BUGS EVOLUTION WITH GENETIC ALGORITHMS / BEDİRHAN ÇELEBİ

Abstract— **Bugs evolution project is an experiment of a way of training neural networks or creating intelligent agents. In bugs evolution program we will try to assemble neural networks (bug brains) from a wide range of neurons that has the attributes we want them to have.In this case finding the food.**

Bugs evolution program uses genetic algortihm method to train intellectual agents.

These intellectual agents are objects that are called bugs. They have simple neural network brains deciding upon which way to go, how far to travel.

All of the bugs have 3 layer neural networks as brains and the size of the individual layers are decided by a parameter.

Their neural networks are initialized with random numbers.

We also have a map that the coordinates represent. Bugs start at the same beginning coordinates.

There are also food objects that spawn on random coordinates on the map.

After initialization bugs are given all the information of the food coordinates.

This data then enriched by the coordinates of the coordinates of the bugs as well.

As a result we have a data that is a matrix has the shape (food coordinates + bug coordinates , number of food)

We could also start bugs at random coordinates and the data will be prepared the same way. It will be unique to each bug.

The neural networks of the bugs will output four directions and distance.

In the next step bugs will move to their new coordinates.

After they assume their new coordinates, a bugs distance from all of the food objects will be calculated and the lowest distance will be the score of the bug.

After this evaluation part bugs scores will be compared and the lowest score bugs will be selected.

Quarter of all the beginning bugs will be selected to reproduce and create the next generation.

Reproduction in this sense is a bit like reshuffling of neural network neurons.

So a neural network layer is basically a matrix of numbers.

I will call all horizontal lines on this matrix, ”cells”.

For the shuffling of the cells. We have three different methods. Single cell shuffle, 2 cell shuffle and four cell shuffle.

For the single cell shuffle we take all of the horizontal lines (cells) in matrices of all the selected bugs and put them in a bag.

And then by choosing random cells from the bag we will assemble a new bug brain. Each layer of the neural network assembled uniquely.

For example first layer is assembled by the cells that were picked up from the first layer and the second are assembled from the cells picked up from the second layer cells.

For the two cell shuffle, instead of having single cells in the bag we group them in two. They are two horizontal line groups in the neural network matrices.

For the four cell shuffle, we do the same procedure but with four cell groups. We put them in a bag and assemble the bugs randomly.

We give half of the population of new bugs to single cell shuffle, and quarter population for each of the group cell shuffles.

We repeat the same processes and we also can check the survivor bugs through the output. This is the process basically.

Bugs that reach the food survive and from their brains we assemble new bugs.

I. Genetic Algorithm

A. Neural Networks

Neural Networks are made of matrices. They are actually bunch of matrices stacked up to be complex enough to memorize and generalize the actions that they learn from data.

$$\begin{bmatrix} 1 & 1 & 1 \\ 2 & 2 & 2 \\ 3 & 3 & 3 \end{bmatrix}$$ first layer of the neural network

$$\begin{bmatrix} 4 & 5 & 6 \end{bmatrix}$$ second layer of the neural network

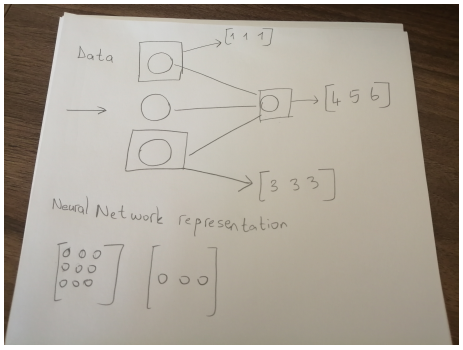

Fig. 1. Representation of a neural network

We represent the data as a matrix as well. Every vector(column) on the matrix is a data point. For example in our experiment we have the data of the food. One food is represented by one vector and if we have two vectors then they become a matrix when we put them together.

Here we have 6 different data particles that have 3 different attributes.

$$\begin{bmatrix} 3 & 4 & 5 & 7 & 8 & 9 \\ 3 & 4 & 5 & 7 & 8 & 9 \\ 3 & 4 & 5 & 7 & 8 & 9 \end{bmatrix}$$

The information processing starts with multiplying the data with the neural network matrices via dot-product. Neural Networks are made up of layers. So one matrix is one layer, the second matrix is the second layer. Data matrix is actually the zeroth layer.

After multiplying with all of the matrices we want to end up with a vector or a single number. In our case, we ant to end up with a vector with four numbers in it.

Our neural networks will give out only four numbers in the end layer.

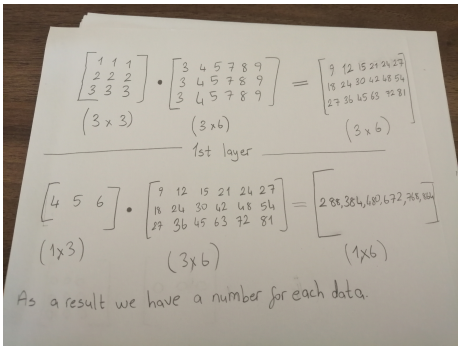

Fig. 2. Data processing

B. Testing the bugs

We have assembled the bugs(neural networks) and they made their moves. After they made their moves we will try to find the closest bug to a food.

We calculate the distances of bugs to the closest food and if it is one of the closest bugs to a food we pick them. For an ”n” number of bugs we will select ”n/4” bugs to breed the next generation.

So far the point is to make neural networks process the data or in other words forward propagate the data and give us some predictions after crunching the numbers.

We start bugs with pre-decided sized , random numbered matrices. As you can expect some are good some are average distant to a food , simply random success. However, it won’t be like that after we are done.

C. Cell Shuffling

We have picked the successful bugs and now we are going to shuffle their neural networks.

Horizontal lines in or neural networks matrices are called a cell. That line by itself could multiply data. From successful bugs we take all of the cells from the neural networks one by one and put them in a bag. Layer 1 lines goes into a bag, and layer 2 lines go into another and layer three goes into another one. We will also do this action with two cell groups put in different bags and four cell groups are put in different bags. Finally we have 9 bags 3 of them single cell 3 of them two cell groups and 3 of them are four cell groups.

D. recreating the bugs

to put it in words we have a gene pool which we can pick from in order to assemble new neural

networks. We pick randomly from the bags and assemble bugs. We create half of the population from the method single cell assembly where we assemble new neural networks from single cell bag.

quarter of it made up of two cell assembly and the other quarter is made with the four cell assembly.

1) Repeat: As we have created the new generation of bugs we put them into test as well and they venture out into the arena trying to transfer their genes to the next generation.

II. Results and Conclusion

Although more experiments and research will be done on this subject i will make some points. Single cell created bugs performed way better than the two cell and four cell assembled bugs. Second point is that in the experiment we are trying to gather as good as possible neurons to come together to have the best neural network that goes to a food coordinate. From checking their scores each time we see that they start pretty badly but after some generations they get better and better. They are able to find food easier. Also when we check the final generations scores we see that almost all of the half of population would have really similar scores that are same to the third to fourth significant figures. Which would mean that their neural networks are also really similar and we could say that bugs have evolved into a specific species of brains from a chaotic randomly initialised brain soup.