Evaluation of Visualization Techniques for Communicating Off-Screen Data

Tony Jimenez, Sophie Engle, Alark Joshi
Department of Computer Science
University of San Francisco

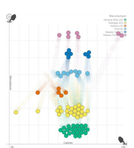
Introduction

- Worldwide, the use of mobile devices like tablets have begun to integrate themselves in people's daily lives.
- However, tablets and other mobile devices do not have the screen size to display intricate visualizations.
- A possible solution to this problem is to create a system that allows users to look at the details of the visualization while still having the context of the rest of the data.
- We created techniques like a histogram aggregation, a box and whiskers aggregation, and a 3 forms of swarm plot aggregation.
- We believe that these techniques will provide a unique perspective on the data and will each serve their own purpose in evaluation off-screen data.
- Our histogram allows users to see distribution within certain ranges, while the box and whisker plot shows the interquartile distribution, and finally the swarm plots allow the users to see the distribution shape of the graph while in bucket form.

Related Work

- **(Drucker et al. 2013):** This paper focuses on how to translate interaction features over to a mobile or tablet setting. The question being posed here is whether or not traditional desktop interfaces work well, or if a gesture-centric touch based interface can work better for the user.
- **(Ramik Sadana and Stasko 2014):** The paper by Sadana and Stasko in 2014 focuses on creating an interactive scatterplot visualization that can be used with techniques similar to those in the Drucker paper to allow for a more gesture-centric interface. The issue with this approach however is that they focus solely on the scatterplot technique.
- **(Rzeszotarski and Kittur 2014):** The paper by Rzeszotarski and Kitturas in 2014 focuses on physics-based affordances and multi-touch interaction techniques. They argue that these techniques allow for better awareness of the data on screen and could potentially lower the time it takes to train someone in understanding a visualization. However one of the concerns that is brought up is that it is not scalable, limiting the amount of points on the screen to around 500.
- **(Rao and Card 1994):** The paper by Rao and Card in 1994 focuses on Merging Graphical and Symbolic Representations in an Interactive Focus by creating a new visualization called the table lens. The table lens is useful because it creates a visualization that can focus on minute details while still keeping the overall shape and distribution of the entire dataset. An issue with this however is looking at certain points takes them out of the scope and it only gives you information on the data without the context of it in the visualization.

Sadana, R., and J. Stasko

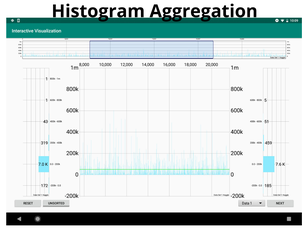


Rzeszotarski, Jeffrey M., and Aniket Kittur

Sadana, Ramik, and John Stasko

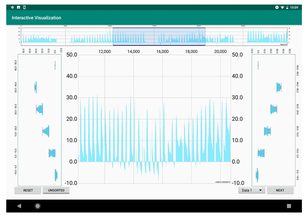
Methodology

Histogram Aggregation

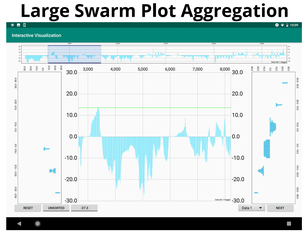


Box and Whisker Aggregation

Small Swarm Plot Aggregation



Large Swarm Plot Aggregation

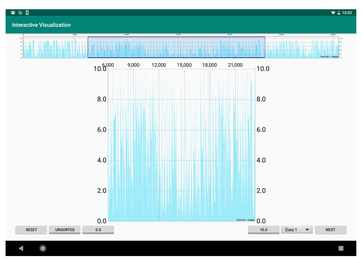


Dynamic Swarm Plot Aggregation

We wanted to create a visualization that can work larger sets of data while not clogging the screen with difficult to read visualizations. This led us to creating graphs on the sides that aggregate all the offscreen data and present it in a different form from the main visualization. A technique that is present in all of our visualizations is the top overview with selection bar. It allows the user to see the entire dataset at a glance, allowing them to scroll easily.

- **Histogram**: Our first aggregation was a histogram that showed the amount of off-screen data in specific ranges.
  - If the chart has moved and data has gone off-screen then the left and right histograms will add the datapoint to the bar updating the height and the label associated with the bar.
- **Box and Whisker:** The next aggregation is a box and whisker plot that creates multiple box and whiskers. This technique allows users to be able to see how many points are in a certain range.
  - We show maximum, minimum, median and the interquartile range
- **Swarm Plot:** The next set of aggregations that we worked on all follow the same basic concept of creating a swarm plot. A swarm plot allows the user to see the shape of the data, which allowed us to show the most amount of information on the aggregation.
  - Seeing the shape of the distribution allows you to more easily put in context the main screen that is zoomed in.
  - The difference between each of the swarm plots is how many points are allowed on screen. Large Swarm plot allows 100 points, the small swarm plot allows 40 and the dynamic swarm plot allows the user to change that input.
  - The reason we chose to divide these aggregations into different sets is that we wanted to see how the differences within each visualization affect the outcome of the survey. Does more points per graph allow the user to understand more of the distribution, and does the added amount of points lead to minor distribution changes to be more apparent?

Control



Experimental Setup

The experiment will be a survey that will have 6 sections 1 for each type of aggregation and then we shall add a control, this has been put on hold for the moment, but we plan to have all users look at each aggregation so we can compare our results within all users.

Conclusion & Future Work

- For our future work, there are multiple ways the project could be enhanced. One way is that we could introduce chunking into our dataset to allow even bigger datasets to be traversed and looked at. One of the major problems we set out to face was creating an environment where large datasets can be easily traversed, through the use of off-screen data, and while we managed to have a good amount of points on our visualization, chunking would make it so that more points in general would be able to be plotted.
- There is also the possibility that other types of aggregations can be used and tested to see what they offer. We only have 5 aggregations, and we could change things up to allow users to see other types of aggregations by clicking a button that would switch the aggregation view. This could allow users to learn about the distribution of the graph while also seeing how the shapes are similar or different from one another.

References

- Drucker, Steven M., Danyel Fisher, Ramik Sadana, Jessica Herron, and M. c. Schraefel. 2013. "TouchViz." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13*. https://doi.org/10.1145/2470654.2481318.
- Keim, Daniel A., Ming C. Hao, Umesh Dayal, and Meichun Hsu. 2002. "Pixel Bar Charts: A Visualization Technique for Very Large Multi-Attribute Data Sets." *Information Visualization*. https://doi.org/10.1057/palgrave/ivs/9500003.
- Rao, Ramana, and Stuart K. Card. 1994. "The Table Lens." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Celebrating Interdependence - CHI '94*. https://doi.org/10.1145/191666.191776.
- Rzeszotarski, Jeffrey M., and Aniket Kittur. 2014. "Kinetica." *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems - CHI '14*. https://doi.org/10.1145/2556288.2557231.
- Sadana, Ramik, and John Stasko. 2014. "Designing and Implementing an Interactive Scatterplot Visualization for a Tablet Computer." *Proceedings of the 2014 International Working Conference on Advanced Visual Interfaces - AVI '14*. https://doi.org/10.1145/2598153.2598163.
- Sadana, R., and J. Stasko. 2016. "Designing Multiple Coordinated Visualizations for Tablets." *Computer Graphics Forum*. https://doi.org/10.1111/cgf.12902.