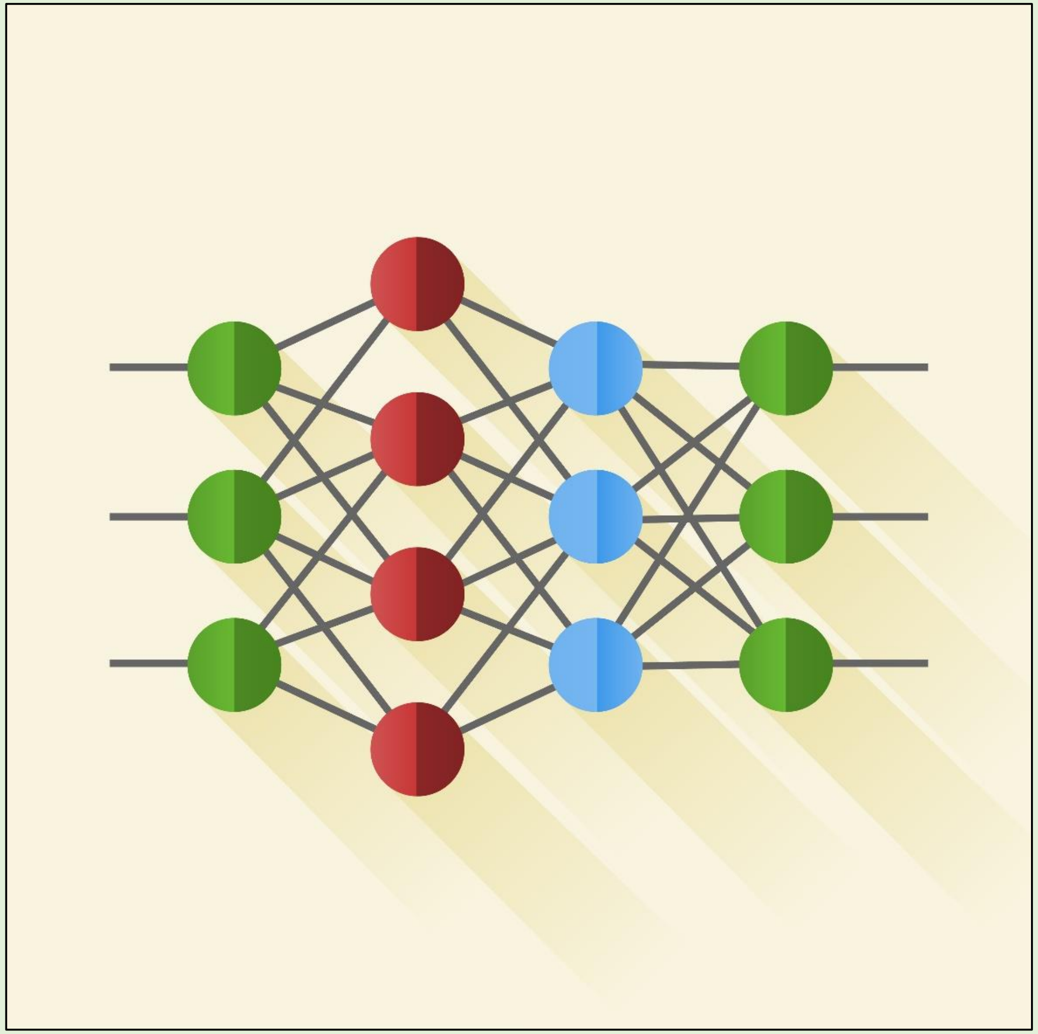
NEUROEVOLUTION

In these changing times, artificial intelligence is fast replacing humans in various tasks.

There are many ways in which a machine can learn to perform certain tasks. One such way is Neuroevolution of Augmented Topology, better known as NEAT.

In this exhibit, we have created a NEAT algorithm to teach the computer to play Flappy Bird, a game known for its simplicity yet difficult nature.



