SYLLABUS

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Electronics, Telecommunications and Information Technology
1.3 Department	Communications
1.4 Field of study	Electronic Engineering, Telecommunications and Information Technologies
1.5 Cycle of study	Master of Science
1.6 Program of study / Qualification	Multimedia Technologies / Master
1.7 Form of education	Full time
1.8 Subject code	TM-E17.20

2. Data about the subject

2.1 Subject name	Deep Learning for Telecommunications (DLT)						
2.2 Subject area	Electronics and Telecommunications Engineering, Software Engineering						
2.3 Course responsible	Assoc. Prof. Adriana STAN, Ph.D. Adriana.Stan@com.utcluj.ro						
2.4 Teacher in charge with seminar / laboratory / project	Assoc. Prof. Adriana STAN, Ph.D. Adriana.Stan@com.utcluj.ro						
2.5 Year of study	2	2.6 Semester	3	2.7 Assessment	E	2.8 Subject category	DA/DO

3. Estimated total time

3.1 Number of hours per week	4	of which: 3.2 course	2	3.3 laboratory	1
3.4 To Total hours in the curriculum	42	of which: 3.5 course	28	3.6 laboratory	14
Distribution of time					hours
Manual, lecture material and notes, bibliography					20
Supplementary study in the library, online specialized platforms and in the field					12
Preparation for seminars / laboratories, homework, reports, portfolios and essays					20
Tutoring					3
Exams and tests					3
Other activities:					

3.7 Total hours of individual study	58
3.8 Total hours per semester	100
3.9 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 curriculum	Algorithms, Linear algebra, Calculus, Programming
4.2 competence	Programming competences

5. Requirements (where appropriate)

5.1. for the course	Video-projector, screen, whiteboard, Cluj-Napoca

5.2. for the seminars / laboratories / projects	Computers with internet access, Cluj-Napoca

6. Specific competences

Professional competences	C2. Applying the basic methods for the acquisition and processing of signals C3. Application of the basic knowledge, concepts and methods regarding the architecture of computer systems, microprocessors, microcontrollers, languages and programming techniques C4. Design, implementation and operation of data, voice, video and multimedia services. This is based on the understanding and the application of fundamental concepts in telecommunications and transmission of information. C5. Selecting, installing, configuring and operating fixed or mobile telecommunications equipment. Equipping a site with usual telecommunications networks
Cross competences	N.A.

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

7.1 General objective	Development of new skills related to machine learning and deep learning and their application in telecommunications
7.2 Specific objectives	1. Development of critical thinking regarding the analysis, design and implementation of machine learning applications. 2. Understanding data requirements and data pre- and post-processing. 3. Visualizing high-dimensional data and its correlations. 4. Understanding and exploiting prediction results and counteracting training and data issues.

8. Contents

8.1 Lecture (syllabus)	Teaching methods	Notes
1. Introduction to Deep Learning. Python and programming frameworks	Presentation, discussions	Video projector
2. Mathematics of deep learning.		
3. Regression. Gradient descent.		
4. Regularization and optimization		
5. Feed forward neural networks		
6. Recurrent neural networks		
7. Convolutional neural networks		
8. Sequence-to-sequence models		
9. Autoencoders and representation learning		
10. Transformers		
11. Generative adversarial networks. Normalizing flows. Diffusion Models		

12. Unsupervised deep learning and transfer learning		
13. DNN deployment and practical issues		
14. Review. Advanced applications and frameworks. Ethical AI		

1. A. Geron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems”, 3rd Edition, October 2022, Publisher(s): O'Reilly Media, Inc. ISBN: 9781098125974
2. C.M. Bishop, “Pattern Recognition and Machine Learning”, ISBN: 978-1-4939-3843-8, 2006
3. S. Russell, P. Norvig, “Artificial Intelligence: A Modern Approach (4th Edition). Pearson 2020, ISBN 9780134610993.

Online references

4. https://www.deeplearningbook.org/
5. https://d2l.ai/
6. https://pytorch.org/tutorials/
7. https://keras.io/
8. https://scikit-learn.org/stable/tutorial/index.html

8.2 Laboratory	Teaching methods	Notes
1. The work methodology is introduced. The examination rules are stated. Relevant projects examples are presented in order to enable students to chose a project subject.	Simulations, experiments, discussions	N/A
2. Students chose their individual project subject. The first version of the specification document is written. Deliverables: specification document v.1.		
3. Students present the revised form of the specification document, and they start the design phase. Deliverables: specification document v.2. and design document v.1.		
4. Project activity		
5. Students present the revised design document. The first version of the application is presented (at least one functionality is implemented). Deliverables: design document v.2., application v.1.		
6. Project activity		
7. Projects presentations session - demo and discussions. The final application and the technical report are delivered		

Bibliography

1. A. Stan, “Introducere în Python folosind Google Colab”, UTPress, 2022
2. M. Lutz, “Learning Python”, 3rd Edition, Released October 2007, Publisher(s): O'Reilly Media, Inc. ISBN: 9780596513986
3. W. Mckinney, “Python for Data Analysis”, 2e, O’Reilly, 2017
4. A. Geron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems”, 3rd Edition, October 2022, Publisher(s): O'Reilly Media, Inc. ISBN: 9781098125974

Online resources

5. https://scikit-learn.org/stable/

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

Acquired skills will be needed in the following possible COR occupations: electronics engineer, telecommunications engineer, system and computer design engineer, or new occupations proposed to be included in COR (sales support engineer, developer of multimedia applications, network operating engineer, test engineer, project manager, traffic engineer, communications system consultant.

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	Involvement (critical and creative thinking, questions, opinions) - I Technical study on a given subject - S	Questions and opinion are recorded and evaluated I max. = 1 Technical study review S max. = 1	I+S = 22%
10.5 Seminar/ Laboratory	Software application - A Technical report - T	Project defended at the end of semester (application demo and questions) A max. = 4 The final report is delivered at the end of semester T max. = 3 Penalization points are applied if the planned deliverables are delayed more than one week (-0.5 x number of delayed weeks)	A + T = 78%
10.6 Minimum standard of performance			

Qualitative point of view

Minimal theoretical and practical knowledge:

- ✓ Knowledge about the main properties of the ML applications and predictions.
- ✓ Knowledge about the principal characteristics of data representations and machine learning algorithms.

Minimal acquired competences:

- ✓ The ability to design architecture and user scenarios for ML applications.
- ✓ The ability to enumerate the main advantages and disadvantages of a ML application is given as an example.
- ✓ The ability to implement a ML application starting from a set of minimal requirements.

Quantitative point of view

- ✓ Attendance and involvement in all practical application sessions
- ✓ The average mark is at least 5 (five).
- ✓ The final mark is computed as: 0,3*Theory mark+0,7*Project mark

Date of filling in:	Responsible	Title First name SURNAME	Signature
19.06.2023	Course	Assoc. Prof. Adriana STAN, Ph.D.	
	Applications	Assoc. Prof. Adriana STAN, Ph.D.	

Date of approval in the Department of Communications 11.07.2023	Head of Communications Department Prof. Virgil DOBROTA, Ph.D.
Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology 12.07.2023	Dean Prof. Ovidiu POP, Ph.D.