Enhancing Visual Comparisons in Interactive Graphs

Mika Käki
Human-Computer Interaction Group
Department of Computer Science
University of Tampere
FIN-33014 University of Tampere, Finland
+358 3 215 8549
mk@cs.uta.fi

1. INTRODUCTION

Static bar and line graphs are widely used techniques in information visualization. Such graphs are excellent mediums for understanding the overall trends and relationships between data items, because many data items are shown simultaneously in the same context. However, making detailed comparisons between only a few items can be a bit of a problem. This is especially true when the compared items are spatially far apart and the graph is dense.

When just a few items have to be compared, the attributes of those particular items must be retrieved from the physical picture into the human short-term memory in order to make the comparison. This information retrieval must be fast due to the time constraints of the memory system. Locating two distinct features of a picture is hard if eyes have no clear marks to target or paths to follow.

Making the graph interactive can enhance such comparisons. Like Dix and Ellis (1998) suggest, extra value can be added to a formerly static visualization even with the simplest interaction. This paper introduces two interactive techniques for making the visual search easier. 1) *Spatial grouping* helps visual search by placing the compared items next to each other. Attention shifting is easy when the required eye movement is short. 2) *Visual landmarks* help visual search by placing attention-catching marks in the picture. These marks guide the eye to the correct position. An interactive graph using both of these techniques is implemented in IMIS (Intelligent Management Information System) (Käki *et al*. 1998) reporting tool.

2. SPATIAL GROUPING

Spatial grouping is an old technique that is commonly used in static visualizations. For example, comparing three years of financial data of a company is easily done this way (see Figure 1). When using this technique in an interactive visualization, the problem is, of course, not the technique itself, but the interactive control mechanism.

2.1 Interaction

A special widget was designed to control the spatial grouping of the data in graphs. With this widget, called Multiple Range Slider, the user can define number, length and locations of the compared datasets. Figure 1 shows the widget in action. In the picture the user has selected three years (-95, -96, and -98) for the comparison and the graph shows the data spatially grouped so that the corresponding months of each time range are located next to each other. Thanks to the grouping, comparisons can be done easily.

In the Multiple Range Slider buttons labeled '+' and '−' are used to add and remove value ranges, respectively. An individual range functions like a thumb in Range Slider (Williamson and Shneiderman 1992), i.e., the size of the range is adjusted by dragging the edges of the range. The sizes of the ranges are constrained to be equal, so dragging the edge of one range will change the sizes of all the ranges. The feedback about this is given to the user in real time. Dragging a range from the center moves it. In this respect the first range is an exception: moving it moves all the ranges by the same amount. This makes it easy to change the view without changing the relative positions of the compared value ranges. Note that there is a small icon in the middle of the first range to make its special behaviour visible.

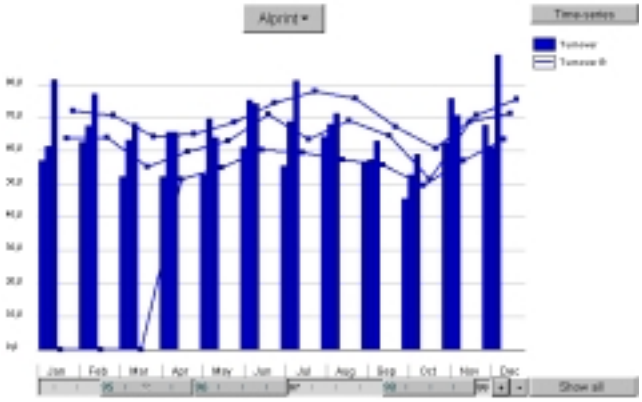

Figure 1. A comparsion enhanced with spatial grouping.

3. VISUAL LANDMARKS

Spatial grouping cannot always be used to facilitate comparisons. Sometimes there is a need to temporarily focus on a small subset of data items. In order to keep the cognitive load minimal, the overall context should not change

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while making such comparison. In practice this means that the structure of the graph or visualization must not change or otherwise the user has to reorient him/herself to the picture. Visual landmarks that are merely added to the picture of interest fulfill this requirement.

3.1 Underlying Principles

The visual appearance of the designed landmarks is based on attributes of the human attention system. The system functions in a way where attention is automatically shifted toward either movement or areas with strong patterns of color, intensity or size contrast (Card *et al*., p. 25). All these features of a picture are preattentive, which means that no cognitive effort is needed in the perception process.

The attributes of the attention system are utilized in the solution in a straightforward manner. The items of interest are presented in stronger color or in higher intensity than the rest of the picture. As a result, attention is easily shifted toward the interesting items.

Note that the same effect could have been achieved in principle by replacing the original color of the element with a stronger one or by placing eye-catching marks to the picture. This would, however, add obtrusive visual clutter to the visualization. Therefore the landmarks are created by fading other elements. This technique produces no extra clutter, preserves the overall context of the picture and still offers clear landmarks for the eye to follow.

3.2 Interaction

A simple point and click syntax is used for controlling the visual landmarks. The user may select multiple values from the x-axis of the graph and/or multiple time-series from the graph legend. The corresponding value ranges and/or time-series are then highlighted. To make landmark removal easy, a button ('Show all') is provided. It simply removes all the landmarks from the picture.

Figure 2 shows an example of the landmarks. In the picture the user has wanted to focus on three months and only two time-series. The use of the landmarks makes the comparison of the interesting items faster, easier and more robust.

The described visual landmarks can also be used to facilitate the reading of a spatially grouped graph. Grouped views get easily quite dense and focusing becomes hard, like in Figure 1. In this situation, the user may focus his/her attention using visual landmarks. When the mouse cursor is placed over a thumb in the slider, the corresponding elements in the graph get highlighted using the landmark technique (Figure 3).

4. CONCLUSIONS AND FUTURE WORK

This paper presented an interaction technique for controlling spatial grouping in graphs and a visualization technique for making unobtrusive visual landmarks. The former technique was based on a new widget, which enables users to make complex queries simply and at the same time gives them good control over the visualization of the results. The visual landmarks, on the other hand, were based on fading items of lesser interest. This preserves overall context of the visualization, but does not add visual clutter. In the future a formal usability test will be carried out.

5. REFERENCES

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Figure 2. A comparison enhanced with landmarks.

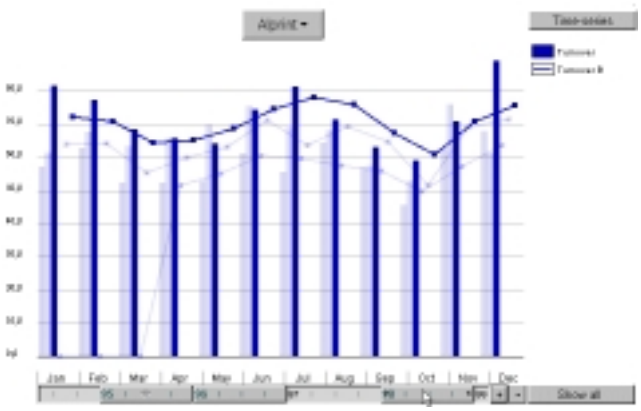

Figure 3. Spatial grouping and landmarks combined. The