Empirical Modelling: A Model of Crossroad Traffic Simulation to Aid Traffic Signal Control

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Abstract

Urban traffic jam has always been a bothersome issue in which traffic signal control plays a critical role. Testing a traffic signal scheduling in a real-world environment is very expensive and also impractical, as well as applying a untested deductive scheduling may cause unnecessary real-world traffic jam. A mathematical approach may accurately calculate a effective scheduling solution, whereas it is complex and abstract. This paper introduces an approach which aims to use potential of Empirical Modelling to simulate a model for network traffic signal and variational traffic condition. The model will help people to experiment different traffic signal scheduling on many traffic conditions in urban traffic settings to seek out an optimal solution for each kind of state. Users observe experiment result in the model directly and intuitively whether these different scheduling reduces average traffic delay and congestion or increase them. Perhaps it will also help people intuitively understand how a non-effective traffic signal scheduling or increased traffic flow produces congestion and traffic delay while observing the process, and how to relief this situation by traffic signal control. It can be also used to simulate traffic base on real-world traffic data, therefore testing and observing efficiency of a particular traffic signal scheduling for real-world issue are provided here. Additionally, many research groups have been working on finding out the optimal traffic signal control solution, such as a multi-agent system for network traffic signal control in which each agent intelligently and dynamically control signal for each intersection through observing ambient conditions and exchanging information with other agent. This model is perfectly capable of constructing a fundamental environment to aid researchers to experiment and observe validity of their research findings before applying them in the real world.

1 Introduction

This paper is focused on studying Empirical Modelling and its Application in the field of traffic related modelling. The EM model introduced in the paper is created to simulate a crossroad traffic map in which users can manipulate traffic signal and set vehicle volume to control the traffic flows in the control panel. The model is created by using EM tools (Donald, Scout and Eden). Scout is used to build the main window layout and construct objects in the map such as roads, traffic flow display windows, intersection areas or parameters setting text-boxes and buttons such as start and end buttons in the control panel. Eden is used to achieve the functionalities of above objects in the model. Donald plays a minor role which draws only background of the GUI.

Each of the main EM concepts (observables, dependency and agency) is presented by using the model. Observables in the model can be identified when surveying vehicle volume on each road or controlling the traffic lights status. In the case of vehicle volume, the volume is dynamically increased or decreased through time. Dependencies in the model is playing a major role of demonstrating that how the model simulates a real-world traffic situation. In this case, a high volume of vehicle on each road and the traffic congestion area are dependent on a high vehicle generating rate (arriving rate) on each road and variations of traffic signal scheduling of the crossroad. A effective signal control plan may instantly change such situation. Reversely, a bad plan may instantly deteriorate the situation. Agents such as users of the model can interact with the model, they can manipulate traffic signal and set vehicle volume to make above dependency changes to observables in the model.

2 The Model of Traffic

Figure 1

In Empirical Modelling, construals are built rather than programs, the model introduced in this paper consists of 3 main construals of urban setting(maps), vehicles and traffic signal lights on the map. A basic looking of map is shown above in Figure 1.

Interacting with these contruals in the model allows users to control traffic signal lights or set a scheduling, set route of vehicles and their amount on a road. During the experiment, users manipulate traffic conditions to directly experience and observe dependency between them, therefore it can be used to collect simulated real-world data and adjusting signal scheduling to seek out an efficient signal control solution for real-world traffic issues in a virtual environment. In this model, urban setting which is a a typical urban traffic example – a crossroad (). It is set in advance and not changeable.

The colour of each road section represents the current traffic signal status: green represents that a green traffic light is given so that all vehicles in this section are movable; red represents a red traffic light is given so that the all vehicles in this section are static. Road 1 and Road 2 may have the same traffic signal status at the same time. Similarly, Road 3 and Road 4 may have the same traffic signal status at the same time as well. However, Road 1 and Road 3 or Road 2 and Road 4 can not be given the same signal. The

There are roads on the map of the model, each of them is divided into 2 sections for the convenience of manipulating them. All vehicles on section A of each road are proposed to traverse the intersection area of the crossroad so that the trafficability of this section depends on a given traffic signal. All vehicles on section B of each road are proposed to depart freely from the crossroad without constraint of traffic signal of the crossroad so that this section is always green.

The 3 grey boxes on the section B of each road shows that the current traffic volume of the section. The middle box displays that the current volume of forward moving vehicle. The box near left-side of the road displays that the current volume of left moving vehicle. The box near right-side of the road displays that current volume of left moving vehicle. The grey box on the section A of each road shows that how many vehicles have arrived on the section and ready to leave the map after the traffic simulation starts.

Each intersection area turns to green to allow vehicles traverse it if a section of the road connecting with this intersection area is given by a green traffic signal. For example, intersection area 1 and 4 in the figure 1 will turn green if Road 1, Section B is green, and also intersection area 3 may turn green as well if Road 2, Section B is red according to the basic traffic regulation so that right moving vehicle may turn right and travel to the Road 3, Section A.

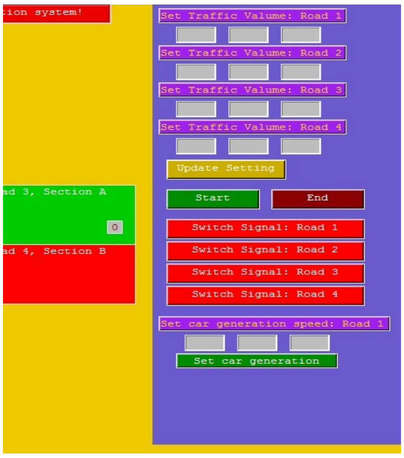

Figure 2

Users are allowed to manipulate parameters in the control panel shown in the figure 2. These buttons and text-boxes performance the functions described by their title or names. For example, user is allowed to change vehicle volumes on each road via input integers in those 9 grey text-boxes on the top of the control panel. The left grey text-box on each row of boxes refers to left moving vehicles. The middle grey text-box on each row of boxes refers to forward moving vehicles and the rest can be done in the same manner. Vehicle generating speed update function allows user to change the generating speed rate of vehicles which newly arrive on the road and queue to traverse the intersection of the crossroad.

User Note:
The model only implements road 1 traffic flow simulation as an example.

Before pressing "start" button to start the traffic flow simulation on road 1, please make sure that switching the traffic signal for road 1, section B to green so that vehicles on this section B are allowed to move and traverse the crossroad.

Do not leave any grey text-box blank or input any string at nay time (only input an integer which is smaller than 99 and bigger than 0) when pressing the update button for both vehicle volume setting or generating speed rate setting.

3 Future Potential

The functions of this model has not been fully implemented. Traffic flow simulation is only implemented on road 1 so that user only can see update vehicle generating speed button for road 1. Future modelling is needed to complete the model.

Future implementation may includes improving the GUI and providing extra function that allows users to set up traffic signal plans in advance and modifying the plans during the traffic simulation rather than switching traffic signal by users manually.

A completed model is capable of playing a fundamental role of constructing an environment for testing the validity of traffic signal plans before applying them in the real world.

4 Conclusion

In conclusion, the model is aimed to simulate an real-world traffic map which helps people to observe traffic jam producing, experiment traffic signal scheduling in different traffic conditions and obtain an efficient signal control policy in such conditions.

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