Assignment 5: EA

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1 Visualize test functions

The contour plots of the test functions help a lot in the identification of the optimal values of the functions. The contour plots are shown in figure 1. In figure 2 are plotted for both the test functions 100 uniformly sampled points evaluated with the test functions. The colours help to identify the optimum of the functions. In the case of the sphere function it's easy to see that in the optimum region is the one in wich the points are close to red. In the rastrigin case it's harder too see the optimum region because the function itself has many minimum points. Using the contour plot we can see that the optimum region is in the center of the function. This fact is confirmed by the scatter plot in which the point in the center of the plots are red.

(a) 2D contour plot for the sphere test function

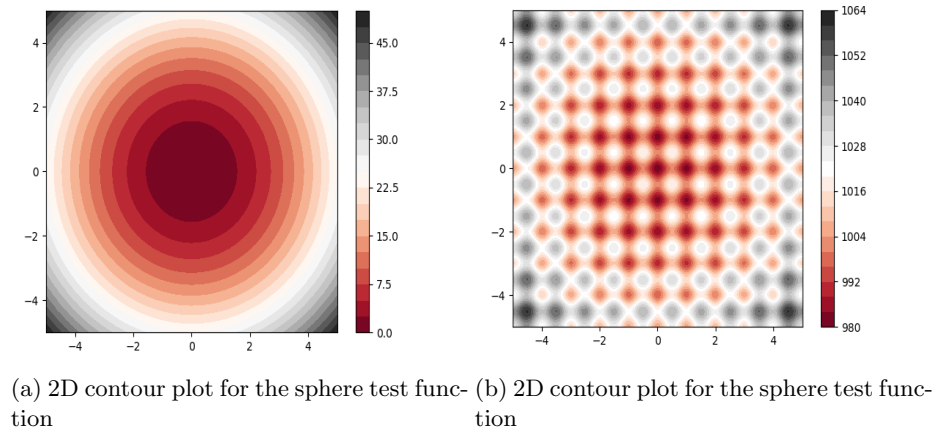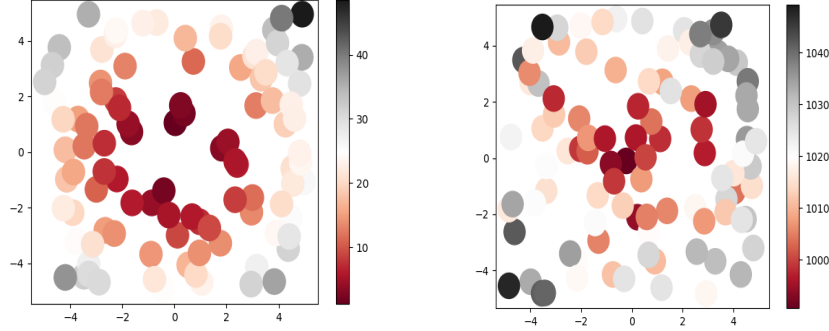(b) 2D contour plot for the sphere test function

Figure 1

(a) 2D plot of 100 samples evaluated with the sphere test function

(b) 2D plot of 100 samples evaluated with the rastrigin test function

Figure 2

2 Cross-Entropy Method (CEM)

The result of the *CEM* are summarized in the tables 1, 2, 3 and 4. The mean and the variance have been initialized following a uniform ditribution between -5 and 5 for the mean and from 0 to 5 for the variance. During the experiments i noticed a problem about the vanishing of the variance. So I added a small costant (0.001) during every generation. Best and worst fitness values for each generation, averaged on 3 runs of CEM are shown in figures 3 and 4

Number of samples: 100, Number of features: 100, Test function: sphere			
Number of generations	Elite set	Best Fitness	Worst Fitness
50	20	89.6	93.5
100	20	72.7	74.0
1000	20	0.0	0.0
50	50	70.6	82.9
100	50	41.7	44.1
1000	50	0.4	0.5

