Project Summary – Self-Driving Learning Car Simulation Using NEAT
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For my final year engineering project, I developed a self-driving car simulation system, which learns to navigate through a 2D environment by using radar sensors, evolutionary neural networks, and reinforcement learning principles. The goal was to explore neural networks and deepen my understanding of AI, and how it can learn decision-making on continuous feedback, sensor inputs, and adaptive neural architectures. The system is built in Python using Pygame for visualization and NEAT (NeuroEvolution of Augmenting Topologies), which evolves topologies with respect to successive generation.

The simulated vehicle gets input through 19 radial distance sensors, each placed 10 degrees apart in front of it. Sensors detect track boundaries within a 300-pixel range. With the input of each sensor, a neural controller outputs one of five values (steering angles and throttle adjustments). NEAT generates progressively improved neural network topologies that optimize the car's performance across generations. I tried to make the simulation more realistic, so I included car physics parameters such as acceleration, friction, turning dynamics, and collision detection.

As NEAT evolves its topology with each generation, the car drives differently on the track—sometimes better and sometimes worse, which often led to network instability, and this part was very challenging. So, I tuned the mechanism to reward consistency, then by the 15th generation, it started to drive smoothly, avoid walls, complete the full track, and even loop it consistently without crashing. Performance was evaluated using metrics, including distance covered, average speed, collision rate, turning efficiency, and driving smoothness.

This project taught me the intricacies of neural networks and reinforcement learning and showed the potential of evolutionary reinforcement learning for autonomous tasks. Improvements can be made in sensors, integration of advanced ML techniques, and step toward real-world deployment. Altogether, from this project I improved my understanding of machine learning, neural network evolution, simulation design, and intelligent control systems—knowledge that is directly relevant to advanced study in Artificial Intelligence Engineering.

Report Link:

https://github.com/pranavchole/Self_Drive_Learning_Car_Simulation/blob/main/Self_Drive_Learning_Car_Simulation/Report/Project_report.pdf