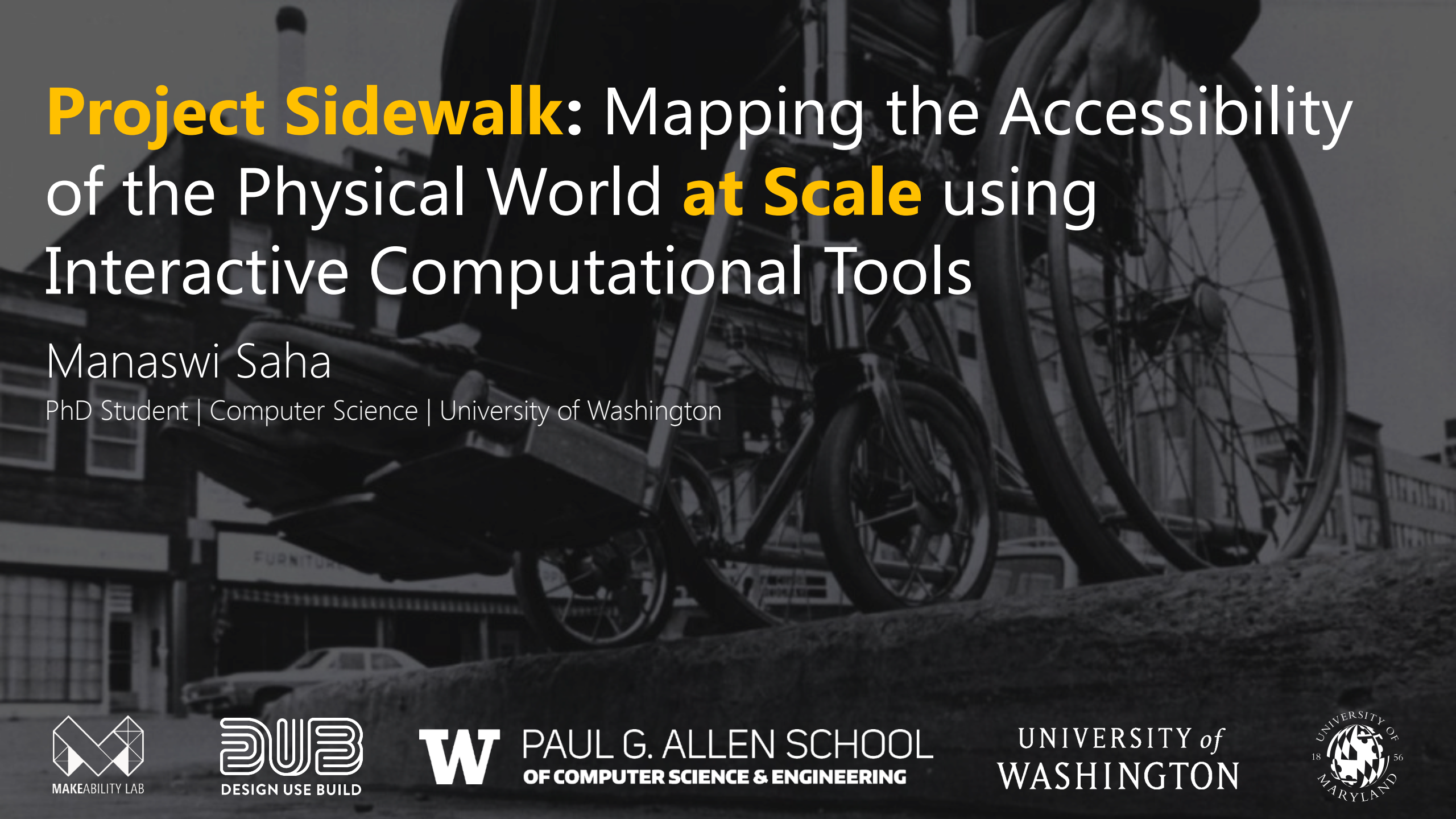


Project Sidewalk: Mapping the Accessibility of the Physical World **at Scale** using Interactive Computational Tools

Manaswi Saha

PhD Student | Computer Science | University of Washington

MAKEABILITY LAB

DESIGN USE BUILD

PAUL G. ALLEN SCHOOL OF COMPUTER SCIENCE & ENGINEERING

UNIVERSITY of WASHINGTON

UNIVERSITY OF MARYLAND 1856

30.6

million U.S. adults have a mobility impairment

Source: US Census, 2010

15.2

million use an assistive aid

Source: US Census, 2010

CHANEL
CHANEL
CHANEL
CHANEL
ONE WAY
NO PARKING
DIESEL

NO CURB RAMPS
CHANEL
ONE WAY
DIESEL

PHYSICAL OBSTACLES

SURFACE PROBLEMS

FedEx
INCOMPLETE SIDEWALKS

PHYSICAL OBSTACLES
NO CURB RAMP
SURFACE DEGRADATION

Accessible infrastructure
has a significant impact
on the independence
and mobility of citizens
[Thapar *et al.*, 2004 ; Nuernberger, 2008]

The National Council on Disability noted that there is **no comprehensive information** on "the degree to which sidewalks are accessible" in cities.

National Council on Disability, 2007
The impact of the Americans with Disabilities Act: Assessing the progress toward achieving the goals of the ADA

OUR VISION

Design systems that transform the way urban accessibility information is **collected** and **utilized**.

Reset View

WELCOME TO ACCESS SCORE

Interactive Visual Exploration of Physical Accessibility

Start exploring the accessibility of Washington DC by dragging the + cursor into a rectangular box over the map.

The selected regions will be colored based on their accessibility scores. More information for the selected regions will be shown on the right sidebar panel.
Click on any specific region to know more about a neighborhood.

Start Coloring!

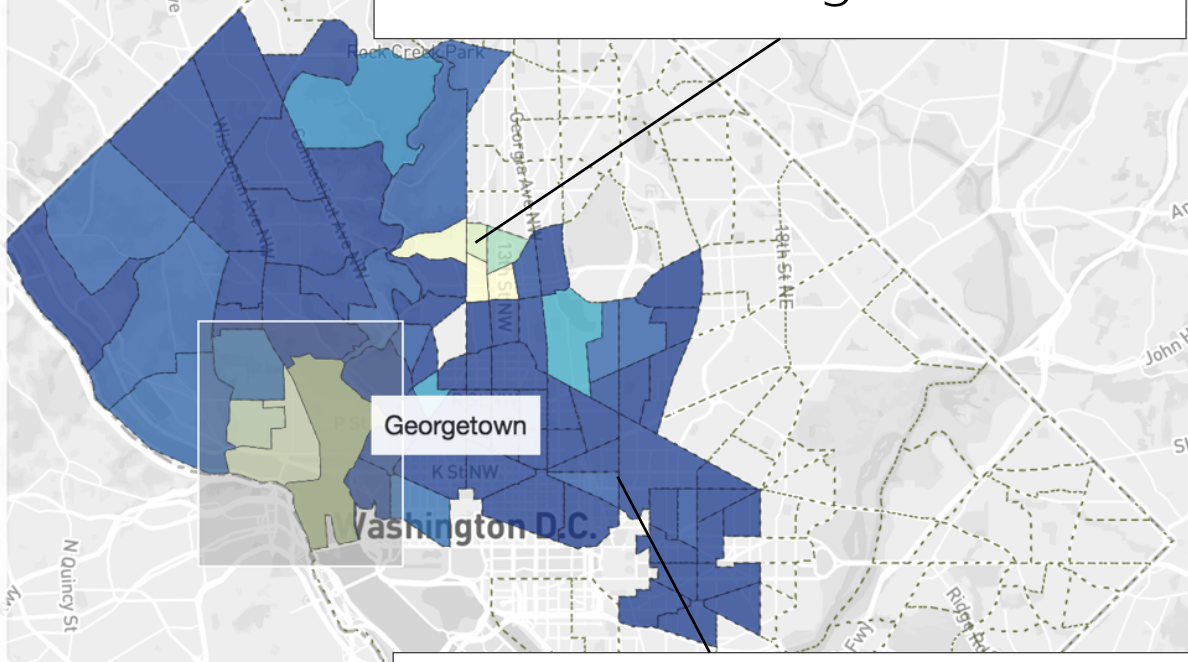
Data Coverage: **100%**
Average Access Score: **89.7**

Know More

Access Scores
- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 90
- 90 - 100

Least accessible (low score) to most accessible (high score)

