SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of 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	48.1

2. Data about the subject

2.1 Subject name				***Pattern recognition systems***	
2.2 Course responsible / lecturer				Prof. dr. eng. Nedevschi Sergiu - Sergiu.Nedevschi@cs.utcluj.ro	
2.3 Teachers in charge of seminars / laboratory / project				Prof. dr. eng. Oniga Florin - Florin.Oniga@cs.utcluj.ro Assoc. prof. eng. Giosan Ion - Ion.GIOSAN@cs.utcluj.ro	
2.4 Year of study	IV	2.5 Semester	7	2.6 Type of assessment (E - exam, C - colloquium, V - verification)	E
2.7 Subject category	*DF – fundamentală, DD – în domeniu, DS – de specialitate, DC – complementară*				DS
	DI – Impusă, DOp – opțională, DFac – facultativă				DOp

3. Estimated total time

3.1 Number of hours per week	5	of which:	Course	2	Seminars	-	Laboratory	2	Project	1
3.2 Number of hours per semester	70	of which:	Course	28	Seminars	-	Laboratory	28	Project	14
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										28
(b) Supplementary study in the library, online and in the field										20
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										23
(d) Tutoring										4
(e) Exams and tests										5
(f) Other activities:										0

3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))	80
3.5 Total hours per semester (3.2+3.4)	150
3.6 Number of credit points	6

4. Pre-requisites (where appropriate)

4.1 Curriculum	Image Processing
4.2 Competence	Computer programming, Data structures and algorithms, Probability Theory, Linear Algebra, Artificial Intelligence.

5. Requirements (where appropriate)

5.1. For the course	Blackboard, video projector, computer
5.2. For the applications	Workstations, specific software (Visual Studio, OpenCV, Python)

6. Specific competence

6.1 Professional competences	**C4 –** Improving the performances of the hardware, software and communication systems (2 credits) • **C4.1 -** Identifying and describing the defining performance elements of hardware, software and communication systems

	• **C4.2 -** Explaining the interaction of the factors that determine the performances of hardware, software and communication systems • **C4.3 -** Applying fundamental methods and principles for increasing performance of hardware, software and communication systems • **C4.4 -** Choosing criteria and methods for performance evaluation of hardware, software and communication systems • **C4.5 -** Developing performance based professional solutions for hardware, software and communication systems **C5 –** Designing, managing the lifetime cycle, integrating and ensuring the integrity of hardware, software and communication systems (2 credits) • **C5.1 -** Specifying the relevant criteria regarding the lifetime cycle, quality, security and the computing system's interaction with the environment and the human operator • **C5.2 -** Using interdisciplinary knowledge for adapting the computing system to the specifc requirements of the application field • **C5.3 -** Using fundamental principles and methods for ensuring the security, the safety and ease of exploitation of the computing systems • **C5.4 -** Adequate utilization of quality, safety and security standards in information processing • **C5.5 -** Creating a project including the problem's identification and analysis, its design and development, also proving an understanding of the basic quality requirements **C6 –** Designing intelligent systems (2 credits) • **C6.1 -** Describing intelligent systems' components • **C6.2 -** Using domain-specific tools for explaining the operation of intelligent systems • **C6.3 -** Applying fundamental methods and principles for specifying solutions for typical problems using intelligent systems • **C6.4 -** Choosing criteria and methods for the evaluation of quality, performances and limitations of information systems • **C6.5 -** Developing and implementing professional projects for intelligent systems
6.2 Cross competences	N/A

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

7.1 General objective	Knowledge, understanding and use of concepts related to pattern recognition.
7.2 Specific objectives	Knowledge, understanding and use of model-based pattern recognition methods using statistical approaches, linear discriminant methods, support vectors, and ensemble of classifiers. Knowledge, understanding and use of the specific operations of a pattern recognition system: data preprocessing, dimensional reduction, relevant feature selection, building the prediction model, selection of the optimum model, performance analysis.

