Survey on Graphical Analysis of Various Route Choice Based on General GPS Trajectories

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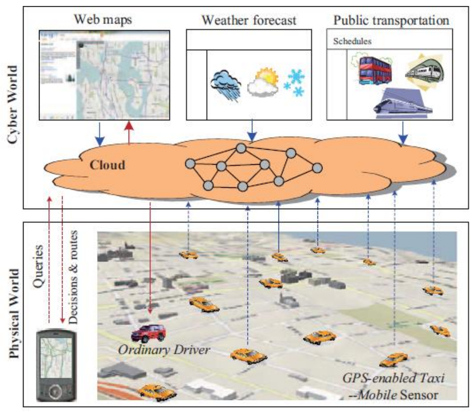
Abstract: ***Routes are multiple in between regions. Different considerations are chosen by a driver with different routes. Spatial and temporal scale are practical reliability and are quite limited in experiment data. Based on GTD (General Trajectory Dataset),which is more realistic in a wider scale, we explore the possibility of studying route choice behavior. Compareto different route choices and exploring the underlying reasons, we develop a visual analytic system to help users handle the large scale trajectory data. Specifically, the system composed of: 1. graphical trajectory query which supports interactive trajectory filtering; 2. the spatial view which gives a summary of all possible routes remove from filtered trajectories; 3. The exploration and hypothesis construction of various factors are provided by the factor visual analytics and the verification with an integrated route choice model. Applying to real taxi GPS dataset, we produce the system's performance and reveal its effectiveness with three cases.***

Keywords: Route Choice Model, Route Choice Behavior, Visual Analysis, Interaction

1. Introduction

Big data has been produced in urban space by developing sensing technologies. Transportation has been most fundamental urban computing application.To understand the travel behavior and to advance the travel experience, various transportation system analyze the city wide human mobility data and other urban data. Urban sensing, data management, analytics has been merge by urban computing and services as an integral process,whichforce light on the rich knowledge of city and better human lives.

When travelling from one place to another place there are often many routes.How drivers make route choices is an interesting topic to understand in transportation area.It helps drivers to make wise travelling decisions and also benefit the city planners in the improvement of route usage.



A cloud-based driving directions service

From above figure, in physical world, GPS (Global Positioning System) equipped taxies are used as mobile sensors probing the traffic flow of a city. To combine and store the information from these taxies as well as some other origin from internet , like weather forecast and web maps , a cloud in the cyber world is built. Finally , in a user's GPS(Global Positioning System) phone , a mobile client that is running will communicate with cloud , accepts a user query and present the result to the user.

The contributions of this project are:

- To analyze the route choice behavior with real GPS (Global Positioning System) data, we develop a visual analytic system.
- Based on general GPS(Global Positioning System) data, we explore the possibility of analyzing various route choice behavior.

Different considerations are chosen by a driver with different routes. In day to day life we experience selecting the route with least time cost. Based on Stated Preference(SP) survey data, research attempts has been made to study the influenced of various factors on route choices. Information in questionnaires, can be directly grap by various choice considerations. Information access from investigation isquite biased and not much reliable enough.

We analyze the opportunity of studying route choice behavior based on general GPS(Global Positioning System) trajectory data.To implement the GPS(Global positioning System) trajectories ,we need to overcome several issues.The issues are concerned with:

- To detect factors that probably influence route choice from general GPS(Global Positioning System) trajectories and verify the significances is a challenge to deal with.
- GPS trajectories in defined spatial and temporal range, extracting trajectories related to various routes from big trajectories is a challenge to be tackled.

We introduce a visual analytics system that leverages people interaction and judgment in the trajectory data mining process from the aspect visual analytics to deal with above challenges: feasible routes are constructed automatically based on filtered trajectories; to explore and raise hypotheses on potential influence, route choice distribution over these factors are visualized with a list of factor derived from general GPS(Global positioning System) trajectory; then hypotheses are checked by the statistical model to draw reliable conclusions.

2. Related Work

In this area, we have analysis on the related work: researchprogress in visual analytics of trajectories,route choice behaviour analysis in transportation field, routevisualization and rank based visualization

2.1 Trajectory Visual Analysis (TVA)

In [1] authors studied Various mining techniques, including pattern mining, outlier detection etc has been analysis in trajectory mining field.In [2] authors study three types of visual analysis: Visualaggregation, pattern extraction and direct depiction .To extract basic data patterns[3], pattern extraction methods has been apply to automatic analysis.To declare high level movement graph, aggregation methods anticipate movement groups. Because of visual cluttering direct plotting has been simply fail. Users can interactively filter the trajectories by manipulating the lenses on the map with the help of Trajectory Lenses .In comparison with TrajectoryLenses,our architecture also allows for the direction assignment.

