance of automatic data analysis, by specifying the practical applications of the discussed methods.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	• Demonstrates basic knowledge of artificial intelligence. It correlates the knowledge related to the field of Artificial Intelligence with that of special mathematics and computer programming. • Apply knowledge in practice It applies standardized methods and tools, specific to the field, to carry out the evaluation and diagnosis process of a situation, depending on the identified/reported problems, and identifies solutions. • It argues and analyzes coherently and correctly the context of application of the basic knowledge of the field, using key concepts of the discipline and the specific methodology. • Oral and written communication in Romanian: uses the scientific vocabulary specific to the field, in order to communicate effectively, in writing and orally. • Oral and written communication in a foreign language (English): demonstrates understanding of subject-related vocabulary in a foreign language.

Transversal (General) Competences	• He works in a team and communicates effectively, coordinating his efforts with others to solve problem situations of medium complexity. • Autonomy and critical thinking: the ability to think in scientific terms, search and analyze data independently, and draw and present conclusions / identify solutions. • Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a process of systematic analysis. • Respect the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity. • Puts elements of emotional intelligence into practice in the appropriate social-emotional management of real-life/academic/professional situations, demonstrating self-control and objectivity in decision-making or stressful situations.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* • He/she lists the most important stages that marked the development of the field. • Defines domain-specific notions: intelligent agent, data, training, optimization, objective function, expert systems, classification, regression, supervised. • Describes and classifies notions related to artificial intelligence, the process of building a modern intelligent agent. Understand autonomous learning phenomena. Understand the limits of practical applicability • He/she highlights consequences of the choices made and the relationships between them. It emphasizes that the most common practical case is that of imperfect optimization, which involves the practical trade-off

Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* • Select and group relevant information for artificial intelligence in a given context. • Reasonably uses specific principles to solve problems that can benefit from an intelligent agent. • Work productively in a team during laboratory applications. • Elaborates a scientific text on the occasion of the report accompanying the project. • Experimentally verifies identified solutions both in the laboratory and in the case of the project. • Solve practical applications.Development of the field, especially of the direction of machine learning, easily allows the creation of distinct themes, of comparable difficulty for large volumes of students so as to allow individualization • Adequately interpret causal relationships. • Analyze and compare the performance and limits of different intelligent systems. • The project assignment requires the correct identification of solutions and the development of solution plans/projects. Formulates conclusions to the experiments carried out. • Argue the identified solutions/solutions
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Select appropriate bibliographic sources and analyze them. • Respect the principles of academic ethics, correctly citing the bibliographic sources used. • Demonstrates responsiveness to new learning contexts. • Demonstrates collaboration with other colleagues and teaching staff in carrying out teaching activities • Demonstrates autonomy in organizing the learning situation/context or situation problem to solve • Demonstrates social responsibility through active involvement in student social life/involvement in the events of the academic community • Promotes/contributes new solutions related to the specialized field to improve the quality of social life. • Realizes the value of his engineering contribution to the identification of solutions viable/sustainable to solve problems in social and economic life (responsibility social). • Applies principles of professional ethics/deontology in analyzing the technological impact of solutions proposed in the specialized field on the environment. • Analyzes and capitalizes on business/entrepreneurial development opportunities in the field of specialty. • Demonstrates real-life situation management skills

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Starting from the analysis of students' learning characteristics and their specific needs, the teaching process will explore modern teaching methods based on slides, animations and other media, as well as conversational-interactive, based on learning models through discovery facilitated by direct and indirect exploration of reality (experiment, demonstration, modelling), but also by action-based methods, such as exercise, practical activities and problem solving. For the subject sections with a pronounced
character of mathematical calculation, teaching with chalk on the blackboard will be used. Being an introductory discipline, the teaching activity will be focused on introducing concepts and exemplifying. Each exposition is framed by an exposition of the practical necessity and a discussion on the applicability of the results. Presentations frequently call for suggestive drawings or graphics, so that the information presented is easy to understand and assimilate.
This discipline covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a climate conducive to discovery learning. It will be considered the practice of active listening and assertive communication skills, as well as feedback construction mechanisms, as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs. Teamwork skills will be practiced to solve different learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	The AI issue: Definitions. The Turing Test. Classification of intelligent systems	2
2	Expert systems: The components of an expert system. Types of expert systems. Formalization of expert systems	2
3	Statistical approaches in artificial intelligence: One-dimensional random variables; Holistic descriptions; Moments; Practical approximations; Multidimensional random variables; Statistical simulation.	4
4	The problem in machine learning: the components; the performance of an ML system; types of learning; Capacity of a model; Limits of learning.	3
5	Non-parametric classification: "Nearest neighbor" rule. Voronoi diagram	1
6	Numerical optimization: Mathematical formulation; Optimization of functions of unidimensional variable; Optimization of functions with multidimensional variable: gradient-based and Newton-type methods; Constrained optimization	3
7	Clustering: problematic. K Means. Hierarchical clustering. DB-Scan.	2
8	Decision trees: classification tree; regression tree. Pruning. Ensembles: aggregation; randomness	3
9	Neural networks: The perceptron; the Delta rule. The Multi-Layer Perceptron: Nonlinear functions; back-propagation. Numerical example. Gradient vanishing	4
10	Support vector machines: formulation - wide classifier; derivation; kernel functions. Multiclass classification with binary classifiers. Support vector machines for regression.	4
	Total:	28

Bibliography:

