Biologically-Inspired Computation

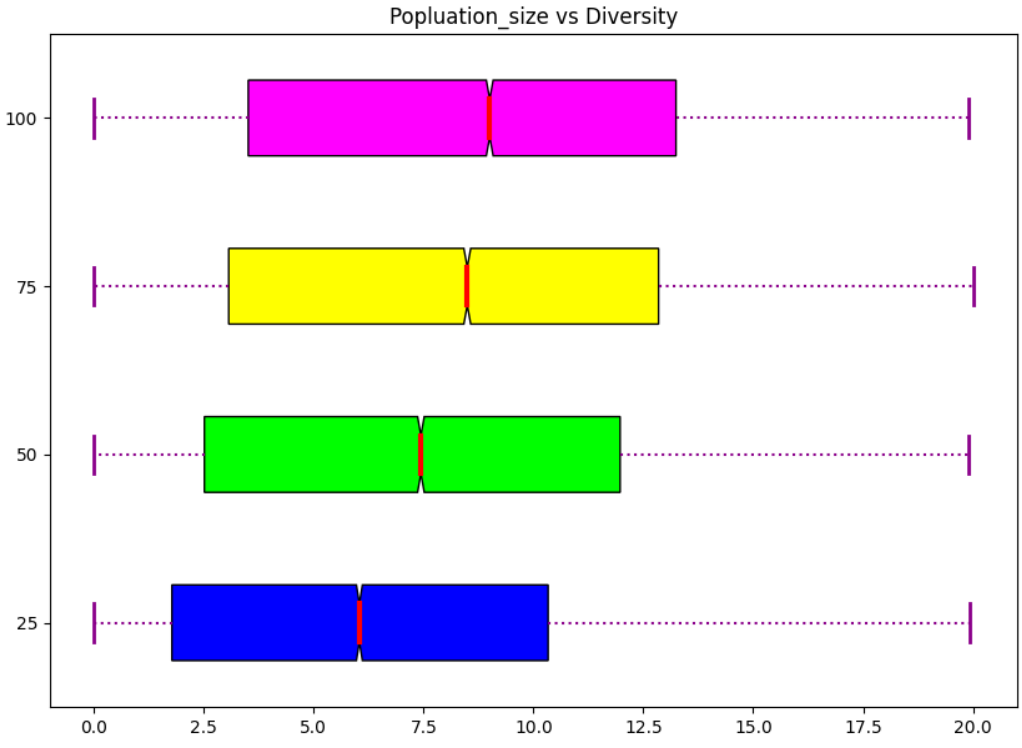
Lab2: Genetic Algorithms in Leap

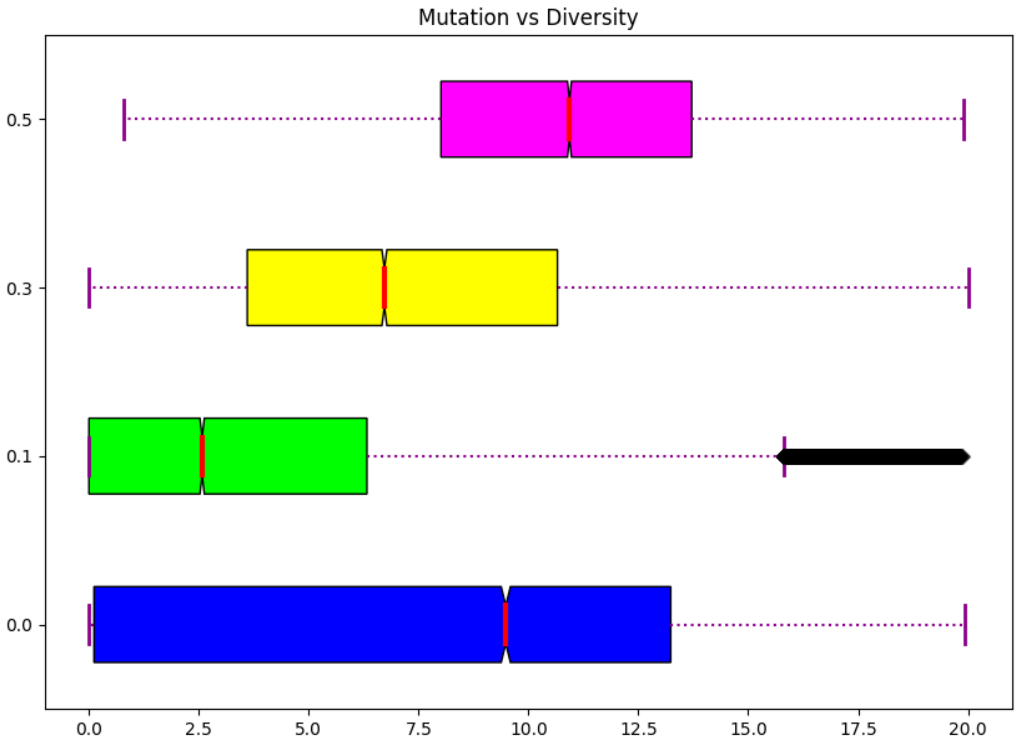
Abdurhman Bahour

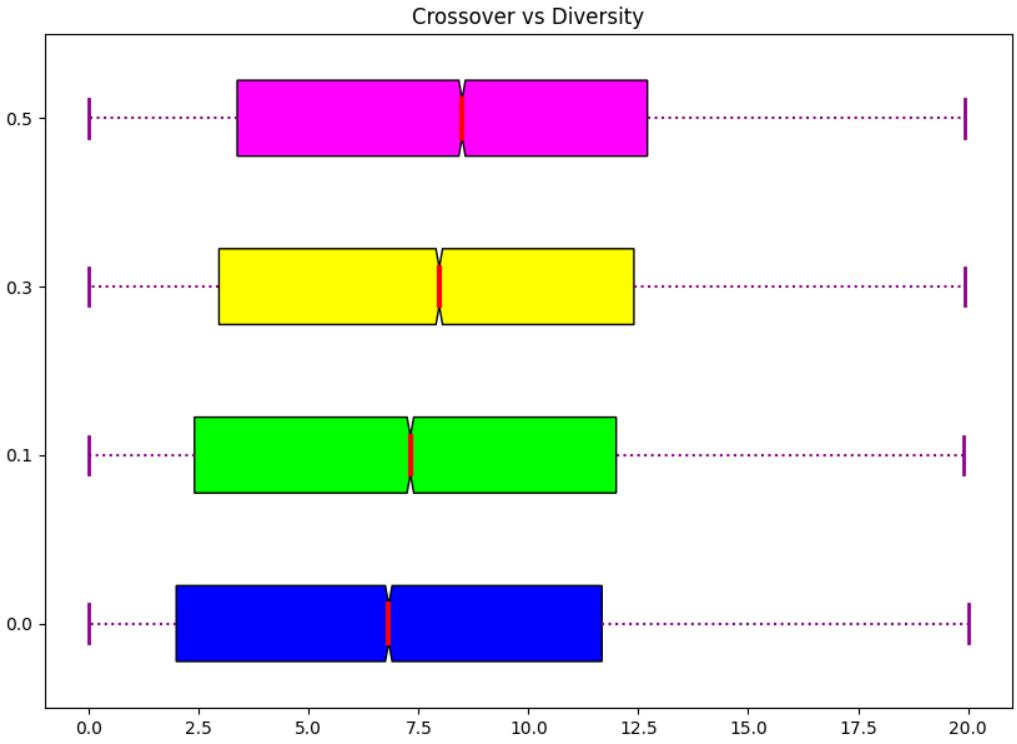
Introduction

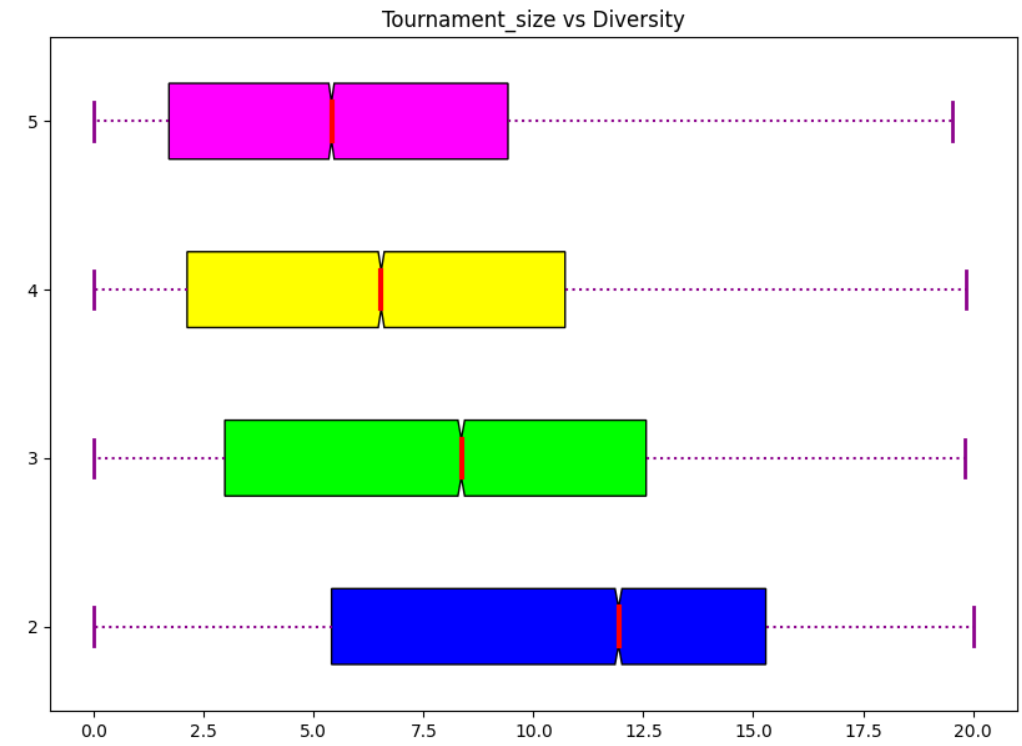
An investigation of the effects of different parameters on the performance of an evolutionary algorithm. The evolutionary algorithm used utilized the LEAP library, the algorithm was run on 256 parameters, with each parameter being run for 30 generations and 20 iterations. The data was stored in 5120 excel files, the data we parsed and the best fitness, best genome, average fitness, and the diversity of each generation was stored in an excel file. This report includes graphs each parameter (population size, mutation probability, crossover probability, and tournament size) graphed with respect to average fitness, and best fitness.

