SYLLABUS

Multiagent systems

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeş-Bolyai University of Cluj-Napoca
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	Applied Computational Intelligence
1.7. Form of education	Full time

2. Information regarding the discipline

2.1. Name of the discipline	**Multiagent systems**					Discipline code	**MME8152**
2.2. Course coordinator					Prof. PhD Czibula Gabriela		
2.3. Seminar coordinator					Prof. PhD Czibula Gabriela		
2.4. Year of study	1	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Discipline regime	Compulsory

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	**1 sem+ 1 pr**
3.4. Total hours in the curriculum	56	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)					26
Additional documentation (in libraries, on electronic platforms, field documentation)					36
Preparation for seminars/labs, homework, papers, portfolios and essays					35
Tutorship					12
Evaluations					10
Other activities:					
3.7. Total individual study hours	**119**				
3.8. Total hours per semester	**175**				
3.9. Number of ECTS credits	**7**				

4. Prerequisites (if necessary)

4.1. curriculum	Artificial Intelligence
4.2. competencies	Programming skills

5. Conditions (if necessary)

5.1. for the course	Classroom with a projector
5.2. for the seminar /lab activities	

6.1. Specific competencies acquired [1]

Professional/essential competencies	• assimilation of mathematical concepts and formal mode/s to understand, verify and validate software systems; • ability to approach and solve complex problems using various techniques of computational intelligence.
Transversal competencies	• capability of information analysis and synthesis; • etic and fair behaviour, commitment to professional deontology; • team work capabilities; able to fulfil different roles.

6.2. Learning outcomes

Knowledge	The student knows: • the ethical and legal principles and rules in scientific research; • methods for modelling, being able to analyse real life problems and to translate them in concrete requirements and to design a corresponding software model; • knowledge related to specifying the requirements of research activities in the domain of computer science in general and computational intelligence in particular and he/she understands the role of research in promoting progress.
Skills	The student is able to: • use specific language and terminology for the field of computational intelligence being able to communicate and interact with members of a team; • advanced computational intelligence knowledge starting from a high level of abstraction and being able to offer implementation solutions for complex software system.
Responsibility and autonomy:	The student has the ability to work independently to: • obtain knowledge necessary for designing, managing and evaluating research activities in the field of computational intelligence; • devise, model and design of complex software applications in the field of computational intelligence.

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

7.1 General objective of the discipline	To present the field of agents as a new research and application domain of Software Engineering and Artificial Intelligence.

[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.

7.2 Specific objective of the discipline	• To introduce the main concepts and methods related to agent oriented software engineering. • To present the connection between agents and other programming paradigms. • To present the connection between multiagent systems and the distributed artificial intelligence field. • To induce the necessity of MAS through the study of relevant industrial and practical applications.

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction ▪ Agent based software engineering • The concept of agent and intelligent agent • Applications	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
2. Agents and intelligent agents • Definitions, properties, taxonomies • Abstract and concrete architectures for intelligent agents • Software agents • Mobile agents, interface agents • Application domains • Agents and Objects • Agents and Expert Systems • Agent based development	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
3. Agent based systems • Design principles of an agent based system • Conceptual modeling using agents • Examples • Agents in complex software systems • Implementation of the agent function • Examples	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
4. Multiagent systems and societies of agents • Coordination, cooperation, communication - protocols • Negotiation • Communication languages between agents • KQML, FIPA-ACL	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
5. Applications of agents and MAS • Agents in e-business and e-	• Interactive exposure • Explanation • Conversation	

commerce • Agents in e-banking • Agents for Distributed Data Mining • Information agents • Industrial applications of MAS	• Didactical demonstration	
6. Distributed problem solving and planning • Agent based modeling • Advantages of using agents • Techniques for DPS and DP	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
7. Distributed constraint satisfaction problems • The problem definition • The hyperresolution based consistency algorithm • Asynchronous backtracking • Examples	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
8. Distributed path finding problems • Asynchronous dynamic programming • Learning Real Time A* • Bidirectional search algorithm • Real time multiagent search algorithm • Examples	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
9. Learning in multiagent systems • Types of learning • Cooperative learning in multiagent systems • Team learning • Concurrent learning • Application domains for multiagent learning	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
MAS research reports presentation	• Interactive exposure • Conversation • Oral assessment	

