Assignment 3 Evolutionary algorithms (EAs)

Aims:

To solve a problem using an Evolutionary Algorithm (EA).

Task:

Specify, design and deploy an application in python that solve your assigned problem using a proper design Evolutionary Algorithm. The applications should follow the following conditions:

1. It must have a nice architecture (follow the UML diagram in proportion of 90% - you can add/change functions, attributes, methods or classes as need it)

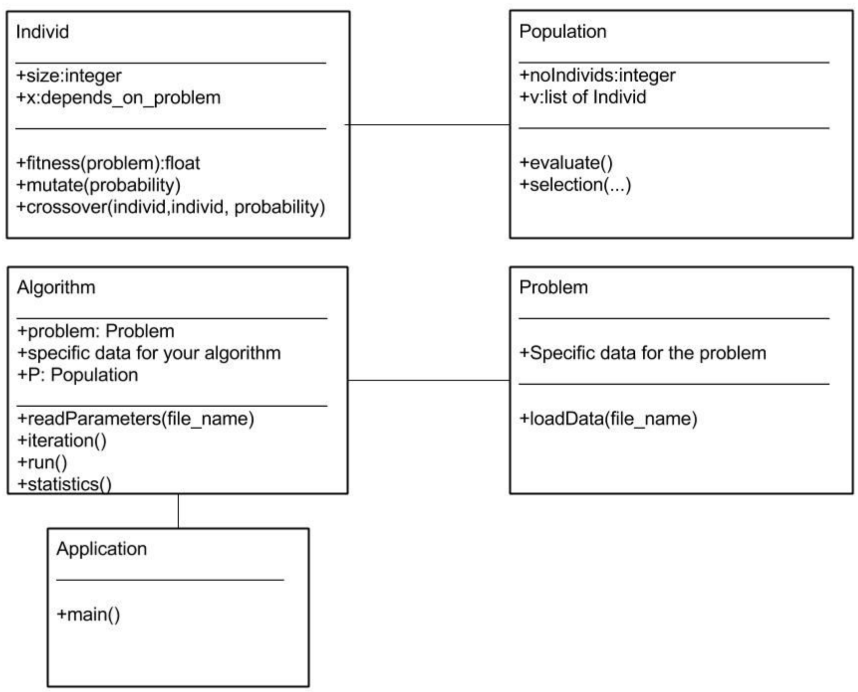


Figure 1: The UML diagram

2. the input data for the problem (if need it) will be in a text file 'dataXX.in' (XX - 01; 02; …),
3. the specific parameters (probability of mutation and crossover, population size and number of generations) 'param.in'
4. Some specific validation tests will be performed and the results displayed on console - the average and standard deviation for the best solutions found by your the algorithm after 1000 evaluations of the fitness function in 30 runs, with populations of 40 individuals.

Points:

- 85 points - the algorithm.
- 10 points for the architecture and for the quality of your application.
- 5 points the statistical validation

- **-10** if the implementation is too similar with the seminar 2 (you need different selection, different operators, or different type of EA, …) - for variations use the methods depicted in lecture 4.

Time:

The deadline is at beginning of the forth laboratory.

General hints:

- Use a proper representation for the problem.
- Use proper variation operators for your representation.
- Study Seminar 2 - you have in it a simple algorithm that you can use to adapt (significant changes are demanded)
- Ask if you don't know how to solve it! Time is important!
- Do NOT solve the problems with other methods. You will not be granted points if you do this.

Problems:

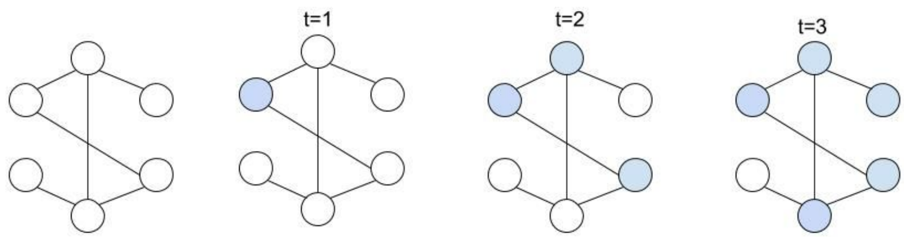
1. Jewelry exhibition

A jeweler wants to participate to an exhibition with sales abroad. Each jewel he wants to take has a certain grammage of precious metal and a price. The rules of that exhibition is that he must have a minimum amount of k pieces and a maximum of l, respectively. He travels by air, so the maximum baggage allowance is G (usually 20 kg). Help him choose the pieces for the exhibition that will bring a larger gain (assuming that he will sell all exhibits), with respect of the constraints imposed by the airline and the fair's organisers.