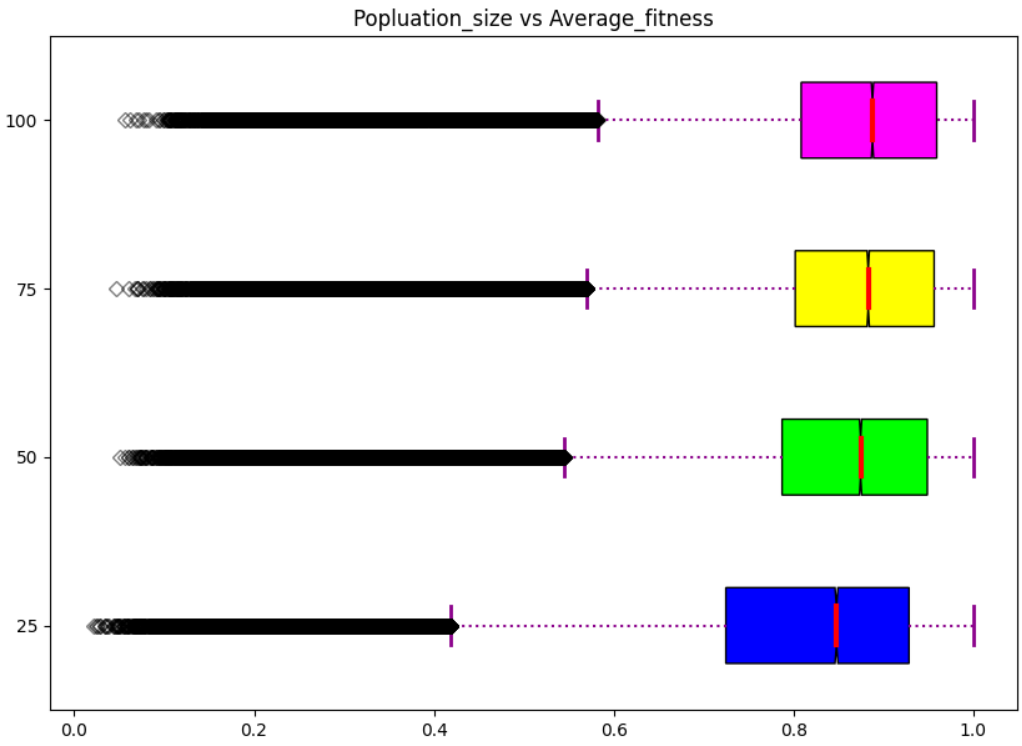
Graphs

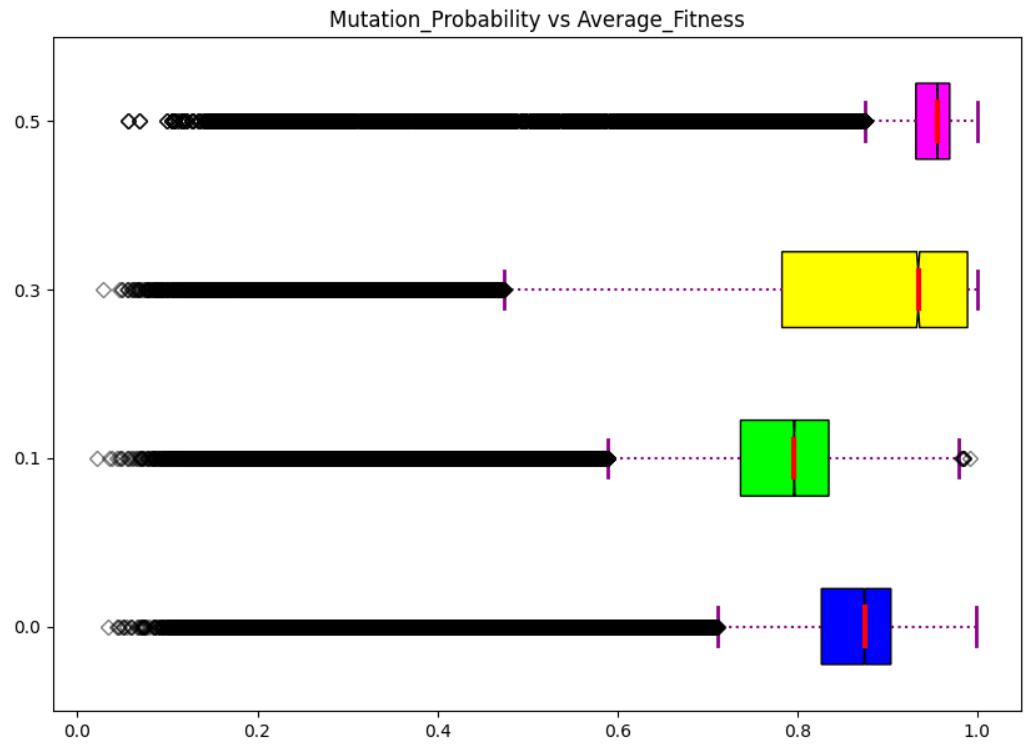


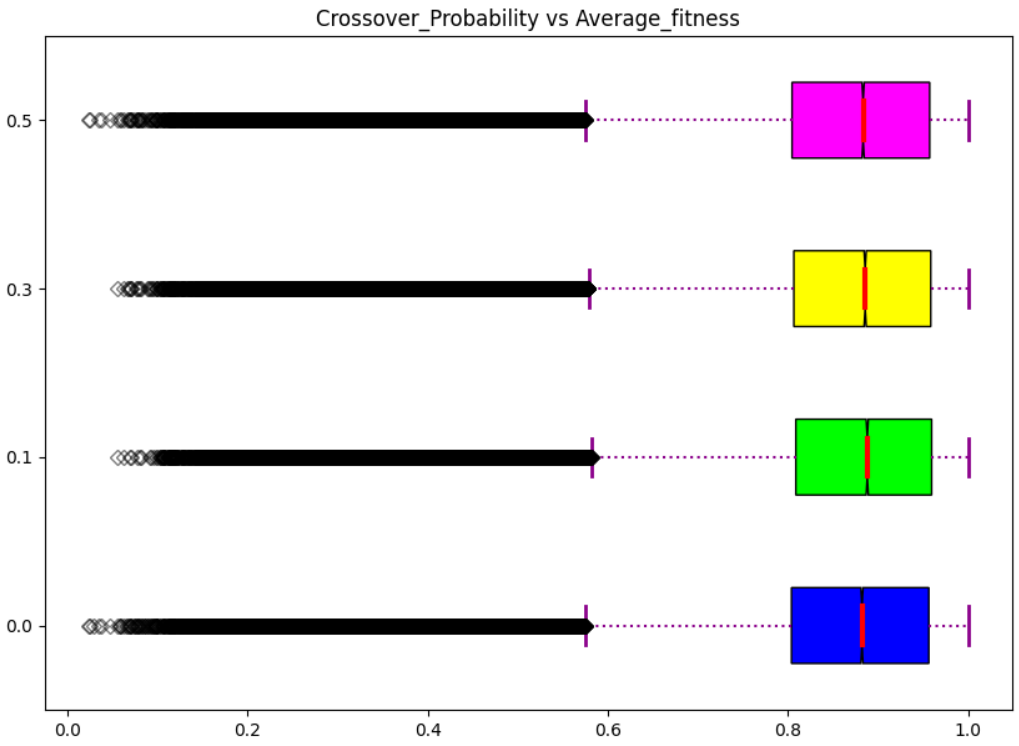

Mutation vs Diversity
0.5
0.3
0.1
0.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

