

SYLLABUS

1. Information regarding the programme

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| 1.1 Higher education institution | Babes-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 | Undergraduate |
| 1.6 Study programme / Qualification | Artificial Intelligence |

2. Information regarding the discipline

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|---|---|--------------|----------|-------------------------|----------|------------------------|-------------------|
| 2.1 Name of the discipline (en) (ro) | Metaheuristics Metaeuristici | | | | | | |
| 2.2 Course coordinator | Prof. dr. Camelia Chira | | | | | | |
| 2.3 Seminar coordinator | Prof. dr. Camelia Chira | | | | | | |
| 2.4. Year of study | 2 | 2.5 Semester | 4 | 2.6. Type of evaluation | E | 2.7 Type of discipline | Compulsory |
| 2.8 Code of the discipline | MLE5205 | | | | | | |

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

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| 3.1 Hours per week | 4 | Of which: 3.2 course | 2 | 3.3 seminar/laboratory | 2 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) | | | | | 30 |
| Preparation for seminars/labs, homework, papers, portfolios and essays | | | | | 28 |
| Tutorship | | | | | 6 |
| Evaluations | | | | | 10 |
| Other activities: | | | | | |
| 3.7 Total individual study hours | 94 | | | | |
| 3.8 Total hours per semester | 150 | | | | |
| 3.9 Number of ECTS credits | 6 | | | | |

4. Prerequisites (if necessary)

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| 4.1. curriculum | <ul style="list-style-type: none"> Algorithms, data structures, statistics |
| 4.2. competencies | <ul style="list-style-type: none"> Average programming skills in a high-level object-oriented programming language |

5. Conditions (if necessary)

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

6. Specific competencies acquired

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| Professional competencies | <p>CE 1.1 Description of concepts and research directions in artificial intelligence</p> <p>CE 1.2 Evaluation of solution quality and stability, and comparisons with solutions obtained using traditional methods</p> <p>CE 1.3 Use of methods, techniques and algorithms from artificial intelligence to model solutions to classes of problems</p> |
| Transversal competencies | <p>TC1 Application of efficient and rigorous working rules, manifest responsible attitudes towards the scientific and didactic fields, underlying the individual potential and respecting professional and ethical principles.</p> <p>TC3 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.</p> |

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

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| 7.1 General objective of the discipline | <ul style="list-style-type: none"> • Metaheuristics aims to study specialized algorithms in solving complex problems |
| 7.2 Specific objective of the discipline | <ul style="list-style-type: none"> • The course focuses on theoretical and practical aspects of metaheuristics and aims to provide an overview of the field and major types of metaheuristics. At the end of the course, students will be able to understand the basic principles that guide the development of metaheuristics and the associated algorithmic approaches, and will have knowledge of their applications. |

8. Content

| 8.1 Course | Teaching methods | Remarks |
|---|---|---------|
| 1. Introduction to metaheuristics | <ul style="list-style-type: none"> • Interactive exposure • Conversation • Examples | |
| 2. Complex problems and modelling real problems. Classical models vs metaheuristics in solving complex problems | <ul style="list-style-type: none"> • Interactive exposure • Conversation • Examples | |
| 3. Representation, evaluation, neighborhood. Local search methods, hill-climbing algorithms | <ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Examples | |

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|---|---|--|
| 4. Single-point methods in solving complex problems – Tabu Search, Simulated Annealing | <ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Examples | |
| 5. Population-based methods in solving complex problems | <ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Examples | |
| 6. Evolutionary computing in solving optimization and search problems | <ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Examples | |
| 7. Design of evolutionary algorithms: binary representation, real representation, vectors, permutations | <ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Examples | |
| 8. Swarm intelligence models | <ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Examples | |
| 9. State-of-the-art models | <ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Examples | |
| 10. Computing models and hybrid systems | <ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Examples | |
| 11. Hybrid models and examples of real-world applications | <ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Examples | |
| 12. -14. Applications of metaheuristics | <ul style="list-style-type: none"> • Interactive exposure • Explanation • Conversation • Examples | |

Bibliography

1. S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 1995
2. C. Groșan, A. Abraham, Intelligent Systems: A Modern Approach, Springer, 2011
3. M. Mitchell, An Introduction to Genetic Algorithms, MIT Press, 1998
4. A. Hopgood, Intelligent Systems for Engineers and Scientists, CRC Press, 2001
5. Marco Dorigo, Christian Blum, Ant colony optimization theory: A survey, Theoretical Computer Science 344 (2005) 243 – 27
6. H.F. Pop, G. Șerban, Inteligență artificială, Cluj Napoca, 2004
7. A. E. Eiben, J.E. Smith, Introduction to Evolutionary Computing, Springer, 2003.
8. D. E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley, 1989.
9. K. A. De Jong, Evolutionary Computation: A Unified Approach. MIT Press, Cambridge, MA, 2006.
10. Z. Michalewicz, D. B. Fogel, How to solve it: Modern Heuristics, 2nd edition, Springer, 2004.

| 8.2 Seminar / laboratory | Teaching methods | Remarks |
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| L1-L2. Solving search problems using standard methods and local search methods | <ul style="list-style-type: none"> • Explanation • Conversation • Individual study • Study case • Brainstorming • Simulation • Exercise | |
| L3-L4. Solving search and optimization problems using single-point methods | | |
| L5-L6. Solving search and optimization problems using evolutionary algorithms | | |
| L7-L8. Solving problems using swarm intelligence algorithms | | |
| L9-L10. Extension and hybridization of heuristic algorithms | | |
| L11-L13. Interpretation and analysis of results for heuristic algorithms in solving complex problems | | |
| Bibliography <ol style="list-style-type: none"> 1. Z. Michalewicz, D. B. Fogel, How to solve it: Modern Heuristics, 2nd edition, Springer, 2004. 2. S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 1995 3. C. Groşan, A. Abraham, Intelligent Systems: A Modern Approach, Springer, 2011 4. M. Mitchell, An Introduction to Genetic Algorithms, MIT Press, 1998 5. A. Hopgood, Intelligent Systems for Engineers and Scientists, CRC Press, 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

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| <ul style="list-style-type: none"> • The course respects the IEEE and ACM Curricula Recommendations for Computer Science studies. • The course exists in the studying program of all major universities in Romania and abroad. • The content of the course is considered by the software companies as important for developing the modelling and programming skills of students. |
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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 concepts of the domain Apply the intelligent principles from the course to solve complex and difficult problems | Written exam | 50% |
| 10.5 Seminar/lab activities | Specification, design, implementation and testing of intelligent methods Solving effectively problems using the implemented methods | Sistematic evaluation of the student in solving tasks Evaluation of lab assignments | 50% |

10.6 Minimum performance standards

- Each student must demonstrate an acceptable level of knowledge and understanding of the domain, the ability to present knowledge in a coherent manner and the ability to establish connections and use this knowledge to solve problems.
- To pass the exam it is required to:
 - At least 2 lab assignments must be presented
 - The average grade (of the written exam and lab) must be minimum 5

Date

26.04.2023

Signature of course coordinator

Prof. univ. dr. Camelia Chira

Signature of seminar coordinator

Prof. univ. dr. Camelia Chira

Date of approval

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Signature of the head of department

Prof. dr. Laura Dioşan