**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 | Computer Science |
| 1.5 Study cycle | Master |
| 1.6 Study programme / Qualification | Data Science for Industry and Society |

**2. Information regarding the discipline**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.1 Name of the discipline (en) (ro) | | | Intelligent modelling | | | | |
| 2.2 Course coordinator | | | Prof. PhD. Dioșan Laura | | | | |
| 2.3 Seminar coordinator | | | Prof. PhD. Dioșan Laura | | | | |
| 2.4. Year of study | **1** | 2.5 Semester | **2** | 2.6. Type of evaluation | **E** | 2.7 Type of discipline | **Compulsory** |
| 2.8 Code of the discipline | | MME8185 | | | | | |

**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 | 1 |
| 3.4 Total hours in the curriculum | 42 | Of which: 3.5 course | 28 | 3.6 seminar/laboratory | 14 |
| Time allotment: | | | | | hours |
| Learning using manual, course support, bibliography, course notes | | | | | 40 |
| Additional documentation (in libraries, on electronic platforms, field documentation) | | | | | 46 |
| Preparation for seminars/labs, homework, papers, portfolios and essays | | | | | 64 |
| Tutorship | | | | | 4 |
| Evaluations | | | | | 4 |
| Other activities: ..... | | | | | - |

| | |
|---|---|
| 3.7 Total individual study hours | 158 |
| 3.8 Total hours per semester | 200 |
| 3.9 Number of ECTS credits | 8 |

**4. Prerequisites** (if necessary)

| | |
|---|---|
| 4.1. curriculum | • Algorithms, data structures, statistics |
| 4.2. competencies | • Average programming skills |

**5. Conditions** (if necessary)

| | |
|---|---|
| 5.1. for the course | • Projector |
| 5.2. for the seminar /lab activities | • Computers, specific development environment |

**6. Specific competencies acquired**

| | |
|---|---|
| **Professional competencies** | **CE1.3** Use of Artificial Intelligence's methods, techniques and algorithms for modelling problem solutions<br><br>**CE1.4.** Identify and explain Artificial Intelligence's techniques and algorithms and solving specific problems<br><br>**CE1.5.** Integration of Artificial Intelligence models and solutions in specific applications |
| **Transversal competencies** | **CT1.** Application of efficient work rules and responsible attitudes towards the scientific domain, for the creative exploitation of one's own potential according to the principles and rules of professional ethics<br><br>**CT2.** Efficient conduct of activities organized in an interdisciplinary group and development of empathic capacity of interpersonal communication, networking and collaboration with diverse groups<br><br>**CT3.** 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 a widely used foreign language. |

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

| | |
|---|---|
| 7.1 General objective of the discipline | Emphasis the proper intelligent methods and techniques (optimisation algorithms, game theory, machine learning) for solving current problems for industry and society (healthcare, biology, psychology, finance, etc. ) |
| 7.2 Specific objective of the discipline | This course is aimed to advance both theoretical and practical aspects of Artificial Intelligence. To the end, the students will be able to:<br>• Identify the society's challenges that can be solved by intelligent methods and to propose AI-based solutions<br>• Describe the AI methods (basic concepts, design and implementation)<br>• Model the social challenges as mathematical problems that can be solved by intelligent algorithms and to adapt them to particular problems<br>• Describe the evaluation criteria of AI methods<br>• Prepare presentations of the implemented projects |

**8. Content**

| **8.1 Course** | Teaching methods | Remarks |
|---|---|---|
| • Introduction to Artificial Intelligence<br>• Problem solving by AI-based mthods<br>• Optimisation AI-based methods<br>  o Problem formalisation<br>  o Methods<br>  ▪ Classical optimisation methods<br>  ▪ Heuristics and meta-heuristic optimisation methods<br>  o Class problems<br>  ▪ Combinatorial optimisation versus continuous optimisation<br>  ▪ Constraint-based optimisation<br>  ▪ Multi-objective and multi-modal optimisation<br>  o Optimisation problems<br>  ▪ Planning problems (resource allocation, routing, scheduling, etc.)<br>  ▪ Examples<br>  • Environment conservation<br>  • Vehicle routing problem<br>  • Nurse rostering<br>  • Timetabling<br>  • Maximisation of influences in social networks<br>• Machine learning methods<br>  o Problem formalisation<br>  ▪ Regression problems<br>  ▪ Supervised classification problems<br>  ▪ Unsupervised classification problems<br>  o Evaluation criteria<br>  ▪ Prediction error, prediction accuracy, precision, recall, etc.<br>  o Machine Learning methods<br>  ▪ K-nearest neighbour | • Interactive exposure<br>• Presentation<br>• Explanation<br>• Practical examples<br>• Case-study discussions | |

| | | |
|---|---|---|
| ▪ Decision trees<br>▪ Neural networks and deep learning<br>o Examples<br>▪ Prediction of illegal activities<br>▪ Urban computing (transportation networks, improvement of mobility and safety, etc.)<br>▪ Health (diagnosis and decision systems, control systems, monitoring, etc.)<br>• Applying machine learning for information processing that were collected in different domains (medical, biological, financial, psychology, etc) and represented in different modalities:<br>o Texts<br>o Images<br>o Sounds<br>o Networks / graphs | | |

