**SYLLABUS**

## 1. Data about the program

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| 1.1 Higher education institution | Babeş – Bolyai University |
| 1.2 Faculty | Faculty of Psychology and Educational Sciences |
| 1.3 Department | Department of Psychology |
| 1.4 Field of study | Psychology - Cognitive Science |
| 1.5 Study cycle | Bachelor |
| 1.6 Study program / Qualification | Psychology - Cognitive Sciences/ Bachelor in Psychology |

## 2. Discipline data

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|---|---|---|---|---|---|---|---|
| 2.1 Name of the discipline | Artificial Intelligence | | | | | | |
| 2.2 Teacher in charge | Lect. Dr. Mircea Ioan-Gabriel | | | | | | |
| 2.3 Teacher in charge | Lect. Dr. Mircea Ioan-Gabriel | | | | | | |
| 2.4 Year of study | I | 2.5 Semester | 2 | 2.6. Type of evaluation | E | 2.7 Discipline regime | DS |

**3. Estimated total time** (hours per semester of teaching activities)

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|---|---|---|---|---|---|
| 3.1 Number of hours per week | 3 | Of which: 3.2 course | 2 | 3.3 seminar / laboratory | 1 |
| 3.4 Total hours in the curriculum | 42 | Of which: 3.5 course | 28 | 3.6 seminar / laboratory | 14 |
| Distribution of time: | | | | | Hours |
| Study by textbook, course support, bibliography, and notes | | | | | 20 |
| Additional documentation in the library, on specialized electronic platforms and in the field | | | | | 13 |
| Preparation of seminars / laboratories, topics, papers, portfolios, and essays | | | | | 20 |
| Tutorship | | | | | 1 |
| Evaluations | | | | | 2 |
| Other activities: research activities | | | | | 2 |

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| 3.7 Total hours of individual study | 58 |
| 3.8 Total hours per semester | 100 |
| 3.9 Number of ECTS credits | 4 |

**1. Prerequisites** (if necessary)

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| 4.1. curriculum | • mathematical analysis, data structures and algorithms, problem solving, statistics |

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| 4.2. competencies | Object oriented programming competencies, algorithmic reasoning, logical reasoning |

1. **Conditions** (if necessary)

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

**2. Specific competencies acquired**

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| **Professional competencies** | • Application of efficient and rigorous knowledge of artificial intelligence, showing responsible attitudes toward the scientific and didactic fields, respecting the professional and ethical principles. |
| **Transversal competencies** | • Use of efficient methods and techniques for learning, information, research and development of abilities for knowledge exploitation, for adapting to the needs of a dynamic society and for communication in Romanian as well as in a widely used foreign language<br>• Use of efficient methods and techniques to learn, inform, research and develop the abilities to value the knowledge, to adapt to requirements of a dynamic society and to communicate in Romanian language and in a language of international circulation |

3. **Objectives of the discipline** (outcome of the acquired competencies)

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| 7.1 General objective of the discipline | • Acquiring solid knowledge regarding core theoretical concepts and models that explain artificial intelligence<br>• Understanding how a computer that can learn, plan, and solve problems autonomously<br>• Acquiring a rigorous and scientific framework applying artificial intelligence |
| 7.2 Specific objective of the discipline | *1. Knowledge and understanding*<br>• Defining the evolution of AI and understanding the concepts of machine learning and other concepts, tools, and techniques to build intelligent systems<br>*2. Explaining and interpretation*<br>• Understanding the factors that influence AI algorithms in real-life<br>*3. Instrumental*<br>• Developing the ability to propose, evaluate, and implement solutions to problems requiring AI techniques<br>*4. Attitude*<br>• Developing an ethical attitude towards using AI |

