UNIVERSITY OF SOUTH FLORIDA

Defense of a Doctoral Dissertation

Constructing Frameworks for Task-Optimized Visualizations

by

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For the Ph.D. degree in Computer Science and Engineering

Visualization is crucial in today's data-driven world to augment and enhance human understanding and decision-making. Effective visualizations must support accuracy in visual task-performance and expressive data communication. The research interest on design guidelines focuses on effective visualization design depend on the visual channels used, chart types, or visual tasks. However, we learned that design choices and visual judgment are co-related, and effectiveness is not one-dimensional, leading to a significant need to understand the intersection of these factors to create optimized visualizations. Hence, constructing frameworks that consider both design decisions and the task being performed enables optimizing visualization design to maximize efficacy. This dissertation describes experiments, techniques, user studies to model user perception for visualization design optimization and data transformation for low-level visual tasks. To begin with, I identify the limitations through a taxonomized state-of-the-art survey on perception-based visualization study focusing on Visualization effectiveness is task-dependent. With a specific focus on the scatterplot, I developed perceptual models for cluster perception and design optimization. In addition to design guidelines from the first experiments, I embody the findings to show design choices based on the visual density of the scatterplot could influence the user's judgment on visual tasks. Further, I address the challenge of assessing line-chart smoothing effectiveness for a range of analytical tasks. In conclusion, I elaborate on utilizing the framework to provide less ambiguous data presentations, leading to better quality and higher confidence in decision-making.

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THE PUBLIC IS INVITED

Publications

1) **Ghulam Jilani Quadri** and Paul Rosen, "A Survey of Perception-Based Visualization Studies by Task." To appear in Transactions on Visualization & Computer Graphics, 2022

2) **Ghulam Jilani Quadri** and Paul Rosen, "Modeling the Influence of Visual Density on Cluster Perception in Scatterplots Using Topology." IEEE Transactions on Visualization & Computer Graphics, 2021.

3) Paul Rosen and **Ghulam Jilani Quadri**, "LineSmooth: An Analytical Framework for Evaluating the Effectiveness of Smoothing Techniques on Line Charts." IEEE Transactions on Visualization & Computer Graphics, 2021.

4) **Ghulam Jilani Quadri**, Jennifer Adorno, Brenton Wiernik, and Paul Rosen, "Scatterplot Design Optimization using Clustering." IEEE Transactions on Visualization & Computer Graphics, 2022 (to appear)

5) **Ghulam Jilani Quadri**, and P. Rosen, "You Can't Publish Replication Studies (and How to Anyways)," In Proceedings of VIS'19: IEEE Conference on Visualization. Workshop on Vis X Vision, 2019.

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