Introduction to Artificial Intelligence – summer 2022 – task #2

Version 1.0

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Please be aware that this exercise is done in pairs (you should inform us about the groups via Teams #General channel – under the post of prof. Paweł Wawrzyński).

Assignment description

The main point of this exercise is to acquire sufficient knowledge related to genetic algorithms. The appropriate source of knowledge about this solution is "Introduction to Artificial Intelligence" lecture ☺, however you can also consider analysis of the information placed within [1].

The main goal of the task is to implement genetic algorithm that will be responsible for analysis of multidimensional quadratic function. The outcome of such analysis should be information about integer number that maximize the above-mentioned function (your program must return information about the last population – both individual members of this population and their target function values).

Your implementation must have the following components and fulfil the following requirements:

- Roulette-wheel selection with scaling
- Single point crossover
- FIFO replacement strategy
- Genetic algorithm must use binary vectors

Please, be aware that multidimensional quadratic function is defined as follows - $f(x) = x^T Ax + b^T x + c$, where c is a scalar, b is a vector of n numbers, A is a $n\,x\,n$ matrix. Moreover, please remember that x is not a single value but a vector.

The user should also have a possibility to specify diversified parameters of the algorithm. They are as follows:

- The problem dimensionality
- The range of searched integers as $d \geq 1$ that for each dimension i, $-2^d \leq x_i < 2^d$
- Function parameters A, b, c
- The algorithm parameters as: population size, crossover probability, mutation probability, number of algorithms iterations

Please, remember that worked-out software must validate all mentioned parameters.

Technical requirements

Please, be aware that all logic needs to be implemented directly by you. **It is not allowed to use any ready-to-use machine learning or optimization libraries / packages (e.g., PyTorch, TensorFlow).** It means that the task is to implement whole logic by yourself (of course, you can use basic linear algebra and math processing packages / libraries – e.g., NumPy).

The preferred language to solve this task is Python. However, it is still possible to prepare the solution with Java/Scala/C/C++/R/C# languages.

How-to submit the task?

- **Deadline:** You should submit the task (source code of your solution) to maciej.szymkowski@pw.edu.pl. The deadlines for each group are given in the table below.

Deadlines for task submission		
Monday group	Wednesday group	Friday group
TBA (we will discuss it during our next meeting – it is related to my absence during first classes)	23.03.2022, 11:59:59 CET	25.03.2022, 11:59:59 CET

- In the title of your e-mail please include "[EARIN] Exercise #2". Moreover, do not forget to include names, surnames, and e-mails of all members of your group (please add them in the e-mail content).
- The results will be discussed during next meeting. The details related to it will be given within our Microsoft Teams channel.
- You can get 0-5 points for this task.
- If you have any questions, please do not hesitate to contact me via e-mail (maciej.szymkowski@pw.edu.pl) or directly by Microsoft Teams platform.

Literature

1. https://www.tutorialspoint.com/genetic_algorithms/genetic_algorithms_introduction.htm (Accessed 06.03.2022)