Bibliography

1. M. Wooldridge, G. Weiss, and P.Ciancarini, editors: Agent-Oriented Software Engineering II Springer- Verlag Lecture Notes in Computer Science Volume 2222, February 2001.
2. F. Zambonelli, N. R. Jennings, and M. Wooldridge. Developing Multiagent Systems: The Gaia Methodology. In ACM Transactions on Software Engineering Methodology, 12(3):317-370, July 2003.
3. Czibula, G., Sisteme multiagent în Inteligenţa Artificială Distribuită. Arhitecturi şi aplicaţii. Editura RisoPrint, Cluj-Napoca, 2006
4. Weiss, G. (Ed.): Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, MIT Press, 1999

8.2 Seminar / laboratory	Teaching methods	Remarks
		The activity is structured as 2 hours classes every
1. Administration of seminars. Survey of the sources of information available on Internet and Intranet	• Interactive exposure • Explanation • Conversation	
2. Survey of the sources of information	• Documentation	

available on Internet and Intranet; chosing the paper topic and scheduling the presentation.	• Explanation • Conversation	
An agent based system (Project 1) will be developed using an open source agent development environment. The second project (Project 2) will be realized from scratch and documented. The software will have to demonstrate the use of multiple agents for some specific task.		
3. Problem definition and specification for Project 2	• Lab assignment • Explanation • Conversation	
4. Comments about the solution (problem analysis) and conceptual modeling of the problem using agents (Project 2). Demonstration of Project 1	• Lab assignment • Explanation • Conversation	
5. Design documentation for Project 2	• Lab assignment • Explanation • Conversation	
6. The electronic version of the source code, test files and any other files required to test Project 2. Project 2 demonstration	• Lab assignment • Explanation Conversation	

Bibliography

1. M. Wooldridge, G. Weiss, and P.Ciancarini, editors: Agent-Oriented Software Engineering II Springer- Verlag Lecture Notes in Computer Science Volume 2222, February 2001.
2. F. Zambonelli, N. R. Jennings, and M. Wooldridge. Developing Multiagent Systems: The Gaia Methodology. In ACM Transactions on Software Engineering Methodology, 12(3):317-370, July 2003.
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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 content of the discipline is consistent with the similar disciplines from other romanian universities and universities from abroad, as well as with the requirements that potential employers would have in the distributed artificial intelligence field.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	A theoretical research report on a learning technique, based on some recent research papers should be prepared and presented	Evaluation of the research report (a written paper of about 10 pages and an oral presentation)	40%
	The correctness and completeness of the accumulated knowledge.	Oral assessment	
10.5 Seminar/laboratory	A software project developed using an open source agent development environment	Evaluation of the project (documentation and demonstration)	15%
	A software project fully implemented, without using existing agent development	Evaluation of the project (software implementation, documentation and demonstration)	25%

	environments.		
10.6 Activity	Class (course, lab) attendance		15%
10.7 Minimum standard of performance			
• Each student has to prove that (s)he acquired an acceptable level of knowledge and understanding of the Machine Learning domain, that (s)he is capable of stating these knowledge in a coherent form, that (s)he has the ability to establish certain connections and to use the knowledge in solving different problems. • Successful passing of the exam is conditioned by the final grade that has to be at least 5.			

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

Not applicable.

Date:

03.04.2025

Signature of course coordinator

Prof. PhD Gabriela CZIBULA

Signature of seminar coordinator

Prof. PhD Gabriela CZIBULA

Date of approval:

Signature of the head of department

Assoc. prof. PhD. Adrian STERCA

[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*.".