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	**Bachelor**
1.6 Study programme / Qualification	**Artificial Intelligence**

2. Information regarding the discipline

2.1 Name of the discipline (en) (ro)			**Graph Algorithms / Algoritmica grafelor**				
2.2 Course coordinator			**Lect. PhD. Radu Lupsa**				
2.3 Seminar coordinator			**Lect. PhD. Radu Lupsa**				
2.4. Year of study	**1**	2.5 Semeste	**2**	2.6. Type of evaluation	**C**	2.7 Type of discipline	**Compulsor y**
2.8 Code of the discipline		MLE5025					

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 + 1 lab
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					20
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					30
Tutorship					4
Evaluations					5
Other activities:					-
3.7 Total individual study hours		69			
3.8 Total hours per semester	125				
3.9 Number of ECTS credits	5				

4. Prerequisites (if necessary)

4.1. curriculum	Data Structures and Algorithms
4.2. competencies	Average skills in analysis and design of algorithms and data structures, including implementing them in a programming language.

5. Conditions (if necessary)

5.1. for the course	
5.2. for the seminar /lab activities	Laboratory with computers; high level programming language environment (C++, Java, .NET, python)

6. Specific competencies acquired

Professional competencies	C3.2 Identificarea si explicarea modelelor informatice de baza adecvate domeniului de aplicare C3.3 Utilizarea modelelor si instrumentelor informatice si matematice pentru rezolvarea problemelor specifice domeniului de aplicare C 4.2 Interpretarea de modele matematice şi informatice (formale) C 4.3 Identificarea modelelor si metodelor adecvate pentru rezolvarea unor probleme reale
Transversal competencies	CT1 Aplicarea regulilor de muncă organizată şi eficientă, a unor atitudini responsabile faţă de domeniul didactic-ştiinţific, pentru valorificarea creativă a propriului potenţial, cu respectarea principiilor şi a normelor de etică profesională CT3 Utilizarea unor metode şi tehnici eficiente de învăţare, informare, cercetare şi dezvoltare a capacităţilor de valorificare a cunoştinţelor, de adaptare la cerinţele unei societăţi dinamice și de comunicare în limba română și într-o limbă de circulație internațională

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

7.1 General objective of the discipline	Knowing the graph theoretical concepts and using these concepts in the problem modelling. Knowing how to implement the graph algorithms in a programming language.
7.2 Specific objective of the discipline	Analysing the issues around the main topics of graph: connectivity, shortest paths, modelling prerequisites and activity planning, flows, traveling salesman problem, planar graphs.

8. Content

8.1 Course	Teaching methods	Remarks
1. Basic graph theory definitions (graph, multigraph, directed graph/multigraph, walk, trail, path), basics on graph representations	Exposure: description, explanation, examples, debate	
2. In-deep study of possible graph representations	Exposure: description,	

	explanation, examples, debate	
3. Connectivity and shortest path problems. Depth-first and breadth-first traversal of a graph. Connected and strongly-connected components.	Exposure: description, explanation, examples, debate	
4. Minimum-cost path in a graph. Dynamic programming approach. Bellman-Ford algorithm.	Exposure: description, explanation, examples, debate	
5. Dijkstra's algorithm . A-star algorithm. Floyd-Warshall algorithm.	Exposure: description, explanation, examples, debate	
6. Dependency graphs, partial order and topological sorting. Topological sorting algorithms and strongly connected components algorithms.	Exposure: description, explanation, examples, debate	
7. Activity planning problem and algorithms.	Exposure: description, explanation, examples, debate	
8. Trees and forests. Minimum spanning trees. Kruskal and Prim algorithms.	Exposure: description, explanation, examples, debate	
9. NP-complete problems. Hamiltonian cycle, Traveling Salesman Problem.	Exposure: description, explanation, examples, debate	
10. Other hard problems: clique, vertex cover, colouring.	Exposure: description, explanation, examples, debate	
11. Eulerian cycle. Planar graphs: Euler's relation, K5 and K3,3 graphs, relations between number of edges and vertices.	Exposure: description, explanation, examples, debate	
12. Transport networks. Maximum flow. Ford-Fulkerson algorithm.	Exposure: description, explanation, examples, debate	
13. Maximum flow of minimum cost.	Exposure: description, explanation, examples, debate	
14. Matching problem	Exposure: description,	

	explanation, examples, debate	

Bibliography

CORMEN, LEISERSON, RIVEST: Introducere in algoritmi, Editura Computer Libris Agora, 2000.
T. TOADERE: Grafe. Teorie, algoritmi si aplicatii , Ed. Albastra, Cluj-N., 2002
KÁSA ZOLTÁN: Combinatiroca cu aplicatii, Presa Universitara Clujeana, 2003.
BERGE C., Graphes et hypergraphes, Dunod, Paris 1970.
BERGE C., Teoria grafurilor si aplicatiile ei, Ed. Tehnica, 1972
http://www.cs.ubbcluj.ro/~rlupsa/edu/grafe/

8.2 Seminar	Teaching methods	Remarks
1. Basic definitions. Graph representations.	Dialogue, debate, case study, guided discovery	
2. More on graph representations. Graph traversals. Connected components.	Dialogue, debate, case study, guided discovery	
3. Finding shortest path. Bellman-Ford algorithm.	Dialogue, debate, case study, guided discovery	
4. Shortest path: Dijkstra and Floyd-Warshall.	Dialogue, debate, case study, guided discovery	
5. Tree traversal. Minimum spanning tree: Kruskal and Prim algorithms.	Dialogue, debate, case study, guided discovery	
6. Planar graphs. Hard problems in graph theory.	Dialogue, debate, case study, guided discovery	
7. Maximim flow and matching problems.	Dialogue, debate, case study, guided discovery	
Laboratory	Teaching methods	Remarks
1. Graph representations	Dialogue, debate, case study, guided discovery	
2. More on graph representations	Dialogue, debate, case study, guided discovery	
3. Connectivity and minimum length paths	Dialogue, debate, case study, guided discovery	
4. Minimum cost paths	Dialogue, debate, case study, guided discovery	
5. Dependency graphs. Minimum spanning trees.	Dialogue, debate,	

	case study, guided discovery	
6. NP-complete problems	Dialogue, debate, case study, guided discovery	
7. Finishing the lab activity.	Dialogue, debate, case study, guided discovery	

Bibliography

CORMEN, LEISERSON, RIVEST: Introducere in algoritmi, Editura Computer Libris Agora, 2000.
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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 respects the IEEE and ACM Curriculla Recommendations for Computer Science studies; The course exists in the studying program of all major universities in Romania and abroad.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	- know the basic principle of the domain; - apply the course concepts - problem solving	Written exam	66.67%
10.5 Seminar/lab activities	be able to implement course concepts and algorithms	Verifying the practical works.	33.33%
10.6 Minimum performance standards			
At least grade 5 (from a scale of 1 to 10) at both written exam and laboratory work.			

Date	Signature of course coordinator	Signature of seminar coordinator
2023-04-26	.....	.....

Date of approval

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Signature of the head of department

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