

COURSE DESCRIPTION

Computational intelligent methods for social good

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	University Babeş-Bolyai Cluj-Napoca
1.2. Faculty	Faculty of Mathematics and Computer Science
1.3. Doctoral School	Doctoral School of Mathematics and Computer Science
1.4. Field of study	Computer Science
1.5. Level of study	PhD

2. Course-related data

2.1. Course title	Computational intelligent methods for social good	Course code	MDR8167
2.2. Course coordinator	Prof. Laura DIOŞAN		
2.3. Seminar coordinator	Prof. Laura DIOŞAN		
2.4. Year of study	2.5. Semester	2.6. Type of assessment	Exam
2.7. Course status	Optional	2.8. Course type	Specialisation subject

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	3	of which: 3.2. course	2	3.3. seminar/ laboratory/ project	1
3.4. Total of hours in the curriculum	36	of which: 3.5. course	24	3.6. seminar/ laboratory	12
Time allocation for individual study (IS) and self-taught activities (ST)					hours
Learning from textbooks, course materials, bibliography, and notes (IS)					62
Additional research in the library, on subject-specific electronic platforms, and on-site					82
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					50
Tutoring (professional guidance)					14
Examinations					6
Other activities					
3.7. Total hours of individual study (IS) and self-taught activities (ST)				214	
3.8. Total hours per semester				250	
3.9. Number of credits				10	

4. Prerequisites (where applicable)

4.1. curriculum-related	Algorithms, Data structures, Statistics, Artificial Intelligence
4.2. skills-related	HPC

5. Specific conditions (where applicable)

5.1. course-related	
5.2. seminar/laboratory-related	

6. Subject-specific learning outcomes

Knowledge
1. (CP2) Knows methods and techniques for identifying and formulating problems.
2. (CP2) Understands the criteria for relevance and originality of scientific problems.
3. (CP8) Knows statistical methods and algorithms for data analysis.
4. (CP8) Understands the functionality of software tools dedicated to the field.
Skills
1. (CP2) Formulates original problems and proposes creative solutions.
2. (CP2) Applies innovative methods to solve identified problems.
3. (CP8) Processes and interprets complex data using advanced tools.
4. (CP8) Creates relevant visualizations and analytical reports.
Responsibility and autonomy
1. (CP2) Assumes responsibility for the quality and impact of the solutions.
2. (CP2) Works autonomously in defining research directions.
3. (CP8) Ensures the accuracy of processed data.
4. (CP8) Works autonomously in selecting data processing methodologies.

7. Contents

7.1. Course	Teaching and learning methods	Remarks¹
Optimization (Lectures 1–3) Formalizing optimization problems Optimization techniques Review of known techniques Heuristic and meta-heuristic techniques (scalable, cooperative, parallel) Classes of optimization problems Combinatorial vs. continuous optimization Constrained optimization Multi-criteria and multi-modal optimization Optimization Problems Planning problems (resource allocation, routing, scheduling) Examples of problems: Environmental/habitat conservation planning Cloud resource forecasting Vehicle routing problem Nurse rostering Timetabling Traffic lights optimization Regular expression inference for text processing Community detection in social networks Intrusion detection systems Automatic software testing Image alignment Influence maximization in social networks	Lecture / Exposition Conversation (guided discussion) Problem-based learning (PBL)	

¹ For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

<p>Game Theory (Lectures 4–6) Basic elements of game theory (Game, Player, Action, Strategy, Payoff, Utility, Dominant Strategy, Maximal Strategy, Minimal Strategy, Nash Equilibrium, Stackelberg Equilibrium) Modeling games as optimization problems Example Problems Security and safety modeled through game theory Surveillance, inspection, and screening systems Modeling human behavior Resource allocation using satellite mapping and poverty data analysis Reducing pollution, poaching, deforestation Machine Learning (Lectures 7–8) Review of known techniques Classification, clustering, probabilistic models, regression Example Problems Prediction of illegal activities Urban computing (transport networks, improving mobility and safety) Health (decision/diagnostic systems, control systems, monitoring systems) Public welfare (education, economic development, justice, public safety)</p> <p>Sequential Decision Processes (Lectures 9–10) Markov decision processes Recurrent neural networks Example Problems Ecosystem management Safety through connectivity Smart vehicle connectivity for safety applications ML for 5G Sentiment analysis and processing (in text and gestures)</p> <p>Computational Systems Based on Cellular Automata (Lectures 11–12) Basic concepts and properties of cellular automata Cellular automata and the philosophy of computational models Example Problems Modeling chemical systems Modeling urban growth processes Traffic flow modeling Modeling military strategies</p>		
<p>Bibliography</p>		
<ol style="list-style-type: none"> 1. A. Hopgood, <i>Intelligent Systems for Engineers and Scientists</i>, CRC Press, 2001 2. T. M. Mitchell, <i>Machine Learning</i>, McGraw-Hill Science, 1997 3. D. J. C. MacKey, <i>Information Theory, Inference and Learning Algorithms</i>, Cambridge University Press, 2003 4. C. Bishop, <i>Pattern Recognition and Machine Learning</i>, 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. <i>Computational Linguistics</i>, 19(2):263-311, 1994 6. Ilachinski, Andrew, 2001, <i>Cellular Automata</i>, Singapore: World Scientific Publishing. 7. Miller, John H. and Scott E. Page, 2007, <i>Complex Adaptive System</i>, Princeton, NJ: Princeton University Press. 8. Bradley, Stephen, Arnoldo Hax, and Thomas Magnanti. "Applied mathematical programming." (1977) 9. Nisan, Noam, et al., eds. <i>Algorithmic game theory</i>. Vol. 1. Cambridge: Cambridge University Press, 2007. 10. Christopher, M. Bishop. <i>PATTERN RECOGNITION AND MACHINE LEARNING</i>. Springer-Verlag New York, 2016. 11. Sutton, Richard S., and Andrew G. Barto. <i>Reinforcement learning: An introduction</i>. Vol. 1. No. 1. Cambridge: MIT press, 1998. 12. Papadimitriou, Christos H., and Kenneth Steiglitz. <i>Combinatorial optimization: algorithms and complexity</i>. Courier Corporation, 1998. 		
<p>7.2. Seminar/ laboratory</p>	<p>Teaching and learning methods</p>	<p>Remarks</p>
<p>Development of projects</p> <ul style="list-style-type: none"> • Application-oriented projects <ul style="list-style-type: none"> ○ e.g., <i>Intelligent methods for limiting deforestation</i> 	<p>Conversation (guided discussion)</p>	

