

Adjacent Total Average Algorithm for Travel Time Prediction

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Abstract: Travel time prediction plays an important role with the development of ATIS (Advanced Travelers Information Systems). It provides useful information which may allow travelers to change their routes and to decide whether or not to make necessary changes to their routes or departure times. Here we proposed a new method ATA (Adjacent total average). The challenge of this paper is to provide accurate travel time to compare with others method. With the use of same set of historical travel time and comparing the previous results of other four methods like Successive Moving Average (SMA), Naïve Bayesian Classification (NBC) method, Switching method and K-means Clustering (MKC) Our algorithms exhibit high accuracy in predicting travel time.

Keywords: Intelligent transportation system, travel time prediction, Successive moving average, NBC method, Switching method.

I. Introduction

As travel time prediction is very Important to numerous intelligent transportation system (ITS) applications such as dynamic route guidance and trip planning, it plays a vital role in ITS with the development of advanced travelers information systems. Recently, accurate estimation of travel times has been central for traffic data analysis. So travel time prediction has become increasingly important as it can help travelers to better adjust their travel schedules. In these applications, travelers want the accurate prediction of travel time from an origin to a destination. Travel time prediction based on vehicle speed and traffic flow is extremely sensitive to external events, like weather condition and traffic incident. It is also supported traffic flow on a designed road depends on daily, weekly and occasional event. Like, daily features distinguish morning and evening rush hour traffic. The time-varying feature to traffic flow is the key concept to estimate accurate travel time. Moreover, accurate and reliable prediction of travel time on road networks is also vital for many dynamic route guidance systems. Prediction helps travellers to decide whether or not they need to change the starting time of their routes or even cancel their trip. Furthermore, accurate travel time prediction enables the generation of the shortest path between the origin and the destination.

A variety of techniques can be used in data mining. The objective of data mining is to query for hidden, previously undefined, and potentially helpful information from data. Most of the data mining techniques help travelers to discover familiar routes and identify unusually busy travel time.

For example, classification techniques [12] can be applied to trained historical data and can be used to classify query data. In the same way, clustering techniques [13] can be used to cluster similar data into the same class so that further classification of a query data can be easily done based on a class of similar data.

Several researches have been done on travel time prediction over the last few years. For example, an NBC [13] classification algorithm was developed in KES 2008 for travel time prediction. Based on the concept of moving average another two methods named SMA and CA [12] were developed in KES 2009 and showed better result.

In this study, we focus a new method that is able to predict travel time reliably and accurate. Experimental results show that our algorithms are considerably effective for predicting travel time than other. The remainder of this paper is organized as follows. The next section provides readers with background and related work on ITS. In Section 3, we propose our algorithms. Experimental results are shown in Section 4. Finally, Section 5 gives conclusions.

II. Literature Review and Motivation

Predictions of travel times on road networks are essential and accurate predictions are important for effective dynamic route guidance system. There are a large number of researches that can deal with accurate prediction of travel time on road networks. On the topic of travel time prediction there is a wide-ranging literature review is presented.

Studies on travel time prediction methods categorized this in two parts as path-based estimation [1,5,7-10,12], where the path travel time indicates time between any two point in the road network and link-based estimation. The methods employed include artificial neural networks [7] [4] as the non-linear predictors.

Largely used linear models include tree method and multivariate linear regression[2,5], time varying coefficient linear regression [12], ARIMA models [10], linear models of system variables [8] and time-varying coefficient linear regression as a component predictor [3]. Another model used a Kohonen Self Organizing Feature Map (SOFM) while the other utilized a fuzzy c-means clustering technique. A linear predictor consisting of a linear combination of the current times and the historical means of the travel times is proposed by Rice et al [8]. An algorithm proposed by Zhang and Rice to predict freeway travel time using a linear model where its coefficients are varying smoothly as the functions of the departure time [12]. Their predictor is applied to two real-life loop detector data sets; one from a 6-mile section of highway I-880 in Hayward, California and the other from Orange County in southern California, about 15 miles south to Los Angeles City. Recently Erick et al [9] investigated a switching model which was consisted of two linear predictors in this research model. Beside this, they have shown that there is a point in future time where the linear predictor is no longer better than the historical mean. That means this point is varied according to day and time for a given roadway. In recent years, travel time prediction received an increasing attention which motivates the development of various travel time predictors. There is a problem in switching method [9], when we measure switching point computational complexity arises. That means there is a limitation in existing system usually provides prediction for only a small number of pre-determined popular routes. Heavy congestion and an ATIS system receive lots of queries for various routes in most major urban areas. So it is less satisfactory, if someone aims to build efficient and flexible ATIS that predict travel time query for arbitrary routes.

In this research, we focus a new method that is able to predict travel time reliably and accurately. Generally this effort is the extension of our previous works. In this study we have tried to cover the benefits of previous methods name NBC [12], SMA and CA [13] by removing the limitations of those methods. Proposed method is able to address the arbitrary route on road networks that is given by user. In order to the experimental result, our method exhibits satisfactory performance in terms of prediction accuracy.

III. Proposed Travel Time Prediction Method

Proposed Method:

In our proposed methods by analyzing the historical data we can predict travel time. As for example, a vehicle enters on a particular road segment at 10:00 AM and wants to predict travel time. we need to accumulate all historical travel time data for that road segment during 10:00 AM. Let $t = t_1, t_2, \dots, t_n$ be the historical travel time data for any road segment where n is the total number of historical data within a given time interval. For travel time prediction problem, we pick as our sub-problems the problem of determining the time prediction of

t_i, t_{i+1}, \dots, t_j . Let $\mathcal{T}[i, j]$ be the predicted time made by computing the time t_i, t_{i+1}, \dots, t_j ; for the full problem, the predicted time to compute t_1, t_2, \dots, t_n would thus be found $\mathcal{T}[1, n]$. The following methods can be used to compute $\mathcal{T}[1, n]$.

