What are User-Adaptive Visualizations? Why are they important?

Visualizations that can personalize information presentation to the needs of each individual user, in real-time.

Research Objectives

1. Identify which users/tasks characteristics impact user visualization experience enough to justify adapting to these characteristics (What to adapt to)
2. Investigate impact of user & task characteristics on attention patterns for specific elements of a visualization, to identify possible targets for adaptation (How to adapt)
3. Investigate if eye-tracking data can inform user models to predict, in real-time, characteristics relevant for adaptation (How and when to adapt)

User studies

Evaluate impact of individual differences on using bar and radar graphs.

Bar/Radar study

- Higher PS corresponds to faster completion time for simple tasks
- Confirmed that PS also impacts the effectiveness of two different visualizations (i.e., users with low PS are slower with radar graphs compared to users with high PS)
- Users with high visWM preferred radar graphs more than users with low visWM
- Users with low verbWM rated bar graphs easier to compare to users with high verbWM
- Patterns in gaze sequences indicate that users with low PS, visWM, and verbWM spent more time reading the task question
- Users with low PS and low verbWM transitioned more often to non-relevant parts of the visualization

Intervention study

- All three cognitive abilities (PS, visWM, verbWM) were found to significantly impact performance with complex tasks
- First study to connect visWM and verbWM to task performance with a visualization
- Analysis of the three of the four evaluated interventions (Bold, Connected, Arrows, De-Emphasis), all significantly improved task performance, regardless of task complexity and delivery time.

ValueChart study

- All three cognitive abilities (PS, visWM, verbWM) were found to significantly impact performance with various low-level tasks
- Linked visExp to performance with complex low-level tasks (i.e., low visWilp users have lower performance)
- For high-level tasks, users with low visWM were faster with the horizontal layout, contrary to previous findings showing that lower visWM users are at a disadvantage

Summary of the analyses and results

- All three cognitive abilities (PS, visWM, verbWM) were found to significantly impact performance with complex tasks
- First study to connect visWM and verbWM to task performance with a visualization
- Analysis of the three of the four evaluated interventions (Bold, Connected, Arrows, De-Emphasis), all significantly improved task performance, regardless of task complexity and delivery time.

Future work

- Use interactive real-world visualizations designed by our industrial partner: www.metroquest.com