Artificial Life with Cognitive Sciences

Labs Report 4

Evolutionary Design in Framsticks

Table of contents

1. Evolutionary goal **2**

2. Default and modified sets of parameters **2**

2.1 Default parameters 2

2.2 Modification 1 3

2.3 Modification 2 3

3. Experiment **4**

3.1 Default 4

3.2 Modification 1 5

3.3 Modification 2 6

4. Quantitative conclusions **7**

5. Qualitative conclusions **8**

6. Youtube links **10**

1. Evolutionary goal

For this experiment, we have chosen to focus on the evolution of a terrestrial creature that is capable of achieving great speed and mobility. We aim to create a being that is optimally designed for traversing terrain and reaching great heights by jumping. We want this creature to possess a unique combination of physical attributes and movement patterns that enable it to cover large distances with ease.

2. Default and modified sets of parameters

2.1 Default parameters

- Selection:

Unchanged	10%
Mutated	70%
Crossed over	20%
Selection rule	Tournament (3 genotypes)
Delete genotypes	Randomly

- Fitness function:

```
return 0.0+this.velocity*1.0+this.distance*0.1+this.vertpos*0.1+this.vertvel*1.0;
```

- Termination criterion: 250000 evaluated creatures;
- Gene pool capacity - 200;
- Encoding - fl;
- Genetics:

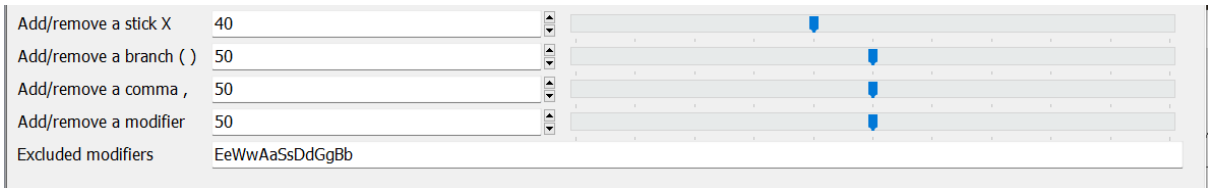

Figure 1: Default genetic parameters for morphology.

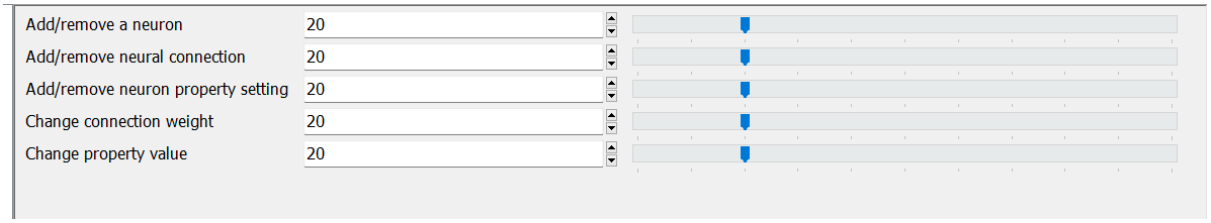

Figure 2: Default genetic parameters for neuron sets

2.2 Modification 1

Modifications:

- Gene pool capacity increased to 500;

2.3 Modification 2

Modifications:

- No crossover;
- Unchanged: 20%;
- Mutated: 80%;

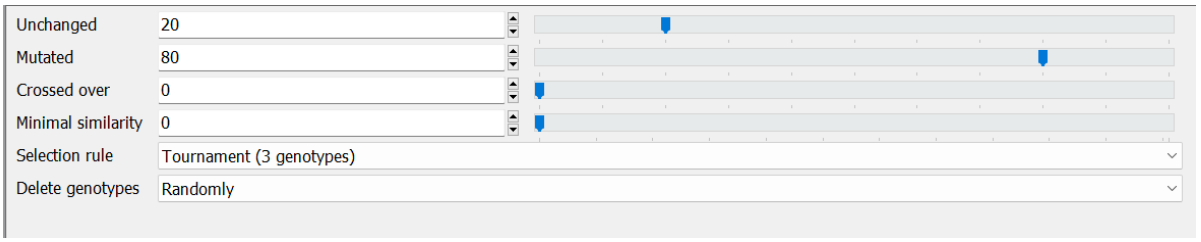

Figure 3: Modified parameters of selection for the experiment (modification 2).