Bibliography


1. A. Hopgood, Intelligent Systems for Engineers and Scientists, CRC Press, 2001
2. T. M. Mitchell, Machine Learning,McGraw-Hill Science, 1997
3. D. J. C. MacKey, Information Theory, Inference and Learning Algorithms, Cambridge University Press, 2003
4. C. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
5. P. F. Brown, S. Della Pietra, V. J. Della Pietra, and R. L. Mercer. The mathematic of statistical machine translation: Parameter estimation. Computational Linguistics, 19(2):263-311, 1994
6. Ilachinski, Andrew, 2001, Cellular Automata, Singapore: World Scientific Publishing.
7. Miller, John H. and Scott E. Page, 2007, Complex Adaptive System, Princeton, NJ: Princeton University Press.
8. Bradley, Stephen, Arnoldo Hax, and Thomas Magnanti. "Applied mathematical programming." (1977) link
9. Nisan, Noam, et al., eds. Algorithmic game theory. Vol. 1. Cambridge: Cambridge University Press, 2007. link
10. Christopher, M. Bishop. PATTERN RECOGNITION AND MACHINE LEARNING. Springer-Verlag New York, 2016.
11. Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. Vol. 1. No. 1. Cambridge: MIT press, 1998. link
    Papadimitriou, Christos H., and Kenneth Steiglitz. Combinatorial optimization: algorithms and complexity. Courier Corporation, 1998.


| **8.2 Seminar / laboratory** | Teaching methods | Remarks |
|---|---|---|
| Project development<br>- Application oriented<br>o E.g. Intelligent methods for customer segmentation in marketing strategies<br>- AI oriented<br>o E.g. Deep Neural Networks for | • Interactive exposure<br>• Explanation<br>• Conversation<br>• Didactical demonstration | |

| | | |
|---|---|---|
| reducing airpolution<br><br>1. Problem description<br>2. Identify the available data<br>3. Define the evaluation criteria<br>4. Identify the proper intelligent tools able to solve the problem<br>5. Problem solving<br>6. Project presentation<br><br>In all the stages, the classes will be organised in an interactive way in order to construct in a collaborative manner feasible solutions. Feedback will be provided along the entire project development from both academic and industry specialists. | | |

Bibliography


1. A. Hopgood, Intelligent Systems for Engineers and Scientists, CRC Press, 2001
2. T. M. Mitchell, Machine Learning,McGraw-Hill Science, 1997
3. D. J. C. MacKey, Information Theory, Inference and Learning Algorithms, Cambridge University Press, 2003
4. C. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
5. P. F. Brown, S. Della Pietra, V. J. Della Pietra, and R. L. Mercer. The mathematic of statistical machine translation: Parameter estimation. Computational Linguistics, 19(2):263-311, 1994
6. Ilachinski, Andrew, 2001, Cellular Automata, Singapore: World Scientific Publishing.
7. Miller, John H. and Scott E. Page, 2007, Complex Adaptive System, Princeton, NJ: Princeton University Press.
8. Bradley, Stephen, Arnoldo Hax, and Thomas Magnanti. "Applied mathematical programming." (1977) link
9. Nisan, Noam, et al., eds. Algorithmic game theory. Vol. 1. Cambridge: Cambridge University Press, 2007. link
10. Christopher, M. Bishop. PATTERN RECOGNITION AND MACHINE LEARNING. Springer-Verlag New York, 2016.
11. Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. Vol. 1. No. 1. Cambridge: MIT press, 1998. link
    Papadimitriou, Christos H., and Kenneth Steiglitz. Combinatorial optimization: algorithms and complexity. Courier Corporation, 1998.


**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 curriculum of many universities in the world.
- The results of course are considered by software companies particularly useful and topical, developing needed abilities in modelling and visualization of data.

**10. Evaluation**

| Type of activity | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 Share in the |
|---|---|---|---|

| | | | |
|---|---|---|---|
| | | | grade (%) |
| 10.4 Course | Know concepts and methods from the domain of artificial intelligence | Research report and presentation | 50% |
| 10.5 Seminar/lab activities | Apply AI techniques in real problems | Project implementation and presentation | 50% |
| 10.6 Minimum performance standards | | | |
| Each student should implement 70% of the project. | | | |

| Date | Signature of course coordinator | Signature of seminar coordinator |
|---|---|---|
| 23 April 2023 | Prof. PhD. Dioșan Laura | Prof. PhD. Dioșan Laura |

| Date of approval | Signature of the head of department |
|---|---|
| ..... | Prof. PhD. Dioșan Laura |