Visualizing Travel Time: Approaches, Perceptual Quality, and User Issues

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ABSTRACT: Perceived travel time is a primary resource that people rely on to understand the environment around them and to make decisions related to where to go and what path to take. Due to the importance of perceived travel time, cartographers and visualization researchers have put significant efforts into development of techniques to visualize this metric in a cartographic format. However, in interpreting the visualizations created, there may be substantial variation in the effectiveness of the different map interfaces based on the reader's situational context (e.g., are they stationary and still planning their route or are they actively moving along a path), or the specific task that needs to be accomplished (e.g., identifying the path that will take the shortest time to traverse to a specific location, finding overall travel time along a predetermined route, or selecting a destination based on travel time to multiple potential options). This variety of factors makes it difficult for map designers and cartographers to design a single map that will properly handle all potential cases for user context and tasks. The motivation of the work presented here is to provide better design guidelines to handle these challenges. In this work, we categorize and analyze different types of travel time visualization to identify what each format offers to a user. Based on the analysis, we derive a hierarchical typology of travel time visualization techniques. For each of the identified groups in the hierarchy, we conduct in-depth analysis to understand their strengths and weaknesses with respect to perceptual quality. We also conduct a secondary analysis to evaluate the user's situational context and task when trying to acquire information related to travel time. Based on our analyses, we construct and discuss a second typology of tasks that considers type of potential platform for viewing (e.g., stationary work station, hand-held device, smart watch), user context (e.g., spatial analysis from professionals, or casual users who make travel decisions in ordinary life), and the task (e.g., identify the travel time to move to a single destination, general evaluation of traffic congestion, etc.). Finally, we synthesize the derived two typologies so that a map designer and cartographer can use it to weigh the benefits and challenges of different potential visual formats for time visualization. We conclude with future research questions which need to be addressed to improve our ability to effectively communicate travel time to users in a way that appropriately matches their specific use case, situation, and contextual needs.

KEYWORDS: Distance visualizations, travel time, mobile mapping

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