3. Experiment

3.1 Default

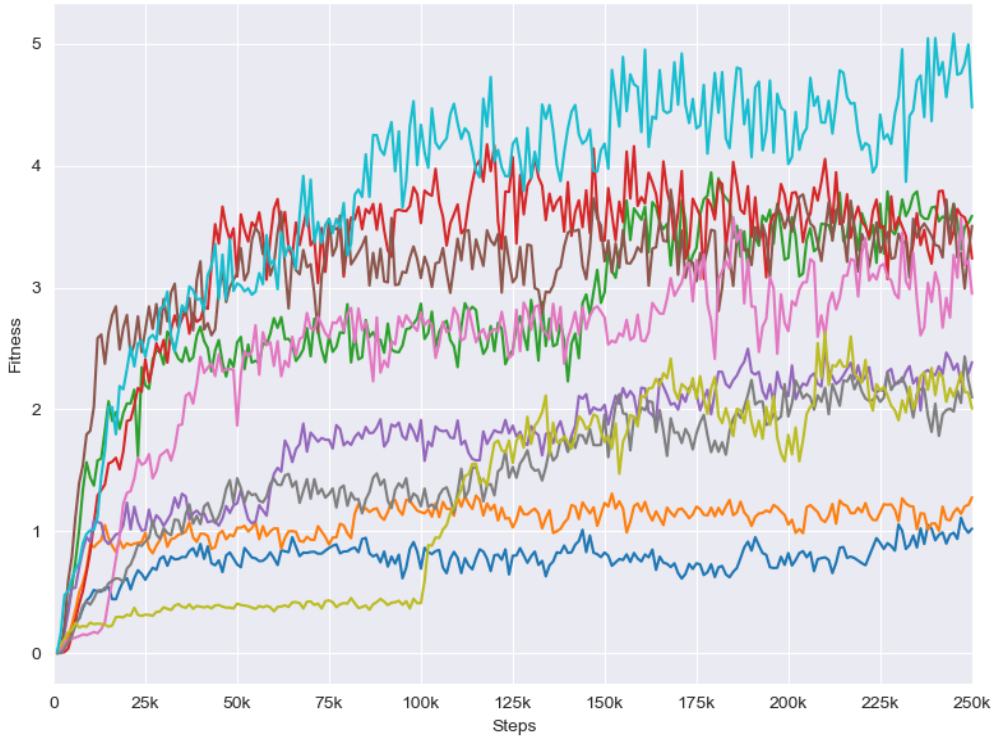

Figure 4: Averages plot of 10 runs for the default parameters.