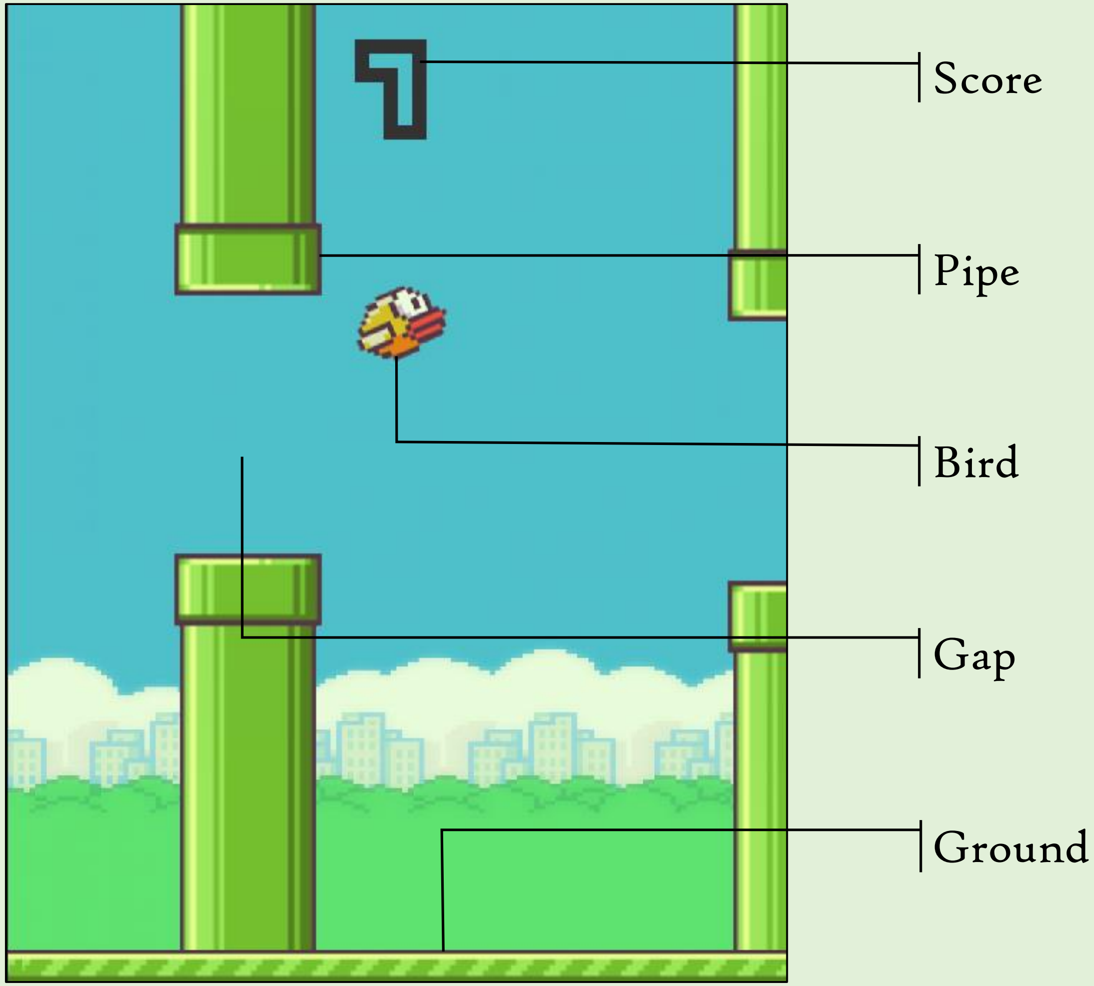
FLAPPY BIRD

The game the computer will be taught to play is Flappy Bird.

Here's a gist of the game:

- The user keeps a bird afloat in air by tapping to make it jump.
- Pipes with gaps in between occasionally arrive, and the bird must be guided through these gaps.
- Failure to keep the bird from hitting the pipes or the ground will result in death.
- The user's score is given based on the number of pipes he has successfully guided the bird through.

Try It!