Green-Yellows indicate inaccessible neighborhoods



Blues indicate an accessible neighborhoods

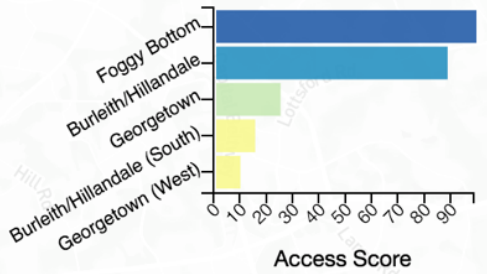
Showing information for the selected area

Georgetown

24.5

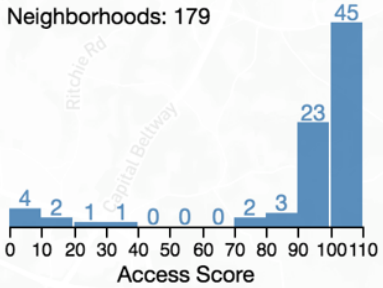
Average score **88.9**

Top 5 accessible regions



Histogram of Access Scores

Total Neighborhoods: 179

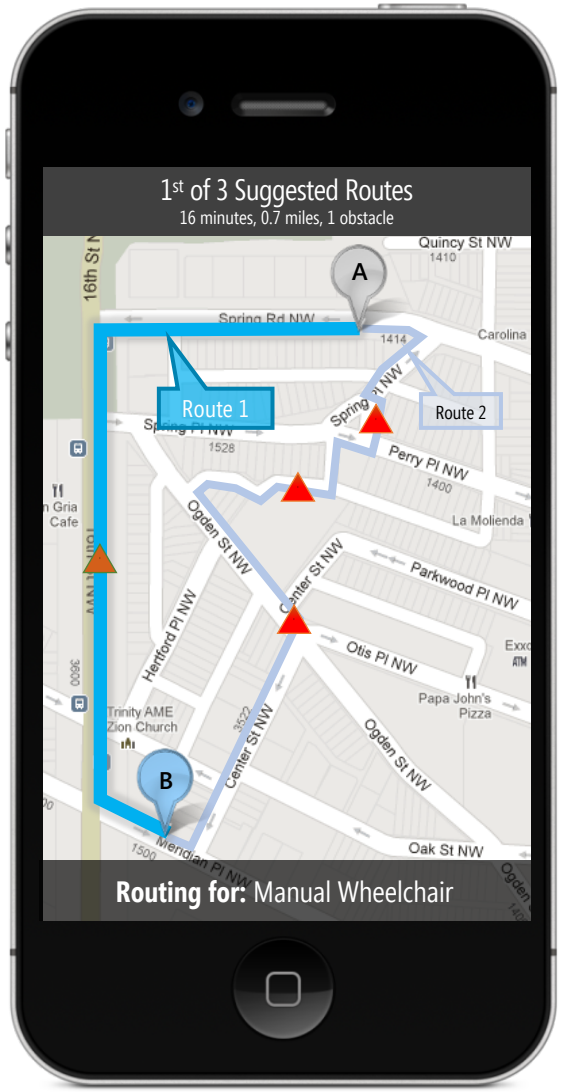


Interactive Visualization of Accessibility Data

mapbox
© Mapbox © OpenStreetMap Improve th

MOTIVATION

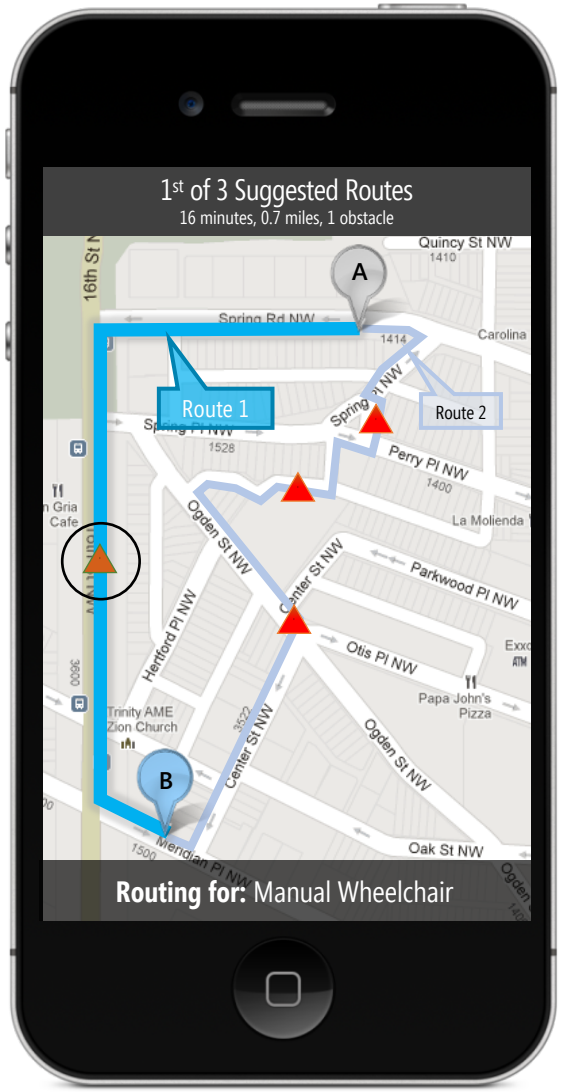
ACCESSIBILITY-AWARE NAVIGATION



Showing alternate routes tailored to a person

MOTIVATION

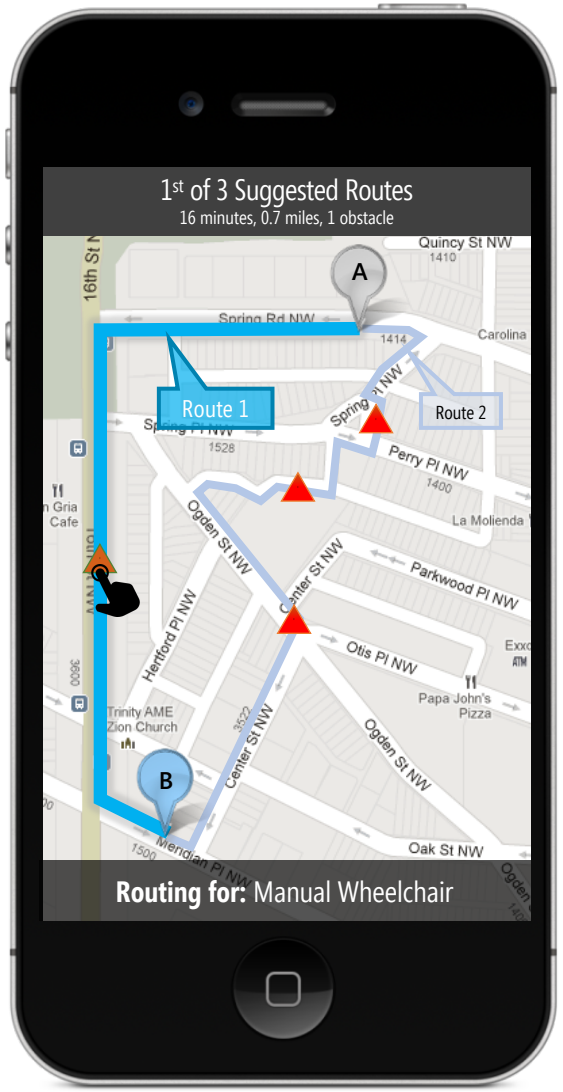
ACCESSIBILITY-AWARE NAVIGATION



Investigating mobility barriers along the route

MOTIVATION

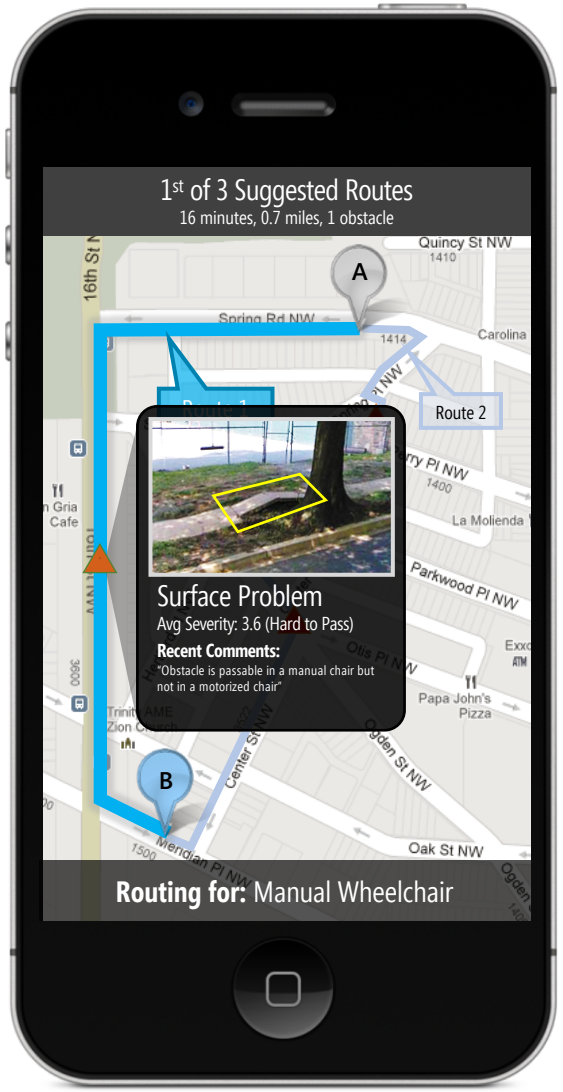
ACCESSIBILITY-AWARE NAVIGATION



Investigating mobility barriers along the route

MOTIVATION

ACCESSIBILITY-AWARE NAVIGATION



Investigating mobility barriers along the route

THESE APPLICATIONS HAVE

HUGE DATA

REQUIREMENTS

THESE APPLICATIONS HAVE

HUGE DATA

REQUIREMENTS

How do we get this data?