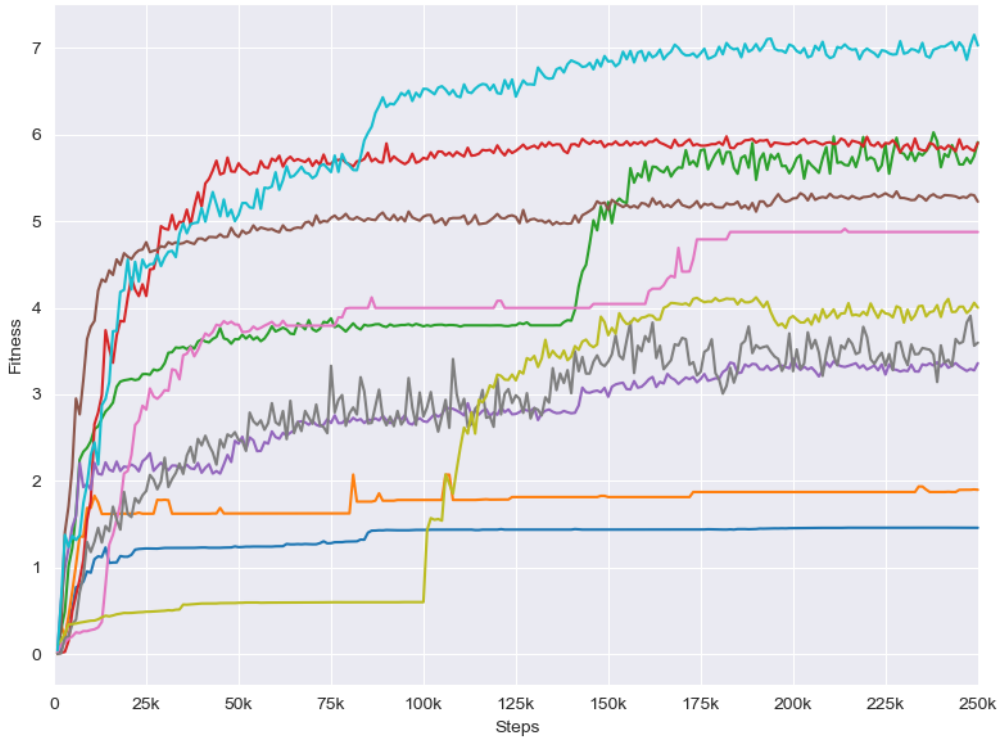

Figure 5: Maxes plot of 10 runs for the default parameters.

3.2 Modification 1

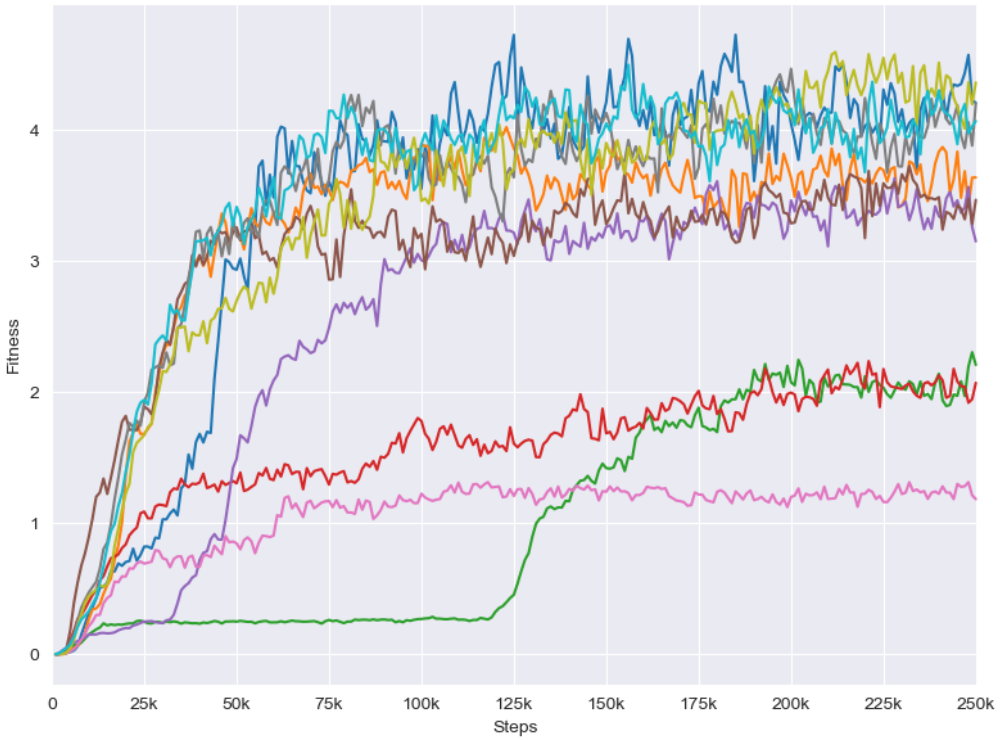

Figure 6: Averages plot of 10 runs for modification 1.