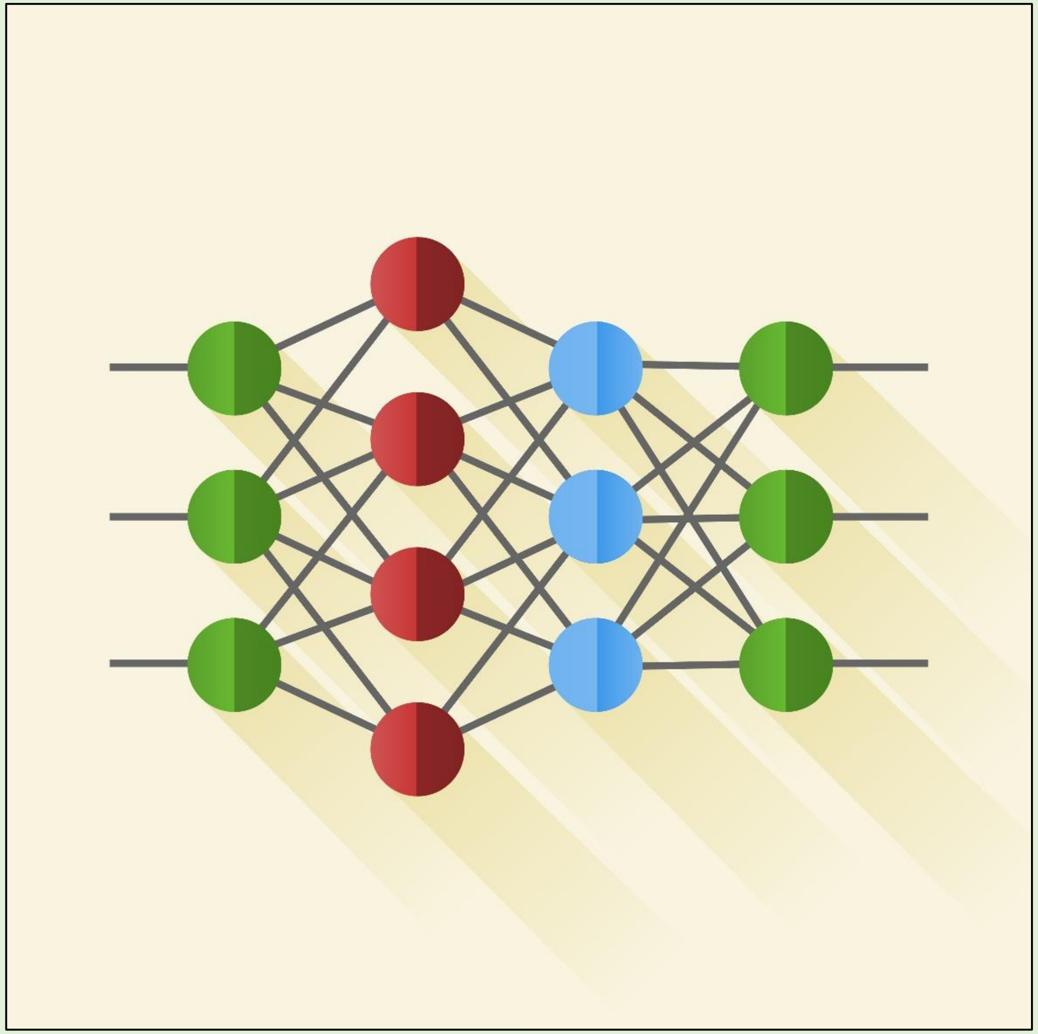


ARTIFICIAL INTELLIGENCE

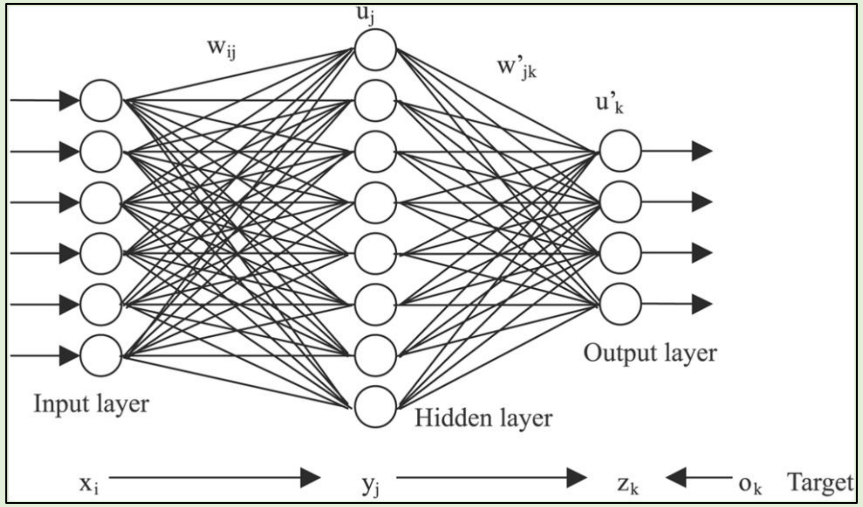
The algorithm used to teach the computer to play is Neuroevolution of Augmented Topology (NEAT). NEAT can be broadly divided into two basic parts:

- Neural Network
- Genetic Algorithm

These individual segments are explained in the subsequent pages.



NEURAL NETWORK