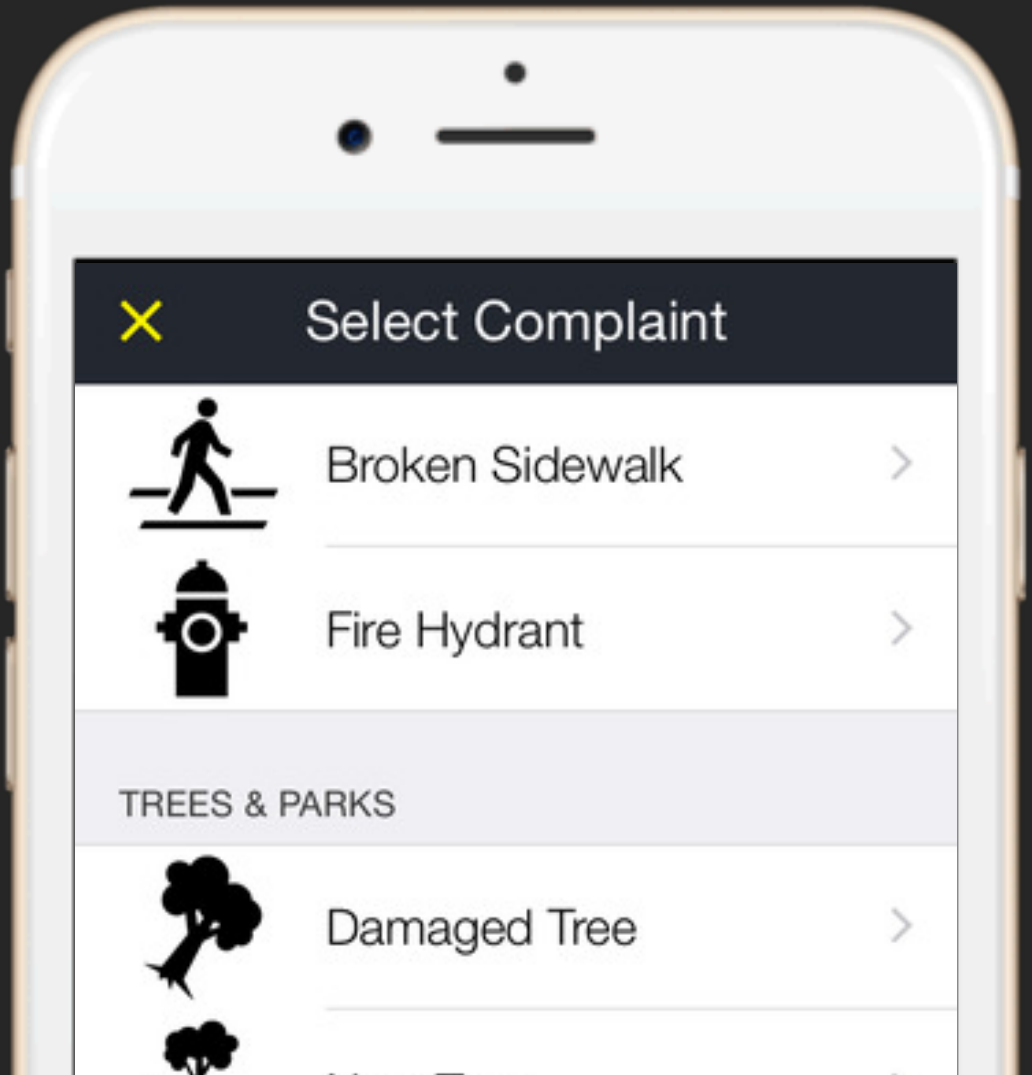
Traditional Physical Audits

Walkability Audit
Wake County, North Carolina

Walkability Audit
Wake County, North Carolina

Safe Routes to School Walkability Audit
Rock Hill, South Carolina

Mobile Reporting Solutions



http://www1.nyc.gov/311/index.page

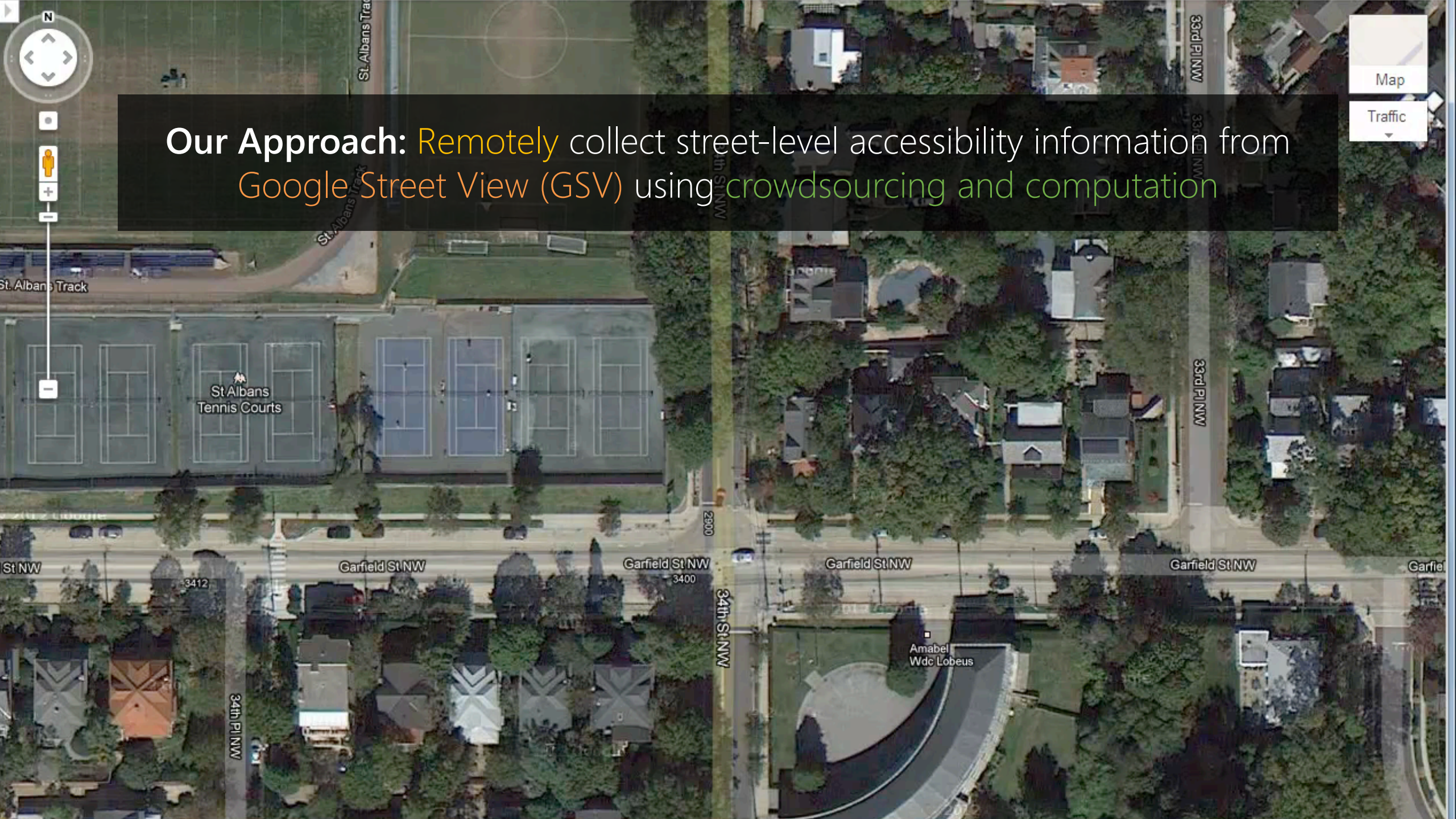
MOTIVATION

CHALLENGES OF TRADITIONAL DATA COLLECTION APPROACHES?

