A Framework for Dynamic Color Adjustment in Visualizations: Improving Accessibility for Sighted, Low Vision, and Colorblind Users

Scarlett(Yi) Yang
University of Toronto, Toronto, Canada

1 Motivation

Visualizations are among the most compelling media for communicating intricate data. However, they rely immensely on color, which excludes people with visual impairments like low vision (LV) and color vision deficiencies (CVD). 295 million people around the world have moderate-to-severe vision impairment(IAPB 2020), most visualizations fail to address their needs. On the other hand, there are various limitations for a sighted people to explore the visualizations specifically prepared for the vision-impaired audience.

Previous approaches using predefined color schemes or automated recoloring algorithms, which failed to be adaptive and flexible. This framework will contribute toward filling this gap by allowing dynamic color adaptation with a view to enhance access by a varied audience in an active user-driven manner.

2 Research Question

The main research question is the design of a framework that will enable real-time user-driven color adaptations in visualizations, and improve the accessibility for sighted, low vision and colorblind viewers.

3 Literature Review

Prior work has targeted visualization accessibility, with special concern for colorblind viewers. Tools like ColorBrewer provide static color palettes optimized for colorblindness (Brewer et al. 2003). Automated recoloring algorithms (Zhu & Mao 2021) adjust images to enhance color discriminability.

However, these approaches are limited in several ways. For example, they primarily focus on colorblindness, neglecting the needs of low vision individuals who may require high-contrast colors, non-color cues, or other accessibility features. In addition, they are based on predefined rules or batch processing, offering little flexibility for real-time, user-driven customization. Also, they lack integration with existing visualization tools, limiting their practical applicability (Fan et al. 2023).

This project builds on these efforts by proposing a dynamic, user-driven framework that integrates multiple accessibility features and allows users to tailor visualizations to their specific needs.

4 Methodology and Outcome

The project will be conducted in three phases: Design, Validation and Documentation.

In the design phase, a framework for dynamic color adjustment will be developed. It also includes a set of design principles for accessible visualizations and a prototype interface for real-time customization.

Then, in the validation phase, evaluate the framework by applying it to existing visualizations, and gathering feedback from various users.

In the last phase, all the findings will be compiled into a report on the design of dynamic color adjustment.

The expected contributions include a new framework for dynamic color adaptation in visualizations, an understanding of how real-time personalization can improve accessibility of visualizations for sighted, low vision and colorblind viewers, and practical guidelines for integrating accessibility into visualization tools.

5 Limitation

This project has several limitations. The first one is, lacking of functional prototype. Due to time constraints, the framework will be demonstrated through mockups and case studies rather than a fully functional tool. Secondly, the user testing is limited, the framework will not be tested with low vision or colorblind users during this project. Also, The framework will focus on specific types of visualization, like bar charts and line graphs, to ensure feasibility within the term. Lastly, this project will not consider blind people because incorporating tools for blind people accessing visualizations is not within the current scope.

To mitigate these risks, the project will employ simulated validation; for example, colorblindness simulators will approximate user needs. Also, provide guidelines for future work, such as implementation of the framework in a functional tool and user studies with low vision and colorblind individuals.

References

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