1. Corneliu Florea, Laura Florea "Inteligență artificială"/ - Editura Universității "Transilvania" din Brașov, 2023 Brașov, ISBN 978-606-19-1635-5, 236 pag.
2. Corneliu Florea "Ingineria Sistemelor cu Inteligenta Artificiala" note de curs disponibile la https://curs.upb.ro/2021/course/view.php?id=10705.
3. Corneliu Florea, Mihai Ciuc "Analiza faciala automată" - editura Politehnica Press, Bucuresti 2016, ISBN 978-606-515-1, 221 pag. Cod CNCSIS 19,
4. Badea, M., Florea, C., Racoviţeanu, A., Florea, L. and Vertan, C., 2023. Timid semi–supervised learning for face expression analysis. Pattern Recognition, 138, p.109417.
5. C. Florea, F. Gieske, "Artistic movement recognition by consensus of boosted SVM based experts", Journal of Visual Communication and Image Representation, Vol 56, pp. 220-233, 2018
6. Stuart Russell, Peter Norvig Artificial Intelligence: A Modern Approach, Pearson, disponibila la https://zoo.cs.yale.edu/classes/cs470/materials/aima2010.pdf
7. Fernández-Delgado, Manuel, Eva Cernadas, Senén Barro, and Dinani Amorim. "Do we need hundreds of classifiers to solve real world classification problems?." The Journal of Machine Learning Research 15, no. 1 (2014): 3133-3181.
8. Christopher M. Bishop, Pattern recognition and Machine learning, Springer ISBN-10: 0-387-31073-8, 2006. Disponibil la http://users.isr.ist.utl.pt/~wurmd/Livros/school/Bishop%20-%20Pattern%20Recognition%20And%20Machine%20Learning%20-%20Springer%20%202006.pdf
9. Ethem Alpaydın "Introduction to Machine Learning" The MIT Press, ISBN 978-0-262-01243-0,2010
10. Alex Smola and S.V.N. Vishwanathan "Introduction to Machine Learning"Cambridge University Press, ISBN 0-521-82583-0, 2008.
11. Ian Goodfellow, Yoshua Bengio, Aaron Courville, „Deep Learning" www.deeplearningbook.org, 2017

LABORATORY

Crt. no.	Content	No. hours
1	Python (Panda, Numpy, Scikit-learn, OpenCv): Familiarization with the working environment. Packages for reading and formatting data	2
2	Python: Expert Systems	2
3	Python (Scikit learn): Clustering (K-means). Nearest neighbor	2
4	Python (Scikit learn): Decision trees. Random Forest	2
5	Python (Scikit learn): Multilayer Perceptron	2
6	Python (Scikit learn): Support vector machines	2
7	Final laboratory colloquium	2
	Total:	14

Bibliography:

1. Mihai Badea, Andrei Racoviteanu, Corneliu Florea " Introduction in Machine learning" Îndrumar de laborator, în curs de editare. Disponibil Online la https://curs.upb.ro/2021/course/view.php?id=10705
2. Corneliu Florea, Mihai Ciuc "Analiza faciala automată" - editura Politehnica Press, Bucuresti 2016, ISBN 978-606-515-1, 221 pag. Cod CNCSIS 19
3. Christopher M. Bishop, Pattern recognition and Machine learning, Springer ISBN-10: 0-387-31073-8, 2006.
4. Ethem Alpaydın "Introduction to Machine Learning" The MIT Press, ISBN 978-0-262-01243-0,2010
5. Alex Smola and S.V.N. Vishwanathan "Introduction to Machine Learning" Cambridge University Press, ISBN 0-521-82583-0, 2008

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Acquisition of fundamental theoretical notions; students will answer a number of questions formulated in such a way as to test the fact that they have understood the concepts they are working with. Various practical problems that benefit from an autonomous and intelligent solution will be formulated and the conceptual application of the defined notions will be verified. He/she gets discouraged thus to learn the concepts by heart	Written exam	20
	The student's ability to solve problems practices related to the concepts taught in the course. They will evaluate search, optimization, learning problems	Written exam	20
11.5 Seminary/laboratory/project	Laboratory: The ability to solve on the computer an artificial intelligence problem	Colloquium on the computer and oral assessment	30
	Homework/Project: Project: Making an application that involves machine learning on a given database. System performance evaluation. Discussion and argumentation of the results obtained	Oral evaluation	30
11.6 Passing conditions			
Obtaining 50% of the total score.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

Through the activities carried out, students develop skills to correctly identify problems that can be effectively addressed with methods specific to artificial intelligence. It aims to strengthen the ability to offer solutions to problems and to propose ideas to improve the situation of existence in the field of artificial intelligence. In the development of the content of the discipline, necessary knowledge in modern economic practice in information technology was taken into account. Materials from specialized literature were also used to select the most robust solutions, but at the same time, the level of preparation of the students at which this subject will be developed was taken into account. Over 10 years of research experience
both fundamental and industrial practice of the holders allows effective filtering of the subject. An important objective of this subject is to introduce the field of Artificial Intelligence to students, so that they have an accurate understanding and can decide in an informed manner if they are interested in the field. We do not propose to present the existing solutions exhaustively, but only to make an introductory presentation. Through statistical analysis activities with intelligent systems, the development of the graduate's skills to manage practical situations that can be faced in real life in order to grow is considered his contribution to the improvement of the socio-economic environment.

Date	Course lecturer	Instructor(s) for practical activities
14.10.2024	Prof. Dr. Corneliu Nicolae FLOREA	S.l. Dr. Ing Andrei RACOVITEANU
		As. drd. Andreea NITU

Date of department approval	Head of department
16.10.2024	Conf. Dr. Bogdan Cristian FLOREA

Date of approval in the Faculty Council	Dean
01.11.2024	Prof. Dr. Mihnea Udrea

Universitatea Națională de Știință și Tehnologie Politehnica București

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