Slow, Manual, and Laborious

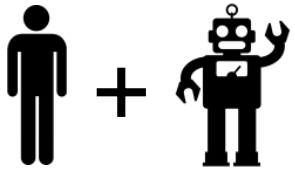
Huge Cost

Localized


Our Approach: Remotely collect street-level accessibility information from Google Street View (GSV) using crowdsourcing and computation
Map
Traffic
St. Albans Track
St Albans Tennis Courts
33rd Pl NW
Garfield St NW
34th St NW
34th Pl NW
Amabel Wdc Lobeus
2900
3400
3412

How can we combine automated methods to increase the data collection efficiency?

Crowdsourced Data Collection



Automated Data Collection

Accessibility-aware Application Design

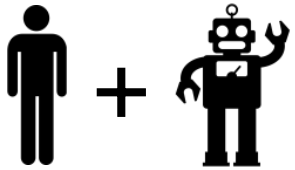
How can we collect accurate street-level accessibility data using crowdsourcing?

How can we leverage this unprecedented level of accessibility data to build new interactive GIS tools?

THIS TALK WILL BE...

Crowdsourced
Data Collection

70%



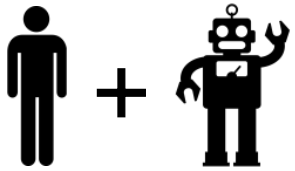
Automated
Data Collection

10%

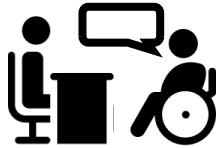
Accessibility-aware
Application Design

20%

Crowdsourced
Data Collection



Automated
Data Collection



Accessibility-aware
Application Design

Crowdsourced
Data Collection

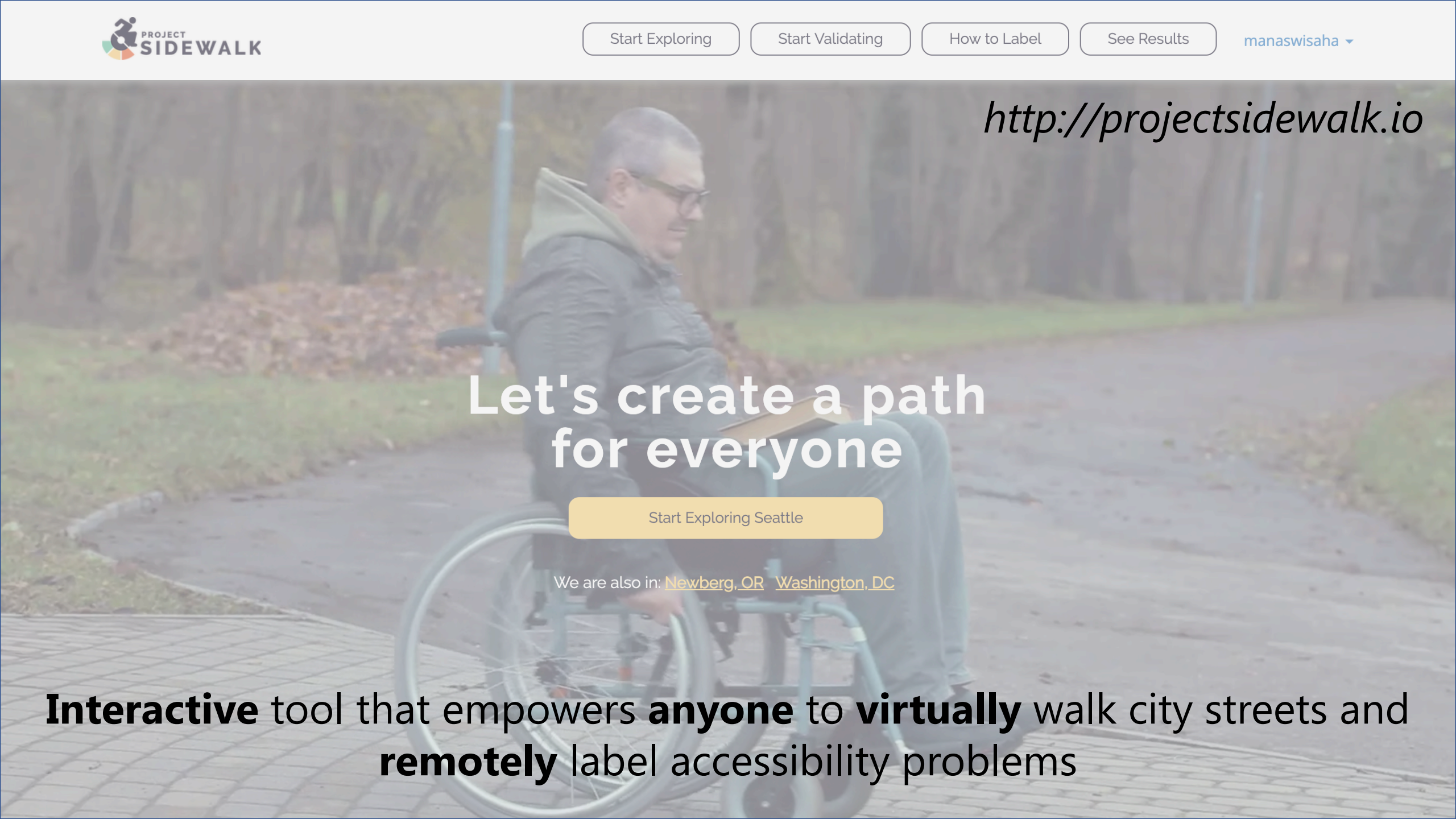
Automated
Data Collection

Accessibility-aware
Application Design

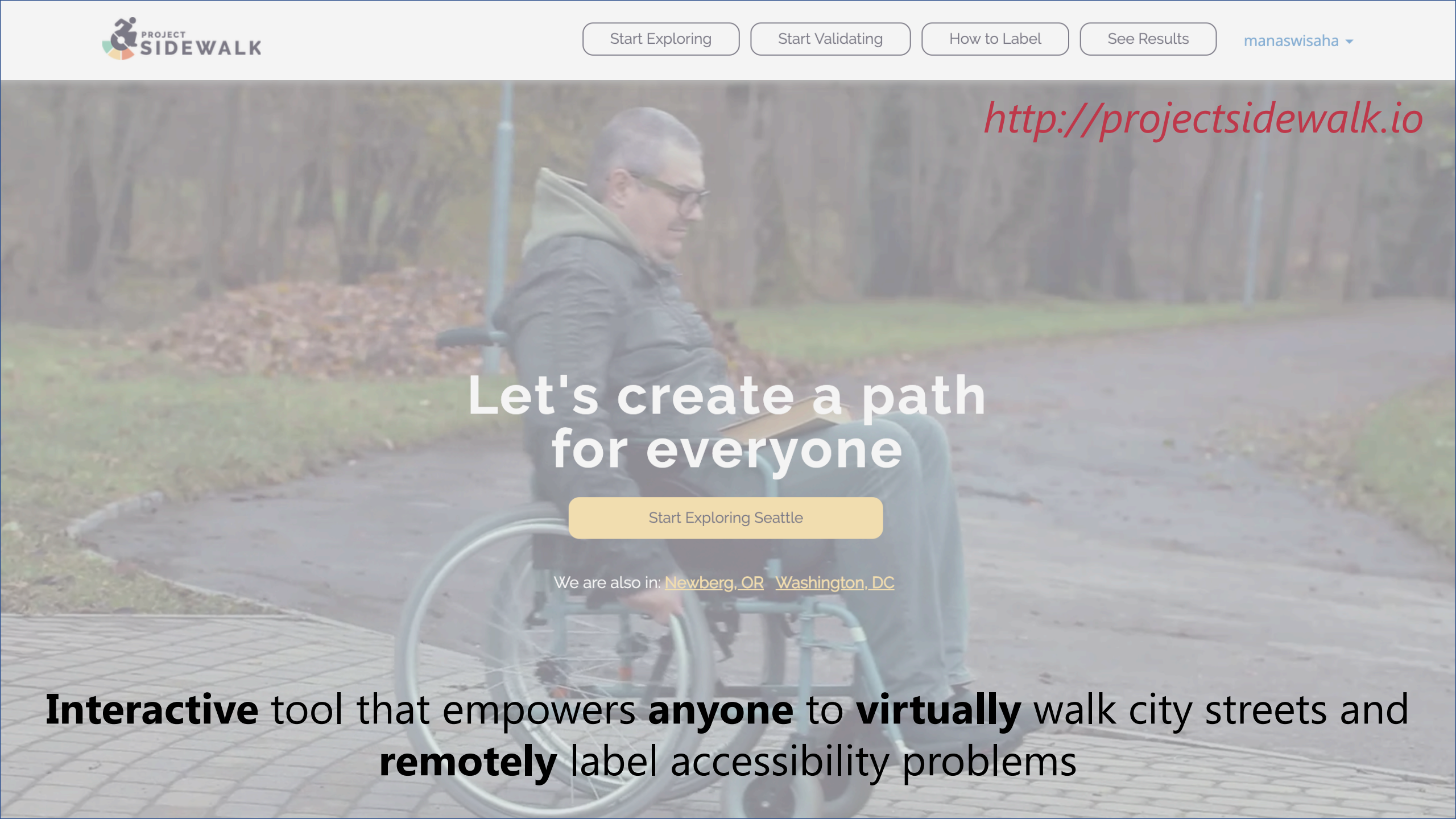
1. How can we design a crowdsourcing system to collect street-level accessibility data from Google Street View?
2. How to quickly train crowd workers to accurately label accessibility features in Google Street View imagery?

