Witam gitas

Kamil Kozioł, Magdalena Sadowska, Wiktor Leszczyński

1 Introduction

This project intends to compare 4 different AI implementations which can be used when making bots that play games

1.1 Podsekcja

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2 Conditions

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2.1 Podsekcja

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3 Genetic algorithm

Genetic Algorithm is a machine learning technique that uses principles of natural selection to find the optimal solution to a problem.

We can determine how good individual is doing by calculating his fitness.

3.1 Algorithm

Each of these steps is repeated untill conditions are met and then the current generation value is increased

3.1.1 Initialization

The first step is initializing a population using random neural networks, where each solution represents a possible strategy for playing the game.

Done only once at the first generation

3.1.2 Evaluation

Each solution is evaluated by playing the game using the corresponding neural network. Fitness score of the solution is calculated based on its performance in the game. The fitness score is a measure of how well the solution performs in achieving the objective of the game.

3.1.3 Selection

Then propabilities of picking each individual are made. Those propabilities range from $\langle 0, 1 \rangle$

3.1.4 Mutation

To introduce diversity into the population, picked by random individuals undergo mutation, where random changes are made to their weights and biases. This process helps to prevent the population from converging too quickly to a local optimum.

Every weight and bias has a change of being mutated based on $mutationRate$

If mutated those are modified using this formula:

$$x = x + randomGaussian(initMean, initStdev) * mutationPower$$

Then being kept at $\langle minValue, maxValue \rangle$

3.1.5 Crossover

The selected solutions are then combined through crossover, where random pairs of individuals exchange weights and biases of neural network to create new offspring solutions. This process mimics the natural process of sexual reproduction, where genes from two parents combine to produce offspring with a mix of genetic traits.

3.1.6 Elites

Some of the best-performing solutions from the previous generation are also added to the new generation

3.2 Fitness function

Fitness function is calculated by this formula:

$$fitness = \begin{cases} age^2 * (2^{apples}) & apples < 10 \\ age^2 * (2^{10}) * (apples - 9) & apples \geq 10 \end{cases}$$

Each snake in the game has a hunger variable, denoted as H. Upon consumption of an apple, H is replenished to a maximum value of $H_{\max}$. At every time step, H decreases and once it reaches 0, the snake perishes.

3.3 Hyperparameters

Hyperparameters can be modified in file *settings.json*.

3.3.1 Neural network

Neural network used to train the snakes is described by this model:

$$Model = \begin{array}{l} InputLayer(28, linear) \\ DenseLayer(20, relu) \\ DenseLayer(12, relu) \\ OutputLayer(4, softmax) \end{array}$$

Description:

$$Layer(neurons, activationFunction)$$

4 NEAT

NEAT - Neuroevolution of Augmenting topologies. Genetic algorithm based on real life evolution and fitness function

NEAT aims to evolve both the weights and structures of neural networks, allowing them to grow and become more complex over time. Unlike traditional approaches that fix the network structure and only optimize the weights, NEAT evolves the topology of the network, including the addition and removal of nodes and connections.

4.1 Neural networks

Neural networks in NEAT aren't static (not including input and output) and they are also evolving with each individual

4.2 General steps

1. Initialization
2. Fitness evaluation
3. Reproduction
4. Crossover
5. Mutation
6. Speciation

4.3 Initialization

The algorithm starts by creating a population of initial neural networks. These networks are small and simple, with minimal or no connections.

4.4 Fitness evaluation

Each neural network in the population is evaluated for its performance on a specific task or problem. This is done by providing inputs to the network,

letting it process the inputs, and obtaining the outputs. The fitness function determines how well the network performs and assigns a fitness score accordingly.

4.4.1 Fitness function

```
fitness = 0

fitness += apples_eaten * 500

if crashed_to_wall or crashed_to_self:
    fitness /= 2

if died_from_hunger:
    fitness -= 250
```

4.5 Mutations

There are 3 types of mutations:

1. New connection between nodes
2. Changing weight of a connection
3. Inserting new node between two connected nodes

Mutation helps explore new areas of the search space and prevent premature convergence.

4.6 Speciation

NEAT introduces a speciation mechanism to maintain diversity in the population. It groups similar networks into species based on their structural similarity. Networks that are in the same species can compete and mate with each other, while networks from different species are protected from excessive competition.

4.7 Seed

Through ovservation it was found that random seed that the snake has started in could highly affect snake's performance. To solve this issue genome evaluation was done at 5 random seeds. The best fitness scored across these seeds was chosen as current generation genome's fitness.

4.8 Summary

After 1000+ generations of evolution, the algorithm produced a highly successful snake that consumed over 60 apples in a single gameplay session.The neural network controlling the snake's movements grew and adapted its structure over time, optimizing decision-making and navigation. This achievement demonstrates NEAT's effectiveness in evolving intelligent agents for complex tasks and showcases its potential for gaming and real-world applications.

5 DeepQ

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5.1 Podsekcja

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6 Supervised Classification

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6.1 Podsekcja

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7 Summary

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7.1 Podsekcja

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