Interactive Computational Tools for Assessing and Understanding Urban Accessibility at Scale

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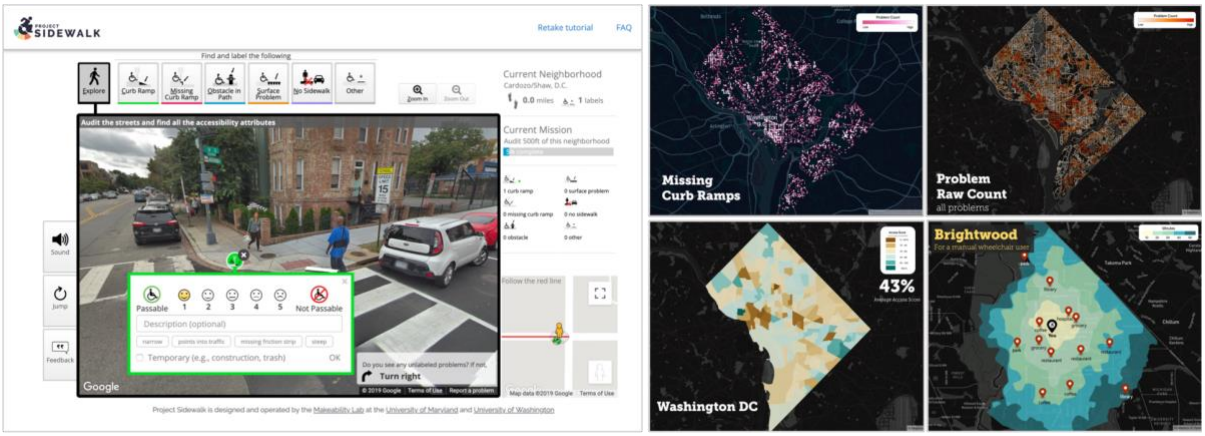

Figure 1. Illustration of (a) Project Sidewalk, a crowdsourcing based tool for collecting urban accessibility data at scale, and (b) Sample of the design probes used in the study on understanding information needs around visualizing urban accessibility.

Abstract

My dissertation research explores assessing urban accessibility and building interactive tools that support decision making processes (*e.g.*, to influence city policy). Using crowdsourcing, visualization, and data science techniques, I will develop a suite of tools that enables stakeholders to understand and communicate about urban accessibility, with a specific focus on sidewalk accessibility. These interactive tools would allow stakeholders to learn about city (in)accessibility, surface underlying causes behind the current state, and help present that information effectively for political advocacy.

Introduction

Urban accessibility *i.e.*, the ability to move around the city by walking/rolling, affects every pedestrian. However, it disproportionately affects people with mobility disabilities. For example, day-to-day tasks such as going to work, traveling to unfamiliar cities, and getting to medical facilities becomes challenging and sometimes prohibitive due to inaccessible infrastructure such as sidewalks. While urban accessibility includes sidewalk and street infrastructure, public transit, and building accessibility, for my dissertation, my primary focus is on sidewalk accessibility.

Sidewalks form the backbone of pedestrian infrastructure. In the US, amongst ~30 million people with disabilities, half report using mobility aids including wheelchairs (3.6 million), canes or crutches, and walkers (11.6 million) [1]. Despite over 25 years since Americans with Disabilities (ADA) Act was passed in 1990 [2], sidewalk accessibility still remains an issue. Several cities have been sued with multi-million-dollar lawsuits [10–14], including major cities like New York, Seattle, San Francisco, and Los Angeles. These lawsuits draw attention to the problem and hold cities accountable. However, such events only happen after the fact—*e.g.*, someone becoming a

paraplegic after an accident due to cracked sidewalk. Holding our local governments accountable and making day-to-day decisions by citizens (*e.g.*, where should I live?) becomes hard without the existence of tools that can provide (a) a sense of the state of (in)accessibility of the physical city infrastructure, (b) visualize and quantify the spread of (in)accessibility, and (c) surface up its root causes *e.g.*, any demographic inequity and disparity in resource allocations for underserved areas within cities. Development of these accessibility-aware tools has been identified as one of the grand challenges [3].

The primary reason for the dearth of these tools has been the lack of comprehensive data on sidewalk accessibility. With the recent city initiatives such as Age Friendly [15] and Vision Zero [16] to make city streets/sidewalks safe and walk/roll friendly along with compliance requirements from ADA regulations and ongoing lawsuits, cities now collect data periodically, and due to recent open data initiatives, the data is often made public [17,18]. However, even with publicly available data, consuming them in meaningful ways is a major roadblock in making assessments and utilizing this data for supporting decision-making processes.

My goal is to make access to this information visible and accessible to the citizens and government alike through easy-to-use interactive tools. I will work on developing tools that will help in (1) building deeper understanding of this issue, (2) increasing transparency and accountability, and (3) provide support for political advocacy. Towards this goal, the larger research question that I focus on is: "*How do we enable and support stakeholders to understand and advocate for urban accessibility?*".

