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Exploratory Visualization through Copy, Cut and Paste

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Abstract

Our goal is to help oceanographers to visualize and navigate their data over several runs. We have been using parallel coordinate plots to display every data value. Through our copy, cut, paste interactions we aim to enable users to drill-down into specific data points and to explore the datasets in a more expressive way. The method allows users to manipulate the PCP on a ZUI canvas, take copies of the current PCP and paste different subset views.

Keywords: Information Visualization, Visual Analytics, Interaction Techniques

Index Terms: Information Interfaces and Presentation [H.5.2]: User Interfaces—Graphical User interfaces (GUI)

1 Introduction

When visualizing and analyzing high dimensional data, it is usual for the visualization scientist and domain experts to explore different parameterizations and visual depictions. In particular, we have been collaborating with ocean scientists, whose research generates huge datasets from many runs with different parameterizations [9]. Our collaborators are interested in investigating sediment transport down an estuary, or along a coast. The change of sediment provides bathymetric variables that help to make better predictions of flooding events.

In order for the researchers to interactively manipulate the information we place the data, of every variable, into a Parallel Coordinate Plot (PCP) (see Fig 1, lower left): every data point becomes one polyline. We couple this information with other linked views, such as rose plots, time-line views, geo-spatial views etc. However, the data is huge, with many Terabytes of data stored from several runs. While displaying all the data into a PCP allows easy manipulation and filtering of the information, it is slow to render, and extreme overplotting makes it difficult to understand. We have used binning techniques [8] and intensity rendering styles, to enhance the PCPs clarity, yet the user is still faced with a difficult challenge of drilling down and exploring particular parameterizations.

What we require is a way to drill down into specific values by copying and editing the PCP. This would allows the scientists to choose a range on, say, salinity, and then look at specific values. Moreover, not only is the data and its depiction important, but also the process of interaction itself enables the user to better understand the information [12]. Our idea is to place the PCP on a Zoomable User interface (ZUI) and provide copy, edit and split operations to manipulate the PCP. In this way we intend to offer oceanographers new interaction techniques in order to help them interact with their data in a more expressive way.

In this work-in-progress paper we present a prototype interface where PCP depictions can be explored through *copy, cut and paste* operations. A user can create a visual depiction, select some of the elements, copy and paste different entities. These copies allow the user to fragment the visualization into smaller and manageable chunks of information. For instance, the user can select high values

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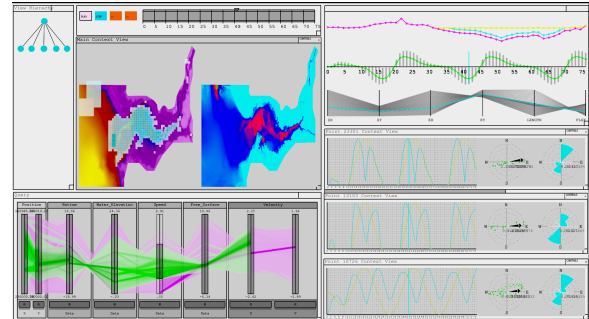¶p.ritsos@bangor.ac.uk

Figure 1: Screenshot from our Visual analytic oceanographic interface, showing multiple coordinated views [9].

of a PCP to be displayed in one view, while low values are displayed in a second view.

2 Related Work

Other tools (e.g., VisTrails [1]) capture an exploratory state, yet our focus is on the experimentation of the different visual depictions. Work by Claussen and Wijk [6] on drawing of axes in PCPs would enable similar functionality, however we intend on making derivatives of the designs through replication and copying commands as well as to integrate our ZUI with other views. The *worlds within worlds* interaction metaphor [7] is another inspiration, where users directly manipulate graphical depictions; so is SDM [5], which supports widgets and allows for the user to directly manipulate aspects of the actual visualization.

In addition, one of our goals is to provide a rich interactive experience for the oceanographers. Several researchers have encouraged the community to investigate and develop the theory and practice of interaction. For instance, Thomas and Cook [16] in their seminal work (in recommendation 3.3) highlight the need to 'create a new science of interaction to support visual analytics'. Yi et al. [17] develop this idea further. In fact, out of the eleven taxonomies that Yi et al. summarize the closest to ours is the Basic Visualization Interaction (BVI) framework of Chuah and Roth [4]. Chuah and Roth divide the tasks into graphical operations, set-operations and data-operations, and presents a hierarchy of interaction styles, and then into methods that operate and transform or manipulate the current visualizations. In a similar way, we use cut, copy and paste and interact with the PCP. Copy and paste creates sub-views of the main PCP, while cut removes part of it.