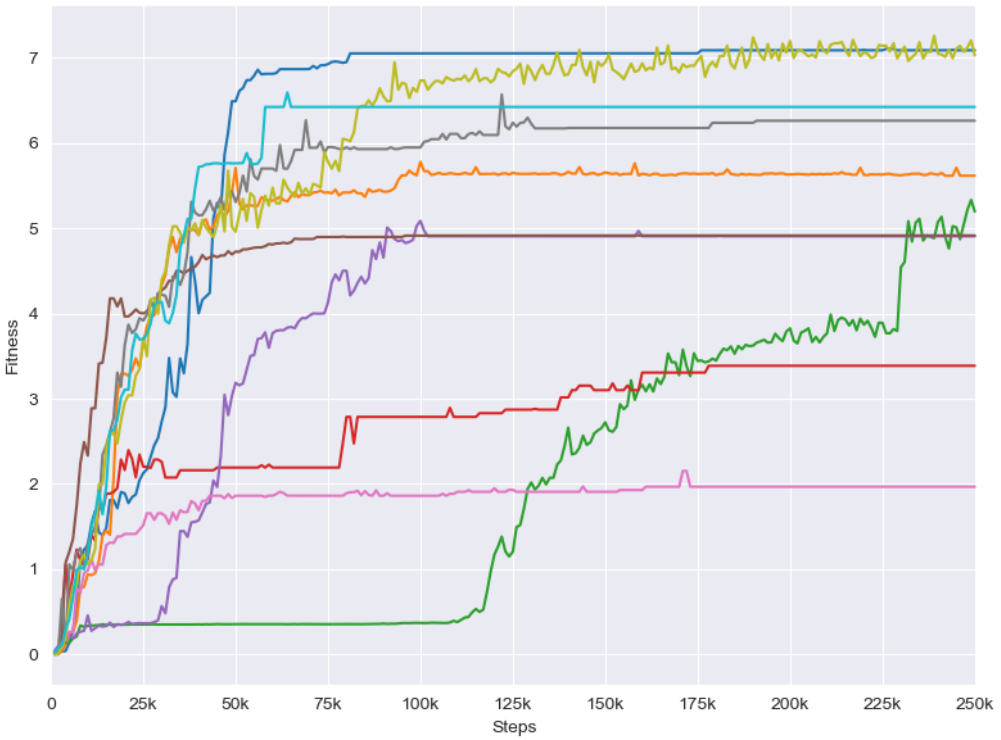

Figure 7: Maxes plot of 10 runs for modification 1.

