A Interactive Visual Interface for Geodata Query with Space-time Cube

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Based on the finding that visual interface has a great influence on the success rate of finding needed datasets in data portals (Xiao et al., 2020), some visualization platforms have been built up to improve efficiency of data query. However, some important aggregated metadata for geodata query are not visualized and only time slider is used to visualize spatiotemporal datasets. Therefore, this research proposes a visualization method that combines space time cube, which is a popular time visualization method recently, and 3D symbols, which use visual variables to represent aggregated metadata, namely data quality, data category, and data size. Based on the method, a prototype is built up using Jiangsu province as the test area. Then, the effectiveness and satisfaction are evaluated.

OBJECTIVE

The overall objective of this project is to design and develop a visualization method of aggregated metadata using space time cube to enable users to get good overview and find needed datasets effectively.

METHODOLOOGY

A concept framework for visualization of multivariable spatiotemporal data is adapted (Li & Kraak, 2010). Fig.1 shows the three components of the concept framework which are adapted to this research.

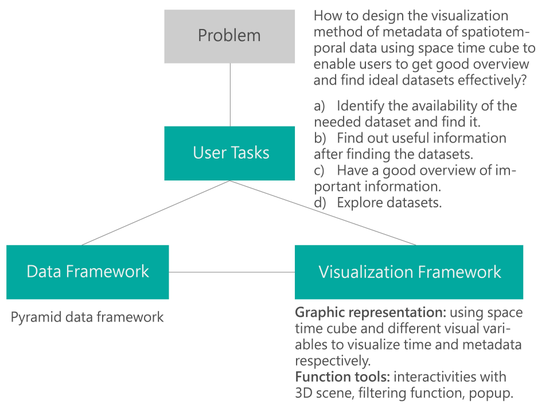

Fig.1 The approach to visual problem-solving involving user tasks, data framework, and visualization framework

The visualization framework is established based on the analysis of user tasks and the data framework adapted. As for the graphic representation,the whole space is a space time cube. The base map is a choropleth map with color value indicating the number of available datasets of each city. Each dataset is visualized by a cube symbol which is placed according to the geographic coordinates and the time. If there are datasets of the same category indicating the same city but with different times, they would be visualized as cube symbols stacked on top of each other along the z-axis. Color, size, and saturation of each cube symbol is used to visualize data category, data size, and data quality respectively. Completeness, an important components of data quality and exists in all data transfer standards, is selected to represent data quality information. It refers to the extent to which all values and all attributes of all features are recorded.

There are three sets of functionalities. The first one is related to the interactivity with 3D scene, including zooming in, zooming out, and rotation. The second set is the filter function. The last one is that when users hover a cube, a popup would be displayed to show detailed information.

CASE STUDY

Test area is the Jiangsu province in China. Geographic data, economic data, social data, and nighttime light data of cities in Jiangsu province are collected. Completeness of each dataset is calculated as the ratio of the number of available records to the total number of records.

The graphic interface is developed using web-related technology. The web map service is provided by Mapbox and a plug-in named Threebox.js is utilized to create 3D symbols with geographic coordinates. The base map is generated by Mapbox Studio. Users can zoom in, zoom out, rotate the scene using mouses. Cubes can be filtered by city and category. When users hover a data cube, time, city, data size, data quality, and data category of the corresponding dataset would be shown. Fig. 2 is the screenshot of this prototype. The prototype is available at: https://unruffled-dijkstra-9403b9.netlify.app.

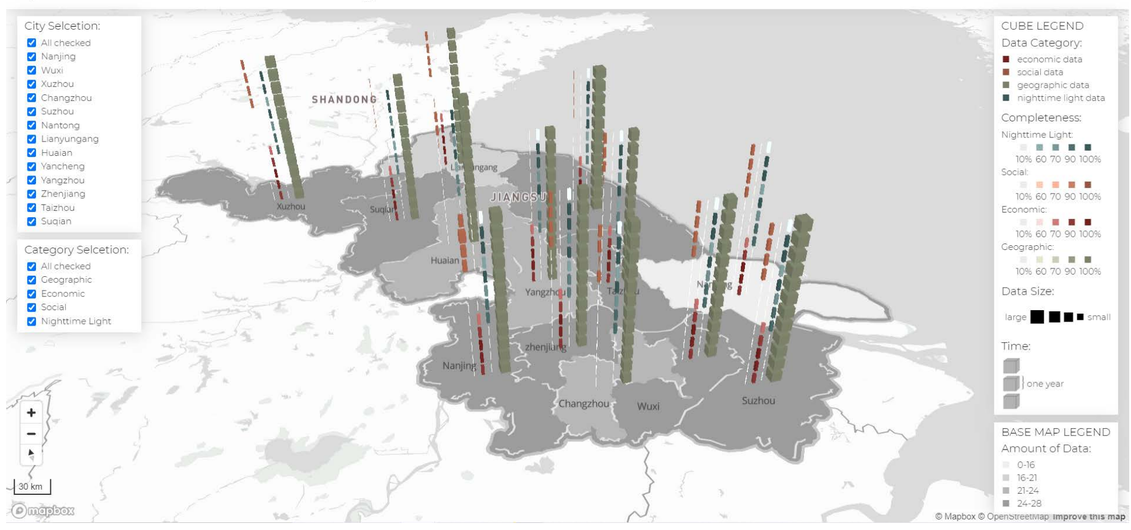

Fig.2 The visual interface to show available datasets of each city in Jiangsu province

EVALUATION

The evaluation was carried out in the form of online questionnaire. There were 32 participants in total.

The effectiveness is evaluated by the correctness of benchmark tasks. The overall performance is good and the result indicates that this visual interface could assist users in identifying needed datasets and providing a good overview of important metadata.

The satisfaction of this visual interface is assessed by the responses in the user attitude investigation. The result is quite diverse. Almost half of the participants thought the space time cube was suitable to visualize spatiotemporal data in this visual interface and that it was simple to complete usual tasks with it. Other participants reported that it was difficult to understand the map.

CONCLUSION

This research proposes an interactive graphic visual interface for geodata query by combing space time cube and 3D symbols. Important metadata for geodata query are visualized. The evaluation result indicates that the effectiveness of the visual interface is good and participants' attitudes towards it are really diverse. Concluded from participants' feedbacks, user-friendly interaction with 3D scene is a critical factor of user's attitude towards this visual interface. Further evaluation of the efficiency of the visual interface can be carried out.

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