2. Rumors

The members of a cultural organization are organized in a network (some members have relationships with other members, each member having at least one

relationship with another member - otherwise it can not be part of the network). In case that one member will find out about an event he will notify all the other members connected to him in one step of the time. Identify a minimal set of members that need to be notified about an event in order to get that info to ALL the members of the associations in t (t=3 for example) time steps.



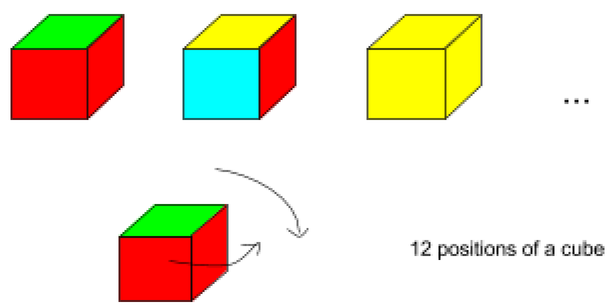
3. Puzzle

A child has a set of words $W = \{w_1, ..., w_{2n}\}$, each word having n characters. Help him build an $n \times n$ crossover puzzle using all the words. For example if $n = 3$ and $W = \{AGE, AGO, BEG, CAB, CAD, DOG\}$ the resulting puzzle would be:

C	A	B
A	G	E
D	O	G

4. Tower

Consider a set of n cubes with coloured facets (each one with a specific colour out of 4 possible ones - red, blue, green and yellow). Form the highest possible tower of k cubes ($k \leq n$) properly rotated, so the lateral faces of the tower will have the same colour.

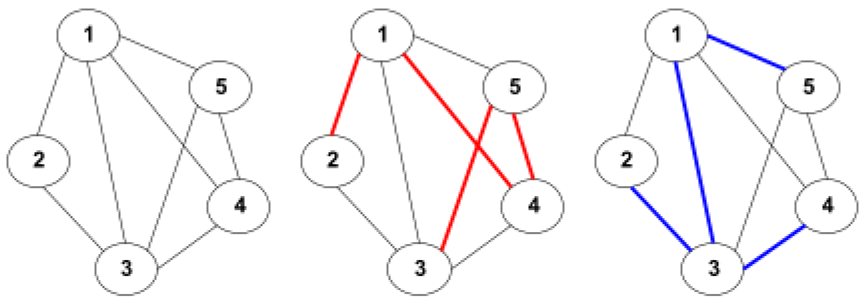


5. Monochromatic Triangle

In an undirected graph $G(V, E)$ with the set of vertices V and the set of edges E find a partitioning of two disjoint subsets $E1$ and $E2$ so that each of the two sub-graphs

$G_1(V, E_1)$ and $G_2(V, E_2)$ does not contain a triangle - any three different nodes u, v, w from V are not connected with edges from the same sub-graph ((u,v), (u,w) and (v,w) are not in E_i).

Example:



For the initial graph G with $V = \{1,2,3,4,5\}$ and $E = \{(1,2), (1,3), (1,4), (1,5), (2,3), (3,4), (3,5), (4,5)\}$ a solution can be :

$$E_1 = \{(1,2), (1, 4), (3,5), (4,5)\} \text{ and } E_2 = \{(1,3), (1,5), (2.3), (3,4)\}.$$

Attention: $E_1 U E_2 = E$ and $E_1 \cap E_2 = \Phi$,

but $E1 = \{(1,2), (1,4), (3,4), (3,5), (4,5)\}$ and $E2 = \{(1,3), (1,5), (2.3)\}$ is not a solution because you have a triangle in E_1 between the nodes 3, 4 and 5.

