A GA-trained NN-based Control Method for Autonomous Vehicles

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Abstract

In this report, the authors present the main motivations that led them to choose this subject as the final project for the Pattern Recognition and Machine Learning course. A brief analysis of previous works in the subject and the expected results are also presented.

1. Introduction

Improvements in processing power in the last few years together with a big offer of available data have made possible many problems be approached with machine learning-related techniques. Among these problems, the control of autonomous vehicles stands out for its great financial attractiveness as many major market players, such as BMW, Tesla and Mercedes invest a lot of resources in this branch of technology [1]. Having considering those facts, we propose a method to control of autonomous vehicles based on neural networks, whose training is performed by an evolutionary algorithm. Here, the goal is that a self-driven vehicle learns how to drive autonomously an specific race track in less time as possible based only on sensors placed on the simulated vehicle.

In it's simplest implementation, the proposed model will be modeled based on states, actions and rewards possible in the environment. The states are considered to be the environment sensing, such as, vehicle's speed, acceleration, angular velocity and five inputs produced by sensors that will measure the distance of the simulated object to the walls at different angular directions. Next, the actions are consisted by all the possible actions that the autonomous driver can take facing an specific state every moment. Consequently, actions are the composed by the actuation of the accelerating and brake pedal and also the steering wheel angle. Finally, each autonomous-driver model will be rewarded and ranked based on how good the vehicle can be self-driven during the race track, i.e. how far the vehicle can drive without hitting any wall and in the case the vehicle completes one lap, how fast it can drive.

Therefore, this paper will explore different neural network structures and evolutionary learning strategies in order to maximize the vehicle self-driveability performance.

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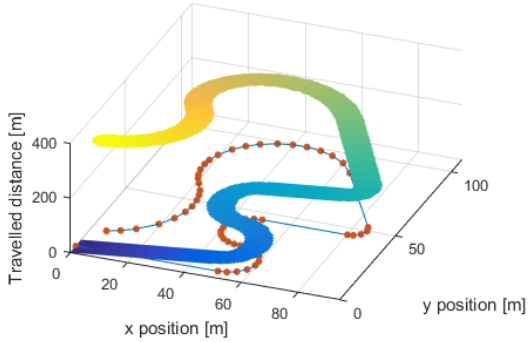

Figure 1. Road map

2. Activities

Some articles have already discussed how to use a genetic algorithm to train neural networks in order to provide control for autonomous systems, notably [2], [3] and [4]. In the final report, the solutions presented by their authors will be discussed and compared with the one we proposed.

3. Proposed Solutions

Given one or more training maps, such as the one in the figure 1, we propose to train a neural network capable of controlling a vehicle in any other map. The chosen training maps must be sufficiently good to represent the biggest number of real life situations commonly found in any other track, otherwise the neural network resulted from this training might not know how to proceed in unknown states. It should be noted that the GA parameter settings must also take into account the bad effects of over fitting.

For the start, the proposed neural network receives 7 inputs states - vehicle's speed, acceleration, angular velocity and 5 distance sensors - and produces 3 outputs actions - a new steering angle and a brake and acceleration pedal actuation. The genetic algorithm, generations with $i = 1000$ individuals are submit to the training maps and evaluated according to the fitness function which considers the time and distance that the simulated object took during the simulation. Eventual collisions are evidently penalized.

References

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