Table 1

3 Natural Evolution Strategy (NES)

The result of *NES* are summarized in the tables 5, 6, 7 and 8 The mean and the variance have been initialized following a uniform ditribution between -5 and 5 for both means and covariance matrix. Best and worst fitness values for
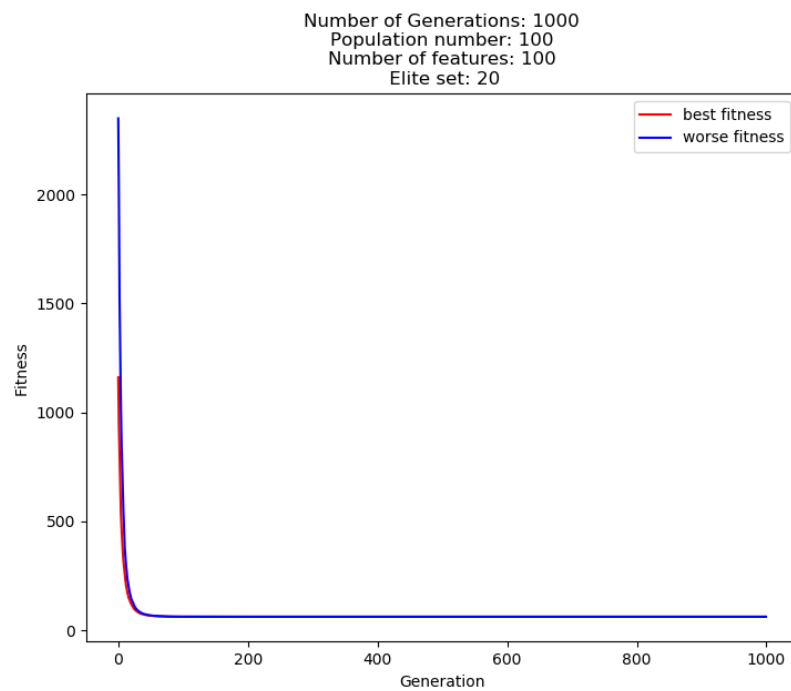
Figure 3: Best and worst fitness values for each generation, averaged on 3 runs of CEM for the sphere function.
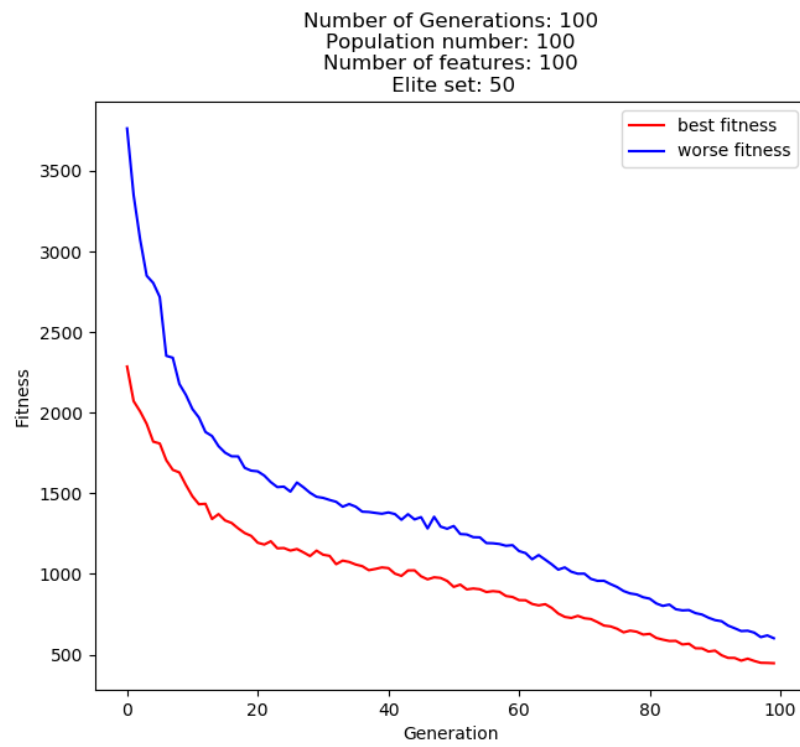
Figure 4: Best and worst fitness values for each generation, averaged on 3 runs of CEM for the rastrigin function.

Number of samples: 1000, Number of features: 100, Test function: sphere			
Number of generations	Elite set	Best Fitness	Worst Fitness
50	200	12.1	14.4
100	200	10.1	10.1
1000	200	0.1	0.1
50	500	61.7	82.2
100	500	20.3	21.9
1000	500	0.0	0.0

Table 2

Number of samples: 100, Number of features: 100, Test function: rastrigin			
Number of generations	Elite set	Best Fitness	Worst Fitness
50	20	158.0	160.1
100	20	270.6	271.3
1000	20	9362.3	9362.3
50	50	491.3	807.7
100	50	478.6	629.6
1000	50	9256.0	9256.0

