International Cartographic Association
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Designing a Web Study to Evaluate the Cognition of Movement Parameters using Static versus Dynamic Visualizations of GPS Tracks

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Keywords: user evaluation, geovisualization, spatiotemporal data, movement visualization, cartography

Abstract:

With the widespread increase in the availability and quality of space-time activity data (Miller, 2005), people increasingly encounter geographic information displays with high visual and cognitive load. It is therefore essential to evaluate the communicative efficiency and effectiveness of various aspects of complex visual displays in helping people understand spatiotemporal data. Fabrikant has called for a "cognitively inspired and perceptually salient" approach to cartographic displays and has done much work on empirically evaluating map displays for the interpretation of spatial data, such as in the case of weather maps (Fabrikant et al., 2010). Cognitive evaluation (similarly referred to as *perceptual evaluation*; Ware, 2013) poses a key opportunity to learn how to support efficient visual communication of complex spatiotemporal information – such as in movement visualization – for applied decision-making. Cartographic representations play an important role in the graphical representation of spatiotemporal information (Fairbairn et al., 2001). Such visualizations, like maps and network diagrams, are increasingly involved in data exploration and analysis of complex behavior in the fields of movement ecology and mobility research (Demšar et al., 2015, Yuan and Raubal, 2012), as movement is necessarily spatiotemporal.

In this study, we compare the use of static and dynamic geovisualizations to evaluate movement parameters including speed and direction. To create the web-based visualizations, we generated seven visualization formats representing movement trajectories using points and lines in DynamoVis (Dodge et al., 2018) in 2D displays. The design of each visualization was systematically varied along the visual variables of size, color, and shape, representing different movement parameters (Bertin, 1983, White, 2017). Using these visualization designs, participants were asked to complete a series of identification and comparison tasks. These tasks included identifying and counting changes in movement along the trajectories, such as pauses, acceleration, deceleration, and directional changes. Other tasks included making comparisons between different segments of trajectories and between two simultaneously presented movement tracks to evaluate how well visualizations assist cognition of relative movement patterns (Laube et al., 2005).

Our work opens a discussion on methodological approaches for evaluating movement visualizations using online surveys and ideas for next steps. Although we originally planned to administer the study in an in-person setting, the web-based design has advantages such as the potential to quickly reach and scale to a broader pool of users, the allowance for maximum flexibility in study completion, and greater validity with regards to transferable use cases for web map visualizations (Griffin et al., 2017). In this workshop on Adaptable Research Methods for Empirical Research with Map Users, hosted by the ICA Commission on Cognitive Visualization, we present a discussion of the study structure, visualization design, adaptation to the web platform, and expected outcomes. This and future planned studies will contribute fundamental insights into the cognition of movement visualizations and inspire new methods for empirical evaluation of geovisualizations. As scholars increasingly aim to generalize their findings about visual communication through means such as geovisualizations, web-based studies can provide broader insight into how to communicate spatiotemporal information to public audiences.

Acknowledgements

This research is supported by the National Science Foundation, Award # 1853681: "Visualizing Motion: A Framework for the Cartography of Movement."

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