2.2 Route Choice Behaviour Analysis (RCBA)

In transportation area route choice behavior has been widely studied. In [4] authors find that 26% people do not use the same route. Circumstanceslike, departuretime, income level and age are found adequately important. To obtain problem related information involving personal details, questionnaires are correctly constructed, here statistical numerical analysis play an essential role.But , investigations are fixed in both sample range and in its effectiveness or validity .Some effective aspects are declared , such as highway percentage , perception of time,traffic light number , etc. In [5] authors study morning route choice patterns based on a GPS(Global Positioning System) dataset. The distinction between recalled and observed situations, realism is also a problem. The data is still problem related and range limited that are dependent to the analytical requirement of particular characteristics.With lower costs and higher precision, GPS (Global Positioning System) records provide more correct behaviour.Rather , system is constructed for general GPS (Global Positioning System) data that cover a much larger range.

2.3 Route Visualization (RV)

In [6] authors studied a well known technique in geographical application to visualize a route is space time cube , which anticipate the effective changes of geographical of a route in 3D space. With the analogy of lenses, to encode more details, [8] authors place a magnified lenses. In [7] authors propose stacking bands in hybrid 2D/3D view to visualize the trajectory attributes. Anisotime flow of map view in a parallel isotime form has been granted for acceptable analysis among routes. To manage easy perception of the geospatial information of routes , we need to keep the map viewcorrect. To show the topology architecture , the abstract route view from flow diagram has been collected. The topological information of various route can be encoded with accurate method.

2.4 Rank Based Visualization (RBV)

In visualization, ranking as an operation to construct data is widely used. However, in our study, we need to trade with dynamic route attribute, for example: the travel time cost attribute of a route which cast the time costs from all trajectories. Ranking technique is combined into line based visualizations [9] as a result of linear property of ordering. By increasing the time dimension, some ranking visualizations compromise with the dynamic changes .By keeping time continuous, in which they segment the ranking into different groups, the [11] authors proposeRank Explorer. Connecting items definite value over various attributes, parallel coordinates [10] visualizes multivariate data. In place of increasing time , we combine the dynamic route attribute samplings by trajectories and introduce a ranking visualization for attribute with separate value and multiple values.

3. Model Overview

In this section we describe Data Structure Constructions (DSC) and Extracting the Optimal Location (EOL).

3.1 Data Structure Construction (DSC)

The leading data structure applied in these areas are trajectory vertex, vertex trajectory indexes and trajectory edge.

- **Trajectory –Vertex Index, Itv: The hidd**en vertices of all trajectories are documented by the trajectory-vertex index.

- **Vertex-Trajectory Index, Ivt:** Each entry is described by a vertex Vi on the road network and this index is inverted trajectory vertex index. The statistic for each road segment and location through an averaging operation can be calculated directly.

- **Trajectory-Edge Index, Ite:** A GPS trajectory is a arrangement of time ordered spatial points. We firstly apply a map- matching algorithm and then trajectory edge index can be constructed. With these indexes , we can identify , the road segments passed by a given trajectory.

3.2 Extracting the Optimal Location (EOP)

To assist the domain experts in selecting the billboard location, smartAdp add an interactive query, called K-location query. The main purpose of K-location query is to extract K-location from the candidates. The weights in these queries are different for each trajectory. These queries are placed on different schemes. To achieve a satisfactory advertising effect, these query aimed at extracting a set of locations with maximum coverage value.

Algorithm 1 k-location query

Algorithm KLocation(Candidate vertices V_{can}, Trajectory-vertex index I_{tv}, Vertex-trajectory index I_{vt}, OD regions R_{od}, Normal weight w_{nor}, OD weight w_{od}, k)
1: identify all the trajectories covered by $V_{can} \rightarrow TR_{can}$
2: **for** each trajectory Tr in TR_{can} **do**
3: set $w(Tr)$ to w_{nor}
4: identify all the trajectories that one of its OD vertices located in $R_{od} \rightarrow TR_{od}$
5: **for** each trajectory Tr in TR_{od} **do**
6: set $w(Tr)$ to w_{od}
7: **for** each vertex v in V_{can} **do**
8: calculate the coverage value $c(v)$ as $\sum_{Tr \in I_{vt}[v]} w(Tr)$
9: $V_{result} := \emptyset$; $TR_{covered} := \emptyset$
10: **for** i := 0 to k-1 **do**
11: pickup v_{max} in V_{can} with the maximum coverage value
12: $V_{result} := V_{result} \bigcup v_{max}$
13: **for** Tr in $I_{vt}[v_{max}] - TR_{covered}$ **do**
14: **for** v in $I_{tv}[Tr]$ **do**
15: $c(v) := c(v) - w(Tr)$
16: $TR_{covered} := TR_{covered} \bigcup I_{vt}[v_{max}]$
17: **return** V_{result}

In each iteration, the algorithm contains two steps.

- Selection : The vertex with maximum coverage value are selected by the algorithm and put it into result set (in line 11 to 12).
- Updating : The coverage value of all vertices are updated at this step. Passing vertices can be identified by using trajectory-Vertex index. The coverage value of every passing vertex V is updated to c(v)-w(Tr) (in line 15).

4. Conclusion

In this project, we explore the possibility of studyingRoute choice behaviour based on taxi GPS trajectories. We systematically study the problem of identifying the optimal billboard locations using massive trajectory data. In this project , we present SmartAdp , an interactive visual analytics system that combines a new application driven mining model. The system's visualizations and interactions are designed carefully according to task oriented considerations.

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