8. Contents

8.1 Lectures	Hours	Teaching methods	Notes
Introduction	2	Interactive teaching, using oral presentations supported by multimedia tools, consultations, involving students in research and	
Probability and Linear Algebra Review	2		
Bayesian Decision Theory 1	2		
Bayesian Decision Theory 2	2		
Parametric Methods for Density Estimation	2		
Nonparametric Methods for Density Estimation	2		
Linear Discriminant Functions; Perceptron	2		
Kernel Methods and Support Vector Machines	2		

Clustering and dimensionality reduction	2	development activities.	
Ensemble Methods	2		
Image Classification Pipeline	2		
Loss Functions and Optimization	2		
Back Propagation and Neural Networks	2		
Convolutional Neural Networks	2		

Bibliography:

1. Richard O. Duda, Peter E. Hart , David G . Stork, "Pattern Clasification", *John Wiley and Sons,* 2001.
2. C.M. Bishop, "Pattern Recognition and Machine Learning", *Springer*, 2006
3. K. Murphy, "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012
4. K. Murphy, "Probabilistic Machine Learning: An Introduction, The MIT Press, 2022
5. Convolutional Neural Networks for Visual Recognition, http://cs231n.stanford.edu, 2023
6. S. Nedevschi, "Lecture Notes", ftp.utcluj.ro/pub/users/nedevschi/PRS/

8.2 Applications - Seminars / Laboratory / Project	Hours	Teaching methods	Notes
Laboratory			
Introduction	2	Presentation using the blackboard and multimedia tools. Experiments and implementation using specific software tools (MS Visual Studio, OpenCV, Python). Evaluation of the design and implementation phases.	
Least Mean Squares Line Fitting	2		
RANSAC – fitting a line to a set of points	2		
Hough Transform for line detection	2		
Distance Transform (DT). Pattern Matching using DT	2		
Statistical analysis of data	2		
Principal Component Analysis	2		
K-means Clustering	2		
K-Nearest Neighbor Classifier	2		
Naïve Bayes Classifier: Simple Digit Recognition Application	2		
Linear classifiers. Perceptron algorithm	2		
Support Vector Machine	2		
Adabost with Decision Stumps	2		
Lab Assessment	2		
Project			
Topic assignment (week 1, 2)	2		
Analyzes, specification and design (week 3,4)	2		
Presentation of the approach (week 5,6)	2		
Implementation (week 6,7,8,9,10); Intermediate pres. (week 9,10)	2		
Evaluation and optimization (week 11,12)	2		
Report elaboration (week 12,13)	2		
Final Presentation (week 13,14)	2		

Bibliography:

1. Richard O. Duda, Peter E. Hart , David G . Stork, "Pattern Clasification", *John Wiley and Sons,* 2001.
2. C.M. Bishop, "Pattern Recognition and Machine Learning", *Springer*, 2006
3. K. Murphy, "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012
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5. Convolutional Neural Networks for Visual Recognition, http://cs231n.stanford.edu, 2023
6. S. Nedevschi, "Lecture Notes", ftp.utcluj.ro/pub/users/nedevschi/SRF/
7. S.Nedevschi, & all, Pattern Recognition Systems - Laboratory Works, UT Press, 2023.

[*] *Se vor preciza, după caz: tematica seminariilor, lucrările de laborator, tematica și etapele proiectului.*

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

The subject is part of the Computer Science and Information Technology curriculum, its contents combining fundamental and practical aspects used in the field of pattern recognition. The subject content is correlated with the

specific curricula of other Universities, in Romania and abroad, and is evaluated by government agencies (CNEAA and ARACIS). The subject's activities are meant to make the students familiar with the applications and the research directions of the image processing field, helped by the internationally renowned experience of the teachers.

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Testing the theoretical knowledge acquired, and the practical abilities of problem solving.	Written exam	50%
Seminar	-	-	-
Laboratory	Testing the practical abilities of designing and implementing solutions to specific problems. Attendance and activity.	Lab assessment, project assessment	50%
Project			
Minimum standard of performance: Modeling and implementation of solutions to specific engineering problems, using the domain's formal apparatus. Grade calculus: 25% laboratory +25% project + 50% final exam Conditions for participating in the final exam: Laboratory ≥ 5, project ≥ 5 Conditions for promotion: grade ≥ 5			

Date of filling in: 26.02.2025	**Responsible**	**Title, First name Last name**	**Signature**
	Course	Prof. dr. eng. Sergiu NEDEVSCHI	
	Applications	Prof. dr. eng. Florin ONIGA	
		Assoc. prof. dr. eng. Ion GIOSAN	

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 Mureșan