SYLLABUS

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	**Departament of Computer Science**
1.4 Field of study	**Computer Science**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Applied Computational Intelligence**

2. Information regarding the discipline

2.1 Name of the discipline	**Multiagent systems**						
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 Type of discipline	**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	1 sem+ 1pr
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	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	
5.2. for the seminar /lab activities	Laboratory with computers; high level programming language environment (.NET or any Java environement a.s.o.)

6. Specific competencies acquired

Professional competencies	• Advanced ability to approach, model and solve phenomena and problems from nature and economy using fundamental knowledge from mathematics and computer science. • Ability to approach and solve complex problems using various techniques of computational intelligence. • Proficient use of methodologies and tools specific to programming languages and software systems.
Transversal competencies	• Ethic and fair behavior, commitment to professional deontology • Team work capabilities; able to fulfill different roles • Professional communication skills; concise and precise description, both oral and written, of professional results, negotiation abilities. • Entrepreneurial skills; working with economical knowledge; continuous learning • Good English communication skills

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.
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	• Interactive exposure • Explanation • Conversation • Didactical demonstration	

• Agents and Expert Systems • Agent based development		
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-commerce • Agents in e-banking • Agents for Distributed Data Mining • Information agents • Industrial applications of MAS	• Interactive exposure • Explanation • Conversation • 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 seminar is structured as 2 hours classes every second week
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 available on Internet and Intranet; chosing the paper topic and scheduling the presentation.	• Documentation • 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. Design documentation for Project 2	• Lab assignment • Explanation • Conversation	
7. 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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4. Weiss, G. (Ed.): Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, MIT Press, 1999

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

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the 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)	50%
	• The correctness and completeness of the accumulated knowledge.	Oral assessment	
10.5 Seminar/lab activities	• A software project developed using an open source ML software	Evaluation of the project (documentation and demonstration)	15%
	• A software project fully implemented, without using existing ML environments.	Evaluation of the project (software implementation, documentation and demonstration)	35%
10.6 Minimum performance standards			
• 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.			

Date	Signature of course coordinator	Signature of seminar coordinator
07.04.2023	Prof. dr. Gabriela Czibula	Prof. dr. Gabriela Czibula

Date of approval

Signature of the head of department
Prof. dr. Dioșan Laura