SYLLABUS

Intelligent Modeling
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	Data Science for Industry and Society
1.7. Form of education	With frequency

2. Information regarding the discipline

2.1. Name of the discipline	Intelligent modelling					Discipline code	MME8185
2.2. Course coordinator					Prof. Dr. Dioşan Laura		
2.3. Seminar coordinator					Prof. Dr. Dioşan Laura		
2.4. Year of study	1	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Discipline regime	Mandatory

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	**2**
3.4. Total hours in the curriculum	42	of which: 3.5 course	28	3.6 seminar/laboratory/project	**28**

Time allotment for individual study (ID) and self-study activities (SA)	**hours**
Learning using manual, course support, bibliography, course notes (SA)	40
Additional documentation (in libraries, on electronic platforms, field documentation)	40
Preparation for seminars/labs, homework, papers, portfolios and essays	60
Tutorship	1
Evaluations	2
Other activities:	1

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

6.1. Specific competencies acquired [1]

Professional/essential competencies	Use of Artificial Intelligence's methods, techniques and algorithms for modelling problem solutions Identify and explain Artificial Intelligence's techniques and algorithms and solving specific problems Integration of Artificial Intelligence models and solutions in specific applications
Transversal competencies	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 Efficient conduct of activities organized in an interdisciplinary group and development of empathic capacity of interpersonal communication, networking and collaboration with diverse groups 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.

6.2. Learning outcomes

Knowledge	The graduate has the ability to develop, design and create new applications, systems or products using good practices in the field. The graduate has knowledge related to programming, mathematics, engineering and technology and has the necessary skills to use them in the creation of complex information systems.
Skills	The student has the ability to understand and communicate information effectively. The student has the ability to develop, design and create new applications, systems or products using good practices in the field The student has the ability to apply general rules to specific problems and produce relevant solutions.
Responsibility and autonomy:	The student has the ability to work independently and is able to combine diverse information to formulate solutions and generate development ideas for new products and applications. The student has the necessary skills to use research support tools

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

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
  ○ Problem formalisation
  ○ Methods
  ▪ Classical optimisation methods
  ▪ Heuristics and meta-heuristic optimisation methods
  ○ Class problems
  ▪ Combinatorial optimisation versus continuous optimisation
  ▪ Constraint-based optimisation
  ▪ Multi-objective and multi-modal optimisation
  ○ Optimisation problems
  ▪ Planning problems (resource allocation, routing, scheduling, etc.)
  ▪ Examples
  • Environment conservation
  • Vehicle routing problem
  • Nurse rostering
	• Interactive exposure
	• Presentation
	• Explanation
	• Practical examples
	• Case-study discussions	

• 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 ▪ 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 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.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	

Bibliography

1. A. Hopgood, Intelligent Systems for Engineers and Scientists, CRC Press, 2001
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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%
10.6Minimum performance standards			
Each student should implement 70% of the project.			

11. Labels ODD (Sustainable Development Goals)[2]

Not applicable

Date	Signature of course coordinator	Signature of seminar coordinator
23 April 2025	Prof. PhD. Dioșan Laura	Prof. PhD. Dioșan Laura

Date of approval	Signature of the head of department
.....	Assoc. Prof. PhD. Sterca Adrian

[2] 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.*".