Training Navigation to Virtual Autonomous Race Cars Using NeuroEvolution

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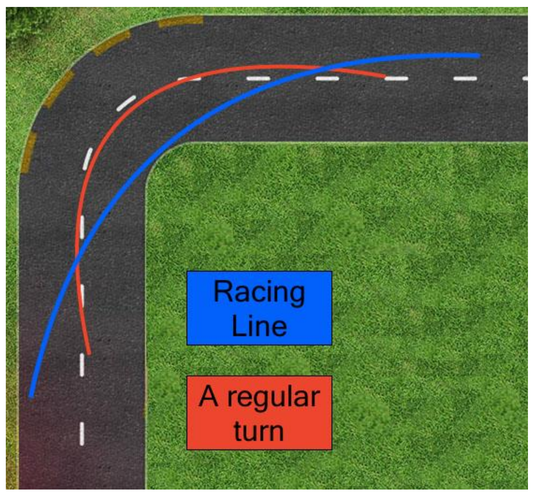
Background

Autonomous vehicles increase mobility, provide driver support, and ensure traffic safety. To navigate a track in the shortest time possible, one must follow the “racing line”, which is the fastest path for a given corner.

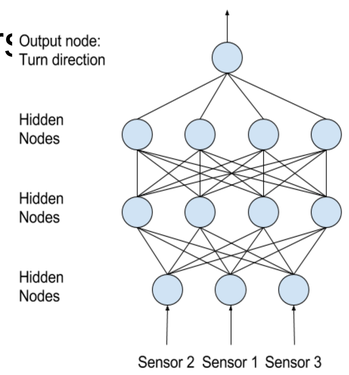


Objectives

- Apply a genetic algorithm to artificial neural networks(ANNs) in order to train a virtual autonomous vehicle(VAV) to quickly navigate turns on a race track.
- VAV completes laps consistently without collisions and surpasses manually driven lap (10.16s).
- VAV lap times stop decreasing.

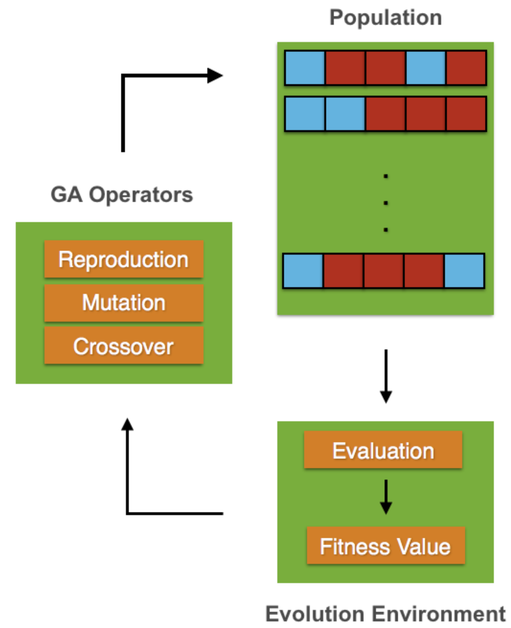
Neural Networks

- Inputs: three sensors on the race car to sense the proximity to the edge of the path.
- Output: Instruction for the VAV to turn toward a specified direction.



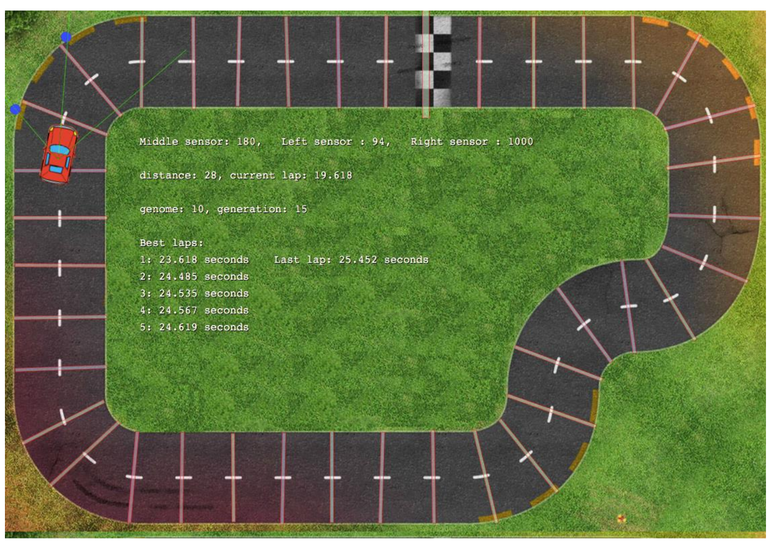
NeuroEvolution

- Fitness function is based on distance and time
- Genomes are ranked by fitness and the worst six genomes are removed.



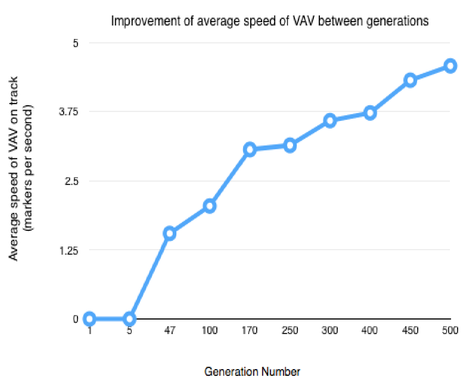
Implementation

- The training of the ANNs was visualized through a virtual race car on a track developed using the Phaser HTML framework.
- The car travels at a constant velocity in a straight line and moves at reduced velocity while turning.
- Track boundary collisions are checked for when the car comes into contact with the edge of the road.



Data Summary

- Until generation 47, the VAV was unable to consistently navigate the track
- The algorithm peaked at generation 500 after which lap times stopped decreasing significantly



Generation	Best time to complete 1 lap (seconds)
1	Infinite (Does not complete lap)
5	Infinite (Does not complete lap)
47	24.6
100	18.6
170	12.4
250	12.1
300	10.6
400	10.2
450	8.8
500	8.3

Future Works

- Improve physics and add obstacles.
- Implementation of the NeuroEvolution of Augmenting Topologies (NEAT) algorithm.

Related Works

1. Y. Saez, D. Perez, O. Sanjuan, P. Isasi, Driving cars by means of genetic algorithms, in Proceedings of tenth International Conference on Parallel Problem Solving from Nature (2008), pp. 1101–1110
2. L. Cardamone, D. Loiacono, P.L. Lanzi, A.P. Bardelli, Searching for the optimal racing line using genetic algorithms, in 2010 IEEE Symposium on Computational Intelligence and Games (CIG) (2010), pp. 388–394. doi:10.1109/ITW.2010.5593330

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