CIFellows 2020-2021

Computing Innovation Fellows

Constructing Frameworks for Task-Optimized Visualizations

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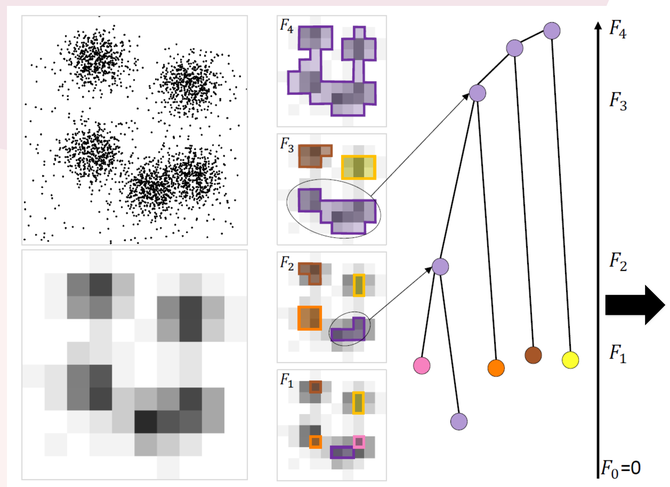
Effective visualization must provide a clear and unbiased understanding of the information in the given data to support user's accuracy in visual task-performance and expressive data communication. Visualization effectiveness, a task-dependent engagement, directly impacting the design choices, is a constant pursuit to ameliorate efficacy. How does the effectiveness of visualization vary with visual task and visual design? How can an intersection of both visual tasks and visual design provide a visualization that optimally communicates data for a given scenario? In this work, we will see how we can resolve such conflicts and make a visualization more effective and optimal.

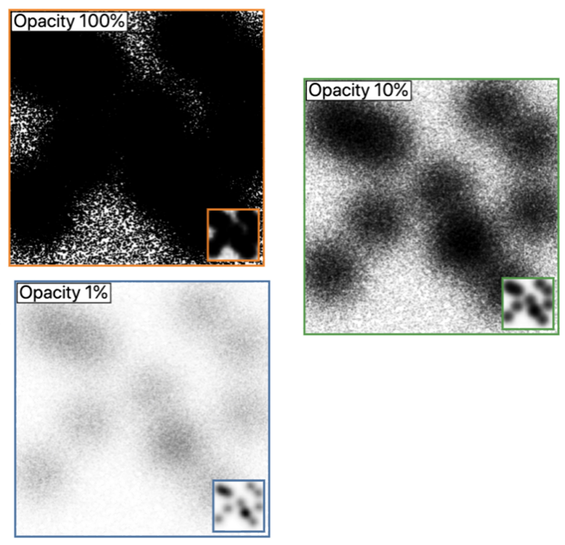
Constructed on previous renowned work that meticulously explores and evaluates visual design, a framework is proposed on visualization parameters in yielding the optimized design choice, data pre-processing suited for a given task.

In this work, I focus on building frameworks that allow visualization designers to optimize the design parameter of the given visualization for the task at hand. My research focuses facilitating design choices and data pre-processing to improve visualization effectiveness for the visual task. I believe in seeing how we can study and investigate visualization design, helping us build a task-optimized framework.

