Assignment 5: Evolutionary Computation
Machine Learning

Deadline: Monday 24 Dec 2018, 21:00

Introduction

In this assignment, you will further deepen your understanding of Evolutionary Algorithms (EA). Please provide a latex based report in the PDF format. We provide you a sample latex project you might use for writing and generating your report. We also provide a skeleton of the code in python, but you don't have to use it. Moreover, you are free to write your code in any language of your choice.

Your report and code must be archived in a file named firstname.lastname and uploaded to the iCorsi website before the deadline expires. Late submissions will result in 0 points.

Where to get help

We encourage you to use the tutorials to ask questions or to discuss exercises with other students. Please note that your code will be cross-checked for plagiarism. Therefore, do not look at any report or code written by others or share your report with others. Violation of that rule will result in 0 points for all students involved. For further questions you can send email to *aleksandar@idsia.ch*.

Tasks

1. **(50 points)** Implement a binary Genetic Algorithm that uses fitness proportional selection, 2-point crossover, and bit-flip mutation to solve the problem in which the fitness is the number of separated pairs of 1s in the chromosome, i.e. $f([1,1,0,1,0]) = 1$, $f([1,0,0,1,0]) = 0$, $f([1,1,1,0,0]) = 1$, $f([1,1,0,1,1]) = 2$

   (a) **(40 points)** Implement and run the algorithm 10 times for each of the four following versions of the problem: $l = 5, 10, 20, 50$, where l is the length of the chromosomes. Vary the population size and mutation rate to obtain good results (optimal and fast convergence).

   (b) **(10 points)** Plot the best fitness in each generation (averaged over the 10 runs), for each of the four problems. There should be one graph with four curves, the x-axis being the generations, and the y-axis the average (best) fitness.

2. **(50 points)** Implement (μ, λ)-ES, where you use uncorrelated mutation with N σ's to minimize the following function:

$$f(\mathbf{x}) = \sum_{i=1}^{N-1} [(1 - x_i)^2 + 100(x_{i+1} - x_i^2)^2]$$

known as the Rosenbrock function, where N is the number of dimensions, and $-5 \leq x_i \leq 10$, $i = 1, 2, \ldots, N$.

   (a) **(40 points)** Implement and run the algorithm 10 times for each of the following four settings, $N = 5, 10, 20, 50$. Choose your own λ, μ to obtain the best results (optimal and fast convergence).

   (b) **(10 points)** Plot the average fitness (over the 10 runs and μ parents) in each generation as well as the variance of the fitness of the parents averaged across the 10 runs for each N. Structure your plots as in 1B, use the same colour style for the mean/variance pair of each N, but use a different line style to distinguish them (i.e. - -). The plot should now contain 8 lines.
