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Dynamic Network Loading Using Cell Transition Model

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Abstract

Static traffic assignment models cannot capture traffic dynamics. Time varying flows, queuing, are not accounted in static models hence traffic dynamics. Hence to replicate the real time scenario Dynamic traffic assignment models are required. Loading the network dynamically gives realistic picture of traffic dynamics which helps for an effective management of traffic congestion hence real picture of incidents all through the network. In this project Cell transmission model (CTM) which is macroscopic and dynamic in nature is used for loading the network dynamically over space and time to capture the traffic dynamics which cannot be captured by using static models to load the network. To investigate how results are affected when a natural incident occurs like sudden increase in demand, vehicle break downs on the link is modelled. Considering each link into number of cells depending upon the free flow speed of typical vehicle in a tick of clock accommodating slower vehicle in the model; the network is loaded dynamically on a three junction road study network consisting ten links to model how the traffic responds to an incident happening in next cell. Simulation for each of the ten links is done and modelled outflow is done and compared with observed outflow. Modelling is done and the network is tested for various incidents depicting the real time scenario, like when traffic enters a cell beyond the capacity flow rate how bottle necks are formed, hence performance of link can be tested. Progression of cell occupancies for different step lengths is modelled and state of a cell is also replicated which is useful to know the real time scenario at a specified cell of a road link at a particular instance of time. The links are modelled and analysed for increased inflow demand, vehicle break downs, capacity drops hence fluctuations in traffic which may be used as real time information for a commuter to make a route choice with help of a user interface. Also for traffic engineer helps in effective planning and management of traffic congestion. Finally we conclude and outline that modelling traffic dynamically effectively tests even the performance of the road network replicating realism which would not be possible with static dynamics, moreover cell transmission model is easier to implement for its simple calculations of linear relationships. Testing and analyzing road network is effectively done.

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1. Introduction

Transport planning is a difficult problem, since many elements of the system interact in complex, unpredictable ways. Hence computational models are used to inform the decision making process. The traditional model; the four step process both from a theoretical and from a practical perspective is insufficient because the four step process does not allow for any kind of (within-day and day-to-day) dynamical development in the system, nor for any kind of disaggregated, "behaviour-oriented" decision making. The second reason depends on the first: Without a coherent representation of time-of day it is difficult to represent issues such as schedule delay, unreliability, being consistently late in an activity chain because of a traffic delay in the morning, spontaneous adjustments, etc. This real time scenario can be captured using dynamic traffic assignment models which assign traffic dynamically over the day. Jeihani (2007) addressed the time dependent traffic assignment which is the real time problem along with various models and approaches. Traffic assignment could be classified into two major categories: static and dynamic. Static traffic assignment models assume that link flows and link travel times remain constant over the planning horizon, while in dynamic traffic assignment (DTA) models, the link flows and link travel times are allowed to be time dependent. Dynamic traffic assignment considers time varying flows while addressing the traffic assignment problem. Hence modelling of traffic flow phenomena such as queuing, spillovers, and shockwaves can be done including temporal choice dimensions - departure time, schedule delay.

1.1 Application areas of DTA

DTA captures complex traffic dynamics and replicates traffic phenomena using the interactions between the demand and supply models. DTA models are applied in the areas of operational planning, real-time operational control of vehicular traffic systems and decision-making considerations. Planning for operations is aimed at making planning decisions for major operations, construction, or demand management actions that are likely to induce a temporal or spatial pattern shift of traffic among different roadway facilities at a corridor- network wide level. Wardrop (1952) posted that the following principles should apply to user-optimal solutions: Every user takes the shortest path available, no user takes a path which is not the shortest path, the system is in equilibrium when no user can change his or her path and thereby lower transportation costs. In DTA, the period being modelled is broken into time slices, starting from the first time slice, a user equilibrium problem are solved. Users are then put along their paths. At the end of the time slice the location of users is determined. Some may have reached their destination and exited the system. Some may still be in route. To start the next time slice, all new users (those entering the network at the start of the current time slice) and existing travellers (those who started in previous time slices and have not yet reached their destinations) are inputs to a new user equilibrium problem, shown that the static user equilibrium problem is a special case of the dynamic user equilibrium problem. Although dynamic traffic assignment models - planning level models involving large networks- typically recognize that traffic travels to many destinations, the models are based on simplistic flow relationships that are not perfectly consistent with the conservation laws of traffic but simulate good traffic flow dynamics under simulation modelling. Nezamuddin (2011) discussed computational issues of simulation based DTA models. DTA models for large-scale regional networks require excessive computational resources. A suite of computational methods based on the combinatorial approach for dynamic traffic assignment is developed. The combinatorial DTA (CDTA) model complements and aids simulation-based DTA models rather than replace them. Solution obtained from the CDTA model was provided as an initial feasible solution to a simulation-based DTA model to improve its efficiency - this process is called "warm starting" the simulation-based DTA model. To further improve the efficiency of the simulation-based DTA model, the warm start process is made more efficient through parallel computing. Models warm-started using the CDTA solution performed better than the purely simulation-based DTA models in terms of equilibrium convergence metrics and run