<ul style="list-style-type: none"> • Projects oriented toward intelligent methods <ul style="list-style-type: none"> ○ e.g., <i>Deep artificial neural networks for reducing pollution</i> 	Algorithmicizing (structuring problems into algorithms) Discovery-based learning Individual study Practice / Exercise	
Bibliography		
<p>13. A. Hopgood, <i>Intelligent Systems for Engineers and Scientists</i>, CRC Press, 2001</p> <p>14. T. M. Mitchell, <i>Machine Learning</i>, McGraw-Hill Science, 1997</p> <p>15. D. J. C. MacKey, <i>Information Theory, Inference and Learning Algorithms</i>, Cambridge University Press, 2003</p> <p>16. C. Bishop, <i>Pattern Recognition and Machine Learning</i>, Springer, 2006</p> <p>17. P. F. Brown, S. Della Pietra, V. J. Della Pietra, and R. L. Mercer. The mathematic of statistical machine translation: Parameter estimation. <i>Computational Linguistics</i>, 19(2):263-311, 1994</p> <p>18. Ilachinski, Andrew, 2001, <i>Cellular Automata</i>, Singapore: World Scientific Publishing.</p> <p>19. Miller, John H. and Scott E. Page, 2007, <i>Complex Adaptive System</i>, Princeton, NJ: Princeton University Press.</p> <p>20. Bradley, Stephen, Arnaldo Hax, and Thomas Magnanti. "Applied mathematical programming." (1977)</p> <p>21. Nisan, Noam, et al., eds. <i>Algorithmic game theory</i>. Vol. 1. Cambridge: Cambridge University Press, 2007.</p> <p>22. Christopher, M. Bishop. <i>PATTERN RECOGNITION AND MACHINE LEARNING</i>. Springer-Verlag New York, 2016.</p> <p>23. Sutton, Richard S., and Andrew G. Barto. <i>Reinforcement learning: An introduction</i>. Vol. 1. No. 1. Cambridge: MIT press, 1998</p> <p>24. Papadimitriou, Christos H., and Kenneth Steiglitz. <i>Combinatorial optimization: algorithms and complexity</i>. Courier Corporation, 1998.</p>		

8. Evaluation

Type of activity	8.1 Evaluation criteria ²	8.2 Evaluation methods ³	8.3 Percentage in the final grade
8.4. Course	Understanding the basic concepts of the field Applying the intelligent principles taught in the course to solve complex and difficult problems	Project presentation	50%
8.5. Seminar/ laboratory	Specifying, designing, implementing, and testing intelligent methods Effectively solving problems using the previously implemented methods	Systematic observation of the student during the completion of laboratory assignments and the development of the project	50%
8.6 Minimum standard for passing			
<p>Each student must demonstrate that they have reached an acceptable level of knowledge and understanding of the field, that they are able to express this knowledge in a coherent manner, and that they have the ability to establish certain connections and use the acquired knowledge to solve problems.</p> <p>To pass the exam, the student must complete at least 70% of the project.</p>			

² The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

³ Both final evaluation methods and ongoing evaluation strategies should be established.

9. SDG labels (Sustainable Development Goals)⁴

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X	<input type="radio"/>	<input type="radio"/>	X					
								No label applies
<input type="radio"/>	X	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				

Date of entry:
13 februarie 2026

Signature of course coordinator

Signature of seminar coordinator

[Handwritten signature]

[Handwritten signature]

Date of approval in the department:

Signature of the head of department

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⁴ Select a single label which, according to the [Implementation of SDG labels in the academic process](#), best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: "No label applies."