Social Network Driven Traffic Decongestion Using Near Time Forecasting

(Extended Abstract)

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ABSTRACT

Preventing traffic congestion by forecasting near time traffic flows is an important problem as it leads to effective use of transport resources. Social network provides information about activities of humans and social events. Thus, with the help of social network, we can extract which humans will attend a particular event (in near time) and can estimate flow of traffic based on it. This opens research area to build a framework for traffic management that can capture essential parameters of real-life behavior and provide a way to iterate upon and evaluate new ideas. In this paper, we present building blocks of such framework and a system to simulate a city with its transport system, humans and their social network. We emphasize on relevant parameters selected and modular design of the framework. To show the utility of the framework, we present experimental studies of few strategies on a public transport system.

Categories and Subject Descriptors

I.2.11 [**Distributed Artificial Intelligence**]: Multiagent systems

General Terms

Experimentation

Keywords

multi-modal traffic management, decongestion, social networks, simulation, framework

1. INTRODUCTION

Traffic congestion is a major problem faced in many parts of world and wastes precious resources - time and fuel. Traffic prediction helps in finding near time traffic flow which can be used to prevent congestion. Social networking sites are a source of human travel information which can be useful for predicting near time traffic flow. Further, these websites are a media of rapid information dissemination. Humans notice events (concert, spot-sale) and quickly spread this information to thousands of others across social network in near time.

In our work, we present a framework that simulates essential components of the problem:

1. a city with its points of interests (homes, offices, train-stations, schools, theaters, hospitals, parks, etc.);
2. a human population with their daily activities;
3. a social network of humans;
4. a transport management system that monitors traffic and plans to control congestion;
5. social events which cause anomalies in traffic pattern.

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Our framework design is generic and components are flexibly pluggable to be useful and extendible by other researchers. We have used agent-based approach to develop our framework. Agent-based architecture facilitates individual behaviors to different actors in the simulation and manages interactions among them. We use Singapore city for the framework parameters and present results of simulation.

In this paper, our focus is that our idea is viable and we can use this for better traffic management. As number of solutions and accuracy of solutions increase, they can be incorporated as pluggable modules in our framework.

2. RELATED WORK

Existing research includes studying traffic simulations and predictions. [6] and [1] investigates the traffic behavior from social networking sites. STAR-CITY (Semantic Traffic Analytics and Reasoning for City) [4] is an innovative system for diagnosis/prediction of traffic conditions and efficient urban planning by semantically analyzing historical data and social media feeds. Our work provides a framework for implementing different approaches for analyzing data of social media and extracting events; in addition it also provides a way of experimenting with strategies that can control congestion and improve traffic management.

3. COMPONENTS OF FRAMEWORK

3.1 Humans and their social network

Humans are modeled as proactive agents. We divide humans into four different categories with distribution: working-professional (40%), student (30%), home-maker (15%) and senior-citizen (15%). Each human category has predefined trips to move in city. Each human in our simulation is a part of social network. Social network consists of humans and relationships between them. Each human influences other humans in its connections to attend an event with a likelihood known as influence probability. While computing influence probability, we consider factors like similarity in age, category and proximity in locations of humans. Information is disseminated in social network using independent cascade model presented in [2][3] .

3.2 Event Broadcaster

Social events like spot sale or a celebrity function can occur and are identified at short notice before their actual occurrence through websites, newspapers, social networks, etc. We encapsulate these

