Academic Journal of Management and Social Sciences
ISSN: 2958-4396 | Vol. 2, No. 3, 2023

Resident Travel Analysis based on GPS Trajectory

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Abstract: Taxi is an important means of transportation, and its trajectory data contains a wealth of travel information. Taxi trajectory data processed by trajectory data mining technology can reflect residents' activity rules and behavior patterns, so as to provide a reference for urban planning decisions. with its wide coverage, high sampling rate, good location accuracy, large data scale and rich information, taxi trajectory data has been widely used in traffic management, urban planning, user behavior analysis and intelligent transportation. Analyze the characteristics of residents' travel demand from two dimensions: time and space. Analysis of travel demand time characteristics. firstly, analyze the overall demand characteristics of residents, and secondly, analyze the demand characteristics of residents on workdays and rest days; In the analysis of spatial characteristics of travel demand, the static and dynamic spatial characteristics of residents are analyzed separately.

Keywords: Time; GPS; Space; Resident; Taxi.

1. Introduction

The application research of trajectory data in cities is mainly divided into urban spatial structure function unit identification, human activity pattern mining, behavior prediction, anomaly monitoring, urban calculation and so on. Taxi trajectory data reflects the behavior characteristics of urban residents, and can reveal the living rules and behavior characteristics of residents by mining and analyzing it. Some scholars identify urban structural units by analyzing trajectory data, providing reference for urban construction decision-making and traffic dredging. In addition to the study of people's travel activities, the use of taxi trajectory data to predict and recommend residents' activities is also the focus of the study. By analyzing the law analysis and pre-measurement of track data, abnormal movement patterns can be identified from the anomaly detection.

With the acceleration of urbanization and the explosion of the number of motor vehicles, the urban traffic problem has become more and more prominent, which has seriously affected and restricted the sustainable development of economic society. he travels pattern of urban residents is affected by the urban structure, showing a certain regularity, reflecting the characteristics of urban traffic. Residents' travel activities are closely related to urban traffic conditions. Therefore, the key to solving urban traffic problems is to master the spatial and temporal characteristics of residents' travel and provide scientific and reasonable data support for urban planning, infrastructure construction and traffic management prediction.

With its wide coverage, high sampling rate, good location accuracy, large data scale and rich information, taxi trajectory data has been widely used in traffic management, urban planning, user behavior analysis and intelligent transportation.

As one of the main transportation modes for urban residents, taxi is an essential part of urban transportation system. Compared with public transportation such as buses and subways that run on fixed lines, taxis are favored by urban residents for their advantages of speed, flexibility, comfort and real-time performance. By analyzing the time characteristics of residents' travel needs, it is helpful to master the time-varying rules of residents' travel throughout the day.

The taxi track contains the internal rules of residents' travel, so the taxi track is the most commonly used data in the field of residents' travel behavior analysis. Domestic and foreign scholars use the taxi track data of different cities to analyze the characteristics of residents' travel time and space behavior. In addition, when taxi trajectory data is used to analyze residents' behavior, the trajectory data is usually selected into passenger trajectory, no-load trajectory and OD point data, and OD point data records the starting point and ending point of residents' travel, fully reflecting residents' travel needs. Therefore, OD analysis is the most commonly used analytical method in residents' travel behavior analysis.

2. Related Research on the Analysis of Residents' Travel Behavior

2.1. Research on Residents' Travel Time Behavior

The taxi track contains the internal rules of residents' travel, so the taxi track is the most commonly used data in the field of residents' travel behavior analysis. Domestic and foreign scholars use the taxi track data of different cities to analyze the characteristics of residents' travel time and space behavior. In addition, when taxi trajectory data is used to analyze residents' behavior, the trajectory data is usually selected into passenger trajectory, no-load trajectory and OD point data, and OD point data records the starting point and ending point of residents' travel, fully reflecting residents' travel needs. Therefore, OD analysis is the most commonly used analytical method in residents' travel behavior analysis.

In the field of residents' travel time behavior analysis, Wang et al [1] proposed the method of using string graph to visualize OD flow data to reveal the temporal and spatial characteristics of Beijing residents' travel, and found that the area with the largest travel volume during the morning rush hour in Beijing is mainly centered on Tian 'anmen Square, extending from south to north to the fourth Ring Road, including Beijing Railway Station, Beijing South Railway Station and Beijing West Railway Station. It provides a new perspective for understanding the changes of residents' travel at different times. In addition, quantitative analysis is often adopted to analyze residents' time behavior. By counting the number of OD points at different times, travel time characteristics of residents in different periods of working

days and rest days are analyzed. For example, Li Ke and Dang Yanzhong [2] split the taxi track data into OD point data and no-load track segment, analyzed the spatio-temporal behavior rules of residents and drivers respectively, identified the peak period of residents' travel based on the number of OD points at different times by using the difference function, and developed the targeted advertising strategy based on the residents' travel behavior rules and drivers' behavior pattern preference. Improve the effect of taxi advertising.

