Understanding View Sizing and Positioning Strategies in Geovisual Analytics

Sen Xu¹ and Vincent Mancuso²

¹GeoVISTA Center, Department of Geography, Pennsylvania State University, PA, USA
²College of Information Science and Technology, Pennsylvania State University, PA, USA

{senxu@psu.edu, vfm105@ist.psu.edu}

Abstract. Advancements in multiple view visualizations have offered analysts great advantages by allowing them to tackle problems from multiple angles. While beneficial, this flexibility in multi-view analytical environments also raises a major question: How should multiple views be organized to best support the analysts goals? This paper discusses preliminary findings regarding strategies that users adopt to size and position multiple views through a task-based experiment. GeoViz toolkit, a multi-view geovisualization tool, was used as an experimental analysis environment. To analyze view manipulation strategies, a political voting data analysis task was designed in which GeoMap, Scatter Plot, Histogram and Parallel Coordinate Plot were used. The experiment was designed to capture how users design their layout when exploring data (analysis mode) and presenting findings (presentation mode). Preliminary results show a number of strategies that offer insight to the spatial thinking of the analysis process, including: intentionally leave gaps between views for cognitive buffer; divide views as “active” vs “reference”. Layout design guidelines and implications for adaptive user interface design from the study are also discussed.

Keywords: Adaptive interfaces, coordinated and multiple views, Geovisualization, visual analytics, GeoViz toolkit, task-based pilot study

1 Introduction

With the advancement in visualization research, it is not uncommon for an analyst to leverage multiple views to tackle analytical problems. There is a number of coordinated and multiple views toolkits for visual analytics, e.g., GeoViz[1], Tulip [2], and GeoDA[3]. These toolkits offer analysts with a selection of visualizations as well as the capacity for reorganizing the layout of a multi-view environment to the analyst’s preference. This creates two major problems with the multi-view visual analytics. First, with so many different views available, the users may not know which view, or combination of views, is most effective to help them meet their goals, especially when the task is exploratory in nature. Second, the analyst has to spend time constantly reorganizing their layouts as they add or remove different visualization components. This process is at best time-consuming, and often, frustrating to the user, thus harmful to the analytical process. This paper focuses on the latter problem.

When a new view is added, or an existing view is removed, the analysts current layout may no longer be acceptable (or comfortable) for them to use and forces them to redesign the already established multi-view environment. Considering the variety of visualizations an analyst may try out, especially in an exploratory study, the effort required to reorganize their view may be detrimental to their ability to complete their task.

One potential solution is Adaptive User Interfaces. In the multi-view situation outlined, the computer could be responsible for automatically resizing and repositioning the windows so the users would be able to seamlessly continue their task.

While this may be a perfectly acceptable solution, a better understanding of the users and how they size and position views must be established first, in order to provide guidelines for designing these adaptive user interfaces.

The layout of a multi-view analytical environment, which analysts “designed” to best support the analysis goal, not only involves efforts to make information from each view easy to see, but also corresponds to analysts’ spatial thinking about the semantics of what each view represents. This paper focuses on an experiment aiming at understanding users’ behaviors and strategies in sizing and positioning the multiple views for geovisual analytics. First we present the research questions and our approach to gain understanding of users’ strategy in designing layout from their working environment. Then we present some preliminary findings and implications on future research.

2 Research Question

Our goal in this paper is to better understand how human users organized multi-view analytical environment. Specifically, we set forth with the two questions below:

- How do users resize/reposition views to support visual analytics tasks?
- How do users reorganize their visual analytics layout for the purposes of presentation?

Following these questions, we conduct a task-based behavioral experiment and interview as a pilot study. The study we designed is outlined in the following section.

3 Methods and Materials

For the purposes of this experiment, the GeoViz Toolkit (Fig. 1) was used as an analysis platform. The GeoViz toolkit was designed to support spatial, temporal and attributable analysis of data. It offers over 20 visualizations for numerical and spatial data. The workspace in GeoViz supports multi-view analysis and all views are coordinated with interactive mouse-over highlighting and single click selection.
3.2 Experiment

To understand user behaviours and preferences in sizing and positioning view layouts, 8 participants were recruited for a short visual analytics task. Before the task, participants were presented with a short story to set the context of the task, and then were briefly trained with GeoViz and the four views' functions. Following the training they were given an analytical task.

For each task the participants were asked to do five things:
1. Add a new view and rearrange all views.
2. Answer an analytical question with available views
3. Save an image of the analysis layout
4. Pretend that they had to present these results to their boss, and re-arrange the windows if necessary
5. Save an image of the presentation layout

After completing the analytical task, participants took part in a semi-structured interview focused on their decisions in sizing and positioning views during the task.

