SYLLABUS

Distributed and Federated Learning

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeş Bolyai University
1.2. Faculty	Faculty of Mathematics and Computer Science
1.3. Department	Department of Computer Science
1.4. Field of study	Computer Science
1.5. Study cycle	Master
1.6. Study programme/Qualification	Artificial Intelligence for Connected Industries
1.7. Form of education	Full time

2. Information regarding the discipline

2.1. Name of the discipline	**Distributed and Federated Learning**					Discipline code	**MME8216**
2.2. Course coordinator				Univ. Lect. PhD Mihoc Tudor Dan			
2.3. Seminar coordinator				Univ. Lect. PhD Mihoc Tudor Dan			
2.4. Year of study	1	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Discipline regime	Obligatory

3. Total estimated time (hours/semester of didactic activities)

3.1. Hours per week	**4**	of which: 3.2 course	**2**	3.3 seminar/laboratory/ project	**0/1/1**
3.4. Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar/laboratory/ project	**0/14/14**

Time allotment for individual study (ID) and self-study activities (SA)	**hours**
Learning using manual, course support, bibliography, course notes (SA)	32
Additional documentation (in libraries, on electronic platforms, field documentation)	30
Preparation for seminars/labs, homework, papers, portfolios and essays	32
Tutorship	7
Evaluations	8
Other activities	10

3.7. Total individual study hours	**119**
3.8. Total hours per semester	**175**
3.9. Number of ECTS credits	**7**

4. Prerequisites (if necessary)

4.1. curriculum	Algorithms and Programming, OOP
4.2. competencies	Good programming skills

5. Conditions (if necessary)

5.1. for the course	Projector
5.2. for the seminar /lab activities	Computers, Network visualization tools, Python/Java/C++ programming environment

6. Specific competencies acquired

Professional/ essential competencies	C3. Analyse software specifications C6. Define software architecture C7. Develop software C13. Create data models C18. Develop with cloud services C19. Implement cloud resources C23. Use software design patterns C24. Perform scientific research C26. Interpret technical requirements
Transversal competencies	CT1. think analytically CT2. apply knowledge of science, technology and engineering CT3. work in teams CT4. solve problems CT5. show entrepreneurial spirit

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• The aim is to provide an overview of federated and distributed learning in terms of performance and security. Both theoretical and practical aspects will be extensively explored to acquire solid expertise on both aspects.
7.2 Specific objective of the discipline	• Explain differences between centralized and decentralized learning • Present and define methods most commonly used in federated learning. • Create competencies in implementing federated learning in various fields (networks, security, health, or others).

8. Content

8.1 Course	Teaching methods	Remarks
1. Course Overview. Introduction to Machine Learning and Federated Learning.	• Interactive exposure • Presentation • Explanation • Practical examples • Case-study discussion	
2. Decentralized Optimization and Gradient descent		
3. Federated learning: FedSGD and FedAvg		
4. Variations of Federated Aggregation		
5. Federated Averaging with Heterogeneous Data		
6. Communication-Efficient Learning of deep networks in Federated Learning		
7. Federated Multi-Task learning		
8. Threats, attacks, and defenses to federated learning		
9-11. Applications (Images, Networks, health, vehicle-to-vehicle communications, and/or others)		
12.-14. Student presentations		

Bibliography

1. H. Brendan McMahan, Eider Moore, Daniel Ramage, Seth Hampson, Blaise Agüera y Arcas, Communication-Efficient Learning of Deep Networks from Decentralized Data, Proceedings of the 20th International Conference on Artificial Intelligence and Statistics (AISTATS) 2017, Fort Lauderdale, Florida, USA. JMLR: W&CP volume 54.
2. Kiyoshi Nakayama, George Jeno, Federated Learning with Python, O'Reilly, October 2022.

3. Lam M. Nguyen, Trong Nghia Hoang, Pin-Yu Chen. Federated Learning. Theory and Practice. Elsevier 2024. ISBN: 9780443190384
4. Flower: A Friendly Federated Learning Framework https://flower.ai/
5. Computational Heterogeneity: FedProx and Scaffold, https://flower.ai/docs/baselines/fedprox.html; FedNova https://flower.ai/docs/baselines/fednova.html
6. Security in federated learning: Krum, Backdoor Federated Learning, SVFed https://github.com/IBM/federated-learning-lib/blob/main/examples/krum/README.md
7. Intel & MobileODT Cervical Cancer Screening Dataset: https://www.kaggle.com/competitions/intel-mobileodt-cervical-cancer-screening
8. Datasets: https://keras.io/api/datasets/; https://medmnist.com/ ; https://opendata-ajuntament.barcelona.cat/en ; https://github.com/cedric-cnam/5G3E-dataset/

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Introduction and project structure	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
2.-3. Build and scale a simple federated learning with MNIST, Cifar-10, Fashion-MNIST, MedMNIST, Shakespeare, and BCN Open Data.		
4.-5. Open-source Federated Learning tools (Pytorch, Flower, etc.).		
6. Federated learning with Non-IID data.		
7. Project presentations		

Bibliography

9. H. Brendan McMahan, Eider Moore, Daniel Ramage, Seth Hampson, Blaise Agüera y Arcas, Communication-Efficient Learning of Deep Networks from Decentralized Data, Proceedings of the 20th International Conference on Artificial Intelligence and Statistics (AISTATS) 2017, Fort Lauderdale, Florida, USA. JMLR: W&CP volume 54.
10. Kiyoshi Nakayama, George Jeno, Federated Learning with Python, O'Reilly, October 2022.
11. Lam M. Nguyen, Trong Nghia Hoang, Pin-Yu Chen. Federated Learning. Theory and Practice. Elsevier 2024. ISBN: 9780443190384
12. Flower: A Friendly Federated Learning Framework https://flower.ai/
13. Computational Heterogeneity: FedProx and Scaffold, https://flower.ai/docs/baselines/fedprox.html; FedNova https://flower.ai/docs/baselines/fednova.html
14. Security in federated learning: Krum, Backdoor Federated Learning, SVFed https://github.com/IBM/federated-learning-lib/blob/main/examples/krum/README.md
15. Intel & MobileODT Cervical Cancer Screening Dataset: https://www.kaggle.com/competitions/intel-mobileodt-cervical-cancer-screening
16. Datasets: https://keras.io/api/datasets/; https://medmnist.com/ ; https://opendata-ajuntament.barcelona.cat/en ; https://github.com/cedric-cnam/5G3E-dataset/

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- The course exists in the studying program of all major universities abroad.
- The course aligns with current research and industry trends recognized by bodies such as IEEE and ACM.
- Federated Learning addresses key priorities in data privacy and decentralized AI, supporting skills demanded in Romania's digital economy, particularly in healthcare, mobility, and secure data systems, in line with the European e-Competence Framework (e-CF).

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Knowledge of basic concepts, models and theories from the domain of social networks;	Written examination/ research report	50%

	Ability to apply known concepts to perform social network analysis.		
10.5 Seminar/laboratory	Specify, design, implement, and test social network analysis methods.	Lab reports, Project implementation and presentation	50%
10.6 Minimum standard of performance			
• Each student should obtain a minimum of 5 for the written exam /research paper and presentation, as well as for the final grade.			

11. Labels ODD (Sustainable Development Goals)[1]

Not applicable.

Date:	Signature of course coordinator	Signature of seminar coordinator
11 April 2025	Univ. Lecturer PhD. Tudor Mihoc	Univ. Lecturer PhD. Tudor Mihoc

Date of approval:
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Signature of the head of department

Assoc. Prof. PhD. Adrian STERCA

[1] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable.*”.