Table 3

each generation, averaged on 3 runs of NES are shown in figures 5

4 Covariance Matrix Adaptation Evolution Strategy (CMA-ES)

The result of *CMAES* are summarized in the table 9,10, 11, 12.The mean and the variance have been initializated following a uniform ditribution between -5 and 5 for both means and covariance matrix. For this case i used only 20 features because every run of the algorithm takes several minutes with higher dimensional spaces. Best and worst fitness values for each generation, averaged on 3 runs of CMAES are shown in figures 6, 7

Number of Generations: 50
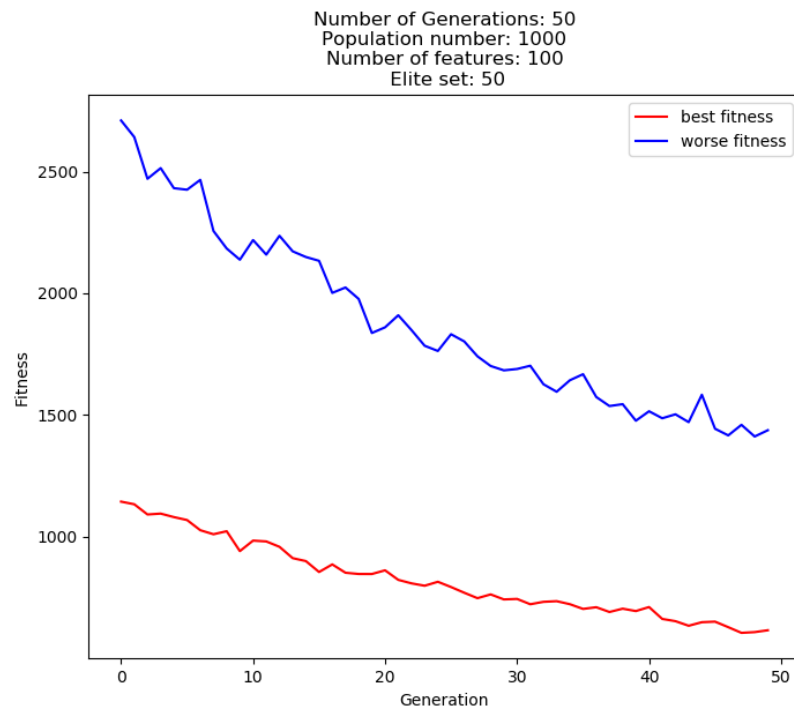Population number: 1000
Number of features: 100
Elite set: 50

Figure 5: Best and worst fitness values for each generation, averaged on 3 runs
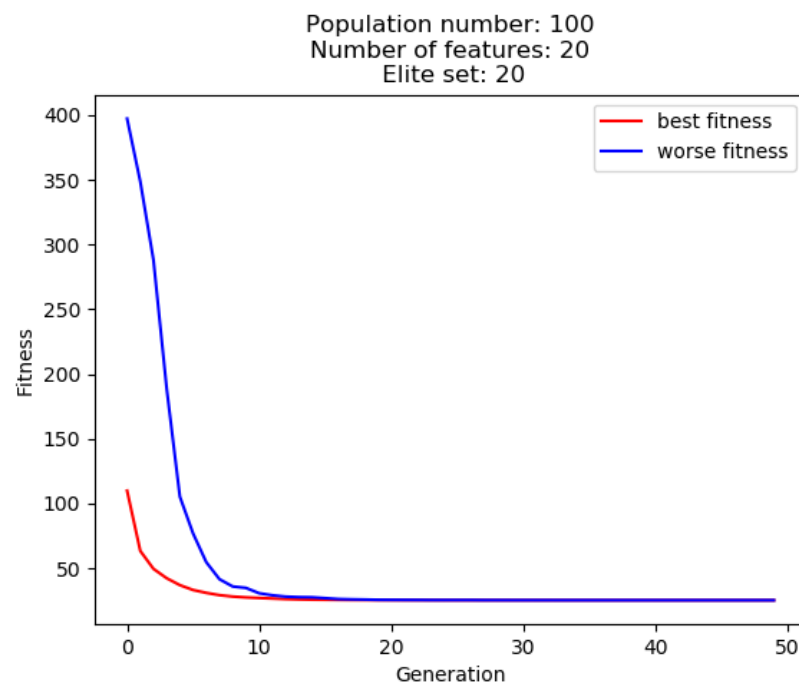of NES for the sphere function.