Neural networks are a very simplified and crude impersonation of a brain.

They consist of an input layer, an output layer, and one or more hidden layers, in which all the calculation takes place.

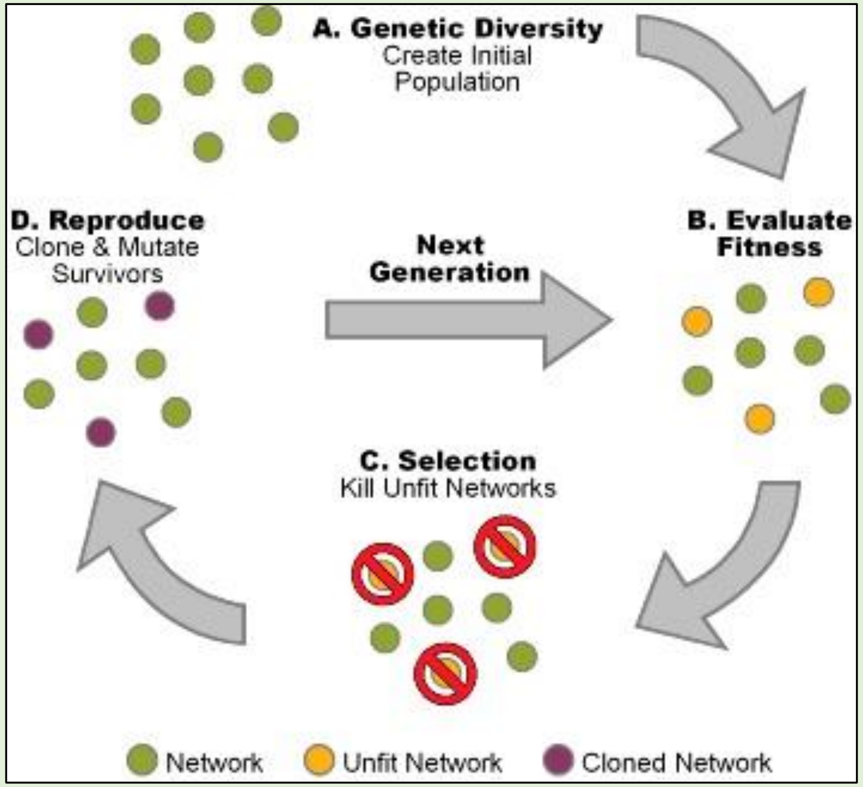
Each layer consists of multiple nodes, which hold specific values. Each node in a layer is linked to every other node in the consequent layer. These links have varying weights.