To answer this overarching question, I characterize urban accessibility as a three-pronged problem: (1) Creating comprehensive datasets: "*How do we gather data around accessibility at scale and foster civic engagement?*" (**RQ1**), (2) Utilizing sidewalk data for making assessments and decisions: "*How might we utilize this data to answer questions around accessibility using interactive visualizations?*" (**RQ2**), and (3) Creating meaningful representations from the visualizations to support advocacy efforts: "*What is the best way to frame the narrative and provide appropriate context to create effective visual data representations for communication and advocacy?*" (**RQ3**).

For addressing each of these concerns, I will investigate methods and tools that allow our target stakeholders to assess the state of urban (in)accessibility, *e.g.*, "*Why does my neighborhood have poor accessibility?*", "*What are the major areas that need significant repairs?*" The five primary stakeholder groups for the envisioned tools are: local government officials (*e.g.*, transit departments), policymakers (*e.g.*, elected officials), accessibility advocates (*e.g.*, advocacy orgs), people with disabilities, and caregivers. Below, I elaborate on the past, ongoing.

Dissertation Research

Data Collection Thread: Using Crowdsourcing and Online Streetview Imagery

Data collection through physical inspections, the primary method used by cities, are a time-consuming, resource-heavy, and an expensive process. For making this process easier and cheaper, I led a 2-year effort to develop and deploy Project Sidewalk[1] [8,9] in Washington DC. Since then, the tool has been deployed in Seattle, WA [19,20], and Newberg, OR [21,22], with more cities to come in the future. Building on prior work [5,6], the web-based crowdsourcing tool

[1]projectsidewalk.io

uses Google Street View wherein volunteers virtually walk on city streets to find and label accessibility issues such as missing curb ramps, presence and absence of sidewalks, obstacles, and surface problems. We quantitatively analyzed the worker performance in terms of common labeling mistakes and behavior. We also performed interviews with three stakeholder groups (*N*=12) to understand perceptions on the utilization of this data. Government officials envisioning using as a triaging method before physical inspection and serving as a civic engagement tool. People with disabilities and caregivers envisioned using this data for accessibility-aware tools such as for navigation.

Visual Data Analytics Thread: Using Interactive Geo-Visualization and Modeling Techniques

Building on the findings from the previous study, prior work on designing location-based assistive tools [4], and our preliminary work on modeling accessibility [7], in this thread of research I want to understand the diverse information needs around visualizing urban accessibility and how we can support them through interactive tools. To answer these questions, I conducted a large (*N*=25) formative study using 24 visualization probes (Figure 1b) with our five stakeholder groups. The primary research questions for this ongoing work are: What are the best ways to visualize sidewalk data and provide actionable insights for decision making, advocacy, and community engagement? and How can we create computational models for urban accessibility to support multi-variate comparative analysis within and across cities? Using the findings from this study, I will work on building web-based interactive visualization tools facilitating exploration and analysis.

Visual Advocacy Thread: Using Storytelling and Narrative Visualization Techniques

In this thread of research, I want to explore: how can we use the prior visualizations to create compelling stories? What are the important contextual factors to consider? For this future work, I intend to work with graphic designers, data journalists, and our existing stakeholders to design and evaluate the tools.

Current Stage of Research

I spent the first half of my PhD working on the first thread—looking into city-scale data collection of sidewalk accessibility with the goal of mapping the accessibility of the world. I developed, publicly deployed, and maintained Project Sidewalk and published this work at CHI 2019 [9]. My current focus is on building new interactive visual analytical tools around the data collected that will allow deeper understanding about physical accessibility. The last piece for my final year would be building tools for creating compelling narratives for visual advocacy for these issues.

Expected Contributions

The planned suite of tools resulting from my research has the potential to facilitate deeper understanding of accessibility and giving voice to citizens in a way that can potentially bring change. Additionally, our findings and tools would allow interested novice users to utilize open city datasets to analyze and find the underlying root causes. Finally, the tools and research findings could be used for other urban issues beyond accessibility.

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About the Author:

Manaswi Saha is a Ph.D. student in the Paul G. Allen School of Computer Science and Engineering at the University of Washington, Seattle advised by Prof. Jon E. Froehlich. Her research lies at the intersection of human computer interaction, accessibility, urban informatics, data visualization, and computational social science. In her PhD, her research focuses on using human-centered methods to study, design, build, and evaluate systems for understanding and improving urban accessibility. She received a Best Paper Award for her work on Project Sidewalk at CHI 2019 and Amazon's Catalyst Award 2019 for her ongoing work on developing tools and techniques to visualize urban accessibility data. She has worked with researchers at Microsoft Research, Adobe Research, CMU, and IIIT-Delhi in the past. Her previous research has been in navigation technology for people with visual impairments, IoT for brick-and-mortar stores, and energy sustainability of smart homes.