

# Report on 2D Simulation of a Self-Driving Car

## Abstract

The rapid advancements in the domain of autonomous vehicles have been largely attributed to the capabilities of neural networks. These networks, with their ability to learn and make decisions based on vast datasets, have become the cornerstone for self-driving car simulations. This research delves into the application of a custom-built neural network in a 2D self-driving car simulation. The primary objective of this study was to gain a comprehensive understanding of neural networks by constructing one from scratch, without the aid of external libraries. The findings from this research underscore the potential of custom-built neural networks in the realm of autonomous vehicles and provide insights into their intricate workings.

## Introduction

Neural networks, a subset of machine learning, have been pivotal in the evolution of autonomous vehicles. Their ability to process vast amounts of data and learn from it has made them an indispensable tool in the development of self-driving cars. While there are numerous libraries and tools available for building neural networks, understanding their fundamental principles is crucial for any researcher in the field. This research project was embarked upon with the primary goal of comprehending the intricate workings of neural networks. By building a neural network from scratch and applying it to a 2D simulation of a self-driving car, this study aimed to delve deep into the nuances of neural network design, training, and application.

## Methodology

The methodology adopted for this research was systematic and aimed at ensuring a thorough understanding of neural networks. The steps involved were as follows:

1. **Data Collection:** Real-world traffic data was sourced from Kaggle. This data was then used to simulate traffic congestion similar to the roads of Gulshan during peak hours.
2. **Neural Network Design:** A custom neural network was designed without the use of any external libraries. The architecture comprised multiple layers, each with its unique set of neurons and activation functions.
3. **Training:** The neural network was trained using the traffic data. The training process involved feeding the network with data, adjusting weights based on errors, and iterating

this process until satisfactory performance was achieved.

4. **Simulation:** A 2D environment was created to simulate the self-driving car's decisions. The trained neural network was then integrated into this environment to observe its decision-making in real-time scenarios.
5. **Evaluation:** The performance of the neural network was evaluated based on its ability to navigate the simulated environment without collisions and its decision-making speed.

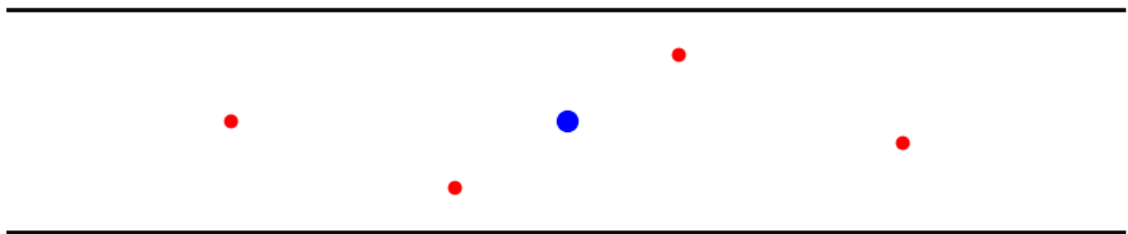
## Results

The results of the simulation were promising and provided valuable insights into the capabilities of the custom-built neural network. The following scenarios were observed during the simulation:

### Car Navigating Through Dense Traffic

In this scenario, the self-driving car was able to navigate through dense traffic without any collisions. The neural network's decision-making capabilities were evident as the car adjusted its speed and direction based on the positions of other vehicles.