6. Pyramid

Consider n cubes of known sides' length s_i and colors c_i. Assemble the highest pyramid from the cubes in such a way that it has 'stability' (there is not a bigger cube over a smaller one) and there are not two consecutive cubes of the same color.

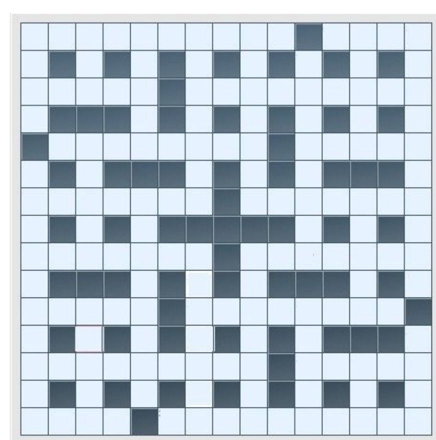
7. Crossword

Solve a crossword puzzle of size $p \times q$ knowing the words and the black positions inside the puzzle.

Example:
Consider the following words list:

[guarantees, aura, taken, orchestra, spelling, creed, dawning, dedpan, nodules, citizen, idles, lifeboat, incurable, fatty, soda, persistent, guts, identities, ask, pawed, lucid, annul, illusory, tooting, soluble, encaged, coffers, merchant, buffs, untie, pizza, toe, abandoning, cyst].

And the 15×15 board:



We have the solution:

8. Disjoint subsets

Consider a set A with n elements and $S_1,\ S_2,\ ...,\ S_m$ subsets of A. Partitionate set A in two disjoint subsets D_1 and D_2 so for all $i=\overline{1,m}$, S_i is not included in either D_1 or D_2.

9. Subgraphs

Consider an undirected graph $G(V,E)$ with $2n$ nodes (V is the set of nodes, and E is the set of edges). Partitionate the set of nodes in two disjoint sets V_1 and V_2, each containing exactly n nodes, in such a way that between any two nodes of the subgraphs determined by the subsets of nodes should be a path (both subgraphs are conex).

10. Processes

There are p tasks and m computers to do them ($p > m$). For each task is known the time that each computer would take to complete it, $d(i,j)$ - the time in which process i is completed by computer j. Schedule all the task to the appropriate computers in such a way to execute them in minimum amount of time. A computer can do just one task one of a time and after it is free can perform another one.

11. Transportation Problem

Two sets are given: F and L (facilities and locations) of equal size, a weight function $w: F\times F \to R$ and a distance function $d: L\times L \to R$. Identify a scalar $f: F \to L$ so the following costs function will be minimized $\sum_{a,b\in F} w(a,b)\cdot d(f(a),f(b))$.

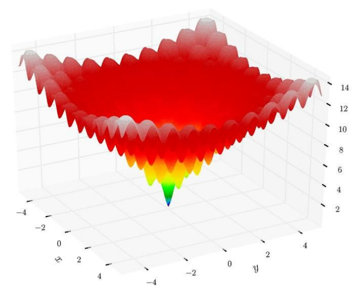
12. The happy horse

Make a horse happy by guiding it to a path on the chessboard in such a way that it moves to every single square once and only once. The little horsie can jump obviously only in the classic L shape (the chess' horse move).

13. Ackley's function

Find the minimum point for the Ackley's function on the domain $[-5,5]\times[-5,5]$**. The function is:**

$$f(x,y) = -20\cdot e^{-0.2\cdot\sqrt{0.5\cdot(x^2+y^2)}} - e^{0.5\cdot(\cos 2\pi x+\cos 2\pi y)} + e + 20$$



14. Cross-in-tray function

Find the optimum point (minimum) for the Cross-in-tray function in the domain $-10 \le x,y \le 10$**. The function is:**

$$f(x,y) = -0.0001\cdot\left[\left|\sin x \cdot \sin y \cdot \exp\left(100-\frac{\sqrt{x^2+y^2}}{\pi}\right)\right| + 1\right]^{0.1}$$

15. McCormick function

Find the minimum for the McCormick function

$$f(x,y) = \sin(s+y) + (x-y)^2 - 1.5x + 2.5y + 1$$

where $(x,y) \in [-1.5,4]\times[-3,4]$**.**