A Project Review-1 Report

On

Traffic Signal Control Using Machine Learning

Submitted in partial fulfillment of the requirement for the award of the degree of

B.TECH IN COMPUTER SCIENCE AND ENGINEERING

GALGOTIAS UNIVERSITY
(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Under the supervision of

MR. AMIT KUMAR

ASSISTANT PROFESSOR

Submitted by:

ADITYA PRATAP SINGH

19SCSE1010559

SCHOOL OF COMPUTING SCIENCE AND ENGINEERING DEPARTMENT OF COMPUTER SCIENCE AND

ENGINEERING GALGOTIAS UNIVERSITY, GREATER NOIDA

INDIA

OCTOBER, 2021-22

LIST OF CONTENT

ABSTRACT

EXISTING PROBLEM:

In urban traffic control, traffic signals have long been a hot topic. Ineffective and inflexible traffic regulation at urban intersections can frequently block traffic flow and inevitably result in traffic congestion. In urban traffic management, a major difficulty is figuring out how to control traffic in a logical way. It will assist urban regions if we bring new strategies with ways to solve this problem. Because traffic light systems are ubiquitous, it would be difficult to change the system, and we would have to overcome certain obstacles to accomplish this task. Rather than changing the current system and introducing new things, we could solve this problem by making minor changes to the existing software, which would eliminate many other barriers.

PROPOSED SOLUTION:

All we need to do is just add some algorithms to main software. With recent advances in machine learning, especially reinforcement learning (RL), traffic signal control using advanced machine learning techniques represents a promising solution to tackle this problem.

TOOLS AND TECHNIQUE USED:

The performance of the proposed method is comprehensively compared with two traditional alternatives for controlling traffic lights. Simulation results indicate that the proposed method significantly reduces the total delay in the network when compared to the alternative methods. Adjacent traffic light intersections will work independently and yet cooperate with each other to a common goal of ensuring the fluency of the traffic flow within traffic network. The experimental results show that the Q-Learning algorithm is able to learn from the dynamic traffic flow and optimized the traffic flow.

OUTPUT:

The proposed project helps in reducing the traffic problem that occurs everyday and also helps in reducing the load of vehicles running on the road by pooling the car for the same destination.

SCOPE:

The current work focuses on how to bring an effective solution to this problem:

- Reduce the traffic congestion.

INTRODUCTION

In the recent years due to technological advancements the automobile sector is also manufacturing a higher number of vehicles and every year almost 253 million vehicles are being manufactured and sold to customers. As the roads cannot expand, we need to look for efficient ways in order to manage the number vehicles on the road. A fully developed city has a limited ability to reconnect to its traffic, thus providing a real time solution to this problem may solve most of the problem. Providing a real time traffic control based on the density of vehicles could be the best solution so far. The main purpose of controlling traffic signal is to simultaneously increase the intersection capacity, decrease delays and guarantee the safety of people and vehicles. It can also help in reducing the unwanted time which people waste by staying at signals. Moreover, at peak hours and at special cases the traffic signals will be working on a real time-based approach instead of the older ways. After a lot of research, it is found out that the main purpose for the accumulation of traffic is due to fixed-time traffic control. In a fixed-time traffic control it has been observed that every part of the road is given an equal time for the movement of vehicles. But by giving an equal amount of time to every part of the road, the traffic congestion does not tend to reduce the amount of traffic. Our project deals with bringing in change with the current traffic signal system and moreover making it real time-based and to glow the green light for the part of the road containing a higher number of vehicles. According to the environment and the test cases the machine will bring out the better after every try as we have used reinforced learning and the mach will also learn from the environment as it is a reward Figure 2 shows Conventional traffic signal timing plan management using statistical information of traffic lacks the ability to rapidly adapt into the dynamic traffic flow. Thus, the necessity for the development of intelligent traffic signal timing plan management is a need to continuously learn from the dynamic traffic environment for adaptability. The Q learning algorithm gathers information of the past actions and tends to learn better and also learns from its environment. The implemented traffic light intersections will be able to learn from the current traffic light intersections and its environment for increasing its adaptability and tends to make a better decision in the future using the Existing System The traffic control lights currently are fixed in a sequence and with a time delay which follows a particular cycle while switching from one signal to other. Sometimes this might cause a lot of congestion on the roads, mainly when there are many vehicles at some part of the road. The sequence of the traffic signal causes the green light to glow for the part of the road where there are very few most effective solution for this problem and will get better after every try as we have used reinforced learning and the mach will also learn from the environment as it is a reward-based learning.

MACHINE LEARNING

Machine learning (ML) is the study of computer algorithms that can improve automatically through experience and by the use of data. It is seen as a part of artificial intelligence. Machine learning algorithms build a model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as in medicine, email filtering, speech recognition, and computer vision, where it is difficult or unfeasible to develop conventional algorithms to perform the needed tasks. A subset of machine learning is closely related to computational statistics, which focuses on making predictions using computers; but not all machine learning is statistical learning. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Data mining is a related field of study, focusing on exploratory data analysis through unsupervised learning. Some implementations of machine learning use data and neural networks in a way that mimics the working of a biological brain. In its application across business problems, machine learning is also referred to as predictive analytics.