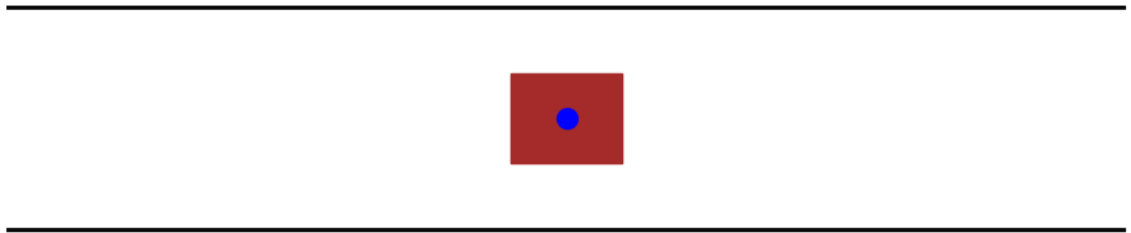
Car Navigating Through Dense Traffic



### Car Avoiding an Unexpected Obstacle

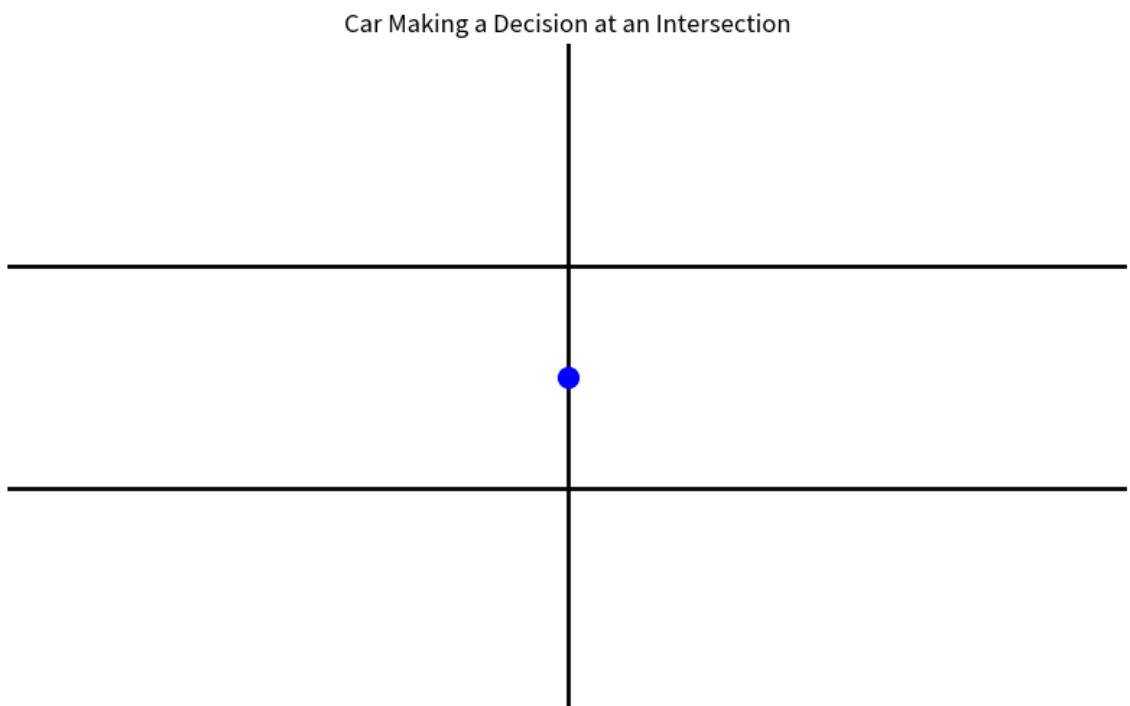
When presented with an unexpected obstacle on the road, the self-driving car was able to detect it and make a timely decision to avoid a collision. This showcases the neural network's ability to react to unforeseen challenges in real-time.

## Car Avoiding an Unexpected Obstacle



## Car Making a Decision at an Intersection

At intersections, the self-driving car demonstrated its capability to assess the situation and make decisions on whether to proceed, stop, or turn. The neural network's training played a crucial role in ensuring that the car made safe and efficient decisions at intersections.



## Discussion

The results of the simulation underscore the potential of custom-built neural networks in autonomous vehicle simulations. By building the neural network from scratch, a deeper understanding of its intricacies was achieved. This hands-on approach provided insights into the neural network's decision-making processes, learning capabilities, and adaptability to real-world scenarios.

The simulation's success in dense traffic scenarios, unexpected obstacles, and intersections highlights the robustness of the neural network. It was observed that the neural network could make real-time decisions, adjust to dynamic environments, and ensure the safety of the vehicle.

One of the significant advantages of building a neural network from scratch is the flexibility it offers. By understanding each layer and neuron's role, optimizations can be made to enhance performance. Moreover, without relying on external libraries, there's a greater degree of control over the network's architecture and functionality.

However, building a neural network from scratch also presents challenges. It requires a deep understanding of mathematical concepts, algorithms, and computational processes. Additionally, it can be time-consuming compared to using pre-built libraries. But the learning experience and the insights gained make it a worthwhile endeavor for researchers aiming to delve deep into the world of neural networks.

## Conclusion

This research project on the 2D simulation of a self-driving car using a custom-built neural network has provided valuable insights into the capabilities and intricacies of neural networks. The simulation's success in various scenarios underscores the potential of neural networks in the realm of autonomous vehicles. Building a neural network from scratch, although challenging, offers a unique learning experience and a deeper understanding of the underlying principles. The findings from this research can serve as a foundation for future studies in the domain of autonomous vehicles and neural networks. As the world moves towards a future dominated by autonomous vehicles, the role of neural networks will undoubtedly be pivotal, and understanding their workings will be crucial for researchers and engineers alike.