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 Tools for Social Good** **Instrumente inteligente pentru bunăstare socială**				
2.2 Course coordinator			**Prof. Dr. Dioșan Laura**				
2.3 Seminar coordinator			**Prof. Dr. Dioșan Laura**				
2.4. Year of study	**2**	2.5 Semester	**3**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Optional**
2.8 Code of the discipline		**MMX9902**					

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	2
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6 seminar/laboratory	28
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					30
Additional documentation (in libraries, on electronic platforms, field documentation)					40
Preparation for seminars/labs, homework, papers, portfolios and essays					41
Tutorship					4
Evaluations					4
Other activities:					-

3.7 Total individual study hours	133
3.8 Total hours per semester	175
3.9 Number of ECTS credits	7

4. Prerequisites (if necessary)

4.1. curriculum	• Algorithms, data structures, statistics, Artificial Intelligence
4.2. competencies	• Average programming skills in a high-level language

5. Conditions (if necessary)

5.1. for the course	• Projector
5.2. for the seminar /lab activities	• For the lab activity, computers with high processing speed are needed.

6. Specific competencies acquired

Professional competencies	CE1.3 Use of Artificial Intelligence methods, techniques and algorithms to model solutions to class of problems CE1.4 Identification and explanation of Artificial Intelligence techniques and algorithms and their use for solving specific problems CE1.5 Using models and solutions from Artificial Intelligence in dedicated 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	• The course has the objective of emphasizing the most relevant intelligent solving techniques (such as optimization algorithms, game theory, machine learning, decision support systems) for current social problems from the domains of health, social good, security and privacy, ecological durability and sustainability, etc.
7.2 Specific objective of the discipline	• The course tackles theoretical and practical aspects of Artificial Intelligence. At the end of the course, students will be able to: o identify social challenges that can be approached with intelligent algorithms and choose the most appropriate intelligent algorithms o describe the intelligent methods presented in the course (including basic concepts, design and implementation of intelligent algorithms) o model social challenges as mathematical problems that can be solved with intelligent algorithms and adapt these algorithms to concrete problems o describe the evaluation criteria and the methodology of applying intelligent methods to improve social good

	○ create written and oral presentations of the developed projects

8. Content

8.1 Course	Teaching methods	Remarks
- Optimization (Course 1-3) ○ Formalizing optimization problems ○ Optimization techniques ▪ review of known techniques ▪ heuristic and meta-heuristic techniques (scalable, cooperative, parallel) ○ Classes of optimization problems ▪ combinatorial optimization vs continuous optimization ▪ constrained optimization ▪ multicriterial and multimodal optimization ○ Optimization problems ▪ planning problems (resource allocation, routing, scheduling) ▪ examples of problems: • planning of environment/habitat conservation • resource provisioning in cloud • vehicle routing problem • nurse rostering • timetabling • traffic lights optimization • regular expression inference for text mining • community detection in social networks • intruder detection systems • automate testing for programs • image alignment • influence maximization in social networks - Game theory (Course 4-6) ○ basic elements from game theory (Game, Player, Action, Strategy, Payoff, Utility, Dominant strategy, Maximal strategy, Minimal strategy, Nash equilibrium, Stackelberg equilibrium) ○ game modelling as optimization problems ○ examples of problems: ▪ security and safety modelled using game theory ▪ surveillance, inspection, screening systems ▪ human behaviour modelling ▪ resource allocation via satellite mapping and poverty data analysis ▪ reducing pollution, poaching, deforestation - Machine learning (Course 7-9) ○ review of known techniques ○ classification, clustering, probabilistic models, regression ○ examples of problems: ▪ prediction of illegal activities ▪ urban computing (transport networks, improvement of	Exposure Conversation Practical examples Case-study discussions	

mobility and safety) ▪ health (decision/diagnose systems, control systems, monitoring systems) ▪ public good (education, economic development, law, public safety) - Sequential decision processes (Course 10-12) o Markov decision processes o recurrent neural networks o examples of problems: ▪ eco-system management ▪ safety through connectivity ▪ smart vehicle connectivity for safety applications ▪ ML for 5G ▪ sentiment analysis and processing (from text, gestures) - Computational systems based on cellular automata (Course 13-14) o basic concepts and properties of cellular automata o cellular automata and the philosophy of computational models o examples of problems: ▪ modelling of chemical systems ▪ modelling of urban growth processes ▪ modelling of traffic flow ▪ modelling of military strategies		

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
12. Papadimitriou, Christos H., and Kenneth Steiglitz. Combinatorial optimization: algorithms and complexity. Courier Corporation, 1998.

8.2 Seminar / laboratory	Teaching methods	Remarks
Development of projects • oriented toward application o for example: *Intelligent methods to limit deforestation* • oriented toward intelligent methods o for example: *Deep artificial neural networks to reduce pollution*	Conversation Algorithmics Discovery Individual study Exercise	Each lab has a 2 hour duration and takes place

Phase 1 (week 1 and 2) • presentation (by the teaching staff) of types of problems that can be solved using intelligent methods • presentation (by the teaching staff) of solving instruments already existing Phase 2 (week 3 and 4) • selection (by student) of problem and solving instrument • discussion about this selection Phase 3 (week 5 and 6) • methodology for solving a concrete problem (steps to follow) Phase 4 (week 7 and 8) • selection of testing data Phase 5 (week 9 and 10) • solving the problem using the selected instrument Phase 6 (week 11 and 12) • solving the problem using the selected instrument Phase 7 (week 13 and 14) • project presentation		once every 2 weeks

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 follows IEEE and ACM curricula recommendations for computer science studies
- The course exists in the studying program of major universities abroad
- Software companies consider the content of the course useful in developing students' modeling and programming abilities

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	• Know basic concepts of the domain • Apply intelligent principles from the course content to solve complex and difficult problems	Project presentation (oral)	30%
10.5 Seminar/lab activities	• Specify, design, implement and test intelligent methods • Effective solving of problems using implemented methods	Systematic observation of the student during laboratory work and project implementation	70%
10.6 Minimum performance standards			
• Each student must demonstrate achieving an acceptable level of knowing and understanding the domain, the ability to express knowledge in a coherent form, the capacity to establish certain connections and use knowledge to solve problems. • To pass the exam the student must: ○ Realize at least 70% from the project			

Date	Signature of course coordinator	Signature of seminar coordinator
October, 2nd, 2024	Prof. PhD. Dioșan Laura	Prof. PhD. Dioșan Laura

Date of approval

Signature of the head of department

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