TYPES:

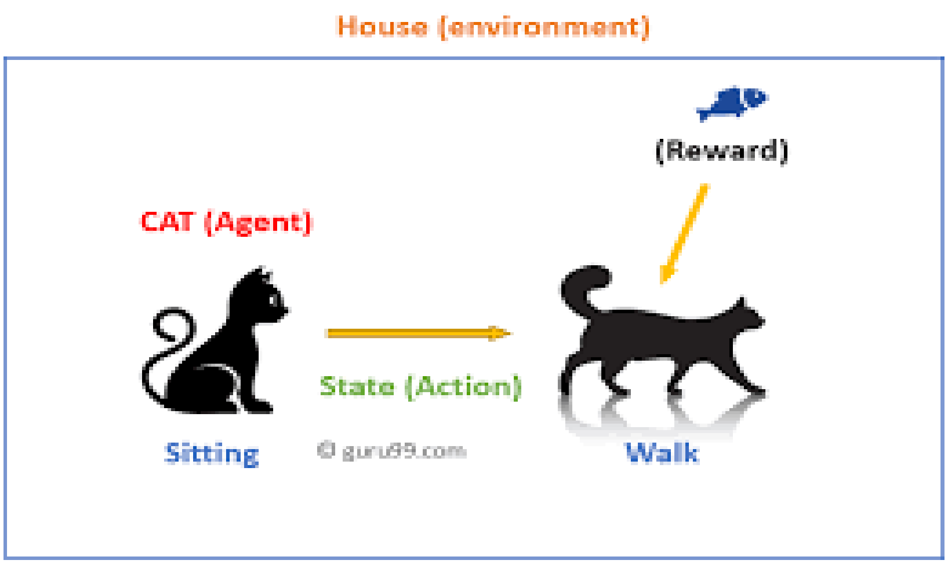
a) SUPERVISED LEARNING

b) UNSUPERVISED LEARNING

c) REINFORCEMENT LEARNING

We are going to use reinforcement learning in our proposed project and also we are used to going some terminologies in our learning. They are:

- Agent
- Environment
- Action
- State
- Reward
- Policy
- Value
- Q-value



AGENT: An entity that can perceive/explore the environment and act upon it.

ENVIRONMENT: A situation in which an agent is present or surrounded by. In RL, we assume the stochastic environment, which means it is random in nature.

ACTIONS: Actions are the moves taken by an agent within the environment.

STATE: State is a situation returned by the environment after each action taken by the agent.

REWARD: A feedback returned to the agent from the environment to evaluate the action of the agent.

POLICY: Policy is a strategy applied by the agent for the next action based on the current state.

VALUE: It is expected long-term retuned with the discount factor and opposite to the short-term reward.

Q-VALUE: It is mostly similar to the value, but it takes one additional parameter as a current action.

PRIMARY FOCUS OF THE SOLUTION BY THE RESULT :

Training convergence

Comparison with benchmarks

Generalization across different traffic patterns

Average queue length (number of halting vehicles per incoming lane) and average wait time used (wait time in second per incoming vehicle) as a performance criterion.

These Figures show the training convergence of our reinforced learning approach under traffic patterns 1 - 3. Traffic pattern 4 is used for testing purposes to validate the generalization ability of our reinforced learning approach.

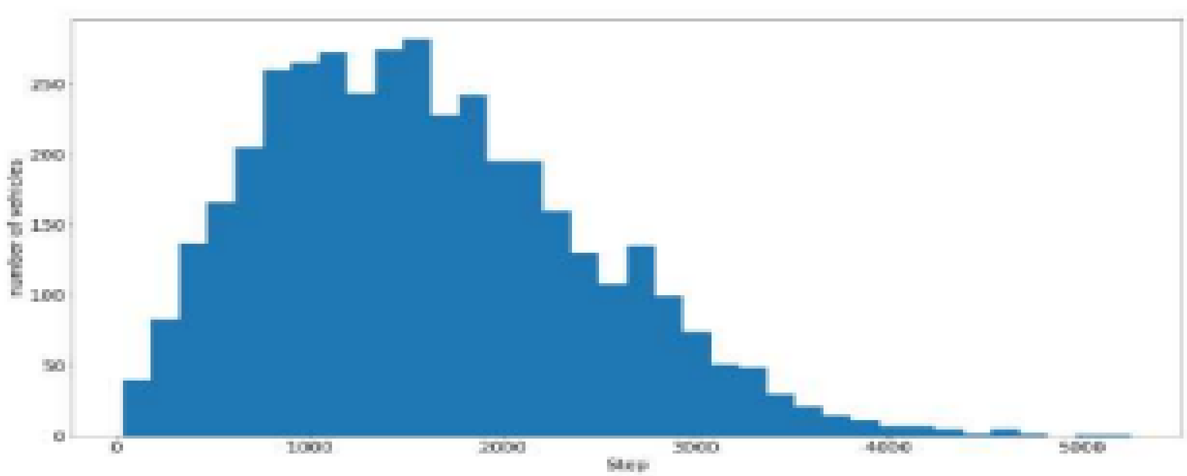
At the beginning of the training process, the Q-learning network explores the control policy by selecting random action with high probability. As training goes on, the Q-learning network gets positive or negative rewards depending upon the weather a corrective action has been taken to reduce the number of halting vehicles.