2.2. Research on Residents' Travel Space Behavior

In the field of analyzing the spatial characteristics of residents' travel, density analysis, hotspot analysis and cluster analysis are commonly used to find the spatial behavior rules of residents. Density analysis includes point density, line density and Kernel density and other modes, which can be realized based on the geographic information system software ArcGIS, among which Kernel Density Estimation (KDE) is the most common one [3-4]. Shen et al [3] proposed an improved network kernel density estimation method to estimate the density of taxi pick-up and drop-off points, and explored the spatial-temporal pattern of taxi travel by considering pick-up and drop-off points, journey and network traffic patterns, and analyzed the network traffic through the analysis of taxi travel between different land types at different times. Long Xueqin et al[4], in order to analyze the spatio-temporal distribution characteristics of ride-hailing hot spots, used ride-hailing order data to build an identification model of ride-hailing hot spots based on network and density estimation, used regression model to cluster and grade ride-hailing hot spots, introduced the network kernel density estimation method measured by road network distance, and based on grid distance attenuation effect, Estimate the kernel density value of residents' boarding and unloading points in specific time periods of working days and non-working days.

In addition, OD analysis is also often used in the analysis of residents' travel space behavior. For example, Dai Weixiu et al [5] defined OD point as the stop point. Considering the lack of semantics in the original taxi trajectory, the semantic interaction matrix was generated after estimating the semantics of the stop point by using the method of point of interest and Gaussian kernel density, and the interaction mode of residents' travel was inferred through the semantic interaction matrix. It is found that there is a significant difference in the interaction patterns between working days and non-working days of Beijing residents. Working days are dominated by interaction between work and residence, while rest days are dominated by interaction between leisure and residence. Xu [6] divided Lanzhou into grid, focused on the number of O points and D points and the travel distance in the grid, and constructed OD matrix. Based on OD matrix data, Xu found the hot spots in the city, used the maximum likelihood estimation method to fit the travel distance, and explored the activity pattern of Lanzhou residents.

Cluster analysis is a method to gather similar elements based on the idea of "birds of a feather flock together". Common clustering methods based on spatial and temporal trajectory include density-based clustering [7-8], mesh-based clustering [10] and partition-based clustering [8]. The common clustering algorithms in density-based clustering include DBSCAN algorithm and OPTICS algorithm, and the common clustering algorithm in partition-based clustering is K-means clustering algorithm. Tang et al [9] used DBSCAN clustering method based on space, time and direction attributes to extract residents' travel patterns from taxi trajectory data, and proposed a parameter optimization method based on statistical characteristics. The clustering results of different attribute combinations were considered and the role of different attributes in the clustering process was further analyzed. To find out the travel patterns of Harbin residents in different time periods, and provide suggestions and references for urban traffic planning and management. Li Jiarong et al [7] proposed an improved clustering algorithm based on OPTICS, aiming at the uneven distribution of trajectory data within the city. Based on the original clustering results, the local density peak was calculated, and the hotspot regional center of taxi boarding and boarding events was further extracted. Zheng et al [10] proposed GRIDDBSCAN, a grid-based density clustering algorithm, to conduct grid density-based clustering on the pre-processed Chongqing taxi track data, and to explore attractive travel hotspots and hotspots. Through the clustering, it was found that residents' hot spots were often concentrated in office areas due to their work during the day. At night, residents' activities are more abundant, which makes the distribution of hot spots relatively dispersed. Park et al [3] proposed a road2vec optimization method based on GPS track to assist in the design of bus lines connecting residential areas and public transportation points and reduce unnecessary waste of transportation resources, and identified the main taxi traffic clusters in commuting events based on K-means algorithm. And design a feeder bus route for each taxi cluster that best reflects its trajectory pattern.

3. Summary

Taxi trajectory data can be used in traffic management, urban planning, user behavior analysis and intelligent transportation. In the analysis of residents' travel behavior, OD point data is usually used to analyze the characteristics of residents' travel behavior from both time and space perspectives. The spatial and temporal characteristics of residents' travel reflect the travel needs of residents. Therefore, based on the spatial and temporal characteristics of residents' travel, it can provide a basis for taxi route recommendation.

In addition to taxis, residents also travel by subway, bus, bicycle, etc. Only the trajectory data of taxis are studied, and the data source is relatively simple, so the research results differ from the actual situation to a certain extent. Therefore, the following research work will focus on the introduction of multi-source data to study the rules of residents' travel activities.

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