Figure 6: Best and worst fitness values for each generation, averaged on 3 runs of CMA for the sphere function.
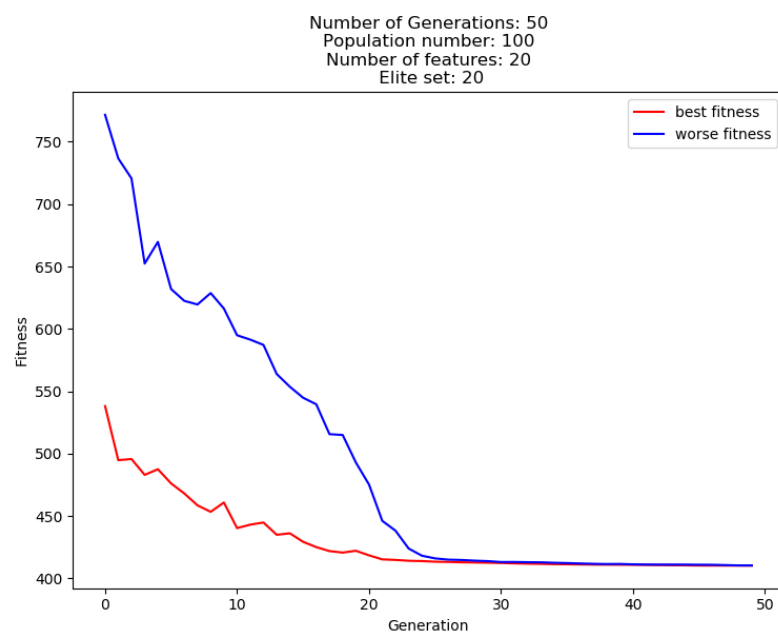
Figure 7: Best and worst fitness values for each generation, averaged on 3 runs of CMA for the sphere function.

Number of samples: 1000, Number of features: 100, Test function: rastrigin			
Number of generations	Elite set	Best Fitness	Worst Fitness
50	200	301.1	747.3
100	200	310.5	542.0
1000	200	9186.6	9186.6
50	500	469.1	907.2
100	500	778.8	1247.1
1000	500	9120.0	9120.0

Table 4

Number of samples: 100, Number of features: 100, Test function: sphere			
Number of generations	Learning Ratio	Best Fitness	Worst Fitness
50	0.01	error	error
100	0.01	error	error
1000	0.01	error	error
50	0.001	13.3	64.0
100	0.001	error	error
1000	0.001	error	error

Table 5

Number of samples: 1000, Number of features: 100, Test function: sphere			
Number of generations	Learning Ratio	Best Fitness	Worst Fitness
50	0.01	error	error
100	0.01	92.8	223.1
1000	0.01	error	error
50	0.001	598.2	1389.1
100	0.001	415.0	1019.8
1000	0.001	286.0	784.7

Table 6

9

Number of samples: 100, Number of features: 100, Test function: rastrigin			
Number of genera-tions	Learning Ratio	Best Fitness	Worst Fitness
50	0.01	error	error
100	0.01	error	error
1000	0.01	error	error
50	0.001	error	error
100	0.001	error	error
1000	0.001	error	error

Table 7

Number of samples: 1000, Number of features: 100, Test function: sphere			
Number of genera-tions	Learning Ratio	Best Fitness	Worst Fitness
50	0.01	error	error
100	0.01	error	error
1000	0.01	error	error
50	0.001	error	error
100	0.001	error	error
1000	0.001	error	error

Table 8

Number of samples: 100, Number of features: 20, Test function: sphere			
Number of genera-tions	Elite set	Best Fitness	Worst Fitness
50	20	26.1	26.1
100	20	49.1	49.1
1000	20	78.9	78.9
50	50	39.4	39.4
100	50	43.9	43.9
1000	50	37.9	37.9

Table 9

Number of samples: 1000, Number of features: 20, Test function: sphere			
Number of generations	Elite set	Best Fitness	Worst Fitness
50	200	3.4	3.4
100	200	0.0	0.0
1000	200	0.0	0.0
50	500	0.0	0.0
100	500	0.0	0.0
1000	500	0.0	0.0

Table 10

Number of samples: 100, Number of features: 20, Test function: rastrigin			
Number of generations	Elite set	Best Fitness	Worst Fitness
50	20	437.8	438.1
100	20	916.5	916.5
1000	20	9933.1	9933.1
50	50	428.2	439.3
100	50 943.6	943.6	
1000	50	9937.0	9937.0

Table 11

Number of samples: 1000, Number of features: 20, Test function: rastrigin			
Number of generations	Elite set	Best Fitness	Worst Fitness
50	200	319.7	320.6
100	200	816.9	816.9
1000	200	9811.2	9811.2
50	500	392.2	574.6
100	500	816.8	845.2
1000	500	error	error

Table 12