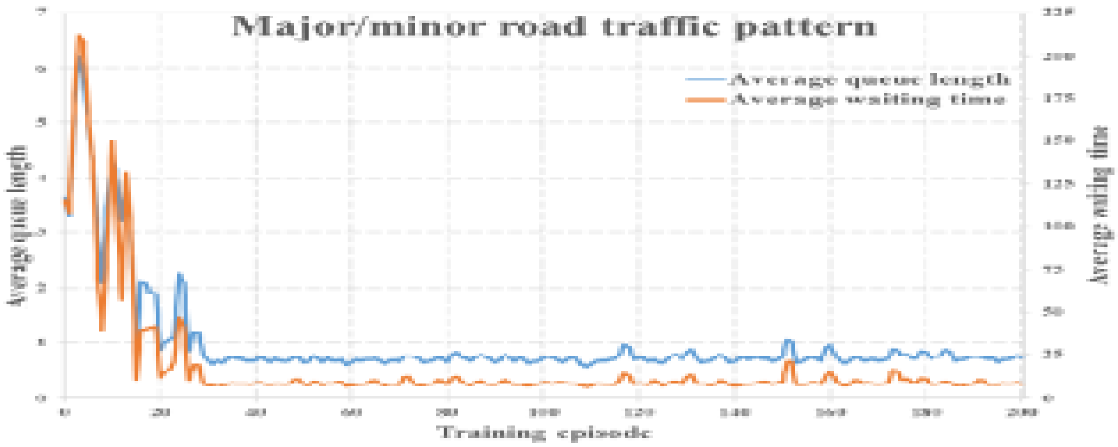
The Q-learning Network gradually exploits the control policy and reduces the average queue length and average wait time . Finally, the Q-learning Network succeeds the stabilized performance with respect to the average queue length and the average wait time. These graphs show the evaluations on how the control policy are learned by our reinforced learning approach generalizes across different traffic patterns.

The entry in the P1 row of the P3 column, it shows the average performance with the reinforced learning approach trained in the traffic pattern P1 and tested in traffic pattern P3. So overall, our reinforced learning approach generalizes well across the different traffic patterns with slight performance variations. The reinforced learning approach are trained in traffic patterns P1-P3 which feature steady traffic flows and also performs well in the traffic pattern P4 which has a time varying traffic flow.

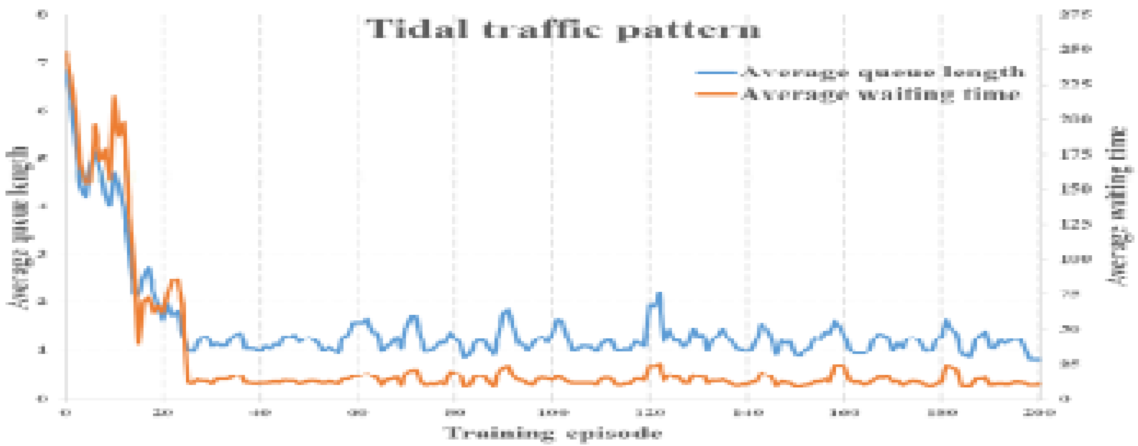
In patterns 1 – 4 from it shows the performance comparison of our reinforced learning approach with the benchmark of traffic signal control methods. The box plots in Figure 26 are obtained by repeating each method 100 times in each traffic pattern. The bold line in the middle of the box is the median, the lower line of the box is the lower quartile and the upper line is the upper quartile. Clearly, the reinforced learning approach is able to achieve a better performance in terms of average queue length and the average wait time in each traffic pattern in terms of the benchmarks.

