# SYLLABUS

## 1.Information regarding the programme

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| 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

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|---|---|---|---|---|---|---|---|
| 2.1 Name of the discipline | **Evolutionary Algorithms** | | | | | | |
| 2.2 Course coordinator | **Conf. dr. Gaskó Noémi** | | | | | | |
| 2.3 Seminar coordinator | **Conf. dr. Gaskó Noémi** | | | | | | |
| 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 |

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| 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: .................. | - |

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| 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)

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| 4.1. curriculum | |
| 4.2. competencies | |

## 5. Conditions (if necessary) -

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| 5.1. for the course | |
| 5.2. for the seminar /lab | |

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| activities | • Room with computers as needed; high level programming language environment |

**6. Specific competencies acquired**

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| **Professional competencies** | • Knowledge, understanding and use of basic concepts of GAs |
| **Transversal competencies** | • Ability to apply GAs to different real life problems<br>• Ability to model phenomena using GAs |

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

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| 7.1 General objective of the discipline<br><br>7.2 Specific objective of the discipline | • an introduction to the field studied.<br>• the basic notion, techniques and algorithms.<br>• the background for advanced courses<br>• application of GAs |

**8. Content**

| 8.1 Course | Teaching methods | Remarks |
|---|---|---|
| • Week 1: Principles of evolutionary computation. Basic and related models. Structure of an evolutionary algorithm | • Interactive exposure<br>• Explanation<br>• Conversation | |
| • Week 2: Genetic algorithms. Problem representation and fitness function. Canonical genetic algorithm. | • Interactive exposure<br>• Explanation<br>• Conversation | |
| • Week 3: Selection – selection pressure; takeover time; standard schemes. | • Interactive exposure<br>• Explanation<br>• Conversation<br>• Didactical demonstration | |
| • Week 4: Selection – proportional selection; premature convergence; scaling mechanisms; rank-based selection | • Interactive exposure<br>• Explanation | |

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|---|---|---|
| | • Conversation<br>• Didactical demonstration | |
| • Week 5: Selection – binary tournament; q-tournament; elitism; steady state EAs; Michalewicz selection; Boltzmann selection | • Interactive exposure<br>• Explanation<br>• Conversation | |
| • Week 6: Variation operators for binary encoding;Variation operators for real-valued encoding | • Interactive exposure<br>• Explanation<br>• Conversation | |
| • Week 7: Hybridisation – specific representation; hybridisation | • Interactive exposure<br>• Explanation<br>• Conversation | |
| • Week 8: Parameter setting and adaptive GAs; adaptive fitness of a search operator | • Interactive exposure<br>• Explanation<br>• Conversation | |
| • Week 9: Adaptive representation –messy genetic algorithms, delta coding; diploidic representation | • Interactive exposure<br>• Explanation<br>• Conversation | |
| • Week 10: Population models and parallel implementations - niching methods; fitness sharing; island and stepping stone models; | • Interactive exposure<br>• Explanation<br>• Conversation | |
| • Week 11: Differential evolution – introduction, parameter settings, variants | • Interactive exposure<br>• Explanation<br>• Conversation<br>• Case studies | |
| • Week 12: Evolution strategies – introduction. (1+1) strategy; standard mutation; Cauchy perturbations | • Interactive exposure<br>• Explanation<br>• Conversation | |
| • Week 13: Evolutionary programming – sequential machine model; function optimization; Cauchy perturbation. | • Interactive exposure<br>• Explanation<br>• Conversation | |

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|---|---|---|
| • Week 14: Search and optimization using genetic algorithms | • Interactive exposure<br>• Conversation | |

**Bibliography**


Eiben A & Smith JE, Introduction to Evolutionary Computing. Springer-Verlag 2010.

David E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning. Addison-Wesley; 1989.

David E. Goldberg, The Design of Innovation: Lessons from the competent genetic algorithms. Springer-Verlag; 2002.

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Michalewicz, Z., Genetic Algorithms + Data Structures = Evolution Programs, Springer, Berlin, 1992.

Dumitrescu, D., B Lazzerini, Evolutionary Computation, CRC Press, New York, Boca Raton, 2000

Dumitrescu, D., Principiile Inteligentei artificiale, Editura Albastra, Cluj,2000.

Dumitrescu, D., Algoritmi genetici si strategii evolutive. Aplicatii in Inteligenta Artificiala, Editura Albastra, Cluj,2000.

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


| 8.2 Seminar / laboratory | Teaching methods | Remarks |
|---|---|---|
| 1. Implementation of some genetic operators and the analysis of their performance | • Interactive exposure<br>• Explanation<br>• Conversation | The laboratory is structured as 2 hours, classes every second week<br>-2 laboratories for this activity |
| 2. Each student chooses a different type of problem (e.g. the traveling salesman problem), and implements three appropriate evolutionary techniques for the selected problem | • Interactive exposure<br>• Explanation<br>• Conversation | -3 laboratories |
| 3. Parameter setting, analysis of the implemented algorithms | • Interactive exposure<br>• Explanation<br>• Conversation | |
| 4. Project presentation, documentation | • Interactive exposure<br>• Conversation | |

**Bibliography**


Eibern A & Smith JE, Introduction to Evolutionary Computing. Springer-Verlag 2010.

David E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning. Addison-Wesley; 1989.

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Deb, K., 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 considered important in the introduction to Genetic Algorithms

## 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;<br>- apply the course concepts<br>- problem solving | Written exam | 30.00% |
| 10.5 Lab activities | -be able to implement course concepts and algorithms<br>-be able to make a practical project during the semester | Practical project | 70.00% |
| 10.6 Minimum performance standards | | | |
| • At least grade 5 (from a scale of 1 to 10) at both written exam and laboratory work. | | | |

| Date | Signature of course coordinator | Signature of seminar coordinator |
|---|---|---|
| | Conf. dr. Gaskó Noémi | Conf. dr. Gaskó Noémi |

| Date of approval | Signature of the head of department |
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| | Conf. dr. András Szilárd |