Survey on Improving Driving Directions with Taxi Drivers Intelligence under Road Failure

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Abstract: ***This paper leverages the intelligence of experienced drivers using smart driving system. The system presents the more number of time-dependent landmark graphs to model the dynamic traffic pattern as well as the intelligence of experienced drivers so as to provide a user with the practically fastest route to a given destination at a given departure time along with peak hour information. In this system, the traffic rhythm of a city is probed and taxi driver's intelligence in choosing driving directions takes as input. A two-stage routing algorithm is designed to compute the practically fastest and customized route for the end-users. In addition, time slots are clustered based on weekdays, weekends and the process is carried out. Proposed strategies are extending the road failure conditions for the driver's so as to choose the correct alternate path for the given destination.***

Keywords: Time dependent fast route, Driving behavior, spatial database, shortest path, Map Service.

1. Introduction

A fast driving route saves not only the time of a driver, but also energy consumption (as more gas is wasted in traffic jams). Therefore, this service is important for both end users and governments aiming to ease traffic problems and protect environment. User's driving behaviors usually vary in their progressing driving experiences. The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions. GPS equipped taxis already exist in major cities, generating a huge number of GPS trajectories every day. Intuitively, taxi drivers are experienced drivers who can usually find out the fastest route to send passengers to a destination based on their knowledge (we believe most taxi drivers are honest although a few of them might give passengers a roundabout trip). When selecting driving directions, besides the distance of a route. GIS or spatial data mining is the application of data mining methods for spatial data. Data mining, which is the partially automated search for hidden patterns in large databases, offers great potential benefits of applying GIS-based decision making. For example, travelling on an unfamiliar route, a user has to pay attention to the road signs, hence drive relatively slowly. Thus, a good routing service should consider these three aspects (routes, traffic, and drivers), which are far beyond the scope of the shortest/fastest path computing. In practice, big cities with heavy traffic problems usually have a large number of taxis traversing on road surfaces. For the sake of management and security, these taxis have already been embedded with a GPS sensor, which enables a taxi to report on its present location to a data center in a certain frequency. Thus, a large number of time-stamped GPS trajectories of taxis have been accumulated and are easy to obtain. Intuitively, taxi drivers are experienced drivers who can usually find out the fastest route to send passengers to a destination based on their knowledge (we believe most taxi drivers are honest although a few of them might give passengers a roundabout trip). Directions, besides the distance of a route, they also consider other factors, such as the time-variant traffic flows on road surfaces, traffic signals and direction changes contained in a route, as well as the probability of accidents. These factors can be learned by experienced drivers, but are too subtle and very difficult to incorporate into existing routing engines. Therefore, these historical taxi trajectories, which imply the intelligence of experienced drivers, provide us with a valuable resource to learn practically fast driving directions.

2. Related Work

The data available for these estimation problems is a small set of sparsely tracked vehicle trajectories, which represents a small fraction of the total vehicle flow through the network. The expectation maximization algorithm that simultaneously learns the likely paths taken by probe vehicles as well as the travel time distributions through the network. The data from San Francisco taxis is used to illustrate the performance of the algorithm. Existing methods can only be used to solve a very special case of the problem, when the leaving time is a single time instant. A straight forward solution to the all FP query is to run existing methods many times, once for every time instant. It proposes a solution based on novel extensions to the A* algorithm, instead of expanding the network many times, it can be expanded once.

2.1 Travel Time and Path Inference from Probe Vehicle data using GPS

T. Hunter, R. Herring, P. Abbeel, and A. Byann considered the problem in estimating real-time traffic conditions from sparse, noisy GPS probe vehicle data. It addresses arterial roads, which are also known as the secondary road network (highways are considered the primary road network).There are several estimation problems: historical traffic patterns, real-time traffic conditions, and forecasting future traffic conditions. The data available for these estimation problems is a small set of sparsely tracked vehicle trajectories, which represents a small fraction of the total vehicle flow through the network. The expectation maximization algorithm that simultaneously learns the likely paths taken by probe vehicles as well as the travel time distributions through the network. The data from San Francisco taxis is used to illustrate the performance of the algorithm [1].

2.2 Finding Fastest Paths on a Road network with Speed Patterns

Gr E. Kanoulas, Y. Du, T. Xia and D. Zhang proposed and solved the Time-Interval All Fastest Path (all FP) query. Given a user-defined leaving or arrival time interval I, a source nodes and an end node e, all FP asks for a set of all fastest paths from s to e, one for each sub-interval of I. Note that the query algorithm should find a partitioning of I into sub-intervals. Existing methods can only be used to solve a very special case of the problem, when the leaving time is a single time instant. A straight forward solution to the all FP query is to run existing methods many times, once for every time instant in I. It proposes a solution based on novel extensions to the A* algorithm, instead of expanding the network many times, it can be expanded once. The travel time on a path is kept as a function of leaving time and the methods to combine travel-time functions are provided to expand a path. A novel lower-bound estimate of travel time is proposed. Performance results reveal that this method is more efficient and more accurate than the discrete-time approach [2].