3 Design methodology & implementation

Our design methodology is one of *replication* and *editing*. Bell [2] writes "Most of us edit as we write .. you change a word in a sentence, write three sentences more, then back up ... or you edit a sentence and a new idea suddenly spins out from a word change". Most multiple view systems allow the user to change some parameters and create a new view of that data (usually the old information replaces the new). Our methodology is to take an original visualization, copy it and then adapt it. This fits in with the three part model of Roberts [15] replace, replicate, overlay, and is used in visual comparison [10]. While we don't use *overlay* at present, it would
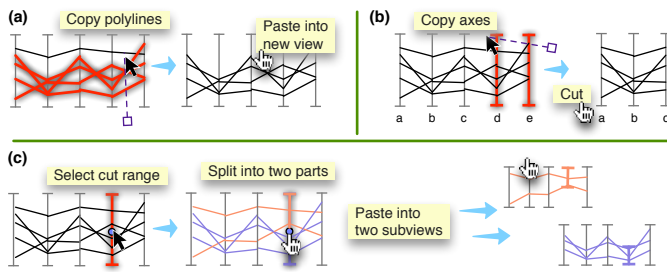
Figure 2: To demonstrate copy and paste, the user has chosen a line selection tool (selecting every element that touches this line); demonstrating the following operations: (a) a subset operation (b) polyline cut, and (c) split then paste to subviews.
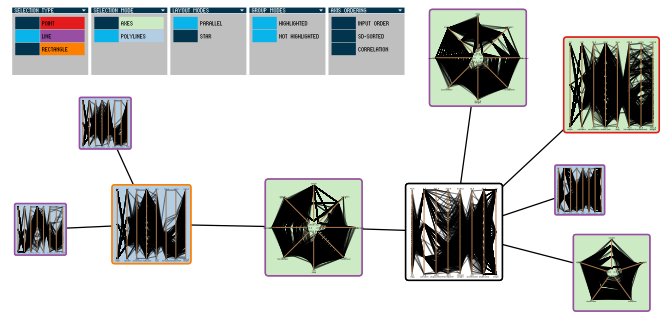

Figure 3: Screenshot of our cut/copy/paste window. Showing a ZUI interface, with menus to control how the paste operations occur. In this prototype stage, the data is using the car dataset, and we are currently integrating the ZUI into the oceanographic tool.

have use to compare data values, in this oceanographic context; or could be used to provide further multiplexing of visual variables [3].

In our design users can start with a visualization and then take copies of the whole, or of parts. Fig 2 shows a schematic of some operations. Specific axis can be selected and pasted to generate a view of only that data (the other parts are removed from the new display), or users can select a split point to derive two versions (one with values above that split point and vice versa.)

Our implementation employs PCP subviews on a zoomable canvas, providing free form positioning. Copy and paste can then be applied hierarchically, making the use of a zoomable canvas for exploring the instances similar to the image trees of Ma [13]. The subviews act as a demonstration of the users' interaction history.

Zoomable interfaces have their merits and challenges. They enable the user to create many depictions, but have been criticized for not demonstrating context (e.g., [11]) and challenge working memory when comparing over instances [14]. We display the context of the editing operations through different colors, and relationships by lines. Also, we have optimized the zoom operation, by only refreshing subviews that are different to those previously updated, where the user can quickly zoom to change their focus.

Our prototype interface is shown in Fig 3 and shows the interface working on the cars dataset. It has full functionality of *cut* (to remove polylines or axis), *copy* to select the whole PCP or sub parts of the display to make subviews of those selections. Users can select a split point along an axis, and the system generates two subviews with the data points above, and another with the values below the split point. It stores the hierarchy information and the user can choose how to display the results (in a star plot or standard PCP). We can *brush* parts of the windows that get highlighted in other related subviews. The user can *re-position* and *resize* the views on the ZUI, *zoom* into specific visualizations, while *automatic layout* algorithms can be applied to position the subviews in the ZUI.

4 FUTURE WORK & CONCLUSIONS

We are currently working on integrating our ZUI into our oceanographic tool. Because our oceanographic tool already stores a hierarchical model of the windows (as shown as the graph view, top left of Fig 1) we are able to use this structure to add in the subviews. Brushing and linking can also be added easily because we have used a similar underlying data structures. We are working to improve the rendering styles, and to use the binning and highlighting techniques of our oceanographic tool.

From our current implementation and experience with using our oceanographic multiple view system, we have found the ZUI window to be extremely useful, and enables the user to try out different parameterizations and explore the dataset through subviews. However it does add many windows, and therefore requires a large screen; certainly additional research is required to manage the many

views, and to help the user in their exploration, such that they do not get lost in a mass of views. In this work-in-progress paper we have described a technique to use copy, paste, cut and split commands, and have presented a working prototype implementation.

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