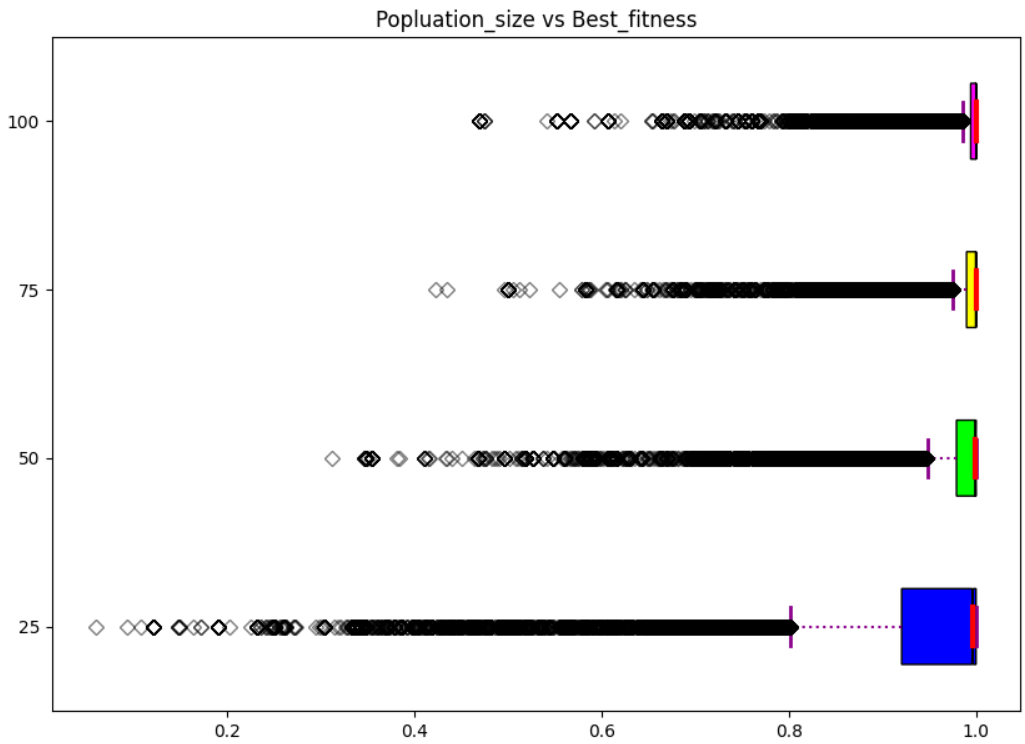

Crossover vs Diversity
0.5
0.3
0.1
0.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

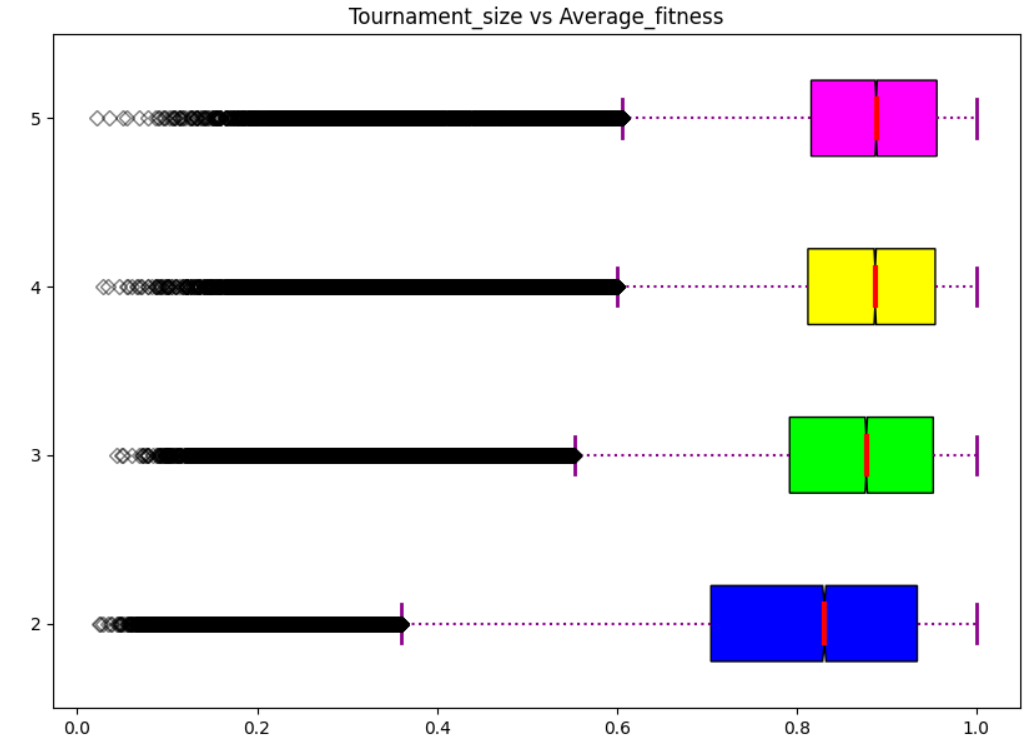

Tournament_size vs Diversity
5
4
3
2
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

