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	1sem+1 project
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 seminar/laboratory	28

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	50
Tutorship	4
Evaluations	4
Other activities:	-

3.7 Total individual study hours	144
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 **CE1.4.** Identify and explain Artificial Intelligence's techniques and algorithms and solving specific problems **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 **CT2.** Efficient conduct of activities organized in an interdisciplinary group and development of empathic capacity of interpersonal communication, networking and collaboration with diverse groups **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: • Identify the society's challenges that can be solved by intelligent methods and to propose AI-based solutions • Describe the AI methods (basic concepts, design and implementation) • Model the social challenges as mathematical problems that can be solved by intelligent algorithms and to adapt them to particular problems • Describe the evaluation criteria of AI methods • Prepare presentations of the implemented projects

8. Content

8.1 Course	Teaching methods	Remarks

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

▪ Decision trees ▪ Neural networks and deep learning o Examples ▪ Prediction of illegal activities ▪ Urban computing (transportation networks, improvement of mobility and safety, etc.) ▪ Health (diagnosis and decision systems, control systems, monitoring, etc.) • Applying machine learning for information processing that were collected in different domains (medical, biological, financial, psychology, etc) and represented in different modalities: o Texts o Images o Sounds 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 - Application oriented o E.g. Intelligent methods for customer segmentation in marketing strategies - AI oriented o E.g. Deep Neural Networks for	• Interactive exposure • Explanation • Conversation • Didactical demonstration	

reducing airpolution 1. Problem description 2. Identify the available data 3. Define the evaluation criteria 4. Identify the proper intelligent tools able to solve the problem 5. Problem solving 6. Project presentation 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
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9. Nisan, Noam, et al., eds. Algorithmic game theory. Vol. 1. Cambridge: Cambridge University Press, 2007. link
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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 2022	Prof. PhD. Dioșan Laura	Prof. PhD. Dioșan Laura

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