# Natural Evolution

Serena Chen, Duncan Hall, David Papp, Nathan Yee

Our project Natural Evolution is a simulation of a natural selection and speciation, using genetic algorithms and neural networks. It shows the evolution of organisms that seek to eat food and reproduce "at will".

The simulation is run in Pygame, and the organisms make decisions using neural networks. As the populations progress further, the organisms are better able to keep themselves alive, despite the lack of explicit selection.

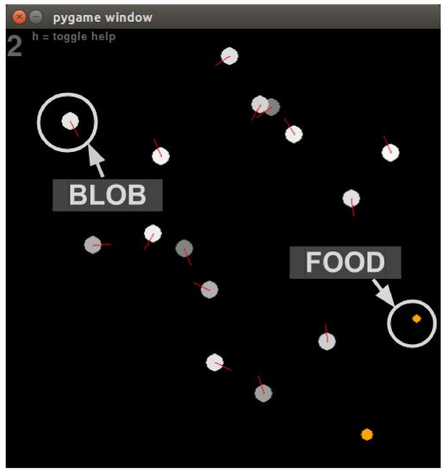
## Big Idea

GENETIC ALGORITHMS often utilize artificial selection to select for the strongest individuals in a generation, based on a cost or scoring function. What happens when the individuals are allowed to reproduce and pass away by themselves?

## The Premise

AT THE BEGINNING OF TIME, there were blobs. These blobs have randomly generated DNA. Blobs that eat food asexually reproduce. When all blobs die, a new population is generated with dna combined and mutated from the top scoring blobs of the previous population.

## Our Simulation

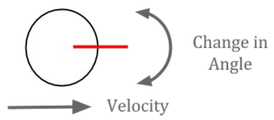



- The Screen shows a 500x500 square, in which all food and blobs are spawned.
- The blobs can move off screen infinitely.
- Red line shows which direction a blob faces
- As blobs lose energy, their colors fade
- Food have random radii, which is purely cosmetic and does not affect the value.

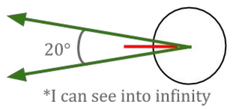
## Blob Anatomy

- 15 blobs and 2 foods are created each generation
- If a blob finds food, it reproduces asexually
- If all blobs die, new generation is created from 2 most fit parents
- Both asexual/sexual reproduction introduce random variation

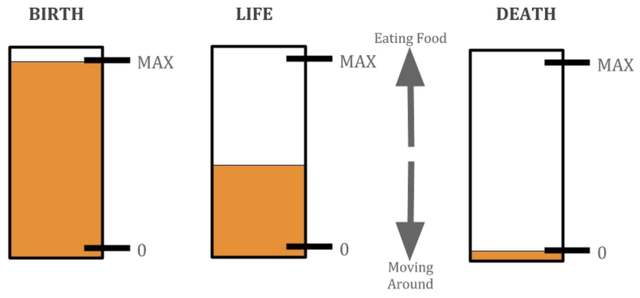
### HOW I MOVE:



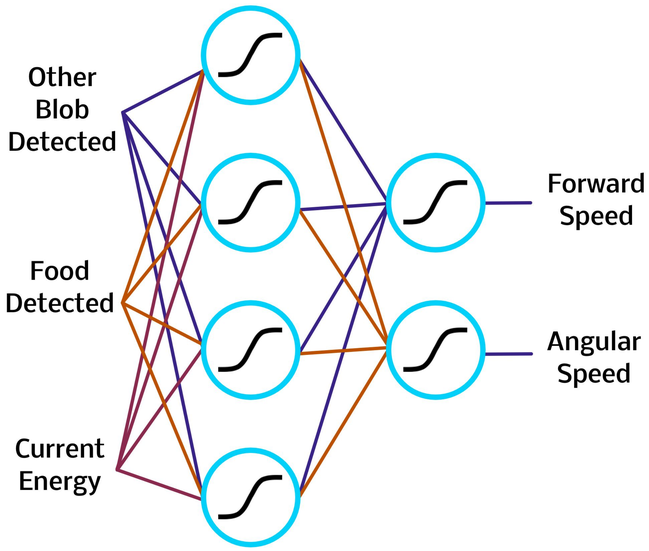

### HOW I SEE:




### ENERGY

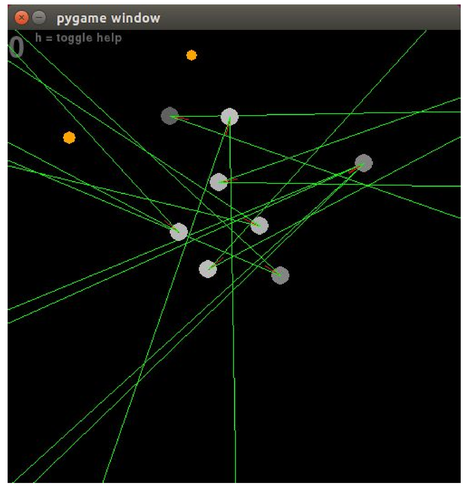



## DNA, or Neural Networks




- A Neural Network takes in an input vector, multiplies it by a weight matrix to get the hidden nodes input vector, applies a sigmoid function element-wise, and multiplies the resultant vector by a second weight matrix to get the outputs
- In this way, it models the decision making process of neurons
- The weights in the neural network are considered the blob's DNA
- Gene recombination of multiple sets of DNA uses the parents' sets of weights and takes them at random
- DNA is mutated at random chance
- DNA is mutatated by adding different values to the weights

## Results




- Blobs spin until food is sighted (maximize "ground covered"
- Blobs move directly towards food
- When low on energy, blobs move slower
- No complex social interaction

## Next Steps

- Simple interface for modifying genetic behavior
- Different food values
- Inter-Blob interaction
- Changing the environment (predators, obstacles)
- Speciation
- Genetically modifying the structure of the neural network

## Simulation

Put laptop here