AUTONOMOUS VEHICLE DRIVING OPERATION

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CSE 4/546 : Reinforcement Learning

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Description

A vehicle that can operate without human supervision or control is known as an autonomous vehicle. In order to navigate and make driving judgments, it makes use of a variety of technology, including cameras, sensors, and artificial intelligence algorithms.

The three main parts of an autonomous vehicle's driving function are :-

1. Perception
2. Decision-making
3. Control

Overall , The seamless and effective operation of an autonomous vehicle is intended to convey passengers reliably and safely between locations without the need for human involvement.

BACKGROUND

Why is autonomous vehicle driving required ?

Transportation could undergo a revolution thanks to autonomous car technology, which could lower accidents, boost productivity, and provide everyone more mobility. To assure the safety and dependability of autonomous cars, thorough testing and validation are necessary before they can be developed and put into use. Traditional testing techniques on actual roads can be costly, time-consuming, and dangerous.

To enable researchers and developers to test and evaluate autonomous driving algorithms in a virtual environment before deploying them in the real world, simulation-based testing platforms are required. One such platform is the CARLA simulator.

In our project , we are using the CARLA simulator . It is an effective tool for advancing the design and testing of autonomous vehicle technologies.

-CARLA stands for Car Learning to Act .

-It is an outdoor driving simulator .

-CARLA is a 3D setting containing a range of urban scenarios and weather conditions, including highways, city streets, and suburban areas, and it was constructed using the Unreal Engine. The simulator can replicate many types of sensors, including cameras, lidar, and radar, and it features a variety of vehicles, including cars, trucks, and motorcycles.

-Cameras, LIDAR, and RADAR are just a few of the sensors that CARLA offers for mounting on the cars. These sensors produce accurate data that can be utilized to train and test algorithms for autonomous driving.

CARLA Environment

States: The current conditions of the environment and the vehicle are referred to as states in CARLA. The speed, location, direction, and sensor data from radars, lidars, and cameras can all be included in this.

Actions : The actions such as steering , throttle and braking can be given .

Rewards : The rewards or incentives are utilized to give the learning agent feedback depending on its behaviors in the environment. The incentives can be created to motivate the agent to adhere to traffic regulations, follow a predetermined trajectory, avoid hazards, or accomplish any other goal pertinent to the particular activity being mimicked.

Implementation

•We first created a separate environment for the CARLA simulator in our system.
•We are using the python version - 3.7 for this as it is the only python version which is compatible with the CARLA Simulator.
•We then installed the CARLA package and installed the simulator and set it up in our system .
•We are using the CARLA 0.9.14 version for this project.
•An agent gathers information about the environment through observations .
•The observations are usually retrieved from the sensor data such as camera images and LiDAR scans.

•The collection of actions that an agent may carry out in the environment is referred to as the action space.
•In CARLA, the action space typically comprises steering, braking, and adjusting the throttle.