PROJECT SIDEWALK

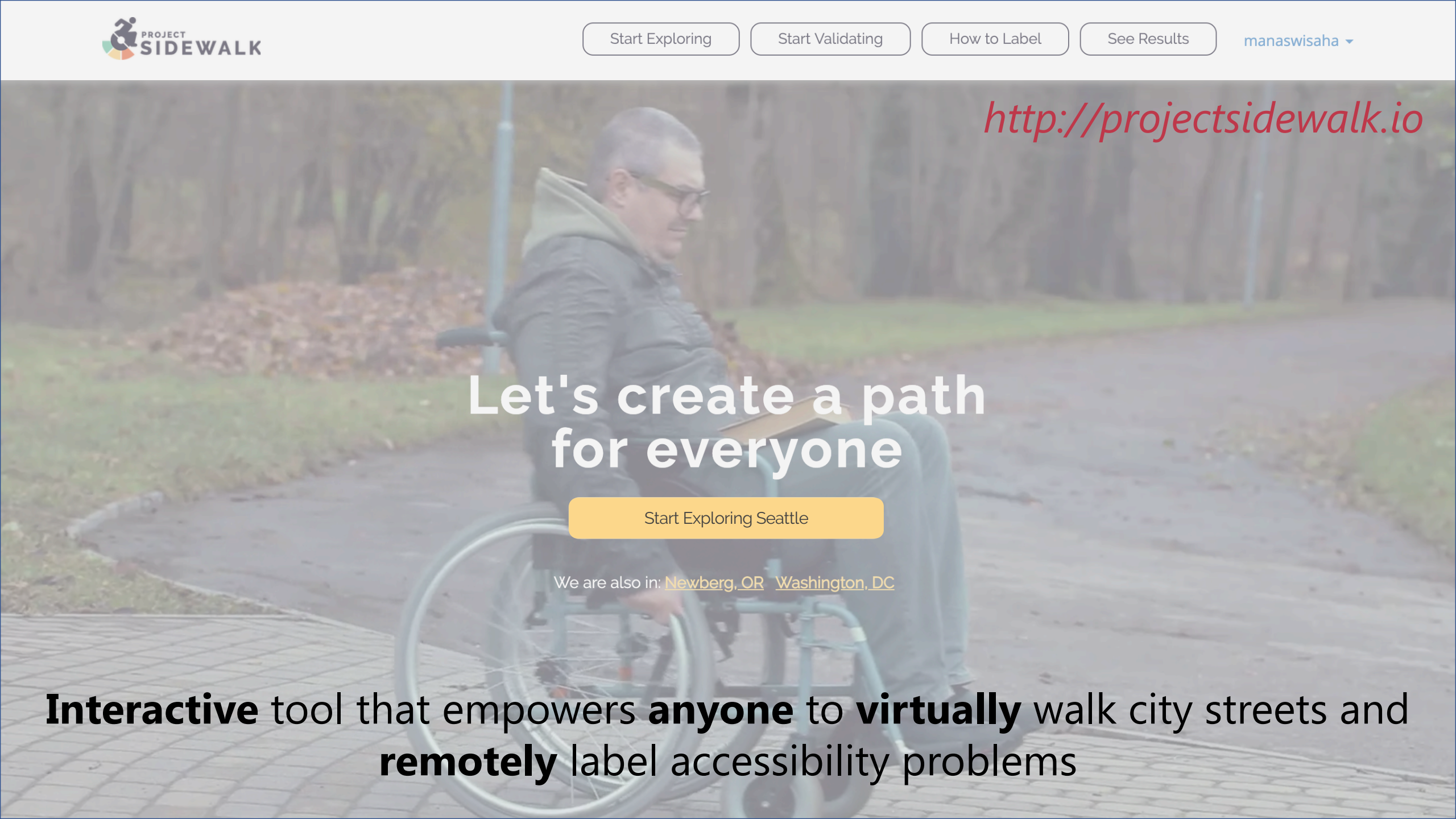
HTTP://PROJECTSIDEWALK.IO



Interactive tool that empowers **anyone** to **virtually** walk city streets and **remotely** label accessibility problems



Interactive tool that empowers **anyone** to **virtually** walk city streets and **remotely** label accessibility problems



Interactive tool that empowers **anyone** to **virtually** walk city streets and **remotely** label accessibility problems

TOOL WALKTHROUGH

Find and label the following

Explore | Curb Ramp | Missing Curb Ramp | Obstacle in Path | Surface Problem | Other

Zoom In | Zoom Out | Undo | Redo

Current Neighborhood
Fort Stanton, D.C.

Sound

Jump

Feedback

Audit 1000ft of Fort Stanton

Your mission is to audit 1000ft of Fort Stanton and find all the accessibility features that affect mobility impaired travelers!

OK

TOOL WALKTHROUGH

Find and label the following

Explore | Curb Ramp | Missing Curb Ramp | Obstacle in Path | Surface Problem | Other

Zoom In | Zoom Out | Undo | Redo

Current Neighborhood

Fort McNair, D.C.