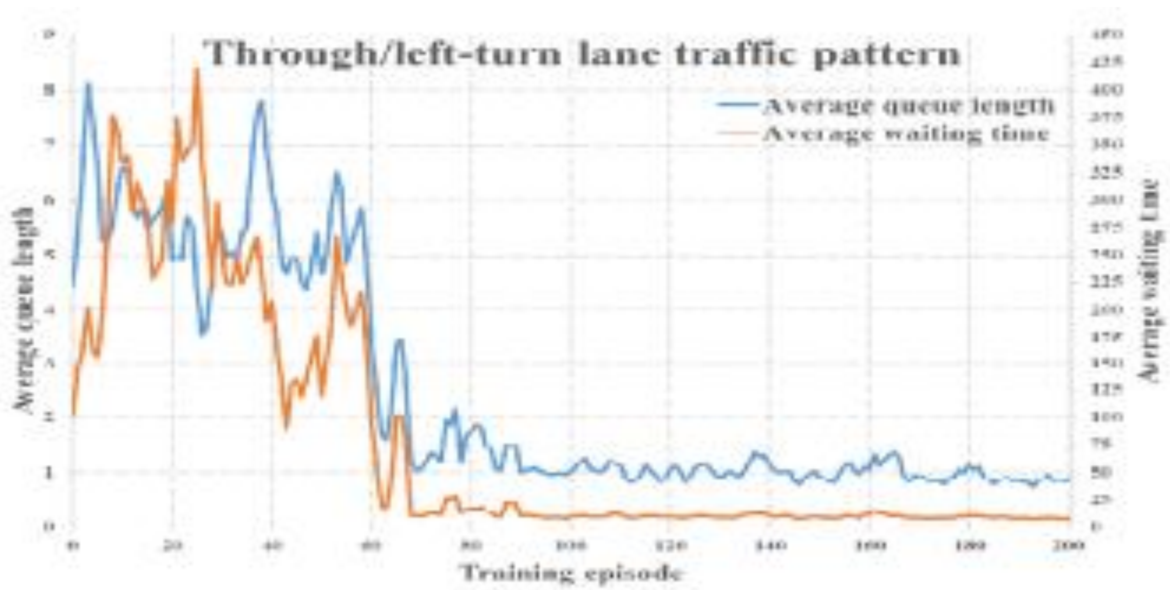
When it is compared with the second-best benchmark, the performance improvements of the rein forced learning approach are still significant in all traffic patterns The model performs simulation data to show that our algorithm learns good action policy that effectively reduces vehicle staying time, thus reducing vehicle delay and traffic congestion, and that our algorithm is stable in making control decisions, like not oscillating between good and bad action policies or even diverging to bad action policies . The average values for the sum of staying time of all vehicles at the intersection are shown.





Major/minor road traffic pattern
Average queue length
Average waiting time
Training episode


Tidal traffic pattern
Average queue length
Average waiting time
Average queue length
Average waiting time
Training episode


Through/left-turn lane traffic pattern
Average queue length
Average waiting time
Average queue length
Average waiting time
Training episode

LITERATURE SURVEY

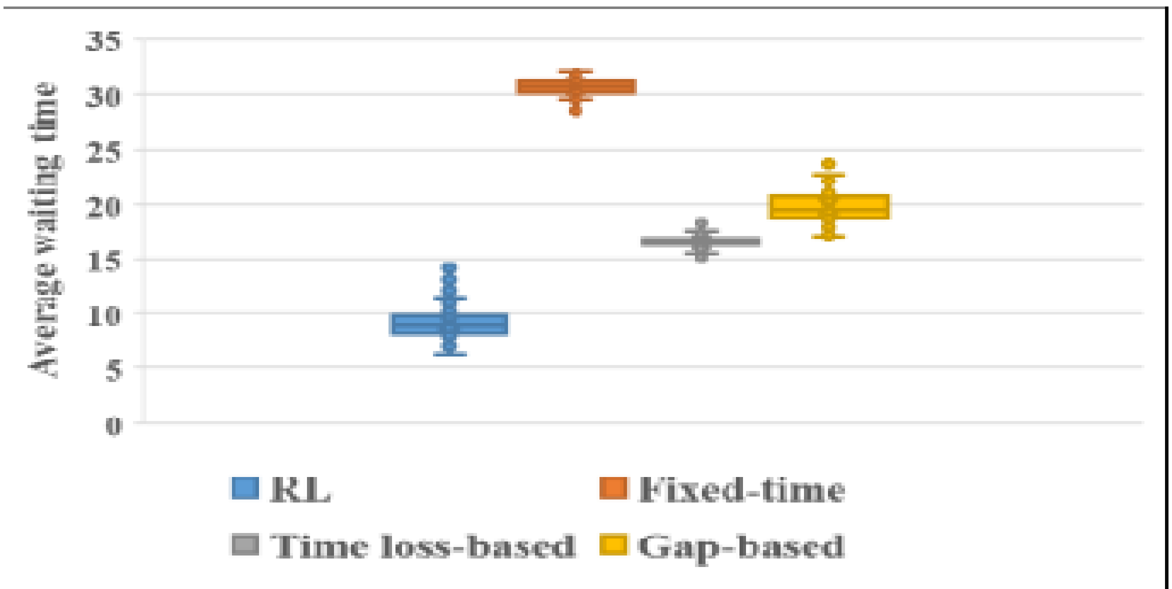
In the recent years due to technological advancements the automobile sector is also manufacturing a higher number of vehicles and every year almost 253 million vehicles are being manufactured and sold to customers. As the roads cannot expand, we need to look for efficient ways in order to manage the number vehicles on the road. A fully developed city has a limited ability to reconnect to its traffic, thus providing a real time solution to this problem may solve most of the problem. Delaying in the traffic system somewhere contributes to a small part of loss in GDP of a country.