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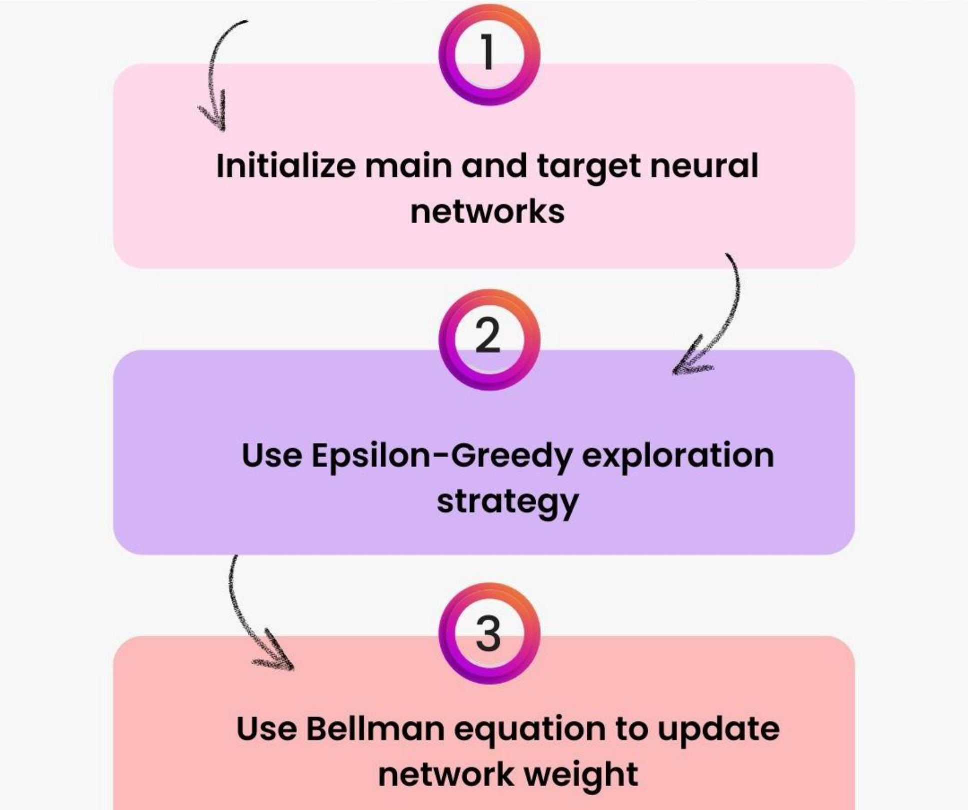
Why is CARLA the best solution?

- Some reasons why CARLA should be used for autonomous vehicle driving are :-
- It provides a safe testing environment .
- Reproducible testing
- Realistic Simulations and Visualizations
- Sensor testing
- Flexibility
- Cost Savings
- Open-source Community
- Compatible with various frameworks

Deep Q-Network

Another model-free RL approach that makes use of contemporary deep learning is DQN. DQN techniques use a deep neural network or convolutional neural network to estimate the Q value function and Q-learning to determine the optimum course of action to take in the current situation.



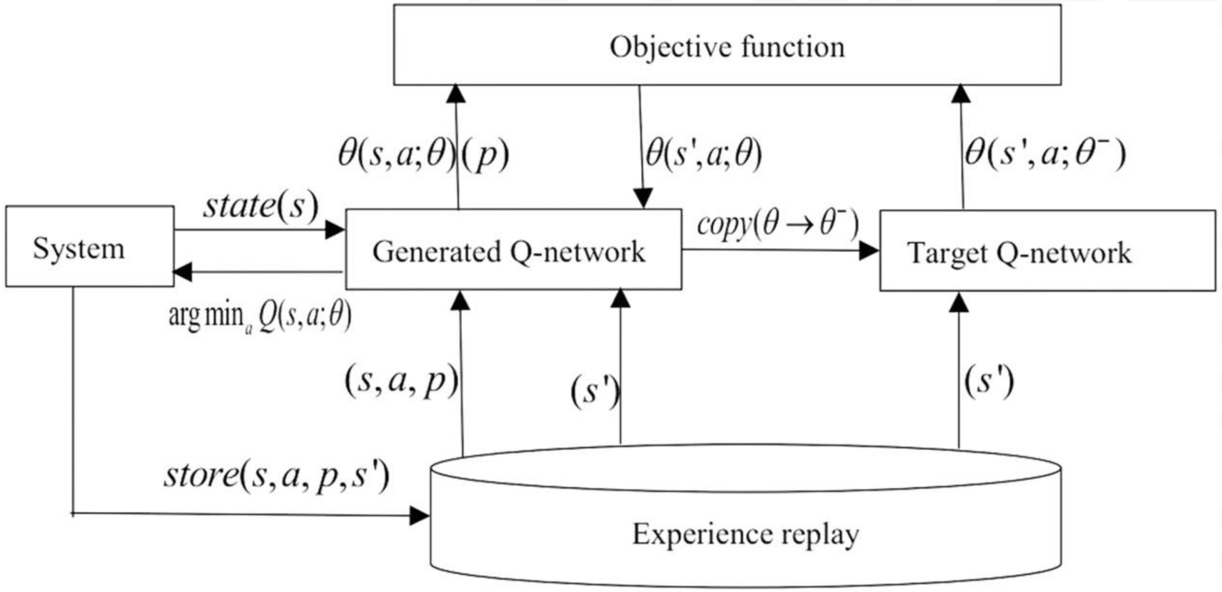
Double Deep Q-Network

By correcting the overestimation of action values that can occur in the original algorithm, DDQN enhances the conventional Q-Learning algorithm.