3.3 Modification 2

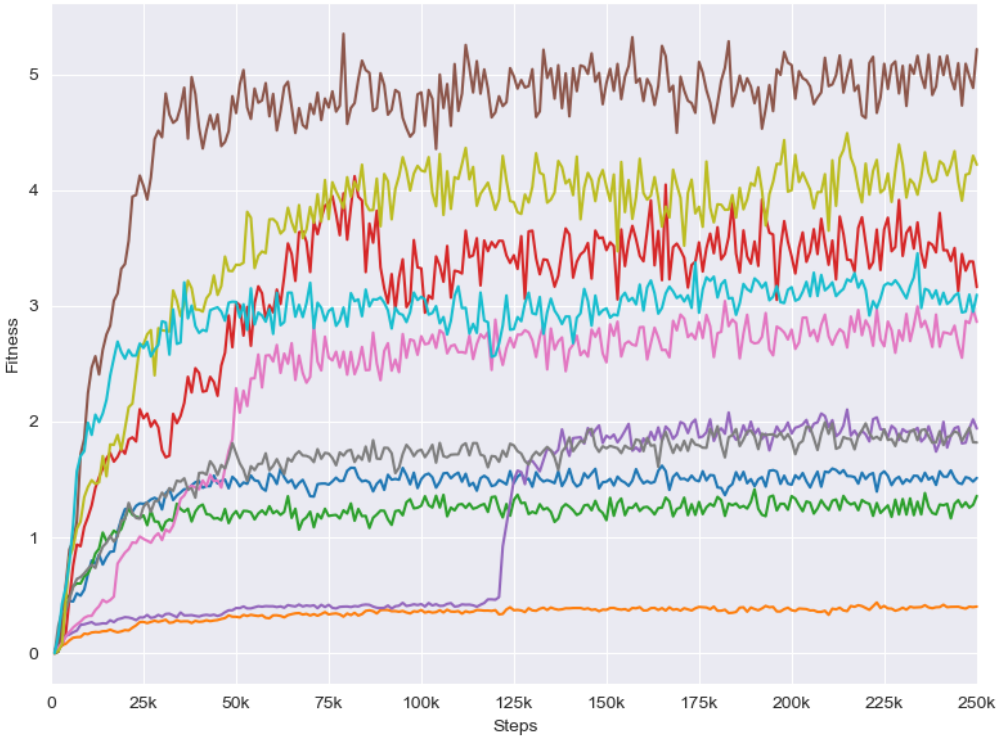

Figure 8: Averages plot of 10 runs for modification 2.

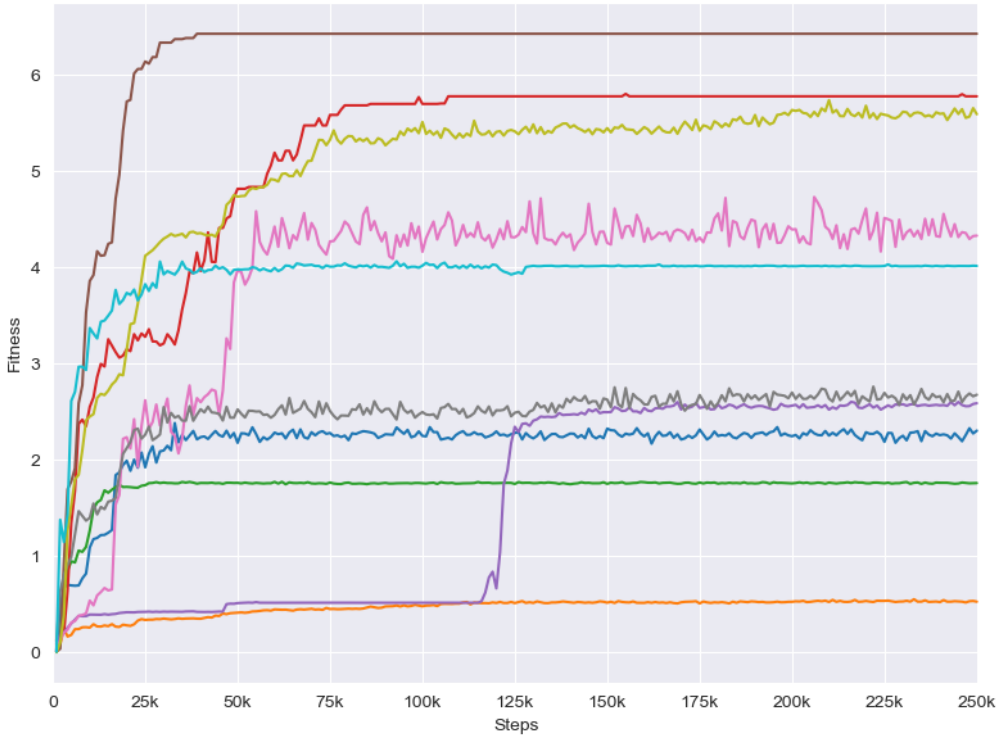

Figure 9: Maxes plot of 10 runs for modification 2.