Here's how the neural network works:

1. Take input values and separately store them in the nodes of the input layer.
2. Multiplying the value in each node with the respective weight of its link a node of the next layer and adding these values, we get a weighted sum for each node in the next layer.
3. Carry out these operations till we reach the output layer. The various output nodes signify various decisions which can be made. The output node which receives the maximum value is the winner. The decision corresponding to the winner is taken.

This algorithm is very similar to the functioning of our brain, where various neurons carrying different information get fed forward and ultimately the brain decides on a particular action.

GENETIC ALGORITHM



Genetic algorithm aims to impersonate the evolution process.

Evolution works like this: In every generation, the fittest species survive, and breed to give the next generation. The others perish. This new generation of fitter species again fights for survival among themselves, and only the fittest survive. Every few generations, some mutation takes place in the DNA of a species. Mutations can be good or bad. Mutations are necessary usually if all species bred in a generation are not fit enough.

Here's how the genetic algorithm works:

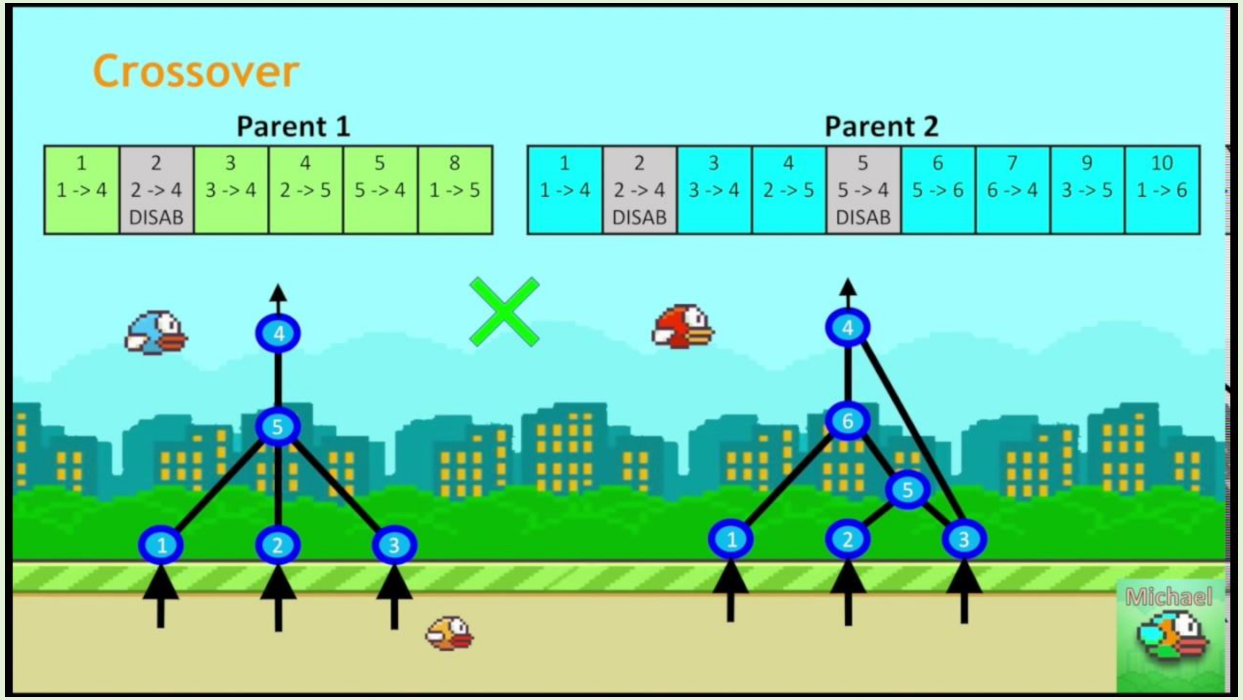
1. A generation of 500 (or many) players is created, with random behavior encoded into them.
2. These players are allowed to play in the game environment.
3. After all the players have died, they are evaluated based on performance.
4. The best performers of the generation are then selectively bred to form a new generation of 500 players, each inheriting from the best of the previous generation.
5. Some slight adjustments are made to these new players, to imitate mutation, and then they are again allowed to play.
6. This process is allowed to continue until a sufficiently strong generation is obtained, which is able to survive in the game environment long enough.

