Course title: Evolutionary algorithms
Course code: ML_EA
Classification of a course group: specialty-related
Course type: obligatory

Field of study: CONTROL, ELECTRONIC AND INFORMATION ENGINEERING (MACRO)
Level of study: second-cycle
Profile of study: general academic
Mode of study: full-time programme
Specialty (specialisation): DATA SCIENCE
Year of study: 1
Semester: 1
Teaching modes and teaching hours:
lectures – 15;
laboratory – 15.
Language/s of instruction: English
Number of ECTS credits *(according to the study programme)***:** 3

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1. Course objectives:

   The aim of the course is making students familiar with issues related to evolutionary algorithms and their applications to engineering, problems in the area of automation, electronics, informatics and biocybernetics. Relations between evolutionary algorithms, optimization theory and classification methods are underlined.

2. Relation of the field-related learning outcomes to modes of teaching and methods of verification as well as to assessment of student's learning outcomes:

symbol	**assumed learning outcomes** *a student who completed the course:*	**teaching modes**	**verification methods and learning outcomes assessment**
Knowledge: a student knows and understands			
K2A_W04	The notion of evolutionary algorithms and their importance to modeling, optimization, classification and data analyses	lecture	credit
K2A_W04 K2A_W08	Ideas and constructions behind basic types of evolutionary algorithms, genetic, memetic, simulated annealing, ant colony, particle swarm, and other nature inspired algorithms.	lecture	credit
Skills: a student can			
K2A_U07	To elaborate, in R or Python environment, implementations of chosen evolutionary algorithms.	laboratory	laboratory task
K2A_U05 K2A_U04	To compare and validate quality of different evolutionary algorithms.	laboratory	laboratory task
K2A_U05 K2A_U04	To perform analysis of the exemplary dataset, with the use of the chosen evolutionary algorithms.	laboratory	laboratory task
Social competences: a student is prepared to			
K2A_K04	Use knowledge from observations of nature to solve technical problems.	laboratory	laboratory task

3. The content of study programme ensuring learning outcomes *(according to the study programme)*:

   Evolutionary Algorithms.

   Biologically-Inspired and Population Based Approaches to Computer Intelligence.

1. Description of methods of determination of ECTS credits:

Type of activity	Number of hours / ECTS credits
Number of course hours regardless of a teaching mode	30/2
Student's workload: studying sources, making a laboratory report, preparation for a test and laboratory,	30/1
Total hours:	**60**
Number of ECTS credits allocated to a course	**3**

2. Summary indexes:
   - number of course hours and ECTS credits at the course with a direct participation of academic teachers or other persons running the course and supervising students: **30/2**,
   - number of course hours and ECTS credits at the course related to the scientific activity conducted at the Silesian University of Technology in a discipline or in disciplines to which a field of study is assigned - in the case of studies

with a general academic profile: **30/2**,

– number of course hours and ECTS credits at the course developing practical skills- in the case of practical studies: –

– number of course hours conducted by academic teachers employed by the Silesian University of Technology as their primary workplace: **30**.

3. Persons conducting particular modes of courses (name, surname, academic degree or degree in arts, title of professor, business e-mail address):

   Lecture: Robert Czabański, PhD, DSc, Assoc. Prof., robert.czabanski@polsl.pl

   Laboratory: Robert Czabański, PhD, DSc, Assoc. Prof., robert.czabanski@polsl.pl, Michał Jeżewski, PhD, michal.jezewski@polsl.pl

4. Detailed description of teaching modes:

   1) lectures:

   – detailed programme's content:

   - Introductory facts on evolutionary algorithms for learning and optimization. Genetic algotithms.
   - Evolutionary strategies – basic and advanced topics. Applications of evolutionary algorithms in engineering, automatic control, electronics and biocybernetics.
   - Fitness, selection, and population management. Stopping criteria. Evaluation of efficiency. Computational complexity and evolutionary algorithms.
   - Memetic algorithms. Genetic and evolutionary programming.
   - Simulated annealing - probabilistic background and relations to optimization theory.
   - Immune algorithms.
   - Ant colony optimization. Particle swarm algorithms.
   - Bat algorithm, flower pollination algorithm, and other nature inspired methods.

   – teaching methods, including distance learning:

   The lectures are conducted using the traditional methods, supported by materials available on the Distance Education Platform. Laboratory classes are project-oriented. Students implement the selected methods, whose task is to solve the problems identified by the tutor.

   – form and criteria for semester completion, including retake tests, as well as conditions for admission to the examination:

   Successful completion of all laboratory tasks. Successful completion of a test during the semester. In case of failure or absence from laboratory classes, revision test and additional classes are scheduled.

   – course organisation and rules of participation in the course, with an indication whether a student's attendance is obligatory

   Classes are conducted in accordance with the schedule available on the Distance Education Platform. Attendance at laboratory classes is compulsory.

   2) description of other teaching modes:

   The aim of the laboratory is to reinforce the knowledge gained during the lecture by means of practical verification. The following exercises are carried out during the laboratory:

   - Application of genetic algorithm to the Traveling Salesperson Problem.
   - Software development for the estimation problem by using a chosen evolutionary algorithm.
   - Analysis of a real dataset by using particle swarm optimization. Performance comparison of different evolutionary algorithms.

5. Description of the method for determining the final grade (rules and criteria for evaluation, as well as the final grade calculation method in the case of a course comprising more than one teaching mode, taking into account all teaching modes and all exam dates and credit tests including retake exams and tests):

   The laboratory tasks and the test are scored between 2.0 and 5.0 points with a step of 0.5 points. The final grade is the average of the test grade and the final assessment of the laboratory classes. The final assessment of the laboratory classes is the average of grades for laboratory tasks. The test and each laboratory task must score a minimum of three points.

6. Method and procedure for making up for

   – student's absence from the course: additional appointments for completing the laboratory classes,

   – differences in study programmes for students changing their field of study, changing university or resuming studies at the Silesian University of Technology: the differences identified on the basis of a comparison of programme variations shall be supplemented.

7. Prerequisites and additional requirements, taking into account the course sequence:

   Algebra, Calculus and differential equations, Physics, Computer programming, Optimization methods, Numerical methods, Statistics and probability theory, Algorithms and data structures. Classifiers.

11. Recommended sources and teaching aids:

- Basic materials: lecture and materials available on the Distance Education Platform.
- X. Yu, M. Gen, Introduction to Evolutionary Algorithms, Springer-Verlag London Limited, 2010.
- D. Simon, Evolutionary Optimization Algorithms (Biologically-Inspired and Population-based Approaches to Computer Intelligence), John Wiley & Sons, Inc., 2013.
- A.E. Eiben, J.E. Smith, Introduction to Evolutionary Computing, Springer-Verlag Berlin Heidelberg 2015.
- Z. Michalewicz, Genetic Algorithms + Data Structures = Evolution Programs, Springer-Verlag Berlin Heidelberg, 1996.
- R.S. Sutton, A.G. Barto, Reinforcement Learning: An Introduction, The MIT Press, Cambridge, Massachusetts, London, England, 2017.

12. Description of teachers' competences (e.g. publications, professional experience, certificates, trainings etc. related to the programme contents implemented as a part of the course):

    The tutors are experienced teachers. They conduct research in the field of artificial intelligence and biologically inspired optimization methods which are confirmed by a number of relevant publications.

13. Other information: –