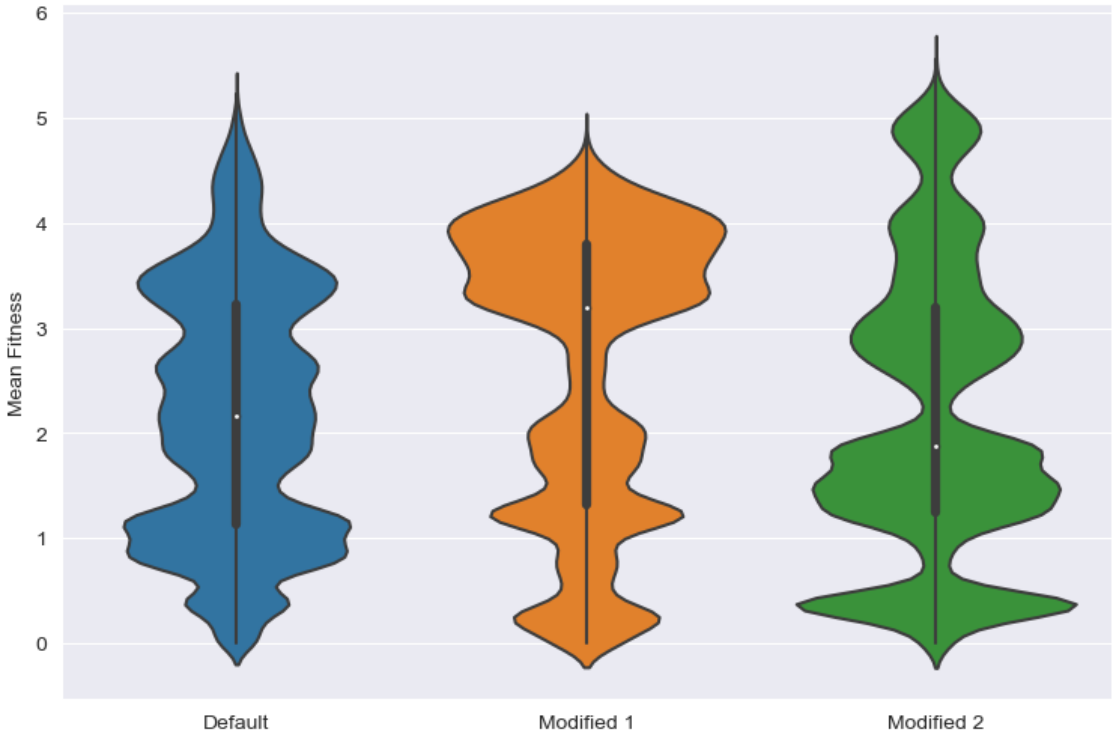

Figure 10: Comparison of the presented parameters.

4. Quantitative conclusions

- We may observe that fitness breakthroughs occur in all runs. Figures 4, 6 and 8. They are the results of beneficial mutations, which lead to new traits that give an individual a competitive advantage.

- There are significant differences between runs regarding the rapidness of the fitness growth, especially during the initial stages of the simulation. It can be attributed to random beneficial mutations and crossovers - if they are beneficial the fitness can grow rapidly and if they are bad the development might lose its momentum.

- Modification 1 is just a simple gene pool capacity increase - from 200 to 500. As shown in Figures 4-7 it results in higher maximum fitness values in most of the runs, but also leads to a decrease in the average fitness of the run.

- In modification 2 removal of the crossover often leads to pre-convergence of the population. Because of that, there are far more runs that end with worse fitness than in the case of the default parameters.

- In the experiment there is room for improvement. It could be run longer and produce much more interesting and better solutions. So the selected stopping criterion may be too strict.

- We can see that in all variances of our experiment populations may get stuck in local optima - those are the places where the graph is almost a straight, horizontal lane. Figures 5, 7 and 9. Graphs clearly infer that modification 2 is the worst one when it comes to overcoming those plateaus due to the lack of crossovers that could cause bigger changes in the genotypes.

5. Qualitative conclusions

- **What is the behavior of the best creatures?**
  Our best creatures have a bending muscle that allows them to leap to great heights by propelling themselves upward. They also possess an elongated "neck" that extends upwards. Surprisingly, there is also a limb used for stability.

- **Do they have some special genotypes?**
  All of the components that make up our organism- sticks, are elongated (using L and l in the genotype), deviating from the standard length.

- **Are the results in line with your expectations? If not, why**?
  We expected creatures with simpler morphology, such as using only one limb, would have better fitness due to their lower mass which would allow them to jump higher. Therefore such results are quite surprising to us.

6. Youtube links

First creature: https://youtu.be/R0WWjs78Kmo

Second creature: https://youtu.be/6kiXC0C9kSk

Third creature: https://youtu.be/L3eAfX-ZClw