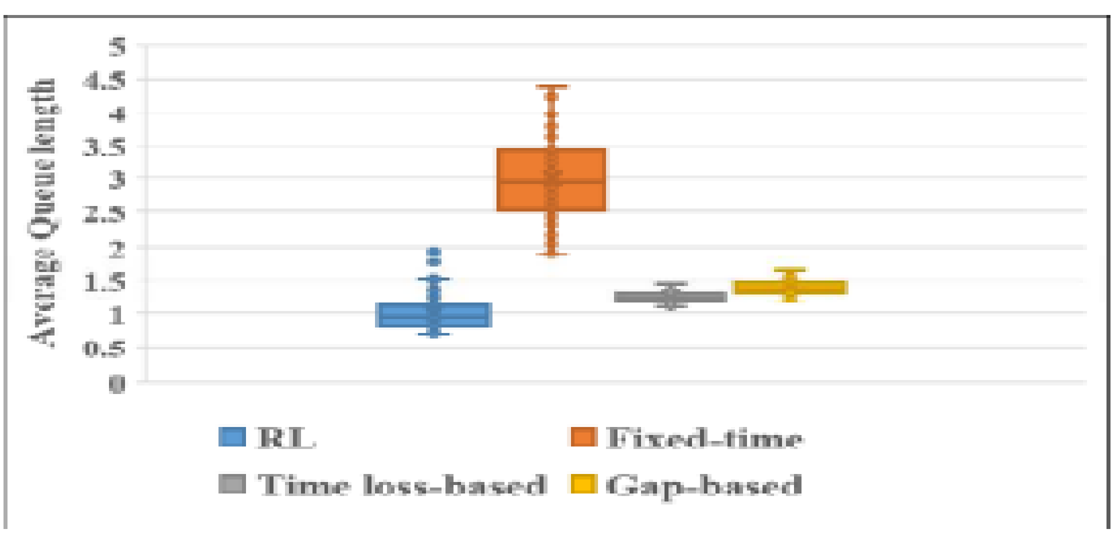
Not only traffic makes things go slower but also cause life savior or fatal for a one's life. Some take birth or some die in this bad condition of traffic. So from our past did we learn something or it's the same thing happening still in our country where we wait for hours or either shout on our surrounding and enjoy the noiseful voice of vehicles and its people. In a country like India where people tend to buy car early in order to show-off or boast rather learning on how to ride that vehicle in a correct way obeying all traffic rules. If we tend to drive properly then the rate of traffic in our country itself will reduce by 50%.

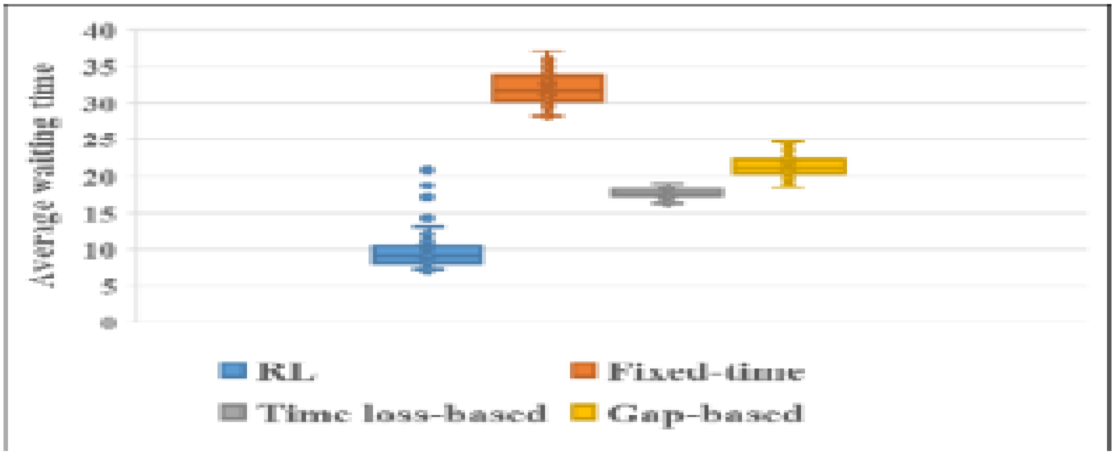
Our project is a density-based traffic control system using reinforced learning to solve this problem. We bring in a slight change to the traffic signal system by making it priority based when there is a huge amount of traffic and then switching it back to the normal sequence after there is less amount of traffic. The system counts the number of vehicles on each part of the road and after the analysis the system takes an appropriate decision as to which road is to be given the highest priority and the longest delay for the corresponding traffic light.