**4. Content**

| **8.1 Course** | Teaching methods | Remarks |
|---|---|---|
| 1. AI : Past, Present and Future - An introduction<br>Historical evolution of AI<br>An ontology of AI | Interactive exposure<br>Explanation<br>Conversation<br>Didactical demonstration | |
| 2. Teaching the machine: supervised classification - Perceptron, Artificial Neural Network | Interactive exposure<br>Explanation<br>Conversation<br>Didactical demonstration | |
| 3. Teaching the machine: supervised regression - Artificial Neural Network | Interactive exposure<br>Explanation Conversation<br>Didactical demonstration | |
| 4. Teaching the machine: clustering and association,dimensionality reduction -<br>KNN, K-means, SOM, PCA.<br>Data visualization and preprocessing | Interactive exposure<br>Explanation Conversation<br>Didactical demonstration | |
| 5. Training and evaluating Machine Learning Models. Loss. Overfitting | Interactive exposure<br>Explanation Conversation<br>Didactical<br>demonstration | |
| 6. Properly Searching for Solutions: Backtracking, DFS, BFS, A*, GAs, ACO - TSP<br>Constraint Satisfaction Problems:<br>one player games Sudoku | Interactive exposure<br>Explanation Conversation<br>Didactical demonstration | |
| 7. Reinforcement Learning | Interactive exposure<br>Explanation Conversation<br>Didactical demonstration | |
| 8. Game Theory and Estimation Theory<br>more player games<br>Hidden Markov Models | Interactive exposure<br>Explanation Conversation<br>Didactical demonstration | |
| 9. Going deeper into the Rabit Hole: The quest for the Real AI<br>Deep Neural Networks - Main Ideas<br>CNNs, RNNs, | Interactive exposure<br>Explanation Conversation<br>Didactical demonstration | |
| 10. The Imitation Game: Mimicking Humanity<br>Spiking Nets, NLP, R-CNNs, Autoencoders, GANs | Interactive exposure<br>Explanation Conversation<br>Didactical demonstration | |
| 11. Deploying and embedding AI algorithms in Real-Life: Computational Challenges, Intelligent IoT, Robots, Autonomous Driving | Interactive exposure<br>Explanation Conversation<br>Didactical demonstration | |

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| 12. The Present and Future of AI : Ethical Aspects | Interactive exposure<br>Explanation Conversation<br>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 Seminar / laboratory** | Teaching methods | Remarks |
|---|---|---|
| Seminar<br>The goal of the seminar is to familiarize the student to the scientific method of documentation and research and to address the topics presented at the courses by tackling concrete case studies.<br>Each student will select a thematic during the semester. At each of the seminaries several students will present their essay on the given thematic by analysing the literature and expressing their own opinions of the matter at hand. The other students should all pick at least one of the papers presented that day, and in the week preceding the presentation of the paper have to comment on the what can be | | |
| improved in a peer-review fashion. The seminar grade is the average from the grade obtained for the presentation and the grade for the assessment of other papers during the semester | | |
| Laboratories<br>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. | | |
| The first lab represents workshops concerning the implementation, from scratch, of a perceptron for the machine learning of the AND logical operation and then of a minimalistic ANN for the machine learning of the XOR logical operation.<br>**HW:implement an ANN from scratch for the fulladder of two bits and two bits**<br>The second lab 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. Also the supervised methods of ML are compared and contrasted against unsupervised implementations. a SOM implementation is given as part of the workshop<br>**HW:train an ANN for nonlinear regression and a KNN for clustering on the iris dataset (with tools)** | Lab assignment<br>Explanation<br>Conversation<br>Scientific method | |

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|---|---|---|
| The third lab 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 an implementation for a genetic algorithm is given but it is not used on the TSP problem.<br>**HW: employ the genetic algorithm to solve the TCP**<br>The fourth lab 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. Also, an implementation of a Hidden Markov Model is given.<br>**HW: transform the decision tree implemented in the workshop into a fuzzy decision tree using the already implemented fuzzy constructs** | Lab assignment<br>Explanation<br>Conversation<br>Scientific method | |
| The last two 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 assignment<br>Explanation<br>Conversation<br>Scientific method | |
| **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** | | |

**5. 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

**6. 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 | Final Written Exam+Quizzes (Good quizzes answers can boost the written exam grade with one point) | 25% |
| | Proper scientific ethics | | |
| 10.5 Seminar / lab activities | Framework design and architecture. Programming principles and practices. Testing. | Scientific Essay | 15% |

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|---|---|---|---|
| | Software application design. Programming principles and practices. Testing. | Peer Review | 15% |
| | IoT software design. Programming principles and practices. Testing. | Lab Homework (5 Assignments) | 45% |
| 10.6 Minimum performance standards | | | |
| • Minimum 5 grade for the course and lab activity | | | |

| Date | Signature of course coordinator | Signature of seminar coordinator |
|---|---|---|
| 16.12.2021 | Lect. Dr. Mircea Ioan-Gabriel | Lect. Dr. Mircea Ioan-Gabriel |

Date of approval

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Signature of the head of department