Chapter 28
Building a Visual Analytics Tool for Location-Based Services

Erdem Kaya
Sabanci University, Turkey

Candemir Doger
Sabanci University, Turkey

Mustafa Tolga Eren
Sabanci University, Turkey

Selim Balcisoy
Sabanci University, Turkey

ABSTRACT

Conventional visualization techniques and tools may need to be modified and tailored for analysis purposes when the data is spatio-temporal. However, there could be a number of pitfalls for the design of such analysis tools that completely rely on the well-known techniques with well-known limitations possibly due to the multidimensionality of spatio-temporal data. In this chapter, an experimental study to empirically testify whether widely accepted advantages and limitations of 2D and 3D representations are valid for the spatio-temporal data visualization is presented. The authors implemented two simple representations, namely density map and density cube, and conducted a laboratory experiment to compare these techniques from task completion time and correctness perspectives. Results of the experiment revealed that the validity of the generally accepted properties of 2D and 3D visualization needs to be reconsidered when designing analytical tools to analyze spatio-temporal data.

INTRODUCTION

Over the past few years, the visualization community has worked on problems closely related with the cartographic and geographic information system (GIS) communities. The cross disciplinary connection between these fields facilitates the visual display and interactive exploration of geospatial data and the information derived from it. Analysis of geographic information in time and space is becoming an important subject with the increasing use of location data in everyday life. Some key challenges are understanding the dynamics of data in time and space, identifying spatial and temporal data patterns, and correlating spatio-temporal data to other data such as sales.

In their extensive work, Andrienko and Andrienko (2006) emphasize the need of visualization techniques and analytical tools that will support spatio-temporal thinking and contribute to solving a large

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range of problems. Nevertheless, due to the sophisticated nature of spatio-temporal data analysis, current visualization techniques and analytical tools are not fully effective and need to be improved (Andrienko et al., 2010).

In this work, we are not proposing novel visualization techniques for spatio-temporal data. Instead, we propose that whether well-known aspects of 2D and 3D representations are also valid in spatio-temporal visualization. To support our findings we conducted an experiment with highly representative scenarios and tasks that could emerge in spatio-temporal data analysis.

The main contribution of this work is a novel empirical study leading to the conclusion that 3D visualizations should be considered as a valid option in spatio-temporal data visualizations. To our knowledge this is the first work providing evidence opposing the findings of the previous research against 3D techniques on this domain. A particular kind of visualization technique is not completely advantageous compared to others as suggested by previous work (Andrienko & Andrienko, 2006; Hicks, O'Malley, Nichols, & Anderson, 2003; Kjellin, Pettersson, Seipel, & Lind, 2010; Munzner, 2008; Robertson, Fernandez, Fisher, Lee, & Stasko, 2008). On the contrary, 2D and 3D visualizations seem to be counterparts completing each other. The advantages of 2D representations over 3D for various kinds of data seems to be well-understood which might mislead to the understanding that 3D has more drawbacks than 2D in spatio-temporal visualization. Based on our study and that of Kjellin et al. (2010), it appears to be the fact that there is enough evidence to reject the idea that 3D visualization should only be considered as secondary option in the visualization of spatio-temporal data.

We have analyzed 2D and 3D density visualization techniques, namely density map (Figure 1a and 1b), and density cube (Figure 1c). Before designing our evaluation methodology, we have interviewed system administrators from a Location Based Services (LBS) company and identified most likely scenarios based on which we performed a laboratory experiment to compare density map and density cube techniques from time (to complete the tasks) and correctness perspectives.

Based on the scenario-wise analysis of our collected data, we found out that participants were able to analyze the data faster with density cube technique in the cases where they need to view a given data window as a whole (e.g. trend detection). However, they were able to answer the questions more accurately overall when they viewed the data with density map technique. Particularly, density map technique was significantly better than the density cube technique in the case of cluttered data. Density map technique assisted participants better in terms of accuracy in finding minimum and maximum, and comparison questions, while no significant difference was observed for trend questions. Our scenario-wise analysis

Figure 1. Views from our experimental tool showing the 2D and 3D representations of spatio temporal data from a commercial friend finder application: 2D density map (on the left) and 3D density cube (on the right). Note that the third dimension for the density cube is time.