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	Department of Mathematics and Computer Science of the Hungarian Line
1.4 Field of study	**Computer Science**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Data Analysis and Modeling**

2. Information regarding the discipline

2.1 Name of the discipline	**Metaheuristic Methods**						
2.2 Course coordinator	**Conf.dr. Gaskó Noémi/Lect.dr. Sándor Réka**						
2.3 Seminar coordinator	**Conf.dr. Gaskó Noémi/Lect.dr. Sándor Réka**						
2.4. Year of study	2	2.5 Semester	3	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Optional**

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	1 sem
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6 seminar/laboratory	14
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					23
Tutorship					7
Evaluations					20
Other activities:					-

3.7 Total individual study hours	80
3.8 Total hours per semester	150
3.9 Number of ECTS credits	7

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	knowledge of basic algorithms, average programming skills, basic mathematical knowledge

5. Conditions (if necessary):

5.1. for the course	classroom with whiteboard and video projector
.2. for the seminar /lab activities	laboratory with whiteboard and video projector

6. . Specific competencies acquired

Professional competencies	• basic metaheuristic methods • analyzing hard optimization problems • applying metaheuristic methods to real world problems
Transversal competencies	• analytical thinking • problem solving competences

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

7.1 General objective of the discipline 7.2 Specific objective of the discipline	• provide an introduction to the field studied. • the basic notion, techniques and algorithms. • ability to analyze hard optimization problems • application of metaheuristics to real world problems • ability to develop new heuristic algorithms.

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction	description, explanation, examples	
2. Efficiency of metaheuristics	description, explanation, examples, debate, dialogue	
3-4. Single state methods: hill climbing, local search methods	description, explanation, examples, dialogue	
5. Simulated Annealing	description, explanation, examples, dialogue	
6. Tabu Search	description, explanation, examples, dialogue	
7-8. Population based methods: differential evolution, genetic algorithms	description, explanation, examples, dialogue	

9-10. Swarm Intelligence: Ant colony, Bee colony, Particle Swarm optimization techniques	description, explanation, examples, dialogue	
10-13. Multiobjective Optimization: multiobjective optimization problem, non-dominance, weighted sum methods, evolutionary multiobjective optimization.	description, explanation, examples, debate, dialogue	
14. Comparison of metaheuristics	description, explanation, examples, debate, dialogue	

8.1 Course	Teaching methods	Remarks
• Week 1: Introduction	description, explanation, examples	
• Week 2: Efficiency of metaheuristics	description, explanation, examples, debate, dialogue	
• Week 3-4: Single state methods: hill climbing, local search methods	description, explanation, examples, dialogue	
• Week 5: Simulated Annealing	description, explanation, examples, dialogue	
• Week 6: Tabu Search	description, explanation, examples, dialogue	
• Week 7-8: Population based methods: differential evolution, genetic algorithms	description, explanation, examples, dialogue	
• Week 9-10: Swarm Intelligence: Ant colony, Bee colony, Particle Swarm optimization techniques	description, explanation, examples, dialogue	
• Week 11-13: Multiobjective Optimization: multiobjective optimization problem, non-dominance, weighted sum methods, evolutionary multiobjective optimization.	description, explanation, examples, debate, dialogue	
• Week 14: Comparison of metaheuristics	description, explanation, examples, debate, dialogue	

Bibliography

Sean Luke: *Essentials of Metaheuristics*, 2013, Freely available for download at http://cs.gmu.edu/~sean/book/metaheuristics/

Stefan Edelkamp, Peter Norvig: *Heuristic Search: Theory and Applications*, Elsevier, 2011.

Fred Glover, Gary A. Kochenberger: *Handbook of Metaheuristics*, Springer, 2010.

El-Ghazali Talbi: *Metaheuristics - From Design to Implementation*, Wiley, 2009 .

Zbigniew Michalewicz, David B. Fogel: *How to Solve It: Modern Heuristics*, Springer, 2004.

Holger H. Hoos ,Thomas Stützle: *Stochastic Local Search*, Morgan Kaufmann, 2005.

Sadiq M. Sait, Habib Youssef: *Iterative Computer Algorithms with Applications in Engineering: Solving Combinatorial Optimization Problems*, Wiley, 2000.

Christos H. Papadimitiou, Kenneth Steiglitz: *Combinatorial Optimization.*, Dover Publications, 2nd edition, 1998.

K. Deb: *Multiobjective optimization using Evolutionary Algorithms*, Wiley, 2001.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Real-world applications. Benchmarks instances	discussion, dialogue	
2. Problem representation, Local search methods	description, individual work, discussion, dialogue	
3. Simulated Annealing	Description, discussion, individual work, dialogue	
4. Tabu search	Description, discussion, individual work, dialogue	
5. Genetic Algorithms	description, discussion, individual work, dialogue	
6. Project presentations, discussion	description, discussion, individual work, dialogue	

Bibliography

Sean Luke: *Essentials of Metaheuristics*, 2013, Freely available for download at http://cs.gmu.edu/~sean/book/metaheuristics/

Stefan Edelkamp, Peter Norvig: *Heuristic Search: Theory and Applications*, Elsevier, 2011.

Fred Glover, Gary A. Kochenberger: *Handbook of Metaheuristics*, Springer, 2010.

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K. Deb: *Multiobjective optimization using Evolutionary Algorithms*, Wiley, 2001.

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 exists in the studying program of all major universities in Romania and abroad;
- The content of the course is based on the texbook: Essentials of Metaheuristics, available online on the website of George Mason University.

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	50.00%
10.5 Lab activities	-be able to implement course concepts and algorithms -be able to make a practical project during the semester	Practical project	50.00%
10.6 Minimum performance standards			
• At least grade 5 (from a scale of 1 to 10) at both written exam and laboratory work.			

Date 23.03.2023
Date of approval

Signature of course coordinator
Conf. dr. Gaskó Noémi

Signature of seminar coordinator
Lect.dr. Sándor Réka

Signature of the head of department
Conf. dr. András Szilárd