4 Preliminary Findings

In this section we present some preliminary findings for user strategies in sizing and position multiple views.

Analysis mode:
Active view(s) vs. Reference view(s)
Intentional gaps and empty space

Presentation mode:
Removing gaps and filling screen
Removing unnecessary interface elements.

4.1 Analysis: Active View(s) vs. Reference View(s)

Ordering views from left to right, top to bottom according to importance was a strategy found across participants. Multiple participants explicitly described their strategy of positioning views during the analysis as using a specific view (or multiple views) as reference and moving them to the right, and diverted their focus to the view on the left, which they referred to as the active view. For example (refer to Fig. 2), during the two view mode, the user focused and interacted with the scatterplot (left) and only used the map (right) as reference. In the next part of the task a new view was added to the screen. When this new view (histogram) was added, the user moved the scatterplot into the reference bin (to the right), and diverted focus to the histogram as it become the active view.

Fig. 2. Active vs. Reference positioning strategy example 1 (left: 2 views, right: 3 views)

As the analysis task progresses, reference views can be “reactivated” by the user, for discovering new knowledge that was not explicit before. In Fig. 3 (the 3 view screenshot), the GeoMap is positioned to the right as a reference (to show the location of counties) while the user focuses on using both the histogram and scatterplot as active views for data exploration.

Fig. 3. Active vs. Reference positioning strategy example 2 (left: 3 views, right: 4 views)

In the next step of the analysis (the 4 view screenshot), the GeoMap was repositioned back to the left to combine with the incoming view—Parallel Coordinate Plot as the combined active views because they were both needed to identify the result county and its voting population composition.

4.2 Analysis: Intentional Gaps and Empty Space

Another unexpected finding was that during analysis mode, several participants intentionally left gaps and space between views rather than keep everything “tidy”. These gaps were described as “cognitive buffers” in the interview by one participant. The rationale behind this layout is that the visual distance between views helped the user to have a cognitive distance to avoid confusion.

Fig. 4. Intentional gaps and empty space in layout

Leaving empty space is a similar behavior that we also found during experimentation. The purpose for leaving some empty space is to “anticipate new views that will be introduced”. When there is no need for filling the empty space – because the size of each view can sufficiently support conveying information to the participant, the participant feels that it’s not necessary to enlarge all the views to cover the empty space. Instead, leaving the space empty can come in handy when new views are introduced without having to reorganize the whole layout.
5.1 Recognition of Active vs. Reference View(s)
An adaptive user interface system for geovisualization should be able to recognize active or reference view(s) in a supervised way (with user input) or an unsupervised way (without user input). This would enable analysts to manipulate views more efficiently, such as “move all reference view to the right while maintaining the order of the views and highlight active views”. Future research in this area could focus on specifically how to identify the active vs. the reference view(s), and how the transitions can be made without interrupting current work flow of the analyst. Additionally consideration will have to be taken to understanding where the participants would want their reference view to be located.

5.2 Adaptively Add/Remove Views
Currently, most automatic organization of a workspace would try to fill up as much space as possible. Inspired by the strategy of “leaving gaps and empty space for incoming views”, to avoid deterring users from adding new views, a good adaptive system may leave gaps or empty space. This procedure would be under the condition that existing views have achieved their suitable functional aspect ratio and size. As mentioned above, these gaps were an unanticipated outcome of this experiment, and we still have little understanding about whether there is an actual performance benefit to leave these “cognitive buffers” for the users. Additionally, it is possible that these gaps were just a result of the participants not wanting to spend the time to organize their screen.

5.3 Default Sizing
The size and aspect ratio of views in an adaptive system should not only be informed by the preferences of the users but also data-driven. For example, if a GeoMap has higher resolution (i.e. showing voting districts of PA rather than counties), the size of the map should be larger than a GeoMap of lower resolution. With regard to aspect ratio, the shape of the GeoMap for California should not be in the same aspect ratio as for Texas. Another example is that a Parallel coordinal plot with 10 axes should be much wider than one with 3 axes. Data-driven sizing cannot save the user from resizing the view—it should provide a better initial understanding of the data visualization by displaying the data in a non-cluttered manner.

6 Conclusion
This paper presents an initial step in understanding user preferences in sizing and positioning multiple views in an analytical environment. We developed a simple experiment that allowed us to observe user behaviours and investigate underlying strategies. We identified interesting findings for both analysis mode and presentation mode. With insights on how users prefer to organize a multi-view environment, guidelines for adaptive visual analytics interfaces are proposed and future research is discussed.

References