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	Master
1.6 Program of study / Qualification	
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Natural Language Processing***			Subject code	**15.00**
2.2 Course responsible / lecturer	Prof. dr. eng. Lemnaru Camelia - camelia.lemnaru@cs.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	As. drd. eng. Negru Vlad-Andrei - Vlad.Negru@cs.utcluj.ro				
2.4 Year of study	2	2.5 Semester	1	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DA – advanced, DS – speciality, DC – complementary				DS
	Optionality: DI – imposed, DO – optional (alternative), DF – optional (free choice)				DI

3. Estimated total time

3.1 Number of hours per week	3	of which:	Course	2	Seminars	-	Laboratory	1	Project	-
3.2 Number of hours per semester	42	of which:	Course	28	Seminars	-	Laboratory	14	Project	-
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										20
(b) Supplementary study in the library, online and in the field										20
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										10
(d) Tutoring										5
(e) Exams and tests										3
(f) Other activities:										-

3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))	58
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	Machine Learning 1
4.2 Competence	Linear algebra, programming, logics, basic statistics

5. Requirements (where appropriate)

5.1. For the course	white/black-board, projector, PC/laptop
5.2. For the applications	white/black-board, projector, PC/laptop

6. Specific competence

6.1 Professional competences	1. Working with advanced mathematical methods and models, engineering and computing specific techniques and technologies. 2. Development of advanced techniques, methods and methodologies in the domains of software design, programming systems and environments and their applications. 3. Innovative design of machine learning systems and related software and hardware using the specific tools. 4. Contextual integration and exploitation of dedicated information systems. 5. Creative pooling of multidisciplinary knowledge in the field of computers and information technology for research, design, optimization, implementation and testing of theories, algorithms and original methods specific to artificial intelligence and computer vision systems.
6.2 Cross competences	1. Proof of knowledge for the economic, ethical, legal and social context associated with the profession, for correct task identification, schedule of activities, responsible decisions, with the final goal the design, preparation and presentation of a scientific paper. 2. Clear and concise description of professional activity flows, tasks and outcomes obtained by assuming the role of leader / project manager or as a member of a research team, as result of personal skills of domain specific information synthesis, global vision, communication skills with collaborators, ability of task stages identification. 3. Exercising the skill of continuous self-education and demonstrating critical, innovative and research abilities

7. Expected Learning Outcomes

Knowledge	NLP fundamental concepts NLP algorithms for various tasks (text classification, sequence tagging, structured classification, text generation) NLP frameworks and libraries data analytics tools data models data storage alternatives data warehouse principles database management systems (DBMS) digital data processing methods algorithms for dealing with unstructured data statistics computer programming software design principles software libraries

Skills	The student is able to: • create data sets • develop NLP and data analytics pipelines • implement NLP algorithms from scratch • evaluate the performance of NLP algorithms • deploy NLP models • establish data processes • manage data • perform dimensionality reduction • interpret technical requirements • use software design patterns • use software libraries • adapt to changes in technological development plans • design user interfaces • implement front-end website designs • use markup languages
Responsibilities and autonomy	The student has the ability to work independently in order to: • develop an analytical approach • take a proactive approach • develop strategies to solve problems • be open minded • coordinate engineering teams

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

8.1 General objective	Understanding basic concepts in natural language processing, the main types of architectures for solutions and challenges associated
8.2 Specific objectives	Understanding and being able to develop and utilize the most important algorithms in NLP. Operate with known frameworks and software tools for NLP.

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Introduction to NLP: history, applications and more	2	Presentations, discussions	
Text preprocessing and representation. Text classification	2		
Structured learning - syntactic parsing, semantic parsing	2		
Pre-transformer sequence modelling	2		
Attention mechanisms and the transformer architecture	2		
Transformer architecture variations	2		
Decoder-only models	2		
Reinforcement Learning and LLMs	2		
Reasoning, grounding, context building with LLMs	2		
Knowledge Graphs and LLMs	2		
Multilinguality and low-resource languages	2		
Bias, ethics, and interpretability	2		
Selected topics in NLP discussion	2		
Review	2		

Bibliography:

- Speech and Language Processing (3rd ed. draft) Dan Jurafsky and James H. Martin
- Mihai Surdeanu, Marco A. Valenzuela-Escárcega (2023). Deep Learning for Natural Language Processing: A Gentle Introduction. Cambridge University Press.
- All Stanford NLP tools: http://nlp.stanford.edu/software/index.shtml

9.2 Applications - Seminars/Laboratory/Project	Hours	Teaching methods	Notes

Tokenization Methods	2	Presentations, discussions, live coding	
Text Classification	2		
Part-of-speech taggin	2		
Cross-lingual transfer in encoder-based language models	2		
Machine Translation	2		
Question Answering	2		
Explainable AI	2		

Bibliography

- Explosion tools (SpaCy, ProdiGy) si HuggingFace
- Selected kaggle.com scripts (https://www.kaggle.com/)

*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 contents of this course are in line with the curricula of top universities around the globe (see bibliography sections). Moreover, the contents of the course cover the most important conceptual and technical aspects needed to develop machine learning solutions at industry level).

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	The ability to solve problems specific to the domain. Course participation and involvement	Final Evaluation	50%
Seminar	-	-	-
Laboratory	The ability to implement and evaluate specific solutions for the proposed problems	Bi-weekly laboratory assessments, final assignment	50%
Project	-	-	-
Minimum standard of performance: Minimum lab grade 5, Minimum final grade: 5			

Date of filling in: 01.09.2025	**Responsible**	**Title First name Last name**	**Signature**
	Course	Prof.dr.ing. Camelia Lemnaru	
	Applications	As.pd.ing. Vlad-Andrei Negru	

Date of approval in the department 17.09.2025	Head of department, Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council 19.09.2025	Dean, Prof.dr.eng. Vlad Mureșan