NEAT

NEAT implements both neural networks and genetic algorithm.

The “behavior” of players is defined by a neural network.

Basically, randomly generated neural networks are applied in the game environment, and based on their performance, they are selectively bred and mutated, until the perfect playing bot is obtained.



Crossover

Parent 1

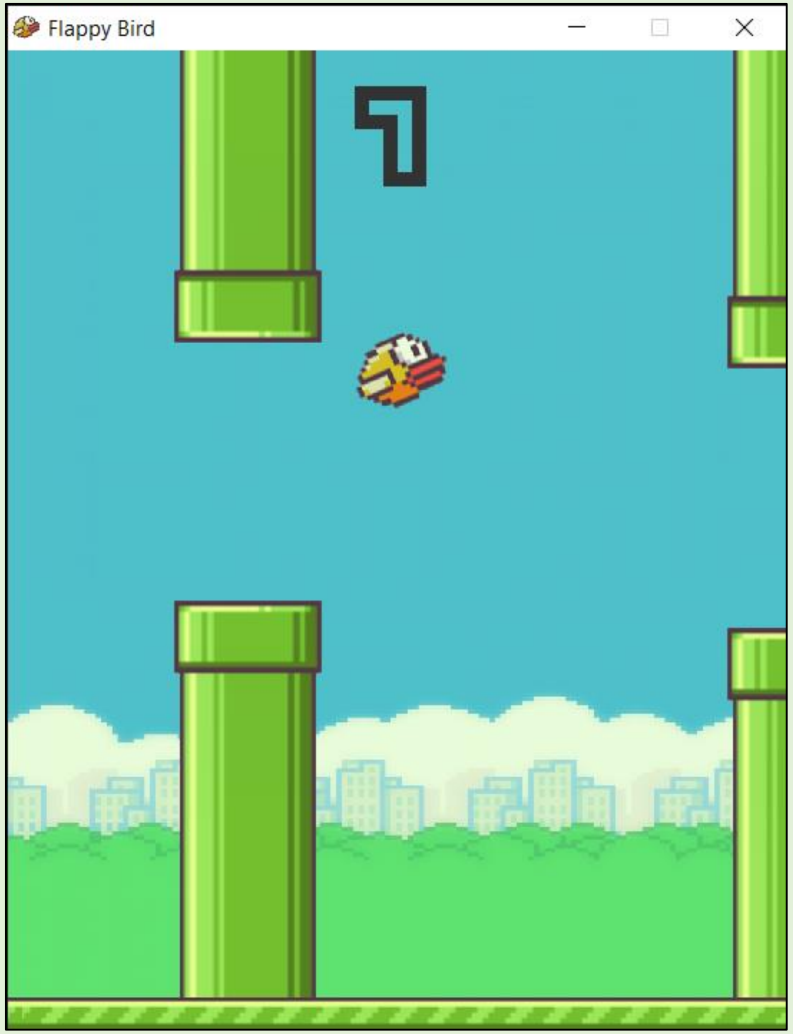
1	2	3	4	5	8
1 -> 4	2 -> 4 DISAB	3 -> 4	2 -> 5	5 -> 4	1 -> 5

