Performance Evaluation project:
Optimizing cars' trajectory with AI

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Part I
Introduction

The goal of this project is split into five parts:

- Creating racing car environment to simulate simple 2D racing car model.
- Implementing Deep Q-learning and Genetic algorithms to optmize the behaviour of a car on trakcs so that the car can have the best trajectories possible.
- Evalute the performances of Deep Q-learning and Genetic algorithms and compare them.
- Evalute the performances of Deep Q-learning depending of the hyperparameters.
- As a bonus: evaluate the performance of our best car's behaviour.

All the code have been made with python.

Part II
Deep Q-learning

1 Markovian decision porcess

2 What is Q value?

3 What is Q learning

Part III
Genetic algorithms

4 What are genetic algorithms

5 Markov Chain modelisation

6 NEAT

Part IV
Car Racing environment

7 Tracks

A track is originally a .png file wich look like the left image of figure 7. Then, the image is converted to a matrix T such that $T[0][0]$ is the bottom left corner. After that, we crop the image, compute the

starting point and the lines of track (that will be explained in the reward part) to have a final result which look the right image of figure 7.

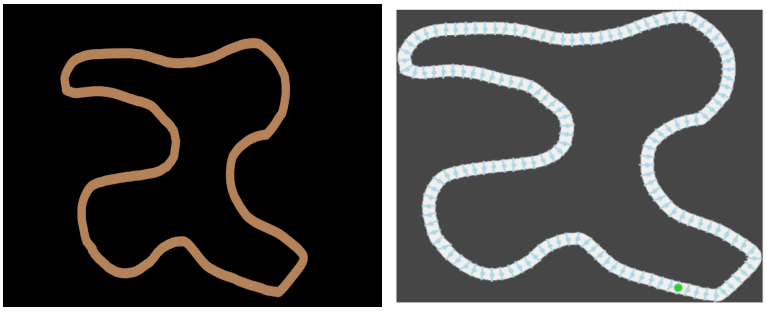

Figure 1: .png and computed track

8 Cars' physics

The Car physic is really simple. It is a 2D cartoon-like physics that act as follow:
The car has to main informations: its speed $\in [0, \text{MaxSpeed}]$ and its rotation $\in [0, 360]$. The physics is simple, at each times step, the car move to next coordinates on direction of the car's rotation and of a lenght equal to the car's speed.
If the coordinates of the car is (x, y), its speed is s and its rotation is α, then, after a time step, the coordinate of the car will be:

$$(s.cos(\frac{\pi}{180}\alpha) + x,\ s.sin(\frac{\pi}{180}\alpha) + x)$$

Moreover, at each time step, the car can make some actions:

- it can accelerate, this will increase the car's speed by a constant
- it can brake, this will decrease the car's speed by reduce the car speed by a constant. The car cannot have a negative speed.
- it can turn, i.e. add a constant $\in [\![-K, K]\!]$ to its rotation. K is a constant that is the maximum angle the car can turn per each time step.

9 Technical aspects of the environment

10 Rewards

Part V
Performance Evaluation

11 Algorithms

12 Best car