P-104

THE SPACE-TIME-CUBE AND THE DISPLAY OF LARGE MOVEMENT DATA SETS: THE LINK BETWEEN VISUALIZATION STRATEGIES AND (CARTO)GRAPHIC DESIGN GUIDELINES

KVELADZE I., KRAAK M.J.
University of Twente, ENSCHEDE, NETHERLANDS

The adoption of modern technologies such as mobile phones and GPS have affected and changed lifestyles and activity behavior of society. It also contributed to the accumulation of massive volumes of movement data. Visualization plays a prominent role in studying these datasets. However, existing visual representations seem weak in their support of complex analytical tasks, especially when it comes to large amounts of diverse movement data.

One of the existing cartographic representations that was specially developed to study the spatio-temporal characteristics of the human activities is the Space-Time-cube (STC). The last decades the interest in this representation has increased considerable because of the technological opportunities. Despite the many domains where the STC is used, it is still unclear what the full possibilities and limitations of this graphic representation are. Its three-dimensional nature allows the easy incorporation of time, but it also increases the complexity of its interpretation. Do users understand its three-dimensional environment? Can all spatio-temporal questions be answered? Can the STC be efficiently and effectively used to display large volumes of data and satisfy user expectations?

The primary objective of this research is to judge the application of the STC in a geovisual analytics environment to support the visualization of large dataset. Since it is known that the display of large volumes of data represents a challenge for almost any graphic representations, this paper proposes a conceptual framework based visualization strategies and design guidelines to support the display.

The Visualization strategy represents a workflow that tries to organize and support the process of data visualization. The workflow depends on the data type, data complexity and the user task to be executed. During the execution of the tasks the geovisual analytics environment has available a large number of geocomputational tools and functions, as well as interactive viewing techniques such as highlighting and brushing that can support the exploration process.

A commonly accepted approach of interactive visual data exploration is Shneiderman's (1996) 'Information Seeking mantra'. It consists of three major phases: overview first, zoom/filter, followed by details on demand. The *overview* level considers the study and display of the general context of the dataset. It specifies the relationships between date elements by aggregating/clustering, while identifying the patterns of interest. *Zoom and Filter* is used to select the data subsets detected in the global view. Then, for the analysis of the selected samples the *details on demand* offer options to study individual elements.

The visualization strategies do not say anything about how the graphics should look like. Therefore, design guidelines are introduced. These are suggestions on how to symbolize the data at hand, based on the (carto)graphic design theory (Bertin, 1983; Tufte, 2006). In linking the guidelines with the visualization strategies one should not only consider the nature of the data, but also the purpose of the particular phase of the workflow.

To verify the above approach the visualization strategies and design guidelines are applied in a different use cases. The cases include:

• The annotated space-time path

A travel log consisting of a trajectory based on different modes of transport, with linked annotations. The challenge is to deal different scales and annotations.

• The historical movement data

The event 'Napoleons march to Moscow' contains fifteen space-time paths (STP) with attribute information. Challenge is to answer question of the individual and combined movement of the armies in space and time.

• Movement behaviors of migratory bird

Complex movement datasets collected by (GPS) transmitters over multiple years in combination with environmental data. Challenge is to represent the complex multidimensional relationships of the trajectories with the environmental data.

• Passive mobile positioning data

Large amounts of movement data collected by mobile phone activities. It contains geographic locations and time stamp information, which informs about the spatio-temporal behavior of the phone holders. Challenge is the application of the data in different geographic studies like tourism and demography.

An extensive usability evaluation, based on user centered design, should reveal the usefulness of the approach as well as inform about the usability of the STC as representation of different movement data sets.

REFERENCES

Bertin J. (1983) Semiology of graphics: diagrams, networks, maps. The University of Wisconsin Press, Madison.

Shneiderman B. (1996) The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations. The Craft of Information Visualization: 364-371.

Tufte E.R. (2006) Beautiful evidence. Graphics Press, Cheshire.