0.0 miles | 0 labels

Current Mission

Audit 1000ft of this neighborhood

15% complete

2 curb ramps

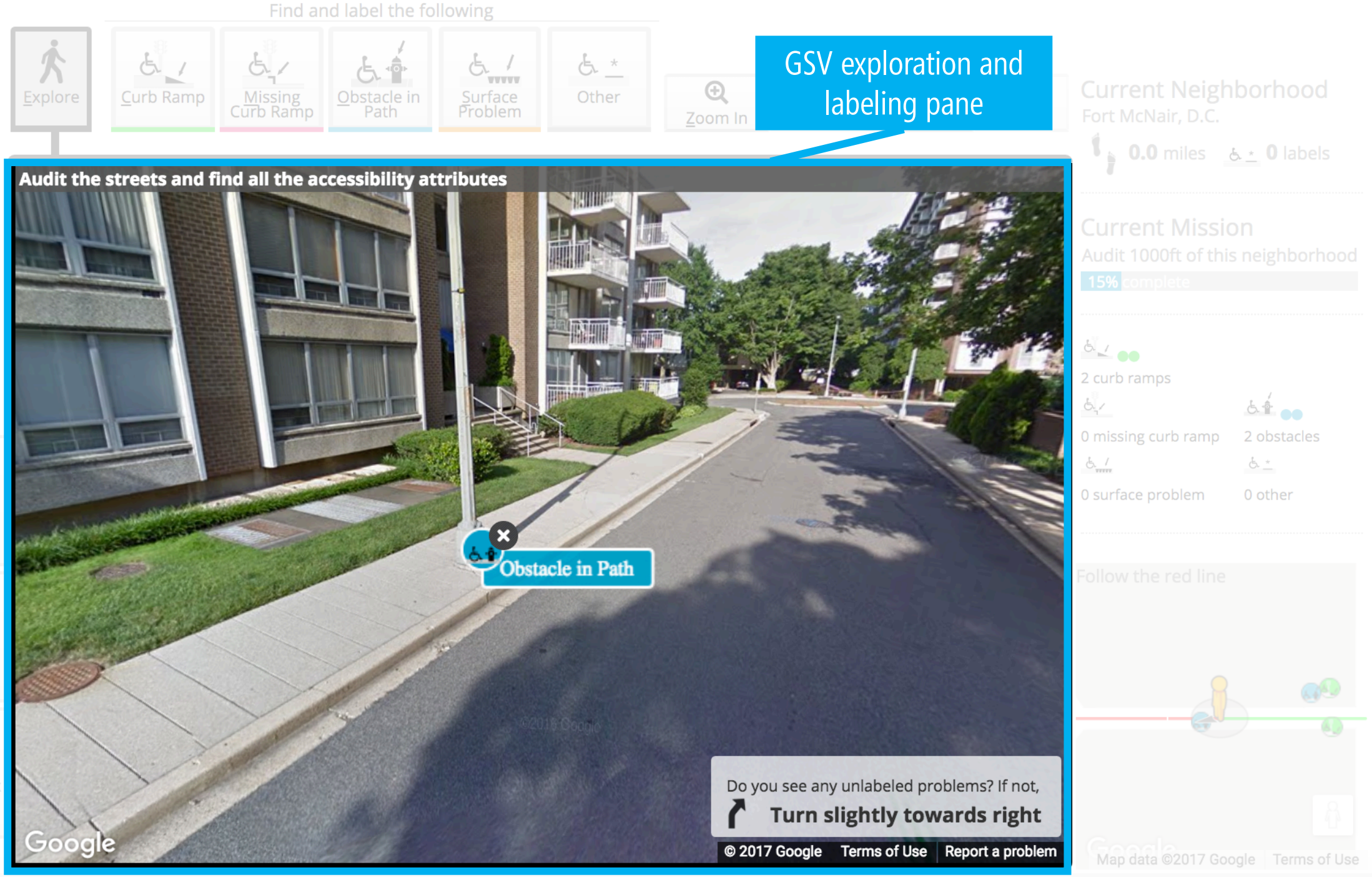
0 missing curb ramp

2 obstacles

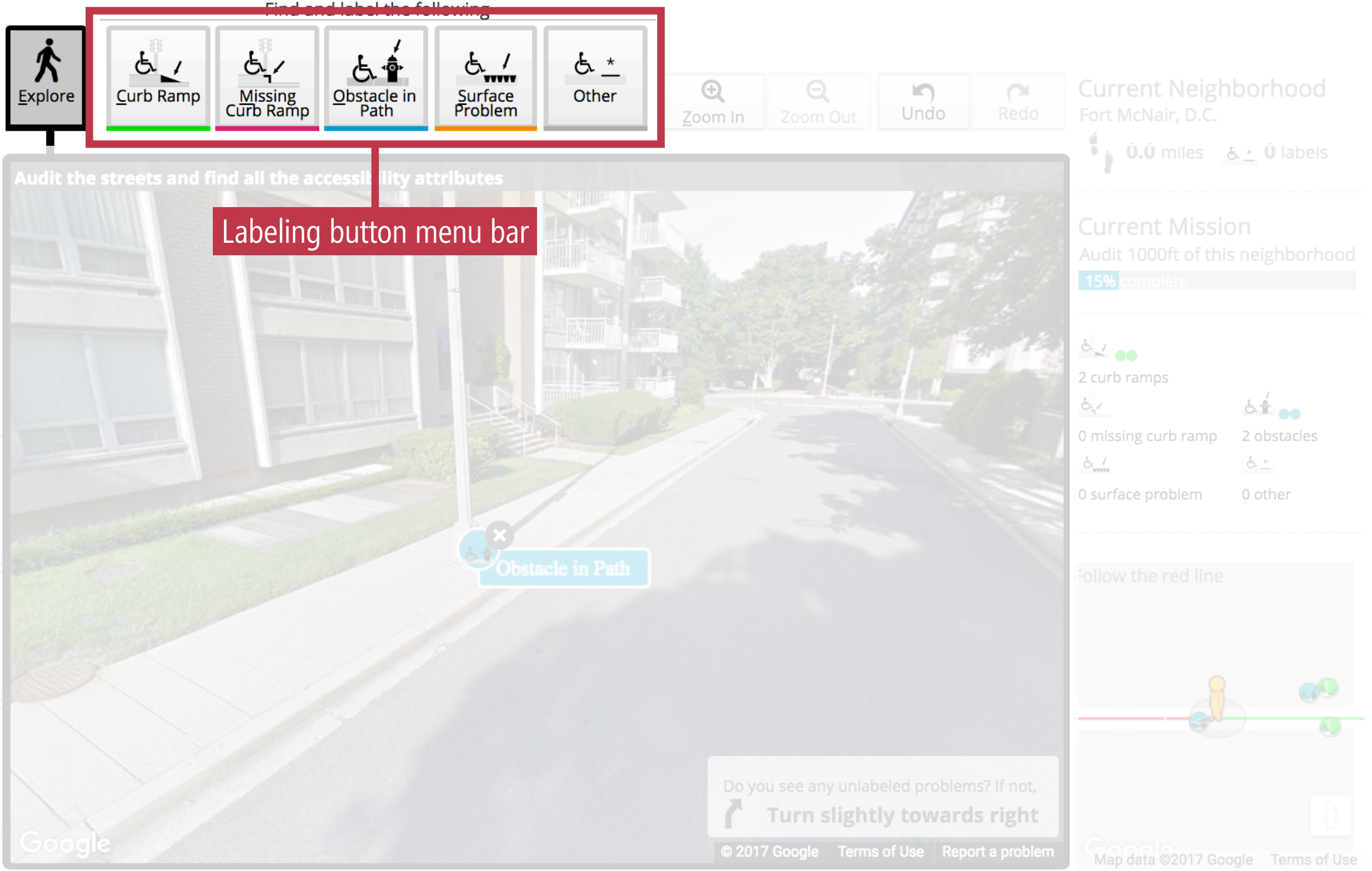
0 surface problem

0 other

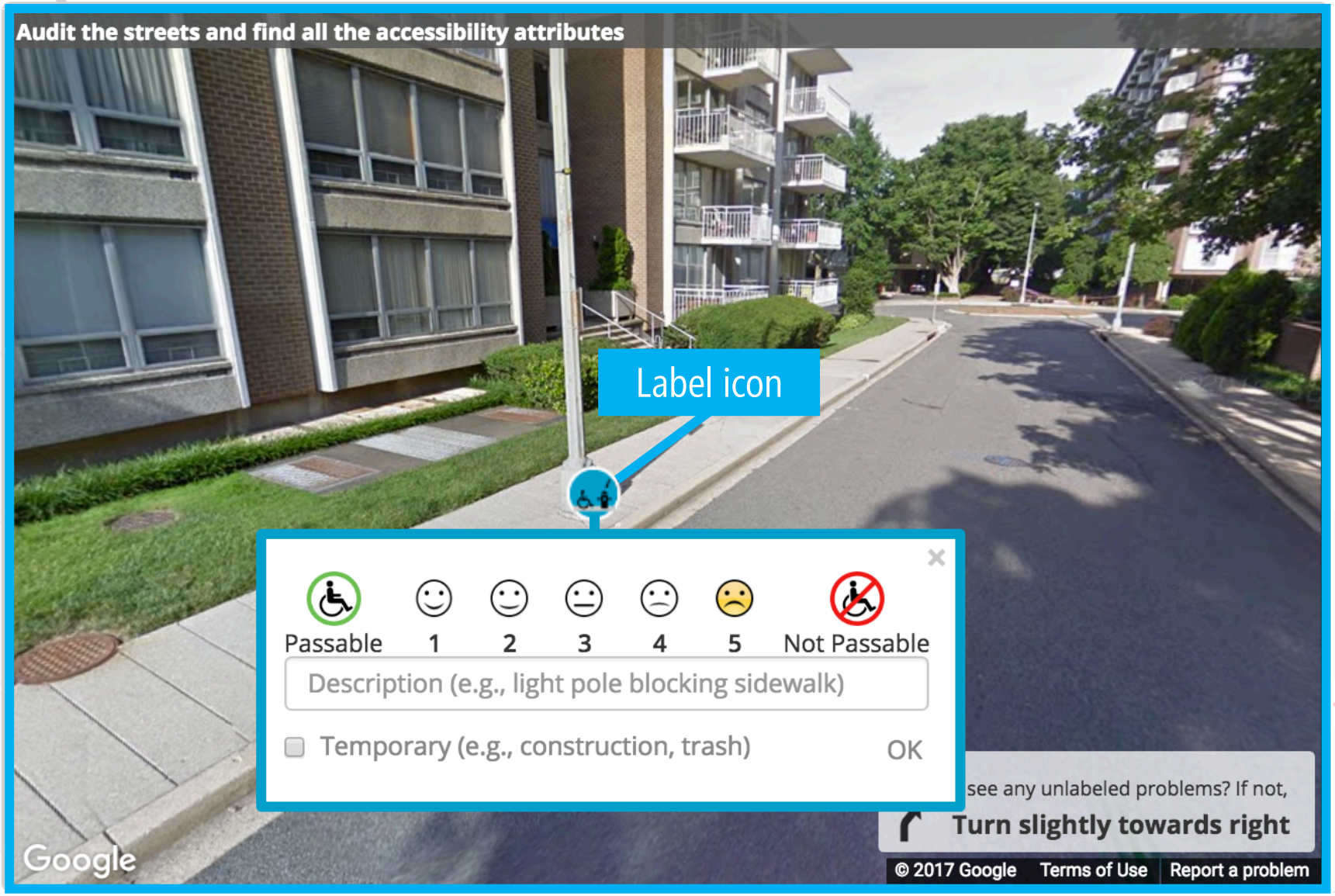
TOOL WALKTHROUGH



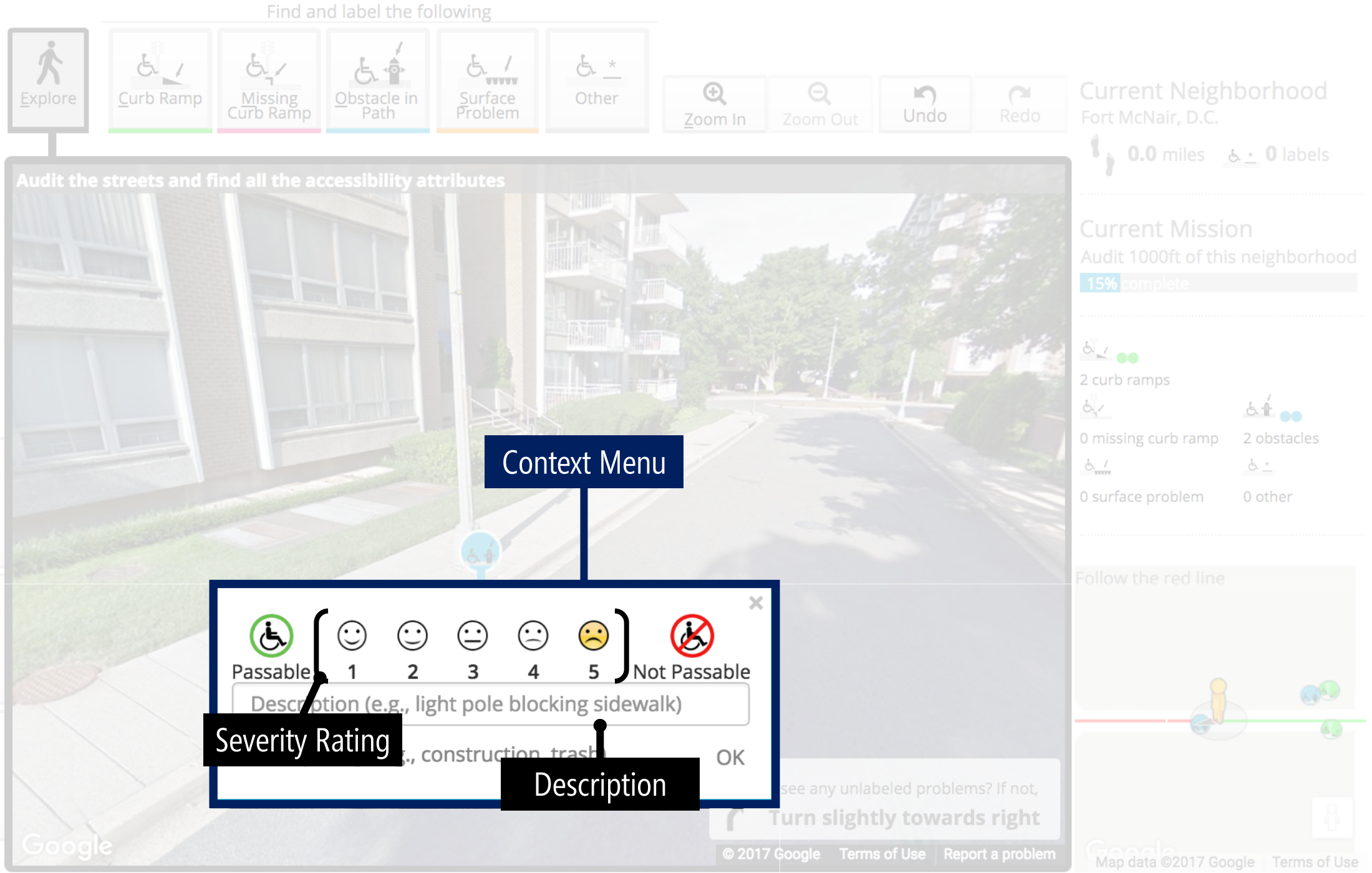
TOOL WALKTHROUGH