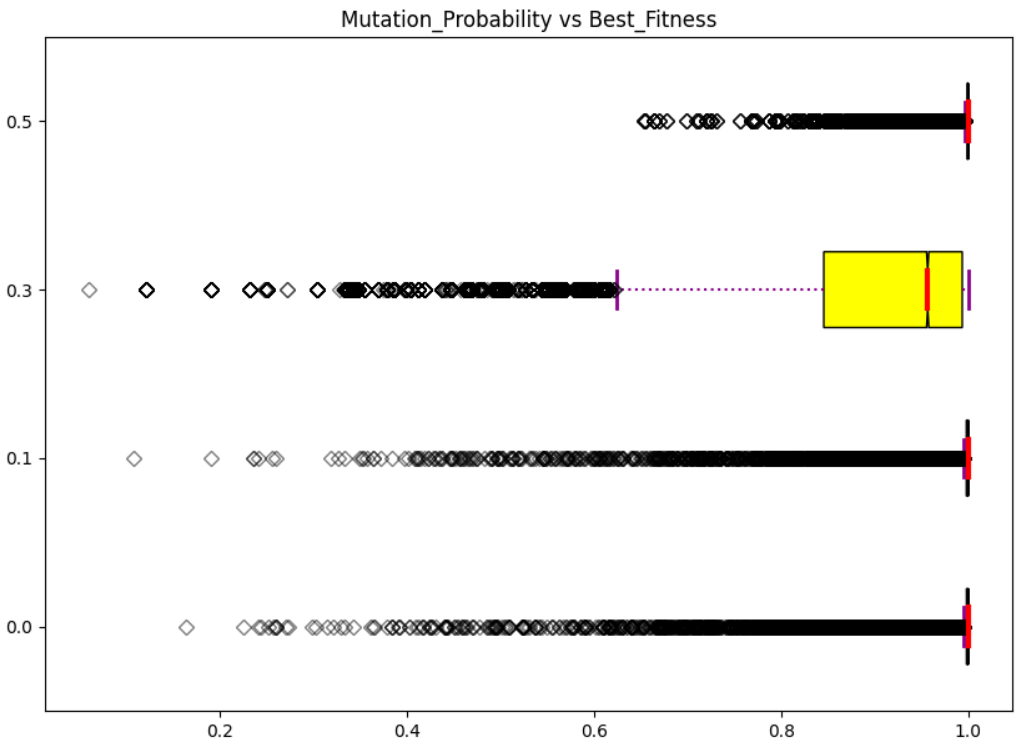

Popluation_size vs Average_fitness
100
75
50
25
0.0
0.2
0.4
0.6
0.8
1.0

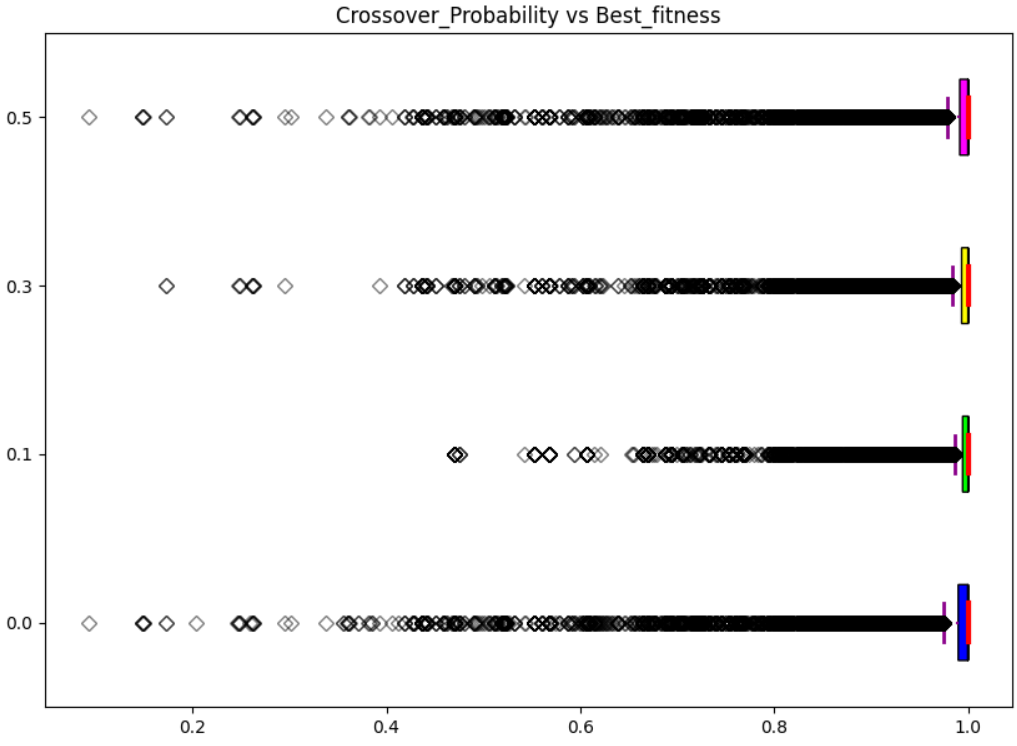

Mutation_Probability vs Average_Fitness
0.5
0.3
0.1
0.0
0.0
0.2
0.4
0.6
0.8
1.0

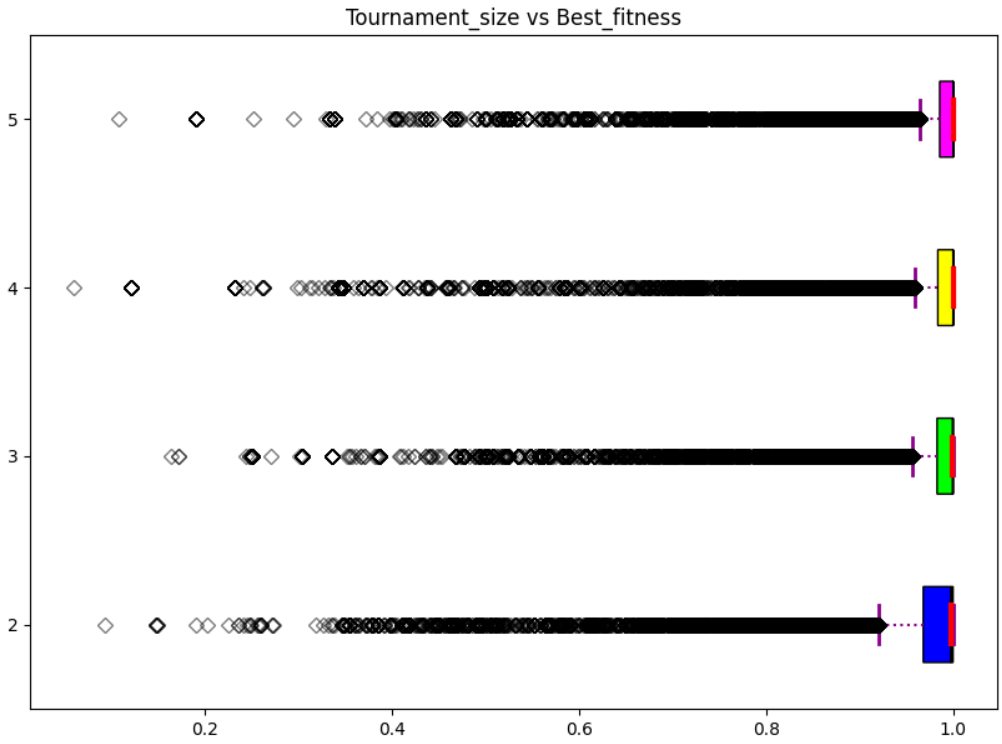

Crossover_Probability vs Average_fitness
0.5
0.3
0.1
0.0
0.0
0.2
0.4
0.6
0.8
1.0

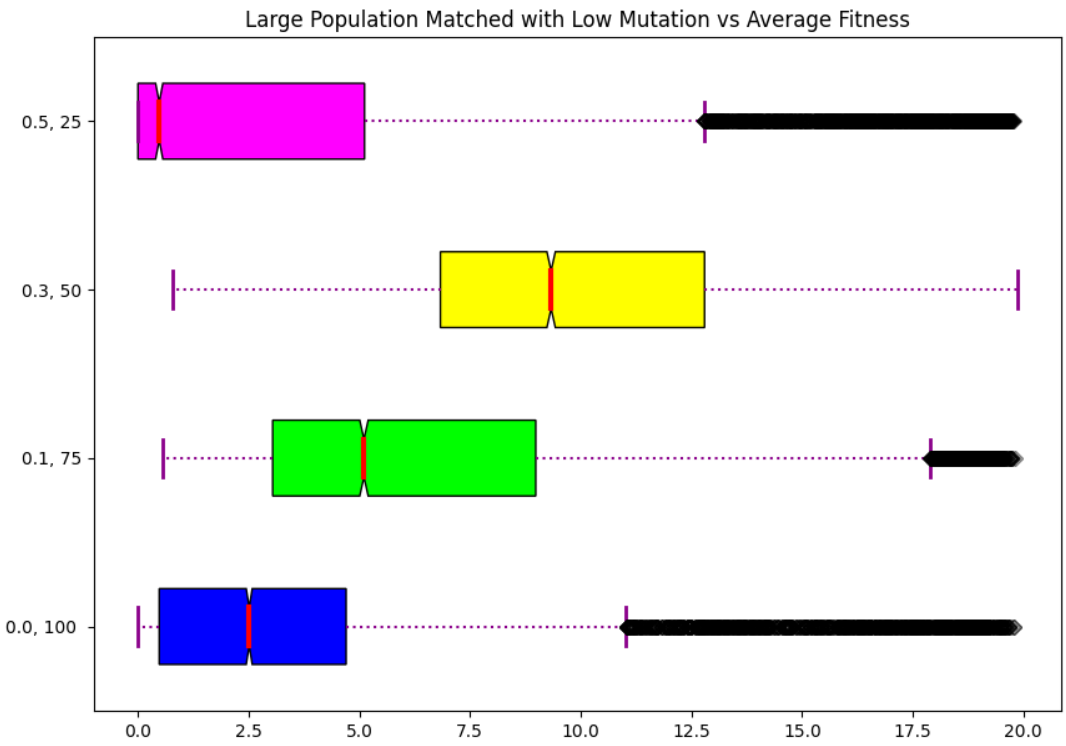

Popluation_size vs Best_fitness
100
75
50
25
0.2
0.4
0.6
0.8
1.0

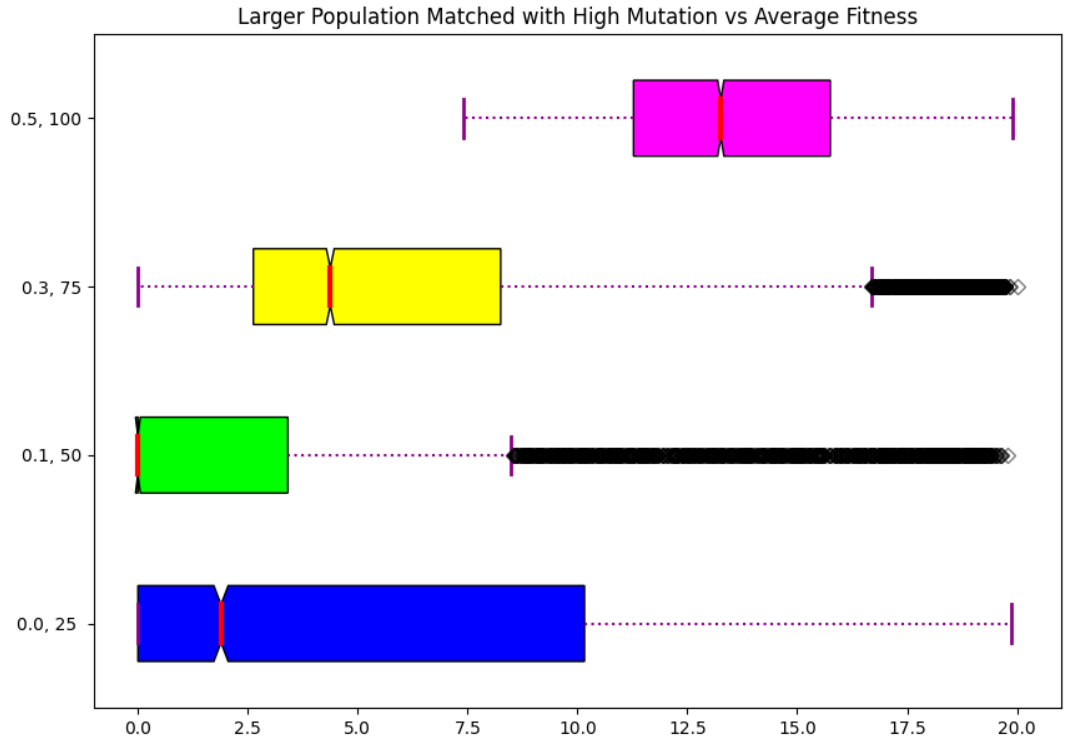

Tournament_size vs Average_fitness
5
4
3
2
0.0
0.2
0.4
0.6
0.8
1.0

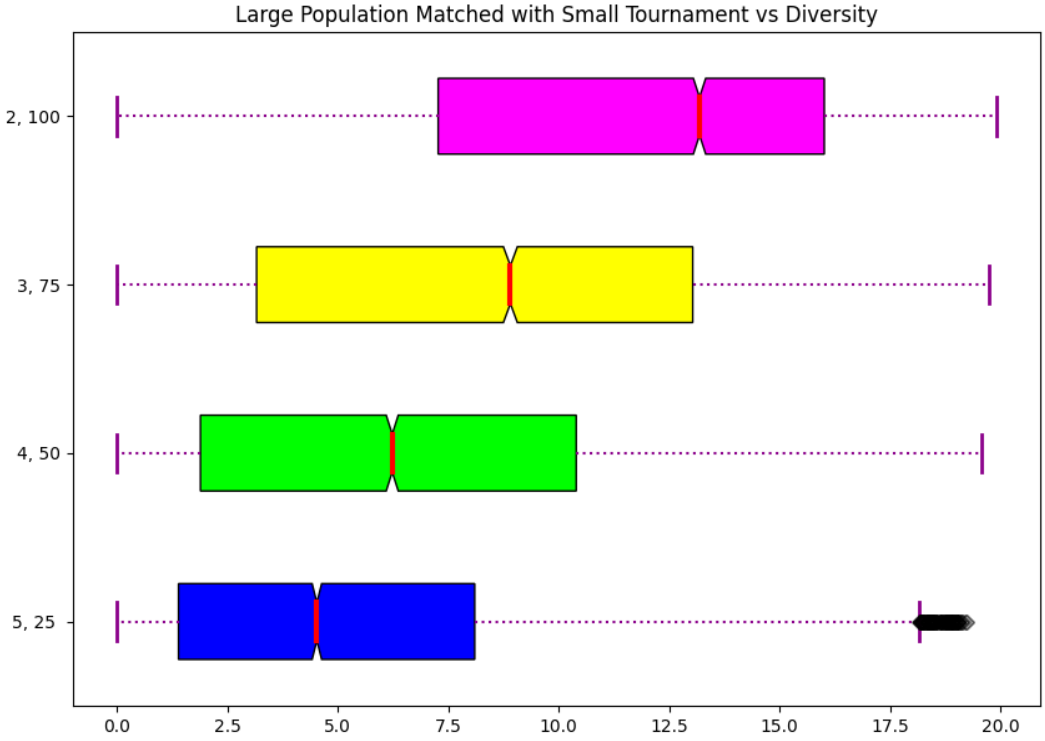

Mutation_Probability vs Best_Fitness
0.5
0.3
0.1
0.0
0.2
0.4
0.6
0.8
1.0

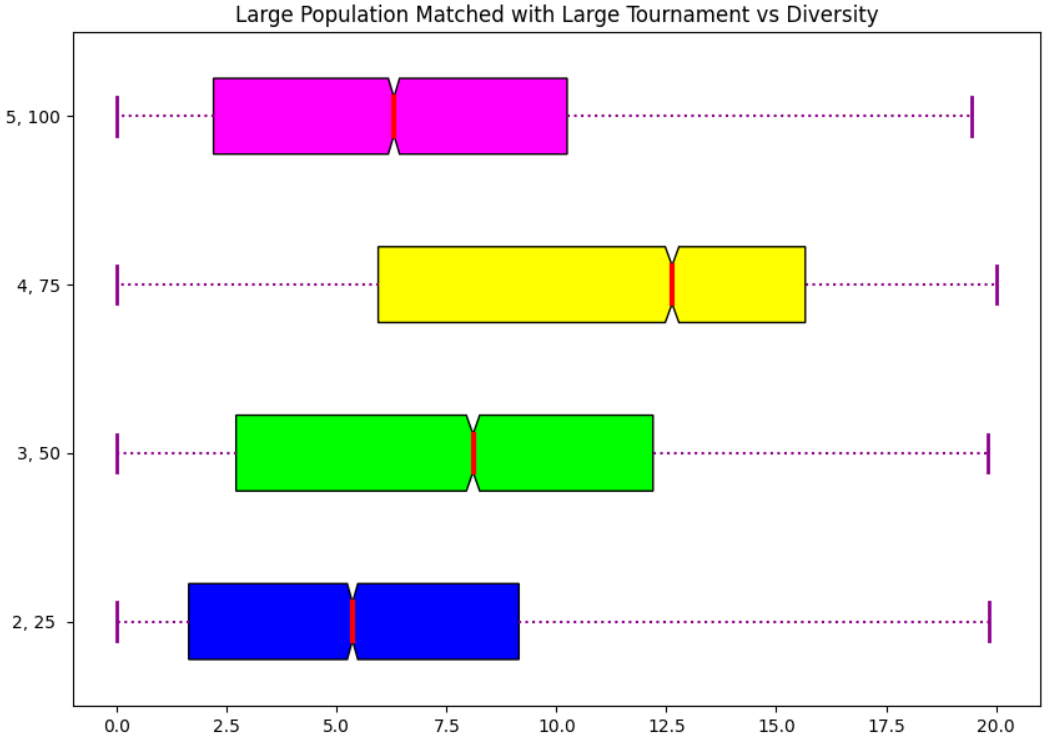

Crossover_Probability vs Best_fitness
0.5
0.3
0.1
0.0
0.2
0.4
0.6
0.8
1.0

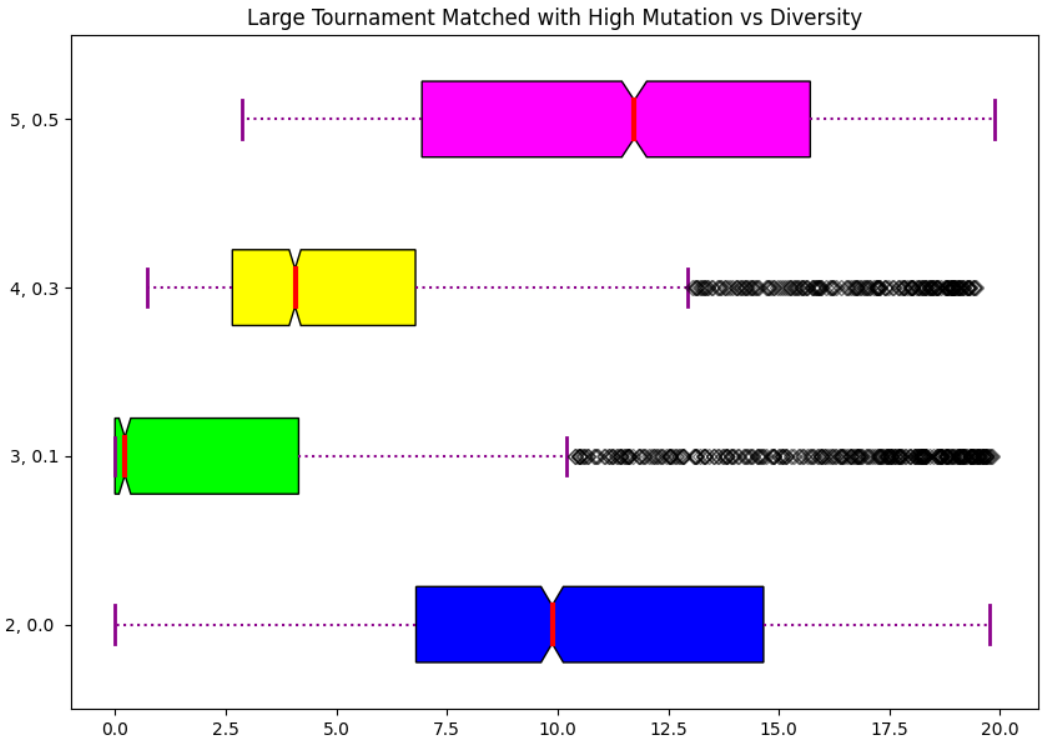

Tournament_size vs Best_fitness
5
4
3
2
0.2
0.4
0.6
0.8
1.0

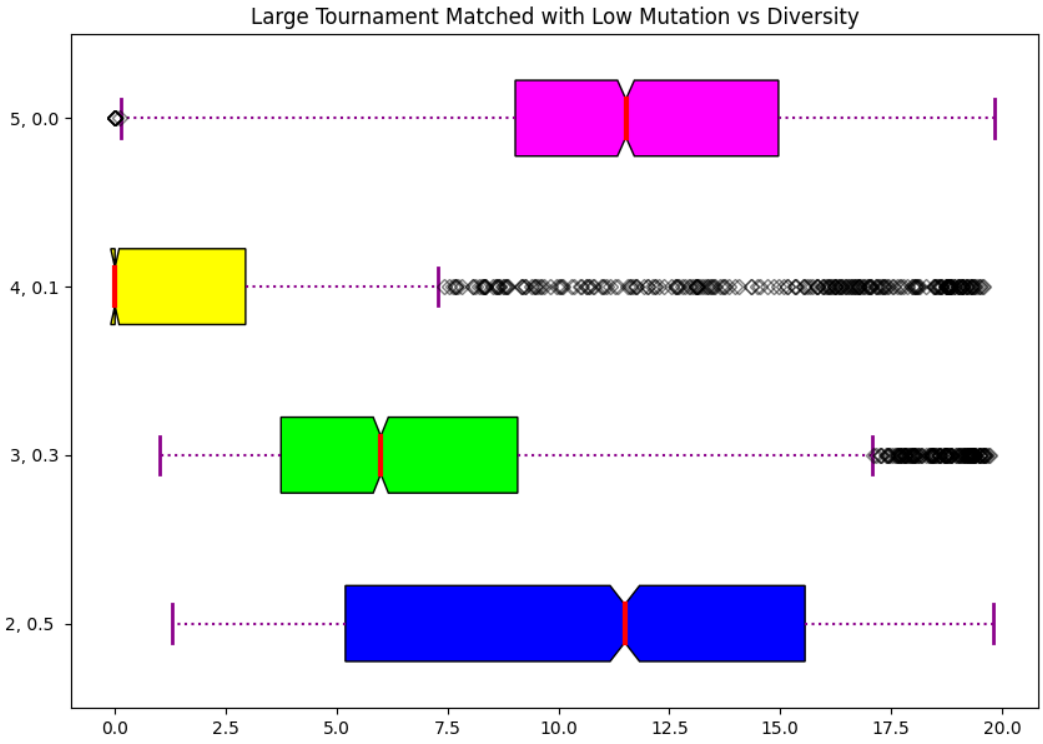

Large Population Matched with Low Mutation vs Average Fitness
0.5, 25
0.3, 50
0.1, 75
0.0, 100
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Larger Population Matched with High Mutation vs Average Fitness
0.5, 100
0.3, 75
0.1, 50
0.0, 25
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Large Population Matched with Small Tournament vs Diversity
2, 100
3, 75
4, 50
5, 25
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Large Population Matched with Large Tournament vs Diversity
5, 100
