TrajAnalytics: An Open-Source, Web-Based Visual Analytics Software of Urban Trajectory Data

Introduction

Advanced technologies in sensing and computing have created urban trajectory datasets of humans and vehicles travelling over urban road networks. Understanding and analyzing the large-scale, complex data reflecting city dynamics is of great importance to enhance both human lives and urban environments. Domain practitioners, researchers, and decision-makers need to store, manage, query and visualize such big datasets.

We develop a software system named TrajAnalytics, which explicitly supports interactive visual analytics of the emerging trajectory data. It offers data management capability and support various data queries by leveraging web-based computing platforms. It allows users to visually conduct queries and make sense of massive trajectory data.

Urban Trajectory Data

- Large amount of trajectory data sets is collected by transportation administrations, companies, and researchers.
- The trajectory data records real-time moving paths sampled as a series of positions over urban networks.
- Rich and heterogeneous information can be associated at each position, including human and vehicle attributes, geographical features, business/urban information, and more.
- Such data is big, spatial, temporal, dynamic, and unstructured.
- In the prototypes of the TrajAnalytics software, public datasets are utilized such as the taxi trips in New York city, and taxi trajectory data of Porto city, Portugal.
- User’s own trajectory dataset is preprocessed and loaded by an independent software module, which can automatically fetch road network and map-match GPS samples.

TrajAnalytics Software Design

- Powerful computing platform so that domain users are not limited by their computational resources and can complete their tasks over daily-used computers.
- It can be used as a stand-alone version or through internet access from our server. It will be made as a software as a service (SaaS) on computing clouds.
- Easy access gateway so that the trajectory data can be retrieved, analyzed, and visualized by different transportation researchers, and their results can be shared and leveraged by others.
- Scalable data storage and management which support a variety of data queries with immediate responses.
- Exploratory visualizations that are informative, intuitive, and facilitate efficient interactions.

TrajAnalytics Framework

TrajAnalytics consists of three components: scalable data management (TrajBase), effective data query (TrajQuery), and interactive visual interface (TrajVis).

TrajBase

A scalable database is specifically designed for storing and managing big trajectory data. TrajBase supports using MySQL, PostgreSQL, and MongoDB. It facilitates fast computation over various data queries in a remote and distributed computing environment. It will be made available as a

TrajQuery

TrajQuery supports the user to conduct spatial queries combined with temporal constraints to extract taxi trips or trajectories. The spatial queries allow users to flexibly combine regional queries over:
- pick-up regions.
- drop-off regions.
- traversed (passed) regions.

TrajVis

The visualization interface contains convenient functions for effective and efficient knowledge discovery:
- Interactive map view.
- Manageable list of multiple queries.
- Save and load queries in GeoJSON files.
- Interactive charts and diagrams for data analytics.

Sample views:

Implementation

TrajAnalytics software is implemented with a set of mainstream software packages: JavaScript libraries for interface and interaction such as Leaflet.js and D3.js; open source databases such as PostGreSQL with spatial indexing for server side data management; and PHP/HTML for web communication. The system is open at our website, and the source code is freely accessible with a BSD licenses. Please visit:

Data Loading and Preprocessing Module

A software module for users to conveniently process their own trajectory data:
- Load raw trajectory data sets with massive GPS sample points
- Automatically fetch corresponding road segments data from OpenStreetMap
- Automatically match the raw data with road segments
- Load into TrajAnalytics database
- Ready for visual analytics tasks in TrajAnalytics system

Conclusion

The mobility and behavior of moving humans and transportation vehicles form the basic component in human society. Our software facilitates easy, online exploration of big trajectory data. It will advance a broad spectrum of applications by enabling researchers to visually analyze the emerging trajectory data.

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