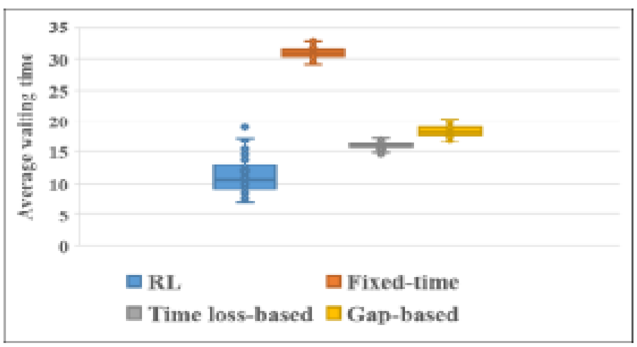
The time constraints have prevented us from being able to analyze our approach when multiple intersections are present. It would be interesting to see if the same state-action pairs would be learned or if the presence of multiple nodes would cause these to change. We generated simulations based on Q-learning and reinforced learning to test a four-intersection model however we have not had time to analyze this and learning Q values for multiple intersections would increase simulation time which itself already takes an hour to run. Permitted more time, then we could expand this simulation scope and possibly consider implementing other state values apart from the vehicle position and velocity matrices. Allowing an intersection to see the states of its neighbours. So this increases in state space that could prove benefit for improving traffic flow, but can also greatly increase learning time.

