Smart Traffic Light Controller Using Deep Reinforcement Learning

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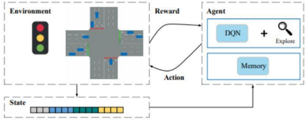
Problem Statement

Smart Traffic Light Controller which efficiently and dynamically manages the congestion in the networks using Deep Reinforcement Learning.
The implementation of the project is done on a simulation platform called SUMO.

Background

The research that has been conducted on traffic signal control using reinforcement learning has been significant.
Earlier efforts were limited by simple simulations and a lack of computational power.



Research conducted has differed in reinforcement learning type, state space definition, action space definition, reward definition, simulator, traffic network geometry and vehicle generation model.

Project Requirements / Product Features

List of requirements.
- Generation of road networks in SUMO simulator.
- Testing the agents with new simulations for better performance.

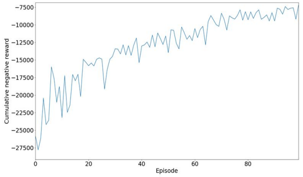
Product features.
- Agent can detect the traffic from the intersection.
- Based on the state of the traffic, the agent takes appropriate action to minimise traffic congestion.
- The cumulative delay and queue length is significantly lesser when compared to the traditional traffic system.
- The more the agent is trained, better it performs.

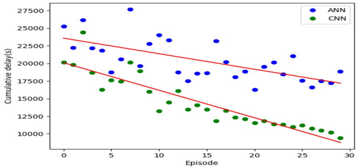
Design Approaches / Methods

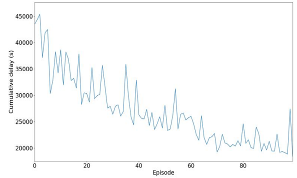
The approach is to use DTSE(discrete traffic state encoding).
The agent(traffic light) observes the state of the environment and in each arm of the intersection.
The incoming lanes are discretized into cells that can identify the presence or absence of a vehicle inside them
And then it trains them accordingly to maximise reward and reduce queue length and delay.

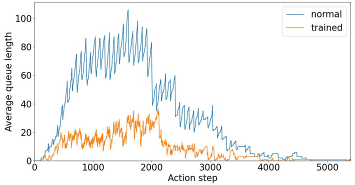
Results and Discussion

Below graphs (Left to right) shows that 1) cumulative negative reward increases as the episodes proceed. 2) the comparison between ANN and CNN model shows that CNN performed better. 3) the cumulative delay decreases drastically as the number of episodes increases. 4) the comparison between the untrained model(Traditional traffic) and the trained one with respect to average queue length and the action step.









Summary of Project Outcome

The project consists of different forms of networks like 3-way, 4-way, 5-way, double and complex intersections which are trained with ANN and CNN models. The outcome of the project is as expected with the initial estimate.

Conclusions and Future Work

An RL approach was able to monitor and control traffic lights in a much more effective manner where appropriate actions were taken on the agents to adjust dynamically to real time traffic.
Future works could include improving the results achieved and expanding it to a much larger network. Introduction to the real world needs proper analysing with different test cases.

References

1. Andrea Vidali, Luca Crociani, Giuseppe Vizzari, Stefania Bandini, “A Deep Reinforcement Learning Approach to Adaptive Traffic Lights Management”.
2. Wade Genders, Saiedeh Razavi, “Using a Deep Reinforcement Learning Agent for Traffic Signal Control”.

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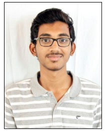

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