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Building an Intelligent Agent to play Flappy Bird using NEAT

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ABSTRACT

Games are an efficient way to measure the progress of AI. Artificial intelligence has been making rapid advances in recent years, and one way to see how it is progressing is by playing games. Go, Atari2600 and Chess are some AI agents which even defeated human players. These AI agents require or have a training stage involved. In this paper, we propose a training strategy to develop an Artificial Intelligence agent using the Neuro-m Evolution of Augmenting Topologies (NEAT) algorithm to play the Flappy Bird Game. NEAT basically implements a genetic algorithm which generates ANNs. Our agent learns to safely dodge all the barriers and flap its way through them, optimally playing the famous "Flappy Bird" game.

Keywords: *Artificial Intelligence; Neural network; Genetic algorithm; Flappy bird; Neuro-Evolution;*

1. INTRODUCTION

The main aim of our work is to develop an Artificial Intelligence-based agent which can play the Flappy Bird Game on itself using a Genetic Algorithm i.e., NEAT.

Flappy Bird is a game very popular amongst mobile players. Flappy Bird achieved great success and received huge popularity. Players need to jump and avoid pipes(obstacles) as the screen moves forward. With each pipe passed, we score more points.

The agent learns when to flap so as to avoid collision with the pipes or the ground or the ceiling. Passing through each pipe-gap leads to an increment in the score while a collision leads to instant death.

A genetic algorithm is described as a heuristic method that simulates the procedure of natural selection that could assist to resolve a sizable style of optimization problems, specifically problems with a stochastic or non-differentiable goal function.

In unsupervised learning tasks, the Neuro-evolution approach is an effective approach to adapt Artificial Neural Networks (ANN). It offers another way to search out the simplest configuration for an ANN without relying on an accurate output value, which is often used to generate an error in order to optimize the network configuration through gradient-descent algorithms such as backpropagation. At the same time, the game is shown as a test environment for a virtual environment, which can help to optimize the learning agents, whose main goal is to know the behavior of non-deterministic phenomena.

NEAT can be described as a Genetic Algorithm which evolves into an Artificial Neural Network(ANN).

In our work, we have applied a Neuro-evolution algorithm which is known as Neuro-evolution of Augmenting Topologies (NEAT) in the game environment of Flappy Bird, which uses a strategy to find a simple agent quickly i.e., in a short play-time and a few generations.

Why NEAT? It's because NEAT starts from simple configuration agents (weights and topology) and further complicates this configuration over generations, which increases the topology, so it's possible to guarantee the simplest solution.

2. THEORY

A Genetic Algorithm(GA) is a heuristic technique that simulates the process of natural selection just like "Survival of the fittest" to solve many optimization problems.

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Keywords involved in GA :

1. Fitness Function: It's like an objective function that takes a solution as an input and generates a score known as a fitness score. This evaluates the quality of the solution. Based on each specific problem the fitness function is calculated.
2. Population: Subset of all candidate solutions to a given problem.
3. Chromosome: Also known as the genome, each candidate solution in the population is a chromosome.
4. Gene: Each element within a chromosome is a gene.
5. Generation: GA performs a set of operators in each iteration on the current population to generate the next generation.

Three Main Steps in GA :

1. Selection: According to the fitness score, solutions in the population are filtered. This is known as Selection. Solutions with higher scores are taken to the next generation.
2. Crossover: Genes of parents are reassembled based on something to form new offspring.
3. Mutation: It's a small random tweak of genes that allows GA to explore solutions and avoid falling into local minima.

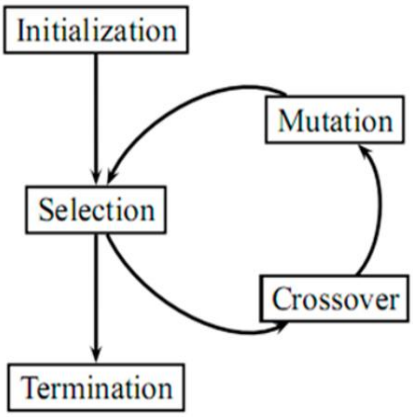

Fig. 1. Steps in GA

3. IMPLEMENTATION

3.1 Appling NEAT to Flappy Bird

Python has a well-developed module for implementing NEAT. The NEAT module also requires a config file.

Here are some import NEAT parameters from the file :

fitness_criterion = max
fitness_threshold = 100
pop_size = 50
reset_on_extinction = False

Fitness function: The fitness function is a combination of different parameters in the game. They are the time for how much the bird is alive in the game, score, and a collision punishment.

Input: Each frame has 3 input parameters. They are a vertical distance from the top pipe and bird, the horizontal distance from the bird to the pipe, and the vertical distance from the bird to the bottom pipe.

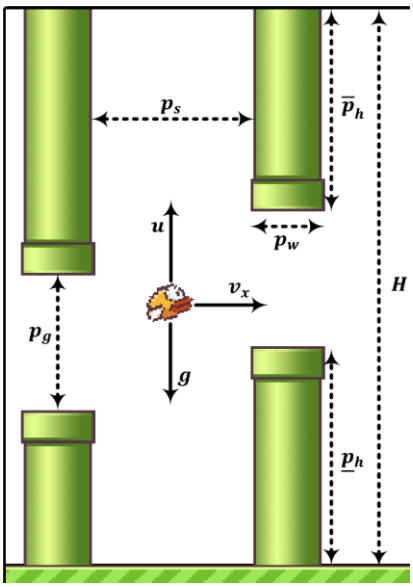

Fig. 2. Game(distances) representation model

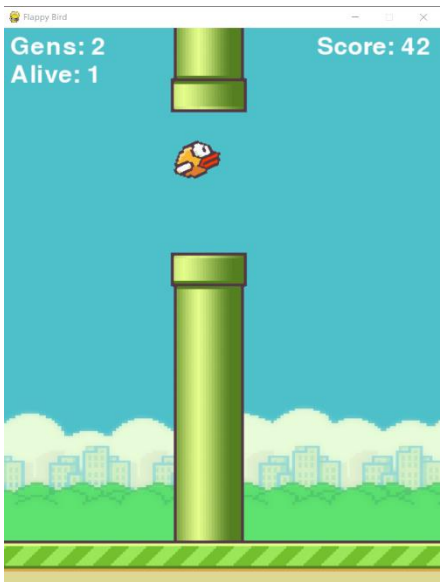

Fig. 3. Game Screenshot

Output: The output is a decision to jump or not.

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Also, in order to get the input information we calculate the position of the bird every time and get indexes of the closest pipe. This way we get all three parameters at any given point in time.

Our game runs in a loop with a frame for each loop. With each frame, the objects move. The bird jumps if needed and calculates the score and checks for possible collisions. The game will update automatically thanks to NEAT.

Steps :

1. We create a population of birds initially and let them all play.
2. For each, we calculate fitness scores and measure their quality
3. When all are killed, we evaluate the current population with the next one using our GA operators.

a. We sort the fitness scores of the current population and pick the top ones and fill the rest with their offsprings

b. We also apply random mutations on each offspring to add some variations.

4. Repeat it again from step 2

4. CONCLUSION

It took us about 8 generations to fully train our IA since Flappy Bird is a Simple Game. For a few starting generations the birds immediately hit the ground. But after 5 or 6, NEAT learned how to avoid collisions. And after generation 8 the bird fully learned how to avoid all pipes. Although the population was very small, NEAT was able to master it within 8 generations proving that NEAT is a very good technique and it's very efficient. Since NEAT tries to find the simplest solution, it's very efficient. This technique can be used in various games in the future as this strategy finds an optimal solution in a very short number of generations.

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