ISSN: 1813-4890

An Overview of Personal Travel Research Based on Spatio-Temporal Traffic Data

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Abstract

Since the 18th Party Congress, with the support of national policies, infrastructure equipment has been gradually completed, the Party's 20th National Strategy for a Stronger Transportation has continued to progress, and certain achievements have been made in the field of intelligent transportation. For the general traveling public, the travel experience is gradually improved by the development of intelligent transportation. The construction of intelligent transportation as well as smart cities cannot be separated from the application and development of big data. In the study of personal travel, big data often refers to the spatio-temporal big data of traffic. In this paper, we briefly review the relevant travel research in recent years based on the personal travel perspective. The data involved in personal travel are mostly related to cell phones, mainly including location data and cell phone signaling data. This paper also combines some brief travel applications of big data for transportation with a frontier outlook. The development of big data combined with transportation is not smooth and needs to be further combined with artificial intelligence algorithms in future research.

Keywords

Big data; travel behavior; intelligent transportation; literature review.

1. Research Background and Related Concepts

The field of transportation, as an important part of national life, has connected different regions of the country, different groups of people, economic development, and every day's travel in its development over the years. In order to continuously achieve the people's aspiration for a better life, the development of the transportation field continues. Since the 18th National Congress of the Communist Party of China, with the support of national policies, infrastructure has gradually improved, and the strategy for a stronger transportation has continued to progress, achieving certain results in the field of intelligent transportation. For ordinary travelers, the travel experience has gradually improved due to the development of intelligent transportation. By 2035, China will basically build a transportation strong country that is "satisfactory to the people, strong in support, and among the world's top," and by 2050, it will fully build a transportation strong country, achieving "people enjoy their travel, and goods flow optimally."

With the support of national policies and infrastructure construction, developing high-quality transportation beloved by the masses and building sustainable smart cities has become the direction of the people's heart. Similarly, high-quality intelligent transportation travel solutions are also needed by the times[1]. The construction of intelligent transportation and smart cities is inseparable from the application and development of big data.

ISSN: 1813-4890

1.1. Traffic Spatio-Temporal Big Data and Related Concepts

Big data, as the name suggests, is characterized by its massive volume. After research and summary, it is generally believed that big data has six characteristics: huge volume (Volume), fast processing (Velocity), diverse modalities (Variety), coexistence of truth and falsehood (Virtual), rich value (Value), and visualization (Visualization) [2]. Combined with the characteristics of space and time, spatiotemporal big data is big data with two major attributes of time and space on a three-dimensional coordinate system.

Human daily activities generate data, and the aggregation of numerous activity data forms big data. Traffic behavior is also a part of daily activities and often has spatiotemporal attributes. Traffic spatiotemporal big data can often be detected by detection devices present in daily activities and is more in line with the rapidly developing Internet of Things. In addition, traffic spatiotemporal big data can also come from unstructured video data and multi-source internet data [2].

Traffic spatiotemporal big data can be divided into dynamic big data and static big data according to type. Static and dynamic can be understood literally; static traffic big data includes more fixed data in the road network and is the content of data commonly used in past research. Dynamic big data sources are more diverse, mainly coming from various collected real-time information [3].

1.2. Individual Travel and Traffic Spatio-Temporal Big Data

The research on individual travel and traffic spatio-temporal big data is mainly connected to the study of travel behavior. Each travel behavior choice of residents forms data, and the study of these data can be used for traffic planning, construction, and management. The study of travel behavior combined with traffic spatio-temporal big data will be more based and has an important role in improving the travel experience of residents. Based on the research support of traffic spatio-temporal big data, the travel patterns and trends of travelers will bring a revolutionary experience to travelers' travel experience.

2. Domestic and Foreign Related Research

Combining traffic big data with travel research analysis, information needs to be effectively and high-quality processed and refined. Research related to traffic big data can be every part of the process in application, such as data collection, data quality processing, travel characteristics contained in big data, needs behind the data, behavioral patterns contained in the data, and information fusion, etc. [4], this paper mainly briefly describes the content of related research, with different focuses.

2.1. Domestic and Foreign Related Research

According to the latest "China Internet Network Development Status Statistical Report," China's netizens have reached 1.051 billion, and the popularity of the internet has reached a certain scale. For the study of individual travel behavior, the source of big data is often related to the mobile phones used in daily life, and mobile location survey technology has the advantages of low cost and high efficiency [5-6]. Big data related to mobile phones mainly includes mobile call data and mobile signaling data [7], as well as location-based information services, all of which contain time and space attributes and can be used for individual travel characteristic research. Research combined with location information is more objective and accurate, has the characteristics of spatiotemporal continuity, and is suitable for deeper research [8].

2.1.1. Mobile Signaling and Call Data

In individual daily life, when using mobile phones for network operations, they will transmit information with nearby base stations. Based on this principle, OD information of residents'

travel can be obtained, which is more accurate than traditional OD surveys. Past theoretical research has demonstrated the importance of mobile signaling information and OD information in travel research, and mobile signaling data can be used for traffic travel analysis research after processing [9]. In addition, the characteristics of mobile signaling data are non-equal time, equal distance return, frequent jumping in positioning, and have a time order [10].