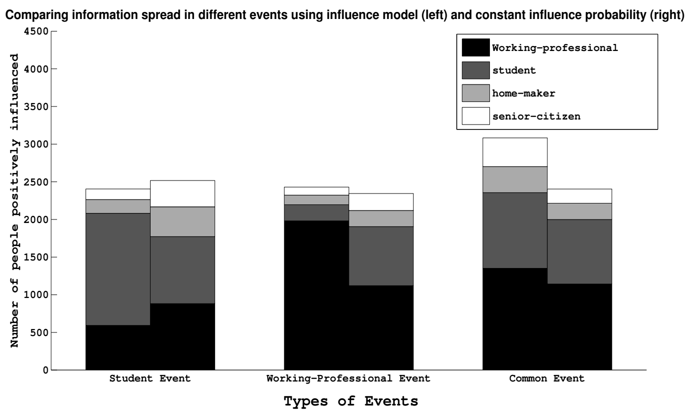

Figure 1: Comparing humans influenced positively for events

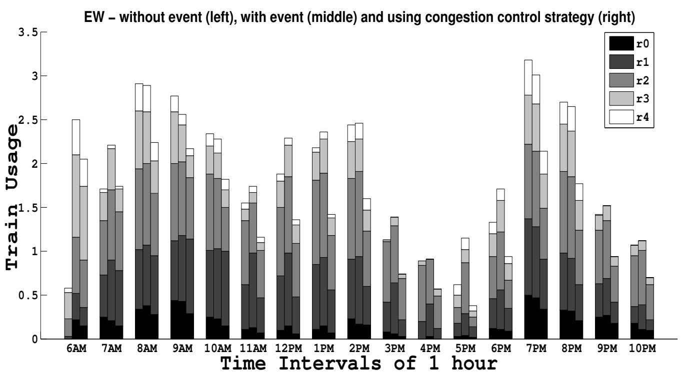

Figure 2: Comparison of Train Usage across EW train line

media into a single module called *event broadcaster*. EventBroadcaster decides where and how often to create events and when to start broadcasting information about an event. Humans poll EventBroadcaster with certain probability at regular intervals to get details about upcoming events.

3.3 Transport System

We use Singapore's metro train network as example to describe framework and its usability. In this section, we describe components that make up transport system: (i) Station Master; (ii) Transport Manager; (iii) Train Inquiry System.

Station Master, implemented as agent for each station, tracks ridership at station and decides at which platform next train should arrive.

Transport Manager decides schedule and capacity of trains to meet changes in ridership of trains. Its main motive is to reduce the amount of time humans wait for trains at stations. It communicates with station master to get ridership at stations, event broadcaster to get information about social events happening in city and social network to find the likelihood of humans attending upcoming events. Based on this information, it starts new trains or changes schedule of existing trains to meet the demand for train ridership.

Train Inquiry System continuously polls transport manager for getting most updated schedule of trains. Humans query this system for train information and plan their trips accordingly.

4. RESULTS

We simulate city of Singapore with a population of 100,000 humans; four major metro lines of Singapore rail network - North South Line (NS), North East Line (NE), East West Line (EW) and Circular Line (CC) with a total of 87 train stations ([5]). Trains have capacity for 310 and follow a schedule.

Table 1: Alternative Routing Approach

	Without alternate routing	**With alternate routing**
Avg waiting time	34.3 mins	31.7 mins
Avg total travel time	82.8 mins	79.5 mins

We validated influence-probability model (section 3.1) by simulating three different types of events: a science exhibition, a professional conference and a wedding event. We studied the distribution of human in terms of both age and category that were influenced positively towards these events. Results showed that ratio of students that attended science exhibition was much higher than other categories of humans (Figure 1).

We simulated an event near EW21 and CC22 between 8:30-10:30 am. To get fine-grained look at usage and wait-time metrics, we divide each train-line into 5 sections - *r0, r1, r2, r3, r4*. We see an increased train usage and average wait times for humans on EW and CC lines during event hours (8:30-10:30 am) (EW line in figure 2).

We implemented a greedy congestion control strategy which alters the train capacity or schedule of trains. Figure 2 shows variation in train usage in time intervals of 1 hour for three experiments: without event, with event and event with control strategy. Each column of graph represents an experiment. Train usage (for a time interval T) is defined as $U_T = (\sum_i t_{iT})/(C * T)$ where t_{iT} is total time for which seat i was occupied (need not be for contiguous duration) in time interval T and C is capacity of the train. Effective train usage decreased slightly with control strategy. We implemented another strategy in which human alters its trip based on state of ridership in trains, i.e. humans may choose a longer path instead of shortest distance path for its trip during congestion hours. This alternative path ensures less travel time for humans. We found that 10% of humans choose to take alternates. Average waiting and travel time are reduced slightly as shown in table 1.

5. CONCLUSION

Traffic congestion wastes resources and needs to be controlled effectively. Social networks can provide ample information about upcoming events and locational distribution of human planning to attend such events. We presented basic building blocks of a framework that captures above idea and provides researchers a platform to further experiment in this area easily. Future work includes incorporating buses and cars as well; and documenting and open-sourcing framework for public use.

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