SYLLABUS

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	**Computers and Information Technology**
1.5 Study cycle	**Bachelor**
1.6 Study programme / Qualification	**Information Engineering**

2. Information regarding the discipline

2.1 Name of the discipline (en) (ro)			**Artificial Intelligence/ Inteligență Artificială**				
2.2 Course coordinator			**Lect. Dr. Mircea Ioan-Gabriel**				
2.3 Seminar coordinator			**Lect. Dr. Mircea Ioan-Gabriel**				
2.4. Year of study	3	2.5 Semester	6	2.6. Type of evaluation	Exam	2.7 Type of discipline	Compulsory DD
2.8 Code of the discipline		MLE5029					

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

3.1 Hours per week	6	Of which: 3.2 course	2	3.3 seminar/laboratory	2LP 2P
3.4 Total hours in the curriculum	84	Of which: 3.5 course	28	3.6 seminar/laboratory	56
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					12
Additional documentation (in libraries, on electronic platforms, field documentation)					6
Preparation for seminars/labs, homework, papers, portfolios and essays					12
Tutorship					3
Evaluations					8
Other activities:					

3.7 Total individual study hours	41
3.8 Total hours per semester	125
3.9 Number of ECTS credits	5

4. Prerequisites (if necessary)

4.1. curriculum	• mathematical analysis, data structures and algorithms, problem solving, statistics
4.2. competencies	• Object oriented programming competencies, algorithmic reasoning, logical reasoning

5. Conditions (if necessary)

5.1. for the course	•
5.2. for the seminar /lab activities	•

6. Specific competencies acquired

Professional competencies	C6.1 Description of the basic concepts for the representation and characterization of signals and the basic concepts of artificial intelligence C6.2 Appropriate use of methods for analyzing fundamental artificial intelligence signals and algorithms C6.3 Use of simulation and programming environments to process signals and model solutions to problem classes C6.4 Quantitative and qualitative evaluation of the performance of intelligent systems C6.5 Incorporate signal processing methods and artificial intelligence solutions into dedicated applications
Transversal competencies	CT1 Honorable, responsible, ethical conduct in the spirit of the law to ensure the reputation of the profession CT3 Demonstrate the spirit of initiative and action to update professional, economic and organizational culture knowledge

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

7.1 General objective of the discipline	• Presenting the evolution of Artificial Intelligence in a historical fashion with emphasis on the new advancements and ethical aspects
7.2 Specific objective of the discipline	• Understanding general AI vs narrow AI • Understanding basic Machine Learning • Understanding traditional AI • Understanding Deep Learning • Using AI in real contexts (especially embedded contexts) •

8. Content

8.1 Course	Teaching methods	Remarks
1. AI : Past, Present and Future - An introduction Historical evolution of AI An ontology of AI	Interactive exposure Explanation Conversation Didactical demonstration	
2. Teaching the machine: supervised classification - Perceptron, Artificial Neural Network	Interactive exposure Explanation Conversation Didactical demonstration	
3. Teaching the machine: supervised regression - Artificial Neural Network	Interactive exposure Explanation Conversation Didactical demonstration	

4. Teaching the machine: clustering and association,dimensionality reduction - KNN, K-means, SOM, PCA. Data visualization and preprocessing	Interactive exposure Explanation Conversation Didactical demonstration	
5. Training and evaluating Machine Learning Models. Loss. Overfitting	Interactive exposure Explanation Conversation Didactical demonstration	
6. Properly Searching for Solutions: Backtracking, DFS, BFS, A*, GAs, ACO - TSP Constraint Satisfaction Problems: one player games Sudoku	Interactive exposure Explanation Conversation Didactical demonstration	
7. Reinforcement Learning	Interactive exposure Explanation Conversation Didactical demonstration	
8. Game Theory and Estimation Theory more player games Hidden Markov Models	Interactive exposure Explanation Conversation Didactical demonstration	
9-10-11. Going deeper into the Rabit Hole: The quest for the Real AI Deep Neural Networks - Main Ideas CNNs, RNNs,	Interactive exposure Explanation Conversation Didactical demonstration	
12. The Imitation Game: Mimicking Humanity Spiking Nets, NLP, R-CNNs, Autoencoders, GANs	Interactive exposure Explanation Conversation Didactical demonstration	
13. Deploying and embedding AI algorithms in Real-Life: Computational Challenges, Intelligent IoT, Robots, Autonomous Driving	Interactive exposure Explanation Conversation Didactical demonstration	
14. The Present and Future of AI : Ethical Aspects	Interactive exposure Explanation Conversation Didactical demonstration	

Bibliography

Programming Fundamentals

1. Donald E. Knuth. 2011. The Art of Computer Programming: Combinatorial Algorithms, Part 1 (1st. ed.). Addison-Wesley Professional.
2. Brian W. Kernighan and Dennis M. Ritchie. 1988. The C Programming Language (2nd. ed.). Prentice Hall Professional Technical Reference.
3. Bruce Eckel. 2000. Thinking in C++, Volume I: Introduction to Standard C++, Second Edition (2nd. ed.). Prentice Hall PTR, USA.
4. Dijkstra, Edsger W. A Discipline of Programming. 1976.
5. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. 2009. Introduction to Algorithms, Third Edition (3rd. ed.). The MIT Press.
6. Thomas H. Cormen. 2013. Algorithms Unlocked. The MIT Press.
7. Antti Laaksonen, Guide to Competitive Programming - Learning and Improving Algorithms Through Contests, Second Edition. Undergraduate Topics in Computer Science, Springer 2020, ISBN 978-3-030-39356-4, pp. 1-296

Artificial Intelligence

1. Stuart Russell and Peter Norvig. 2009. Artificial Intelligence: A Modern Approach (3rd. ed.).

Prentice Hall Press, USA.
2. Géron, Aurélien. Hands-on Machine Learning with Scikit-Learn, Keras and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. 2nd ed., O'Reilly, 2019.
3. David James. 2018. Introduction to Machine Learning with Python: A Guide for Beginners in Data Science (1st. ed.). CreateSpace Independent Publishing Platform, North Charleston, SC, USA.
4. Ian Goodfellow, Yoshua Bengio, and Aaron Courville. 2016. Deep Learning. The MIT Press.