Method Using Adjacent total Average:

In this section, we present our new method for predicting travel time namely Adjacent total Average which can be mathematically described by following formula:

$$\mathcal{T}[i,j] = \begin{cases} t_i & \text{if } i = j \\ \frac{\sum_{k=1}^{i-1} (\mathcal{T}[i-k][j-(k+1)] + \mathcal{T}[i-k][j-k]) + \mathcal{T}[i][j-1] + \mathcal{T}[i+1][j]}{i*2} & \text{if } i < j \end{cases}$$

If $i = j$, then $\mathcal{T}[i, j]$ is equal to t_i for $i = 1, 2, \dots, n$. In other case, if $i < j$ then we split the time sequence t_i, t_{i+1}, \dots, t_j . We can compute $\mathcal{T}[i, j]$ by taking the summation of sub-predicted times $\mathcal{T}[i-k][j-(k+1)]$, $\mathcal{T}[i-k][j-k]$ with addition to $\mathcal{T}[i][j-1]$ and $\mathcal{T}[i+1][j]$ and divide that summation by $i*2$. Finally, we find the value of $\mathcal{T}[1, n]$ indicates predicted travel time.

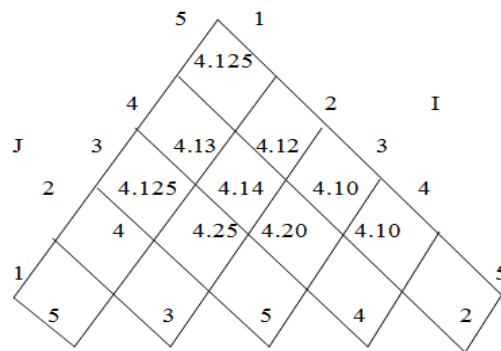


Fig:1

IV. Simulations Results

To measure the performance of different predictors we used Pusan National University (PNU) generator [12]. This generator is based on real traffic situation in Pusan city, South Korea. To collect real traffic delay the PNU generator use Global Positioning System (GPS) sensor. Traffic pattern of Pusan city was extracted from this data. According to this traffic pattern, PNU generator simulates and generates trajectory data which is almost same as real data. 167,669 trajectories are generated by using this generator. Every trajectory are consists of several road segments . This data organization format sufficiently reflects real traffic situations. The data is divided into two categories, namely training data and test data sets to evaluate the better performance of the algorithms. 30 days traffic data are used as testing data set and 365 days traffic data are used as training data set. Testing data sets are chronologically after 365 days data used for training. Data from 365 training days are used for fitting the model. However, 30 days test data are used to measure prediction performance for all methods.

V. Comparison and Prediction Accuracy

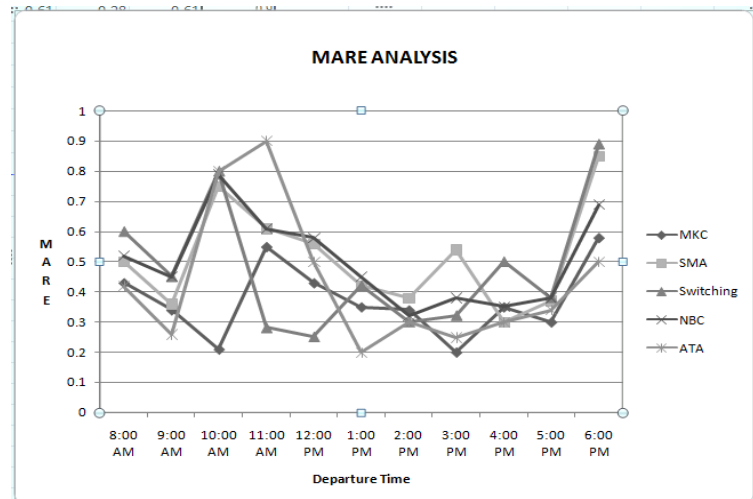
MARE are used to compare the accuracy among all methods. To measure overall error in travel time prediction MARE is the simplest and well-known method. MARE computes the magnitude of the relative error over the desired time range. The MARE is measured by the following form

$$MARE = \frac{1}{N} \sum_{t=1}^N \frac{|x(t) - x^*(t)|}{x(t)}$$

Where X(t)=Observation value
 X*(t)=predicted value
 N=Number of Sample

VI. Performance Analysis

In experimental evaluation, proposed methods are tested against other predictors like NBC, Switching, MKC, and SMA. From 8 AM to 6 PM we examined prediction errors of all predictors. There are 11 test cases evaluated between 8 AM and 6 PM. The line chart shown in Fig.1 illustrates relative performance of all travel time predictors. From the overall point of view, proposed method performs much better than NBC, Switching, MKC, and SMA. method. In this method, it is shown that eight test cases exhibit errors less than 0.50. At 09.00 AM, 01.00 PM, 3.00 PM and 6.00 PM our method ATA predicted more accurately than others and datasets of those period included uncertain data. Here we add the line chart to show the mare with compare other method.



VII. Conclusion And Future Work

In our paper, an efficient method for predicting travel time with arbitrary routes in road network is focused. Though there are many studies on predicting travel time in a road network for ATIS, there we research on travel time prediction by considering arbitrary routes. The ATA algorithm is one of technique for travel time prediction. We see that, in most text case simulation results suggest that proposed methods provide a more precise prediction. Our algorithms also demonstrated the feasibility of adopting a classification approach in traffic data analysis. We used PNU trajectory data generator for our experiment which provided real trajectory data.

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