4, 75
3, 50
2, 25
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Large Tournament Matched with High Mutation vs Diversity
5, 0.5
4, 0.3
3, 0.1
2, 0.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Large Tournament Matched with Low Mutation vs Diversity
5, 0.0
4, 0.1
3, 0.3
2, 0.5
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

Discussion

Which parameters have the biggest impact on performance in terms of fitness achieved?

Mutation probability has the biggest impact on performance in terms of fitness achieved, looking at the boxplot changing the parameters for population size and crossover probability has no affect at all on average fitness, tournament size has very little effect on average fitness. Looking at the graph above we can see a direct correlation between a higher mutation probability and average fitness.

How does selection pressure influence performance?

Selection pressure does influence average fitness, the higher the selection pressure the lower the average fitness. Lower genetic variation resulting in populations getting stuck and unable to evolve to better fitness results. Looking at the tournament size vs best fitness graph we see that the standard deviation is lower when the tournament size increases. That the mean is also slightly higher when tournament size is larger.

Are both crossover and mutation necessary?

Crossover and mutations are not both necessary looking at the crossover we notice little effect on average and best fitness. Looking at mutation we notice that mutation has the highest effect on average fitness. Because the average fitness doesn't change at all when crossover probability changes we can conclude that it has no effect and is therefore not necessary.

Which parameters interact with each other the most?

The interaction between larger populations and high mutation with relation to average fitness and a larger population with low mutation interact well with each other. We deduce that a high mutation probability with a larger population has a higher average fitness than a small population with a high mutation probability. Meaning that mutation probability and population size are directly proportional.

How does the population size affect performance?

The larger the population size the smaller the standard deviation is for best fitness. A smaller standard deviation means that more individuals have a fitness score equal to 1 or close to 1. A larger population also means a higher average fitness score. This is due to the fact that a larger population has a larger selection pool to mutate and converge.

How do the different parameter values affect the diversity of the population?

Looking at the graphs above we can see that a larger population directory corresponds to diversity. A higher mutation probability also corresponds to a more diverse population when ignoring 0.0 mutation probabilities. A higher crossover also corresponds to a more diverse population. A Larger tournament size corresponds to a less diverse population.

How do Tournament size and population size affect diversity?

Looking at a large population matched with large Tournament and a large population matched with small tournament size we see no direct interaction between the two. A tournament of size 2 and a population of size 25 saw almost no difference to a tournament of size 5 and a population of 25. The other population sizes also saw no difference when changing tournament size. It is worth mentioning that a population size 100 did see a difference when changing tournament size, the reason behind this is unknow.

How does tournament size and mutation probability affect diversity?

Looking at a large Tournament matched with high mutation and a large Tournament matched with high mutation we some correlation. Looking at tournament size of 3 and a mutation probability of 0.3 we see it has a higher diversity than a tournament size of 3 and a mutation probability of 0.1. A Tournament 2, Mutation 0.5 higher diversity than Tournament 2, Mutation 0.0. A Tournament 4, Mutation 0.3 higher diversity than Tournament 4, Mutation 0.1. A Tournament 5, Mutation 0.5 higher diversity than Tournament 5, Mutation 0.0. So we can say that tournament size and mutation probability interact with each other. The interaction between large tournament and high mutation correlates to large diversity.