The Q-values of each action in each state, which stand for the anticipated future benefit of performing that action in that state, are learned by the algorithm in typical Q-Learning. However, when function approximation is used, which occurs frequently in large state spaces, these Q-values might become overstated. As a result, less-than-ideal decisions may be made.

Double Deep Q-Network

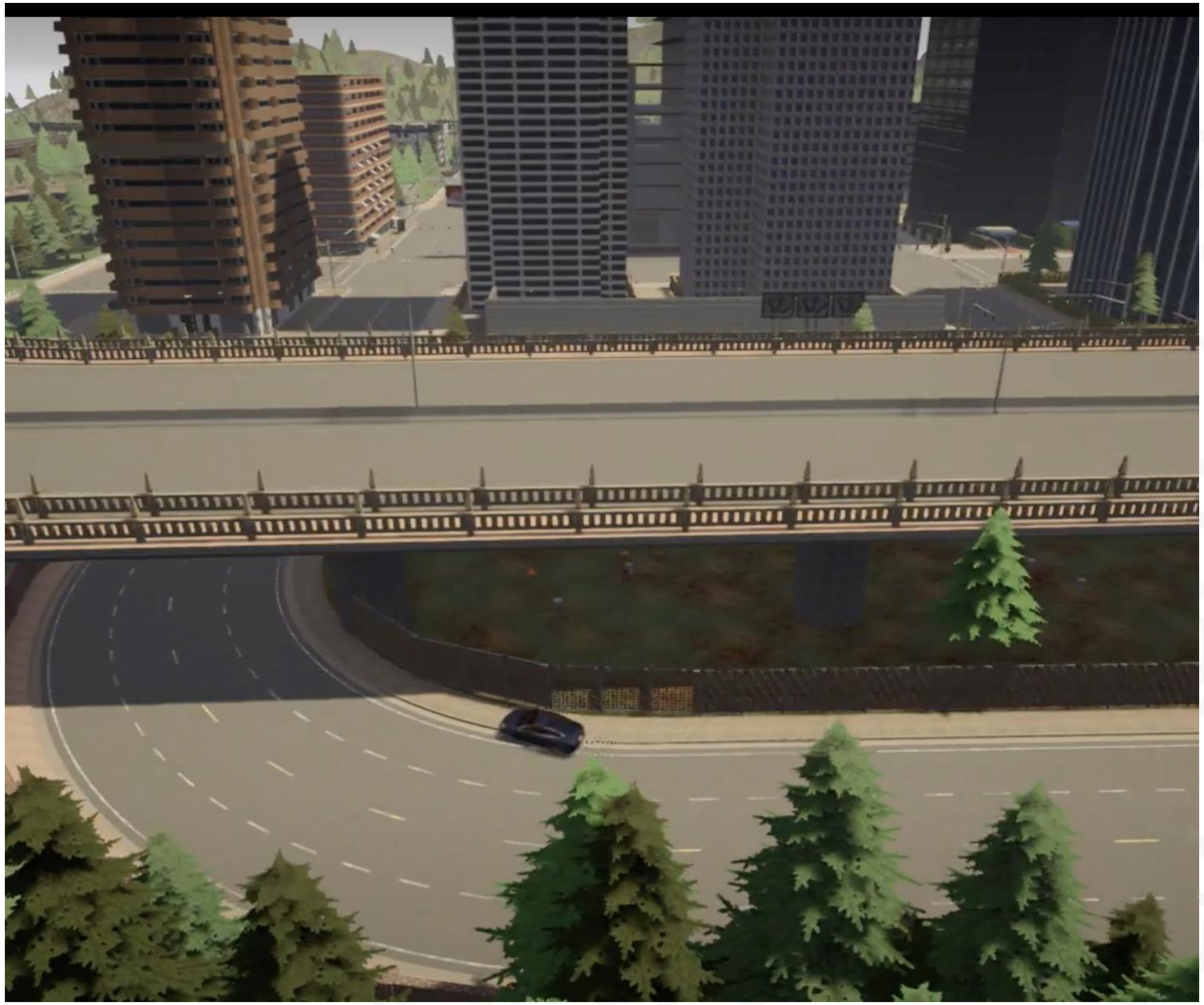
By creating a second network that is used to choose the actions to be executed, DDQN resolves this problem. While the secondary network is used to assess the Q-value of the selected action, the primary network is utilized to estimate the Q-values of each action in each state. To reduce the overestimation of Q-values, the idea is to decouple the selection and evaluation of activities.