IoT

1. Dimitrios Serpanos and Marilyn Wolf. 2017. Internet-of-Things (IoT) Systems: Architectures, Algorithms, Methodologies (1st. ed.). Springer Publishing Company, Incorporated.
2. Samuel Greengard. 2015. The Internet of Things. The MIT Press.

Scientific Research

1. Justin Zobel. 2015. Writing for Computer Science (3rd. ed.). Springer Publishing Company, Incorporated.
2. Philip W.L. Fong. 2009. Reading a computer science research paper. SIGCSE Bull. 41, 2 (June 2009), 138–140. DOI:https://doi.org/10.1145/1595453.1595493
3. Lury, Celia. Routledge Handbook of Interdisciplinary Research Methods. , 2018.
4. Repko, Allen F, et al. Case Studies in Interdisciplinary Research. Thousand Oaks, CA: SAGE Publications, Inc., 2012. SAGE Research Methods. 13 Jan 2021, doi: http://www.doi.org/10.4135/9781483349541
5. Repko, Allen F, Rick Szostak, and Michelle P. Buchberger. Introduction to Interdisciplinary Studies. , 2017.
6. Repko, Allen F, and Rick Szostak. Interdisciplinary Research: Process and Theory. , 2017.

8.2 Project	Teaching methods	Remarks
Week 1: How to make a sentient AI Robot Week 2: Perceptron Week 3: Neural Network Week 4: Unsupervised Learning Week 5: Decision Making Week 6:Making the Robot move on a 2D surface Week 7:Reinforcement Learning Week 8:Spiking Neural Networks Week 9:Face Detection Week 10:Face Recognition Week 11:Sound Processing(Speech to text/Text to speech) Week 12:Emotion Detection Week 13:Music and Image Generation Week 14:Putting it all together	Lab assignment Explanation Conversation Scientific method	
8.3 Seminar / laboratory	Teaching methods	Remarks
Laboratories Labs are viewed as workshops. The assignments are submitted on git and graded by the teacher. The student is informed of his grading in a detailed manner. Students can contest the grades on their assignments at the beginning of the lab.		

Lab 1: represents workshops concerning the implementation, from scratch, of a perceptron for the machine learning of the AND logical operation. **Lab 2:** regards the implementation of a minimalistic ANN for the machine learning of the XOR logical operation. *HW:implement an ANN from scratch for the fulladder of two bits and two bits* **Lab 3:** focuses on the employment of the ANN for solving regression problems, loss computation and mainly on the entire flow : data preprocessing and analysis -> training (and validation) -> testing. **Lab 4** the supervised methods of ML are compared and contrasted against unsupervised implementations. a SOM implementation is given as part of the workshop *HW:train an ANN for nonlinear regression and a KNN for clustering on the iris dataset (with tools)*	Lab assignment Explanation Conversation Scientific method	
Lab 5 focuses on searching algorithms: having TSP as the problem to beat, we discuss one by one the implementation of the bruteforce approach, the branch&bound and the simulated annealing. Also **Lab 6** introduces an implementation for a genetic used on the TSP problem. *HW: employ the genetic algorithm to solve the TCP* **Lab 7** tackles decision making in the context of uncertainty and probability. The workshop covers the implementation of a decision tree and the basis of fuzzy sets and variables. **Lab 8** regards the implementation of a Hidden Markov Model. *HW: transform the decision tree implemented in the workshop into a fuzzy decision tree using the already implemented fuzzy constructs*	Lab assignment Explanation Conversation Scientific method	
The last six workshops won't cover actual implementations. Their purpose is to illustrate the proper usage of the most popular industrial frameworks in the deep learning realm : tensorflow, keras, pytorch, etc. as well as spectacular products at work. **Lab 9:** Convolutional Neural Networks - introduction **Lab 10:** Convolutional Neural Networks - approfundation **Lab 11:** Recurrent Neural Networks **Lab 12:** LSTMS **Lab 13:** Autoencoders **Lab 14:** Generative Adversial Networks **HW:run two or three methods of solving on the same problem and construct a table of performance comparison between the techniques on the same benchmark**	Lab assignment Explanation Conversation Scientific method	

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 follows the IEEE and ACM curricular recommendations for computer science studies

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Proper understanding of scientific research methodologies in Computer Science Proper scientific ethics	Final Written Exam+Quizzes (Good quizzes answers can boost the written exam grade with one point)	25%
10.5 Seminar / lab activities	Framework design and architecture. Programming principles and practices. Testing.	Scientific Essay	10%
	Software application design. Programming principles and practices. Testing.	Peer Review	10%
	IoT software design. Programming principles and practices. Testing.	Lab Homework (5 Assignments)	35%
10.5.1 Project	IoT software design. Programming principles and practices. Testing.	Implementation of a sentient AI Robot	20%
10.6 Minimum performance standards			
• Minimum 5 grade for the course and lab activity			

Date Signature of course coordinator Signature of seminar coordinator

Mai 2022

Date of approval Signature of the head of department

Prof. dr. Laura Dioşan

24.05.2022