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Positioning Error in Mobile Phone Tracking Data with Consideration of Geographic Environment Factors

Song Xiaoqing [a, b], Long Yi [a, *], Zhang Ling [a]

[a] *School of Geography, Nanjing Normal University, Nanjing, China, xqsong@whu.edu.cn, longyi@njnu.edu.cn, lingzhang.sky@gmail.com*

[b] *School of Geography and Tourism, Anhui Normal University, Wuhu, Anhui, China, xqsong@whu.edu.cn*

* Corresponding author

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Abstract:

Background. With the rapid development of information and communication technology and social media network, it is possible to get massive individual trajectory data which contains time and space information of individual mobility or activity on different temporal-spatial scale. Recently, it becomes a hot research topic in the field of Human science, sociology and geography etc that studying human mobility patterns or urban dynamic with mobile phone tracking data, GPS data and social media data and so on. Especially, the application of mobile phone tracking data is more and more extensive. However, the positioning accuracy of mobile phone tracking data on the mobile terminal is not high. Coupled with the uncertainty factors in the process of data collection and knowledge mining, the spatial analysis results are not reliable, easy to cause decision-making errors and serious consequences. Therefore, it is urgent to study the positioning error in mobile phone tracking data, including the source of error, influence factors and distribution characteristics of positioning error. However, such research is still in its infancy, there are still a lot of challenges considering the influence of geographic environment. What are the key geographic environment factors that affect the positioning accuracy of mobile phone tracking data? How do these key geographic factors affect the positioning accuracy? Can we construct a positioning error spatial distribution model of mobile phone tracking data that considering geographic environment factors? The study of these problems can help us understand the positioning error of mobile phone tracking data and improve the positioning accuracy of the data.

Objective. In view of the above challenges, this research studies the positioning error of mobile phone tracking data with consideration of geographic environment factors, such as terrain, land types, weather, season and so on. The purpose is to explore the source, influencing factors and distribution characteristics of positioning error. Looking for the quantitative relationship between geographic environment factors and positioning errors in order to improve the positioning accuracy of mobile phone tracking data. Data sources include mobile phone tracking data, GPS data and basic geographic data.

Contents. The main research content includes the following three aspects: ①In this part, the most important work is to collect data and to analyse the data. We collected two parts of data including human trajectory data and geographic environment data. The trajectory data includes mobile phone tracking data and GPS data. We developed an APP to collect trajectory data. Then, we collected the mobile phone tracking data and GPS data of volunteers at the same time. And then, geographic environment around the volunteers, such as terrain, land types, weather, season and so on, was collected. After that, we explored the key geographic environment factors affecting the positioning error of mobile phone data. We used the GPS location of the volunteers as a relatively accurate position. The GPS data and mobile phone tracking data of the same volunteer were plotted into the space-time trajectories respectively. The error of mobile phone tracking data was analysed by comparing the two trajectories of the volunteers. We used correlation analysis, principal component analysis and other methods to explore the key geographic environment factors affecting the positioning error of mobile phone data. ②The second part of this research is to construct a spatial distribution model of positioning error in mobile phone tracking data that considering the key geographic environment factors. In this part, we quantified the error between mobile phone tracking data and GPS data with error indexes such as median error and covariance and took them as the positioning error of mobile phone tracking data approximately. And then, the key geographic environment factors were extracted as a subset of impact factors. After that, we used the machine learning algorithm random forest to construct the error distribution model combining the key factors. We divided the data set into training set and test set to learn and test the model. ③ In the end, we will select typical areas for experiments to analyse the validity and expression quality of the model.

Summary. This research contributes to both theory and application. This is an important supplement to the research on the quality and uncertainty of spatial big data and it will help mobile phone data play a more effective application value in future research. In recent years, the rapid development of data acquisition means has led to the rapid accumulation of spatial data and generated spatial big data with geographic location information. However, the uncertainty in spatial big data leads to the quality problem of spatial big data, which is one of the main bottlenecks restricting the effective

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utilization of spatial big data. As an important part of spatial big data, it is necessary to study the quality and uncertainty of mobile phone data. In view of this, we delve into the key geographical environment factors that affect the positioning error of mobile phone data, extract error evaluation indexes and construct the spatial distribution model of positioning error with machine learning algorithms. To explore the distribution law of mobile phone data positioning error under different geographical scenarios. In addition, considering the high accuracy of personal travel GPS positioning, this study takes personal travel GPS positioning data as the comparative object of mobile phone data for analysis.

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