DEMO

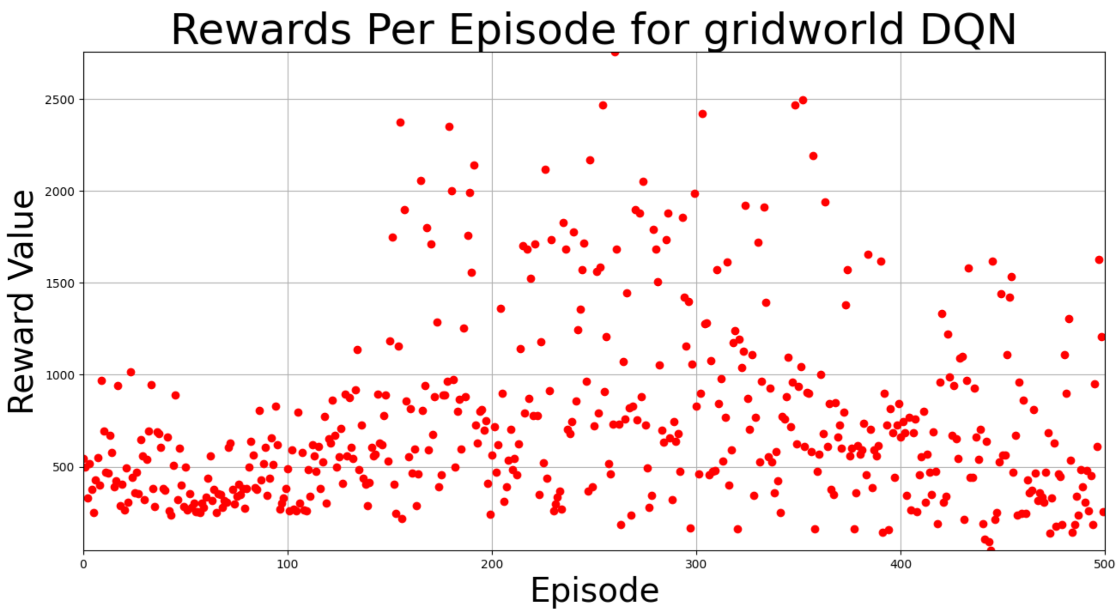
We have implemented DQN in Carla Environment and built the environment from scratch. Attached is a video that demonstrates evaluation of the trained DQN agent.

https://drive.google.com/file/d/1WoCvpLrmqwcVaQZ_40er71pXne61uuQa/view?usp=sharing



RESULTS

We can see that the Deep Q-Network algorithm is working well with the CARLA simulator . The graph shows an upward trend . The agent is able to learn with the increase in the number of episodes and is able to properly drive itself while maintaining the lane and taking proper turns avoiding any collision.



CONTRIBUTIONS

Name	Contribution
Raj Kishor Khatik	34
Harshvardhan Gupta	33
Parvani Ghosh	33

THANK YOU !!
Any Questions ?