Data Visualization Sliders

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ABSTRACT

Computer sliders are a generic user input mechanism for specifying a numeric value from a range. For data visualization, the effectiveness of sliders may be increased by using the space inside the slider as

- an interactive color scale,
- a barplot for discrete data, and
- a density plot for continuous data.

The idea is to show the selected values in relation to the data and its distribution. Furthermore, the selection mechanism may be generalized using a painting metaphor to specify arbitrary, disconnected intervals while maintaining an intuitive user-interface.

KEYWORDS: high interaction, thresholding, information visualization, selection, dynamic graphics

INTRODUCTION

Sliders are a general-purpose user input mechanism enabling users to specify a single input value from a well-defined range. They are widely used in all graphical user-interface systems including Motif, Sun's OPEN LOOK, Apple's Macintosh, and Microsoft Windows. Sliders are easy to use, intuitive, and provide a sensitive mechanism for specifying values. Sliders have a threshold bar positioned within a scale that the user manipulates with a mouse to select a value. Graphical input tools with similar function include dials, bars, pointers, gauges, and potentiometers [6].

A common application of a slider in information visualization is to control a threshold filtering the entities shown on the display. For example, Becker et al. [3] use a double-edged slider with upper and lower thresholds on their network maps, Eick et al. [5] use a categorical slider on their software displays for selecting an arbitrary subset from hundreds of time-ordered software modifications, and Ahlberg et al. [1] describe their alpha-slider for selecting a single string from sorted list. Ahlberg and Shneiderman's FilmFinder [2] uses a suite of double-edged sliders.

The idea uniting these applications is filtering. In each case sliders are used to restrict the information portrayed on the screen, thereby pruning the visual clutter and enabling the analyst to see important underlying patterns. The pruning of visual clutter from data-rich displays by adjusting sliders is particularly effective in information visualization, and even more so when done dynamically.

Data Visualization Sliders

The data visualization slider in Figure 1 is tied to *frost*, the average number of frost free days in the state capitol [7] of the 48 continental states. The average number of frost free days ranges from 364.5 in California to 179 in North Dakota with an average of 264.

Figure 1 shows four instances of the slider that the user may toggle between with a pop-up menu. Slider versions A and B treat *frost* as continuous data within a range and versions C and D treat *frost* as categorical data with 50 discrete values, one for each state. The idea in A is to combine a visualization color[1] scale and a slider with interaction techniques. B extends this by showing the smoothed distribution of *frost*. C maps *frost* level to one color-coded bar, and is particularly interesting when there are enough distinct values so that each bar is one pixel wide [4]. D generalizes this idea to encode the *frost* in the bar's length.

This slider improves upon traditional sliders for data visualization in three ways:

- The space inside the slider is used as a color scale, thereby efficiently utilizing screen real estate, a limited and precious commodity. The color scale may have discrete values as in A and B or be a spectrum as in C and D.
- The data values are shown as tick marks in a "rug plot" [9] (p.135) along the edge in versions A and B and as the bar lengths in version D.
- The distribution of the data is shown as a density plot in version B and as the bar lengths in version D.

A user operates a traditional slider by depressing the left mouse button to engage the bar and then moves it to a new position. The slider in Figure 1 generalizes this intuitive user interface by enabling a user to select arbitrary regions. A user sweeps the mouse over the slider with the left button depressed to select a region or the middle mouse button depressed to de-select. The selected, or turned-on, regions are shown in their color and, the unselected, or turned-off,

[1] In the black and white version of this paper color has been mapped to gray level.

regions are shown in dark gray. This action is similar to operating a paint program, where the user paints-on or paints-off the intervals of interest. In A a portion of the bottom color is turned-off, in B the middle and top are turned-off, in C all bars are on, and in D only the top few bars are on. D is also interesting because the colors have been rescaled for finer fidelity within the top few bars.

Besides toggling between the versions, some other interesting pop-up menu options include:

- Color rescaling on C and D which re-allocates the color spectrum to the currently active bars, thereby providing increased color fidelity, and
- Range zooming for increased scale sensitivity,
- Animation for C and D which causes the computer to sequentially activate each bar in turn, and
- Labeling to print the statistic values next to the bars in C and D.

The density plot in B shows the smoothed distribution [8] of *frost*. By default, the color scale divisions in A and B are linear, but for skewed variables, linear spacing may be inefficient. The user may adjust the partitions interactively with the mouse to select a natural place for the division such as a low spot on the density curve.

Summary

The slider described here generalizes the generic functionality of traditions sliders along several orthogonal directions. The important ideas include:

- Enabling a user to specify an arbitrary number of disconnected intervals while preserving the intuitive slider interface.
- Using the space inside the slider as a color scale.
- Interactively rebinding the colors either to the active bars or adjusting the color divisions.
- Presenting the distribution of the data.
- Showing individual data values, either as tick marks or as bar lengths.
- Moving between the representations under user control, thereby enabling the users to explore from several perspectives.

Linking sliders to the data they control suggests many natural and obvious extensions.

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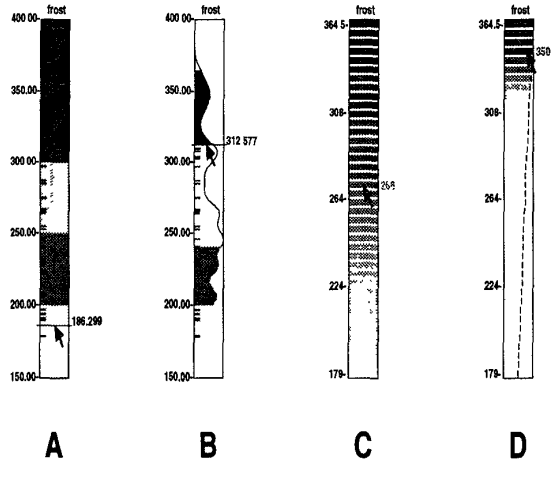

Figure 1: Four versions of a data visualization slider tied to *frost*, the average number of frost free days in the state capital. Sliders A and B treat *frost* as a continuous variable and C and D as a discrete variable. The space inside of the slider box functions as a color scale (A and B) and shows the distribution of the variable (B and D). Users operate the slider by turning or or off regions of interest using a painting metaphor (A, B and D), with the colored area on and gray area off, and may manipulate the color scale (D).