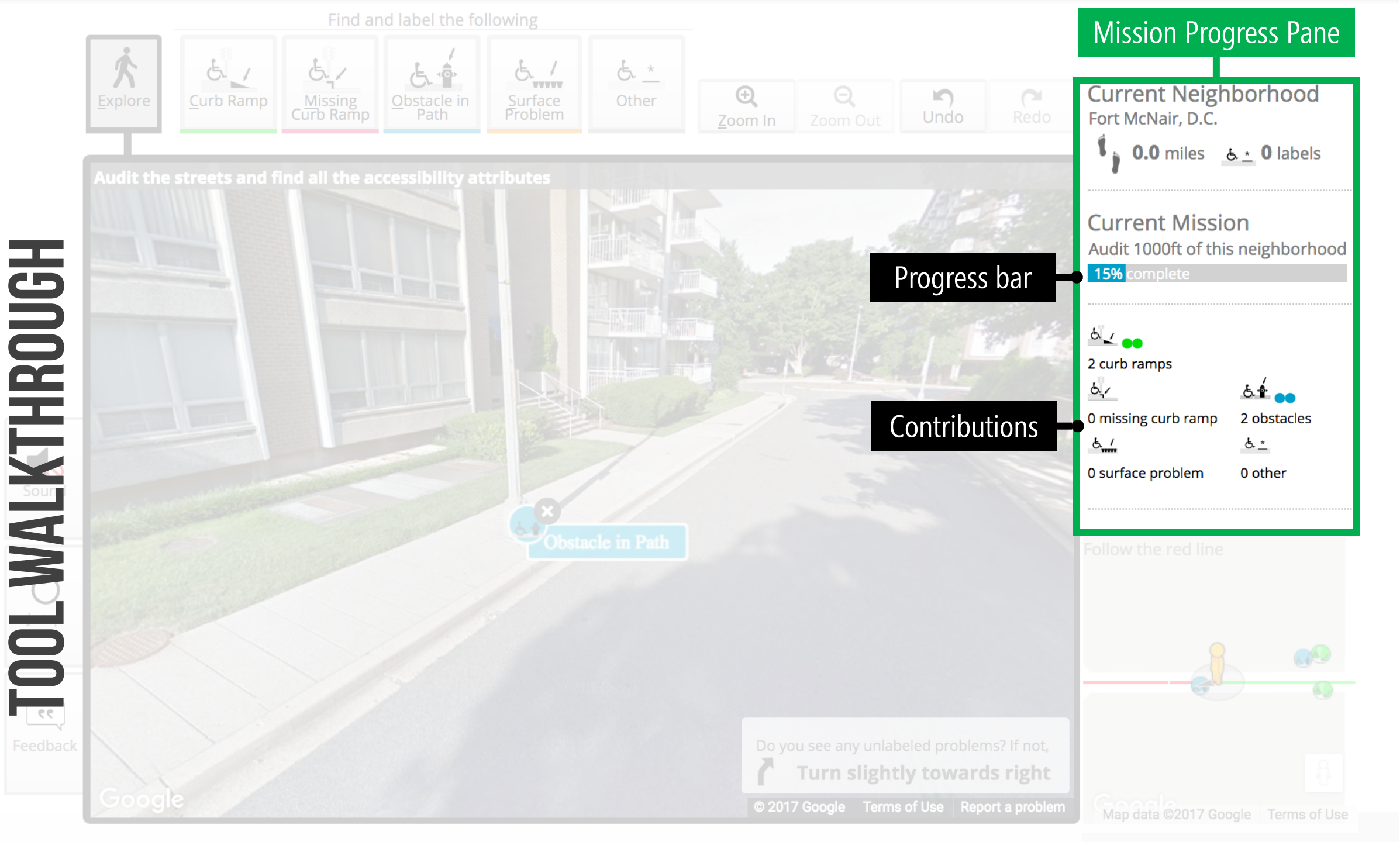
TOOL WALKTHROUGH



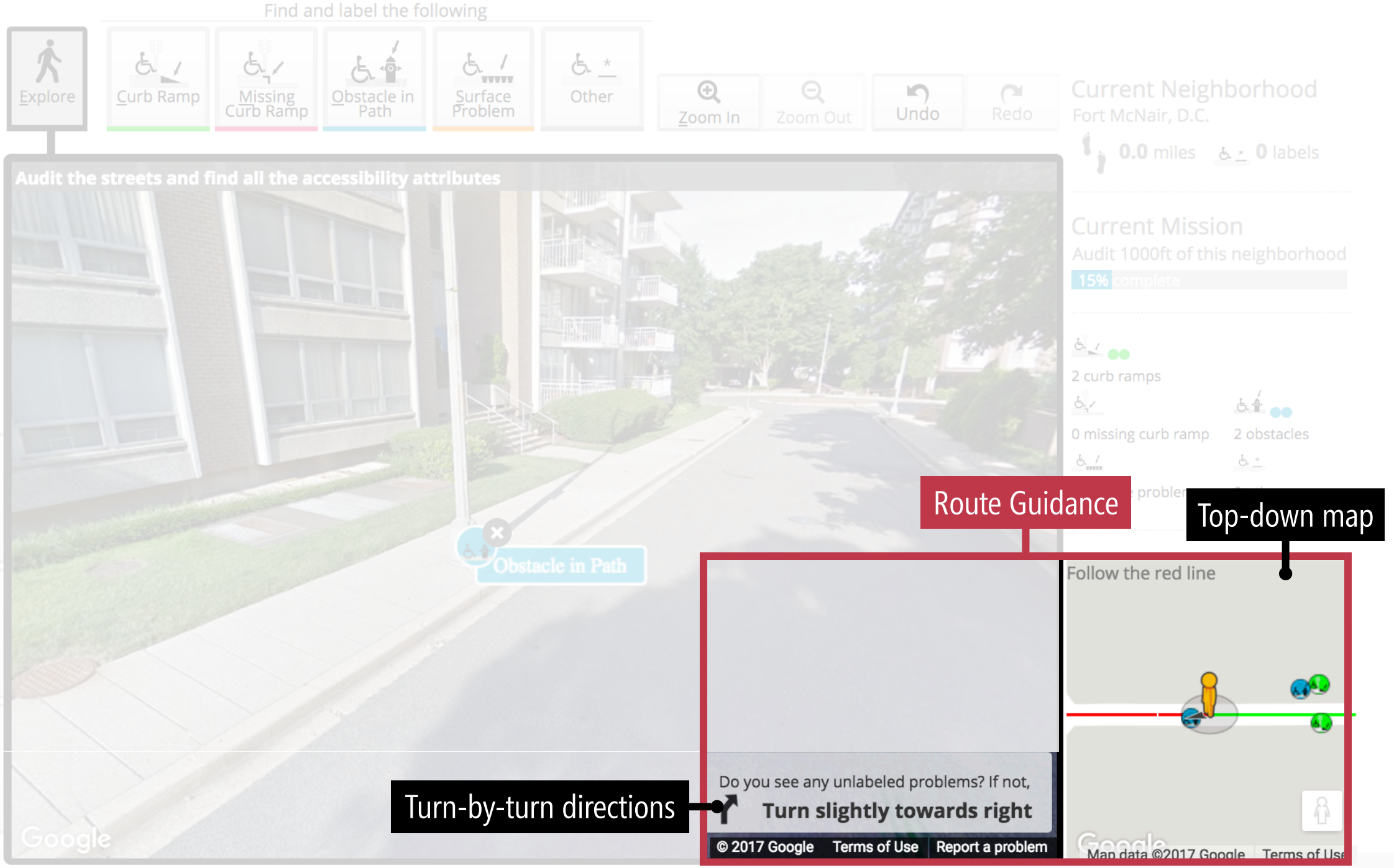
TOOL WALKTHROUGH



TOOL WALKTHROUGH



TOOL WALKTHROUGH



PROJECT SIDEWALK SYSTEM

INTERACTIVE TUTORIAL

Find and label the following

Explore | Curb Ramp | Missing Curb Ramp | Obstacle in Path | Surface Problem | No Sidewalk | Other | Zoom In | Zoom Out