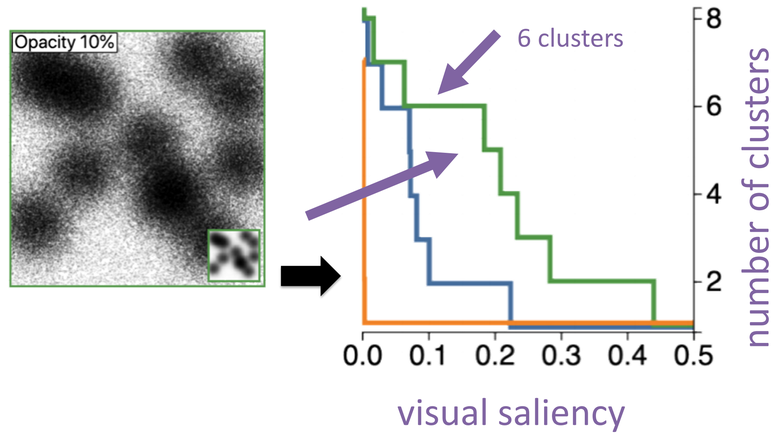
Clustering in Scatterplots



Histogram on Visual Density — Visual Density –Based Merge Three

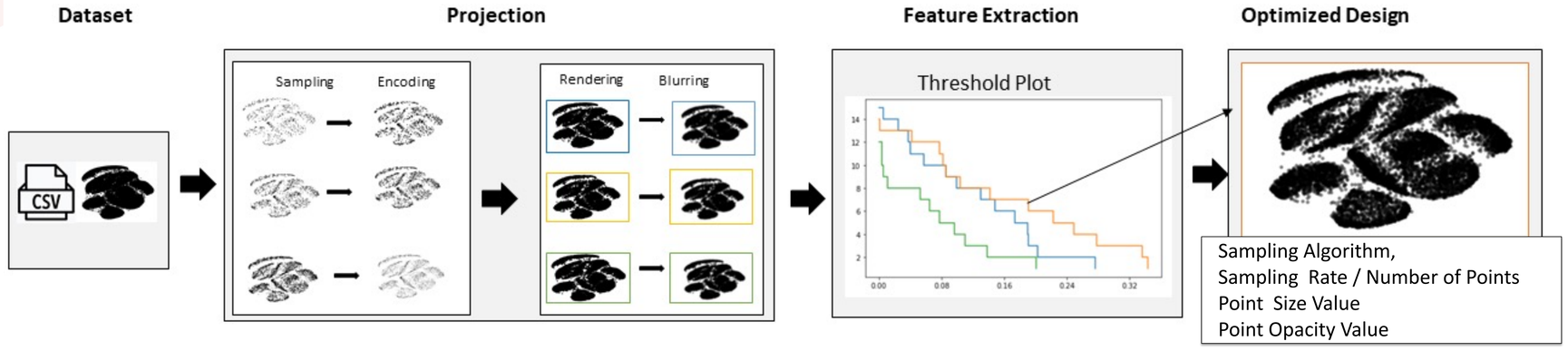


Scatterplot Designs with Varying Opacity value

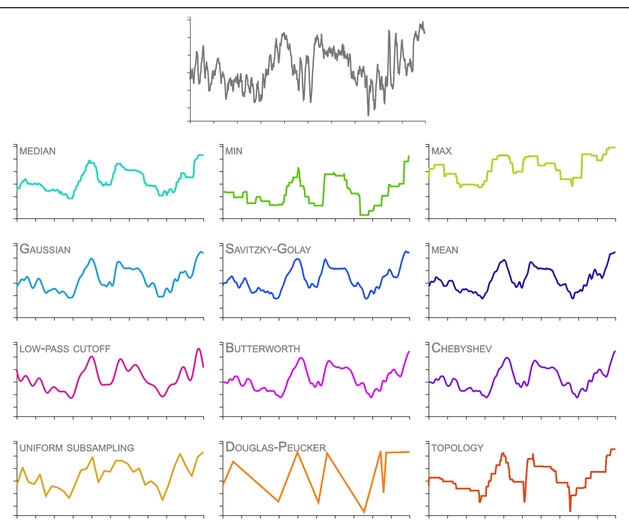


Threshold Plot for 3 Scatterplot Image

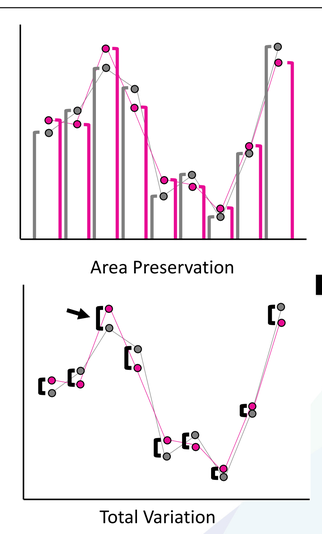
- Design optimization is a perennial topic in information visualization, striving to effectively visualize the data for better interpretation and accurate user task performance. **Visualization effectiveness is task-dependent.**
- I developed perceptual models for cluster perception and design optimization on the scatterplot. In addition, I employ the findings to **show design choices based on the visual density of the scatterplot could influence the user's judgment on visual tasks**.
- I address the challenge of assessing line chart smoothing effectiveness for a range of analytical tasks using **an analytical framework for measuring the effectiveness of smoothing techniques.** The framework evaluation shows that no single smoothing technique is ideal for all visual analytics tasks
- These findings collectively inform how to optimize a visualization design on visual encoding, data aspects, and data transformation to support the user's performance at low-level visual tasks. I elaborate on utilizing the framework to provide less ambiguous data presentations, leading to better quality and higher decision-making confidence.



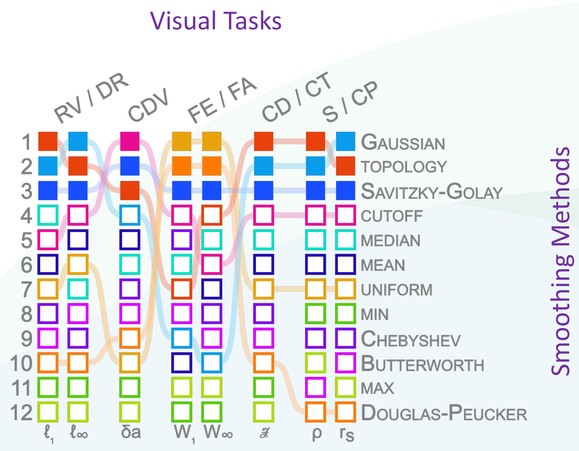
Line Chart Smoothing



Same Dataset with Different Line Smoothing Methods



Two of the Metrics of Effectiveness



Ranking of Line Smoothing Methods

Building frameworks that include both perceptions of visual encodings and tasks is an essential step to optimizing visualization. I preferably in this work, extend the previous studies applying the Feedback-Loop System and models the optimization of visualization using human perception. This study describes experiments, techniques, and user studies to model user perception for visualization design optimization and data transformation for low-level visual tasks.

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