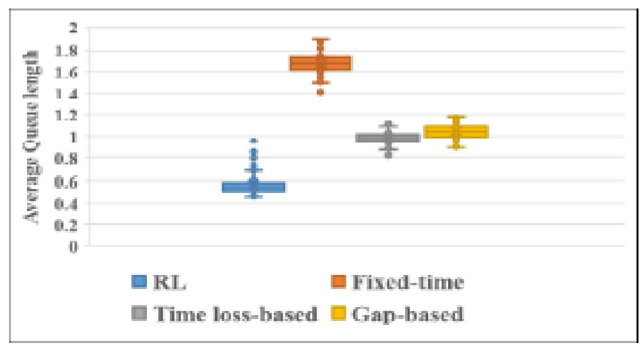
SOME GRAPHICAL REPRESENTATION OF ACCIDENTS AND LACK OF AWARENESS



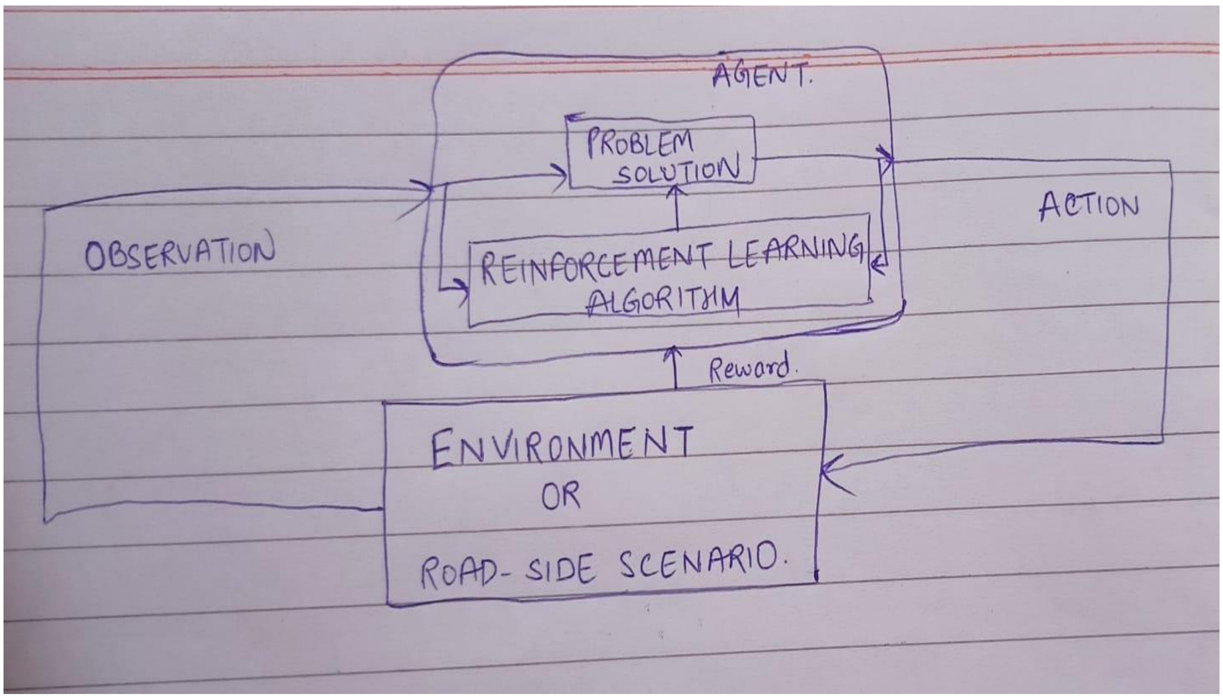


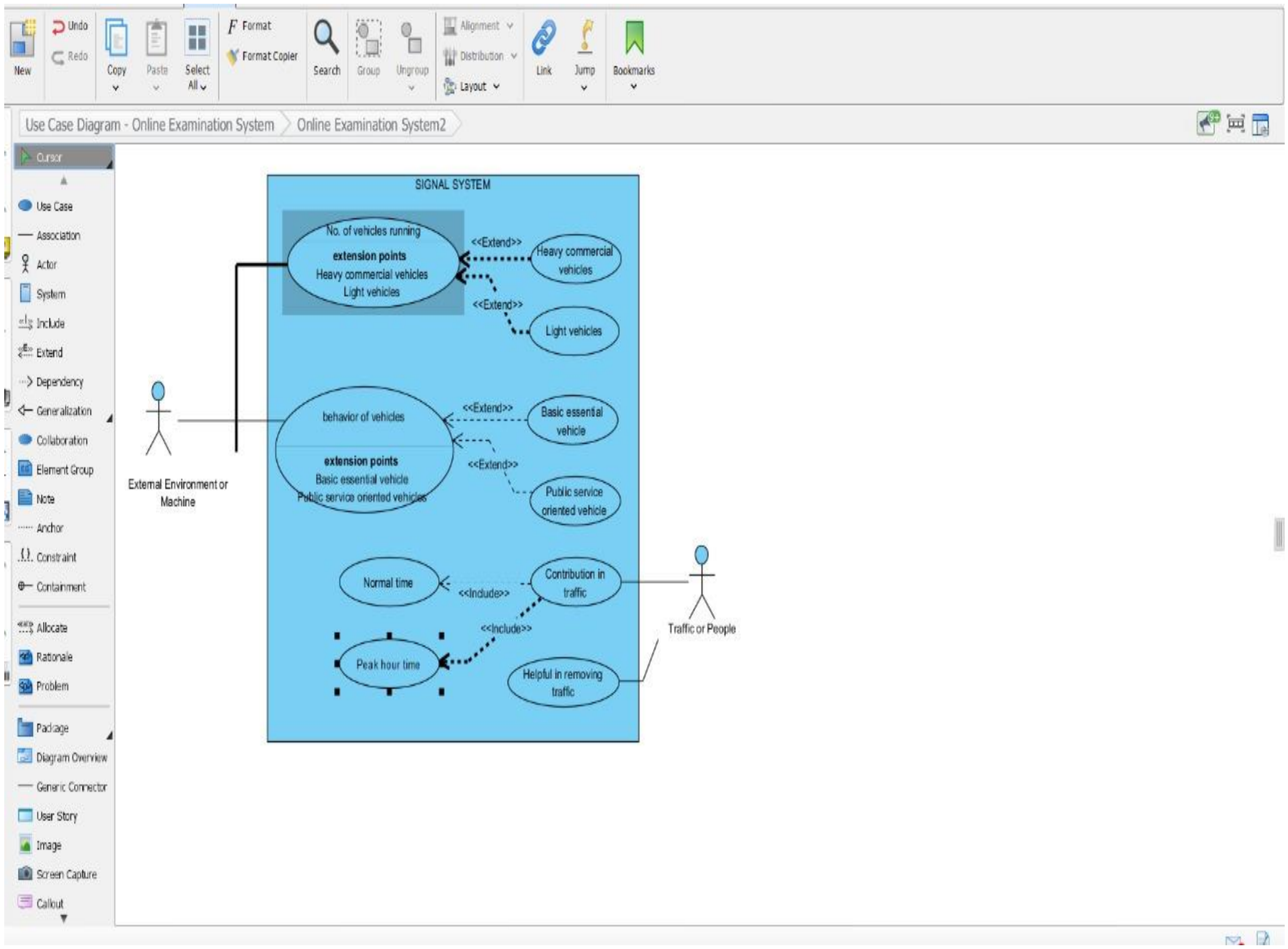

Average waiting time
40
35
30
25
20
15
10
5
0
RL
Fixed-time
Time loss-based
Gap-based