In the study of mobile signaling, since signaling data does not directly contain OD, the focus of the study is often on mining, and subsequent travel behavior research is often similar. Past research can be divided into two OD acquisition methods based on different location tracking technologies: (1) geometric location method; (2) location area data method [11]. Du Changhai and others, based on their research, used an improved particle algorithm to improve the shortcomings of the geometric location method and location data method, obtaining more accurate OD information [12]. In the study of travel behavior with mobile signaling data, travel characteristics are often summarized, including commuting trajectories, basic conditions of travel, such as origin, destination, and travel time [13].

Due to the errors in the collected data itself, especially the adverse effects of base station positioning, the final conclusion has problems such as vague concepts, uncertain data quality, and unclear analysis methods, and the results cannot withstand scrutiny. However, it cannot be denied that past research has confirmed the practical application of mobile signaling and call data in traffic spatio-temporal big data, compared with traditional OD surveys, has more advantages.

Through the above research, it can be found that the research on mobile signaling and call big data is more suitable for large-area OD, job-housing distribution, and other macro traffic travel characteristic analysis. It is currently difficult to extract micro detailed travel chain information such as departure and arrival time, travel mode, and transfer time. Its technical application scenarios and scope are limited to a certain extent. Subsequent research should consider the standardization, indexing, and transparency of big data analysis, and can combine location information for more comprehensive behavior research, which can solve the base station positioning problem to a certain extent.

2.1.2. Location Information Data

The research mechanism of travel behavior based on location information is similar to mobile signaling, but location information is obtained through satellite data and is generally more continuous. Recent research often combines computer science for behavior prediction research.

Martic constructed a travel characteristic model through the GPS data of 136 volunteers. Although 136 individuals are not a large amount of data, the study theoretically proves the feasibility of travel characteristic prediction research [14]. In this direction of research, more knowledge of computer science is combined, requiring more algorithm content. Yang Fei and others use algorithm content such as wavelet analysis and neural networks to analyze the differences in travel data produced by different modes of transportation, exploring the feasibility and effectiveness of various data mining algorithms for individual travel parameter extraction, and further conducting travel characteristic research [15].

However, location information is not without shortcomings. Identifying different modes of travel is a difficult point in this direction of research, and many algorithms in the past (such as decision trees, fuzzy logic, Bayesian networks, neural networks) cannot solve this problem well.

Position information (GPS) trajectory data is still a relatively new research method, bringing more opportunities for the development of traffic spatio-temporal big data, but current research is still not perfect. In future research, more attention should be paid to algorithm identification of different travel mode characteristics, and more refined characteristic research should also consider data collection security issues. Recent research and commercial

applications have seen the emergence of visualization applications that can more clearly judge user travel patterns, of course, this is also related to the source of data.

3. Big Data Visualization Applications

This section mainly introduces the visualization research of big data travel behavior from Yang Junjian [16]. The study is based on urban traffic big data and uses a visual form to display the travel characteristics of users. The research can be briefly divided into three parts related to transportation: data mining processing, travel display feature acquisition, and travel implicit feature and travel pattern mining.

In the data mining stage, whether it is Baidu Map or the daily operation of public transportation data, it briefly contains user OD information, that is, the time and place of departure and arrival. After obtaining the data, processing is required. Researchers mainly use Python to solve data missing, quality inspection, and other data issues. It is also necessary to uniformly express different types of data for subsequent use.

In the travel display feature stage, researchers mine existing data and perform simple processing to obtain travel-related frequency, frequency statistics, and various distributions (spatial and temporal distribution, mode distribution, frequency frequency distribution) analysis. Combined with the analyzed data, simple visualization display can be performed. The so-called implicit features are the mined display feature data. Implicit features are more inclined to individual travel research, which can mine the traveler's workplace, commute situation, travel preferences, etc., from the travel data through algorithms. At the same time, travel patterns can also be mined to predict subsequent travel.

A simple review of this research shows that the processing and classification of traffic big data are more inclined to the application of computers. Deeper research still needs to combine more big data to guide the real world, but data visualization and clearer travel chains are meaningful in themselves.

4. Summary and Outlook

This paper starts from the perspective of individual travel behavior research and reviews the recent travel research combined with traffic spatio-temporal big data. For individuals, the closest must be the daily communication devices. In the research part of mobile signaling, more focus is on OD recognition. In the research of location information, further behavior prediction is carried out. Both research directions have some areas that need to be improved. In the more cutting-edge behavior research, combined with more computer science content, a deeper understanding of artificial intelligence algorithms is needed. As mentioned earlier, travel behavior research is not only the simple application level mentioned in this paper. Deeper, it should include more operations such as data processing, gridification, quality analysis, visualization, etc. In future individual travel behavior research, data security issues should also be considered. In addition, many data sets also need more optimized algorithms to save performance.

Traffic spatio-temporal big data can also be applied to group travel research, which is related to individual travel research. Simply put, the study of traffic spatio-temporal big data can help travel as a service and improve user travel experience. In addition, for the traffic supply side, more reasonable resource allocation can be obtained, and the demand side can obtain smarter recommendations. The travel research of traffic spatio-temporal big data will further optimize the simulation design on the market. It is believed that future research results can help better travel experience and also contribute to intelligent transportation and smart cities. It should be

noted that due to personal ability limitations, the content of the review may be biased, and past research may not be fully reviewed.

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