Parent 2

1	2	3	4	5	6	7	9	10
1 -> 4	2 -> 4 DISAB	3 -> 4	2 -> 5	5 -> 4 DISAB	5 -> 6	6 -> 4	3 -> 5	1 -> 6

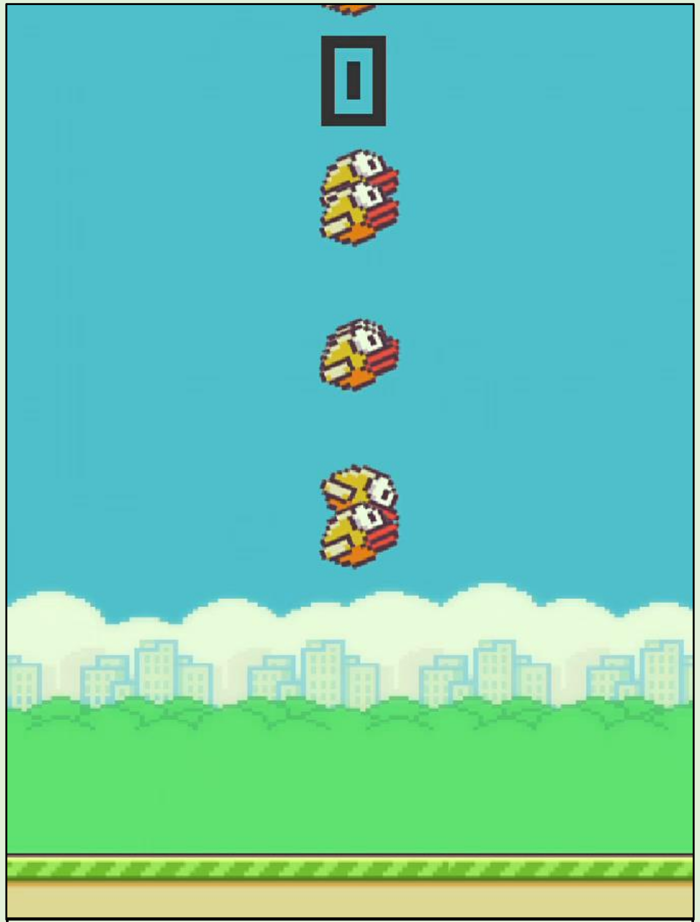
APPLICATION

The concept of NEAT was coded in Java and then embedded into a Flappy Bird environment by us. Flappy Bird is a relatively simple game, and it usually takes 5 to 10 generations to obtain the perfect playing bot. We have a visual demonstration of the learning process during runtime. Enjoy!

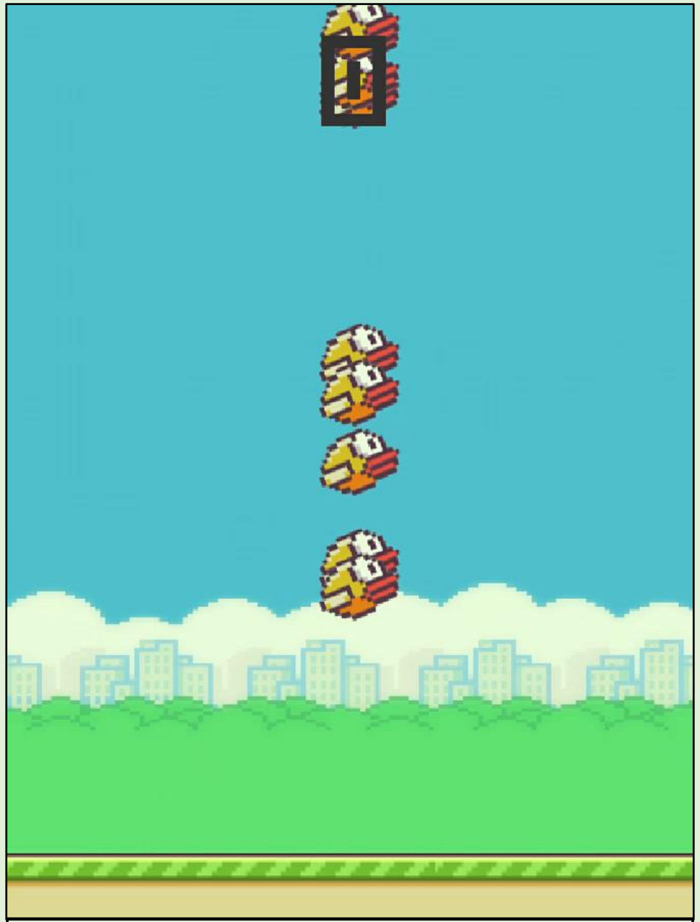


Execute Live

RECORDED VIDEOS



Training Process



Fully Trained AI