2.3 Map-Matching for Low Sampling-Rate GPS Trajectories

Y. Lou, C. Zhang, Y. Zheng, X. Xie, W. Wang, and Y. Huang, proposed map-matching for Low Sampling –Rate. Map-matching is the process of aligning a sequence of observed user positions with the road network on a digital map. It is a fundamental pre-processing step for many applications, such as moving object management, traffic flow analysis, and driving directions. In practice, there exists a huge amount of low-sampling-rate. Unfortunately, most current map-matching approaches only deal with high-sampling-rate (typically one point every 10-30s) GPS data, and become less effective for low-sampling-rate points as the uncertainty in data increases. A novel global map-matching algorithm called ST-Matching for low-sampling-rate GPS trajectories. ST-Matching considered the spatial geometric and topological structures of the road network and the temporal/speed constraints of the trajectories. Based on spatial-temporal analysis, a candidate graph is constructed from which the best matching path sequence is identified. ST-Matching with the incremental algorithm and Average-Freshet-Distance (AFD) based global map-matching algorithm [3]. The experiments are performed both on synthetic and real dataset. The results show that the ST-matching algorithm significantly outperform incremental algorithm in terms of matching accuracy for low-sampling trajectories.

2.4 Map Matching Algorithm Based on an Interactive Voting

J. Yuan, Y. Zheng, C. Zhang, and X. Xie, proposed a Map Matching Algorithm based on Interactive-Voting. In this paper, matching a raw GPS trajectory to the roads on a digital map is often referred to as the Map Matching problem. However, the occurrence of lower-sampling-rate trajectories (e.g. One point per 2 minutes) has brought lots of challenges to existing map matching algorithms. To address this problem, the proposed system is Interactive Voting-based Map Matching (IVMM) algorithm based on the following three insights: The position context of a GPS point as well as the topological information of road networks, the mutual influence between GPS points (i.e., the matching result of a point references the positions of its neighbors; in turn, when matching its neighbors, the position of this point will also be referenced), and the strength of the mutual influence weighted by the distance between GPS points (i.e., the farther distance is the weaker influence exists).In this approach, it not only considers the spatial and temporal information of a GPS trajectory but also devise a voting-based strategy to model the weighted mutual Influence between GPS points. IVMM algorithm based on a user-labeled real trajectory dataset are evaluated, as a result, the IVMM algorithm outperforms the related method (ST-Matching algorithm) [4].

2.5. Continuous Time Dynamic Shortest Path Algorithms

B.C. Dean considered the problem of computing shortest paths through a dynamic network, a network with time-varying characteristics, such as arc travel times and costs, which are known for all values of time. Many types of networks, most notably transportation networks, exhibit such predictable dynamic behavior over the course of time. Dynamic shortest path problems are currently solved in practice by algorithms which operate within a discrete-time framework. A new set of algorithms for computing shortest paths in continuous-time dynamic networks and demonstrate for the first time in the literature the feasibility and the advantages of solving dynamic shortest path problems in continuous time. All time-dependent network data functions are given as piecewise linear functions of time, a representation capable of easily modeling most common dynamic problems. Additionally, this form of representation and the solution algorithms developed are well suited for many augmented static problems such as time-constrained minimum-cost shortest path problems and with time windows. The classification, formulation, and mathematical properties of all common variants of the continuous-time dynamic shortest path problem are discussed. Two classes of solution algorithms are introduced, both of which are shown to solve all variants of the problem. In problems where arc travel time functions exhibit First-In-First-Out (FIFO) behavior, these algorithms have polynomial running time; although the general problem is NP-hard, the average-case running time for many common problems should be quite reasonable. Computational results are given which support the theoretical analysis of these algorithms, and which provide a comparison with existing discrete-time algorithms; in most cases, continuous-time approaches are shown to be much more efficient, both in running time and storage requirements, than their discrete-time counterparts. Finally, in order to further reduce computation time, the parallel algorithm and hybrid continuous-discrete approximation algorithms are introduced which exploit favorable characteristics of algorithms from both domains [5].

3. Conclusion

The system includes more number of landmark graphs are prepared for more road networks and their inter-connectivity. Moreover, Road Failed conditions are also taken into account so that the number of vertices and edges dropped out in the resultant graphs are also considered. the system mines the intelligence of experienced drivers from a large number of taxi trajectories and provide the end user with a smart route, which incorporates the physical feature of a route, the time-dependent traffic flow as well as the user's driving behaviors (of both the fleet drivers and of the end users for whom the route is being computed). It includes heavy traffic in peak hours' scenario as well as road terminal failure scenario. This paper shows that the method significantly outperforms the competing methods in the aspects of effectiveness and efficiency in finding the practically fastest routes.

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