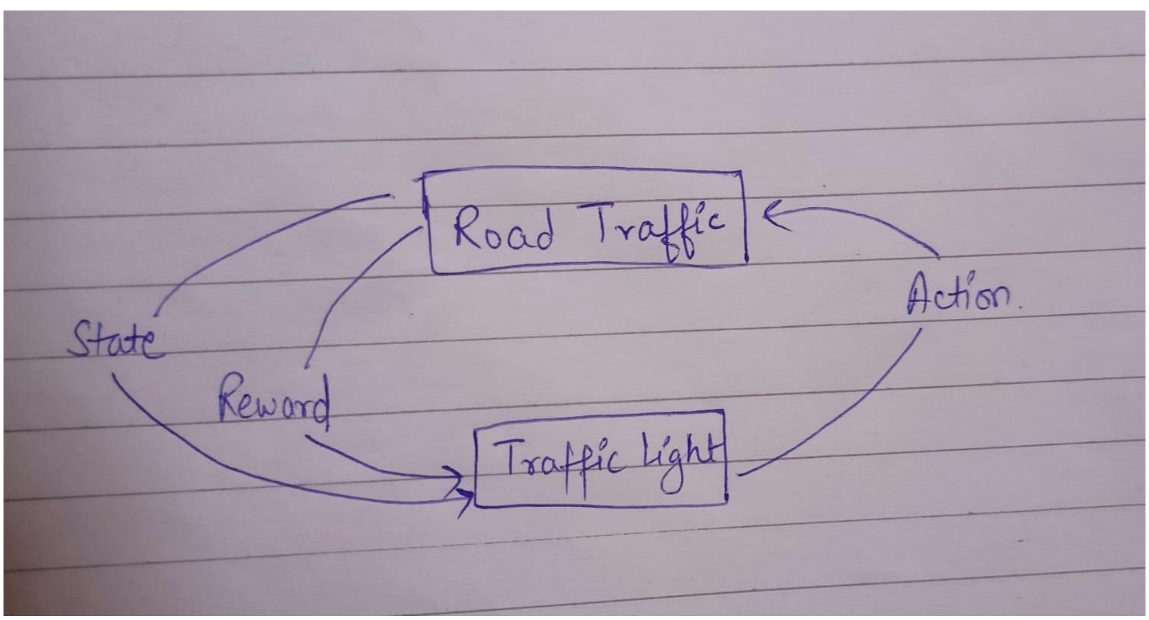

Average waiting time
35
30
25
20
15
10
5
0
RL
Fixed-time
Time loss-based
Gap-based


Average Queue length
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
RL
Fixed-time
Time loss-based
Gap-based

DIAGRAM


AGENT.
PROBLEM SOLUTION
OBSERVATION
REINFORCEMENT LEARNING ALGORITHM
ACTION
Reward.
ENVIRONMENT
OR
ROAD-SIDE SCENARIO.


Use Case Diagram - Online Examination System
Online Examination System2
SIGNAL SYSTEM
No. of vehicles running
extension points
Heavy commercial vehicles
Light vehicles
<<Extend>>
Heavy commercial vehicles
<<Extend>>
Light vehicles
behavior of vehicles
extension points
Basic essential vehicle
Public service oriented vehicles
<<Extend>>
Basic essential vehicle
<<Extend>>
Public service oriented vehicle
External Environment or Machine
Normal time
<<Include>>
Contribution in traffic
<<Include>>
Peak hour time
Helpful in removing traffic
Traffic or People


Road Traffic
Action.
State
Reward
Traffic Light

SOME BASIC APPROACH:

Time-series approach: This approach attempts to predict traffic light phases by determining patterns of the temporal variation of traffic flow.

Stochastic approach: The stochastic approach utilizes probabilistic model forecast traffic flow.

Non-parametric approaches: The algorithms of nonparametric approaches have no (or very little) prior knowledge about the form of the true function that is being modelled .

PROBLEM STATEMENT

- The vehicles on the other part of the road have to keep waiting for their turn.
- The congestion on the road even gets worst after some point of time.
- In some parts, due to the heavy congestion ambulance gets stuck and the patient has to wash his hands from his life.
- Also due to congestion, chance of getting poor environment as the combustions coming out of the vehicle harms the environment.

CONCLUSION:

This project uses neural networks and reinforced learning to create an intelligent traffic signal controller that takes into the consideration of the spatial-temporal characteristics of urban traffic flows. Q-learning network is proposed to extract the information from the state space in order to derive the optimal signal control policy and to perform with large state space which consists of real-time vehicle position and speed.

There is scope for an improvement of the Q-learning network by changing the performance in convergence and stability. Advanced techniques such as dulling network and double Q-learning network can be employed. By extending the reinforced learning approach to more complex urban intersection settings such as an arterial or a multi-intersection network presents interesting challenges for exploration of the proposed methodology.

SCOPE AND OUTPUT

The current work focuses on how to bring an effective solution to this problem:

- Reduce the traffic congestion.

The experimental results show that the Q-Learning algorithm is able to learn from the dynamic traffic flow and optimized the traffic flow.

REFERENCES

1. Araghi, S., Khosravi, A., Johnstone, M., & Creighton, D. (2013, October). Q-learning method for controlling traffic signal phase time in a single intersection. In 16th International IEEE Conference on Intelligent Transportation Systems (ITSC 2013) (pp. 12611265) (cit. on pp. 36).
2. Balaji, P. G., German, X., & Srinivasan, D. (2010). Urban traffic signal control using reinforcement learning agents. IET Intelligent Transport Systems, 4(3), 177188 (cit. on pp. 31).
3. Abdulhai, B., Pringle, R., & Karakoulas, G. J. (2003). Reinforcement learning for true adaptive traffic signal control. Journal of Transportation Engineering, 129(3), 278285 (cit. on pp. 24).
4. Barimani, N., Kian, A.R., Moshiri, B.: Real time adaptive non-linear estimator/predictor design for traffic systems with inadequate detectors. Intell. Transp. Syst. IET 8(3), 308–321 (2014).

THANK YOU…..

☺