

About

For this project, I decided to make a simulation of natural selection. The program consists of a small world with "bugs," "food pellets," and "poison pellets." Food Pellets increase the lifespan of a bug upon a collision, and poison pellets decrease it. This is controlled by an "energy" variable that decreases over time.

The bugs have very simple neural networks using a basic implementation of the integrate and fire neuron^[1]. The structure of their "brains" is determined by their genes, as is their appearance.

When there are less than three bugs left alive, the program finds the two bugs that lived the longest (or two random bugs if they all die at the same time), and mixes their "DNA" together. There is also a chance for mutations to happen during this process.

The bugs have various input neurons (I have added and removed a few since I began working on this), which let them see the position of the closest object to them (a bug, food pellet, or poison pellet), as well as its color. They also have three output neurons, which tell them to either rotate left, rotate right, or move in whichever direction they are pointing. During their evolution, neurons can be added or removed via mutation. The same goes for connections between neurons. The amount of input and output neurons stays the same.

Postmortem

In terms of the actual code, this ended up a bit clunkier and messier than what I had planned. I had intended for the functionality of the "neurons" to be contained completely within its own class, but I ran into some issues with that, and ended up making each bug loop through all its neurons in order to trigger them properly. Additionally, the way the "breeding" process works became a little messy, and, if I were to start this over from scratch, there would be quite a few things I would design differently.

So far, I have not seen any bugs evolve to be able to identify and seek out FoodPellets, nor have any appeared to be able to avoid PoisonPellets.

There are two common evolutionary paths they seem to go toward: either launching themselves in one direction, hoping to hit some FoodPellets along the way, or swimming around in large circles for the same purpose. At one point, I gave the bugs an input neuron that would trigger when it hit an edge, hoping that that would lead to some behavioral changes, but it does not seem to make a huge difference. I also gave them an input neuron that became more stimulated as they got closer to dying, but all that did most of the time was make them rapidly spin in circles when they were about to die. This was kind of sad (and not helpful in making it more interesting) so I disabled it.

I haven't let the simulation go on for long enough to see if that's all that can happen, but I let a couple simulations go to about generation #200 and it didn't produce very interesting results.

Overall, it was a fun project and I learned a lot from it. In the past, I made a similar simulation with plants that was interesting to watch evolve, and I've wanted to make something simulating animal-like evolution for a while. Hopefully I can continue tweaking some of this simulation's parameters and produce some interesting behavior.

I made an imgur post with clips of some of the more interesting runs:

<https://imgur.com/a/Qoc2iOp>

Reference

This is what I used for my implementation of the integrate-and-fire neuron:

<https://mark-kramer.github.io/Case-Studies-Python/IF.html>