

VIDA (Visual Information Density Adjuster)

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ABSTRACT

Multiple studies have shown that clutter or sparsity in visual representations can have negative effects ranging from decreased user performance to diminished visual appeal. We have developed a system that assists users in the construction and navigation of visualizations with appropriate visual information density. This system, VIDA (Visual Information Density Adjuster), applies a cartographic principle to minimize clutter and sparsity in visual displays of information.

Keywords

Clutter, constant information density, interactive graphics, information navigation, multiscale interfaces, visual interfaces, visualization, zoomable interfaces

INTRODUCTION

Clutter or sparsity in visual displays of information can be undesirable for a number of reasons. For example, clutter can result in overplotting, in which certain objects are not visible because they are occluded by other objects. Sparsity can result in inefficient use of the available display space. These problems are difficult to address in static displays of information. In the increasingly popular interactive visualization systems, they are even more complex.

A guiding principle that addresses clutter and sparsity can be derived from the *Principle of Constant Information Density*, drawn from the cartographic literature [7]. This principle states that the number of objects per display unit should be constant. A more general formulation posits that the amount of information (as defined by metrics discussed below) should remain constant as the user interacts with a visualization. We have designed and implemented a system, the Visual Information Density Adjuster (VIDA), that applies the Principle of Constant Information Density to the construction and navigation of

visualizations.

The remainder of this paper is organized as follows. In the next section, we describe the database visualization system that provides the context for our work. We then describe an extension to this system that helps users construct visualizations with appropriate visual detail. We next describe a method for automatically creating constant information density visualizations of non-uniform data distributions. We then introduce a novel zoom method that is particularly appropriate for constant information density displays. Finally, we present related work and conclude.

DATASPLASH

DataSplash is a direct manipulation system in which users can construct and navigate visualizations [2, 4]. Like a number of other visualization systems, DataSplash represents objects in a two-dimensional canvas over which the user may pan and zoom. In such systems, zooming changes the user's distance from the canvas, also known as the perceived *elevation*. Objects' appearances change as users zoom closer to or further away from the visualization. This functionality is known as *semantic zoom* [8, 3].

DataSplash provides a unique device called a layer manager with which users can graphically specify the point at which transitions between different representations occur. The layer manager allows users to interactively program semantic zoom applications.

THE VIDA LAYER MANAGER

Our experience with DataSplash indicates that users find it difficult to construct visualizations that display an appropriate amount of detail. We have developed an extension to the DataSplash layer manager that gives users feedback about the density of applications as they create them [10]. This mechanism, which is based on the Principle of Constant Information Density, helps users create visualizations that display, on average, a constant amount of information as the user zooms.

VIDA DISPLAYS OF NON-UNIFORM DATA DISTRIBUTIONS

Many data sets have non-uniform distributions; naïve visualizations of these data sets have areas that are sparse or dense. We have developed an extension to DataSplash that automatically creates displays that are uniform in the x , y , and z dimensions. Users express constraints about visual representations that should appear in the display. The system applies these constraints to subdivisions of the display such that each subdivision meets a target density value [11].

GOAL-DIRECTED ZOOM

Because the amount of display space available to an object varies with elevation, a graphical representation of an object that has appropriate visual complexity at one elevation may have inappropriate visual complexity at other elevations. Many zooming systems address this issue by supporting multiple graphical representations of objects. Multiple representations allow a balance between display density, elevation, and representation.

Consider the relationship between zooming and choice of representation in such systems. In naïve systems, elevation and choice of representation are controlled independently by the user. In semantic zoom systems, the elevation determines the choice of representation [8, 3]. An alternative is a system in which the choice of representation determines the elevation. We call the functionality provided by such a system *goal-directed zoom* [9]. We have incorporated goal-directed zoom in VIDA. Therefore, when a VIDA user chooses the representation they wish to see, VIDA automatically navigates to an elevation at which that representation appears at appropriate detail.

RELATED WORK

A number of interactive visualization systems provide clutter reduction mechanisms. For example, Ahlberg and Shneiderman's work allows the user to filter objects in the display dynamically [1]. This technique does not differentially filter subdivisions of the display. Therefore, the resulting visualizations can have regions that are too dense and/or too sparse. Fishkin and Stone extend the dynamic query model by providing movable filters that the user can position manually in the display [5]. This technique is highly appropriate for non-uniform data. However, unlike VIDA, the movable filter technique as described in this work requires the user to choose explicitly the areas to which filtering is applied. One can imagine using VIDA's density techniques to place movable filters appropriately.

Non-linear magnification schemes can also be used to minimize clutter in the display [6]. In fisheye views, for example, objects are viewed as though through a fisheye lens so that objects in the center of the screen are given more display space than objects on the periphery.

Further discussion of related work appears in [9, 10, 11].

CONCLUSIONS

We have presented a system, VIDA, that applies the Principle of Constant Information Density in an interactive visualization environment. VIDA can provide users interactive feedback about density as they create visualizations. VIDA can also construct uniform visualizations of non-uniform data distributions. Finally, VIDA incorporates a novel zoom method appropriate to constant information density visualizations.

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