In this Street View image, we have drawn an arrow to a curb ramp. Let's label it. Click the flashing **"Curb Ramp" button** above.

Current Neighborhood

Woodridge, D.C.

0.0 miles | 0 labels

Current Mission

Complete the onboarding tutorial!

0% complete

0 curb ramp | 0 surface problem

0 missing curb ramp | 0 no sidewalk

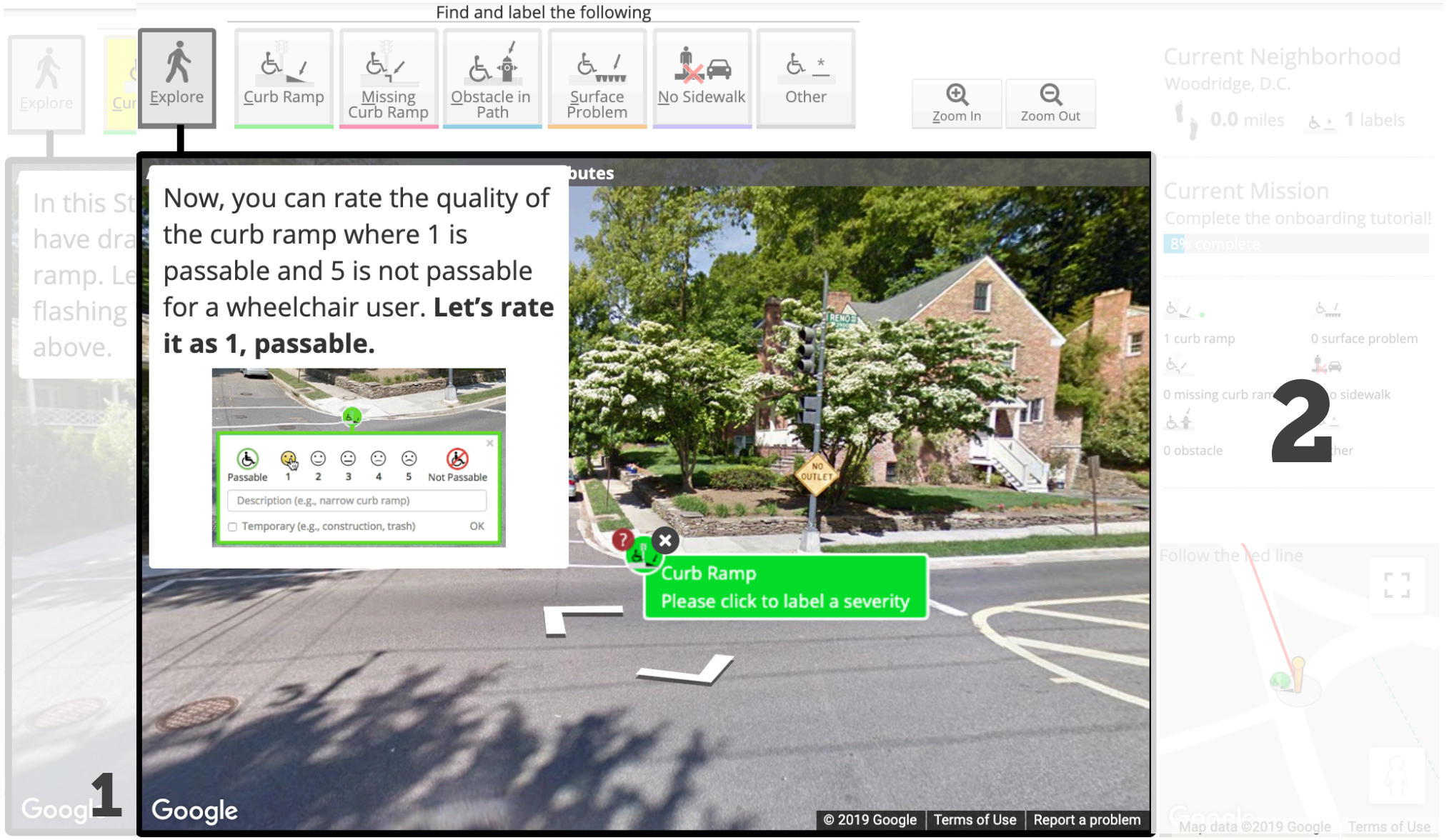
0 obstacle | 0 other

1

Follow the red line

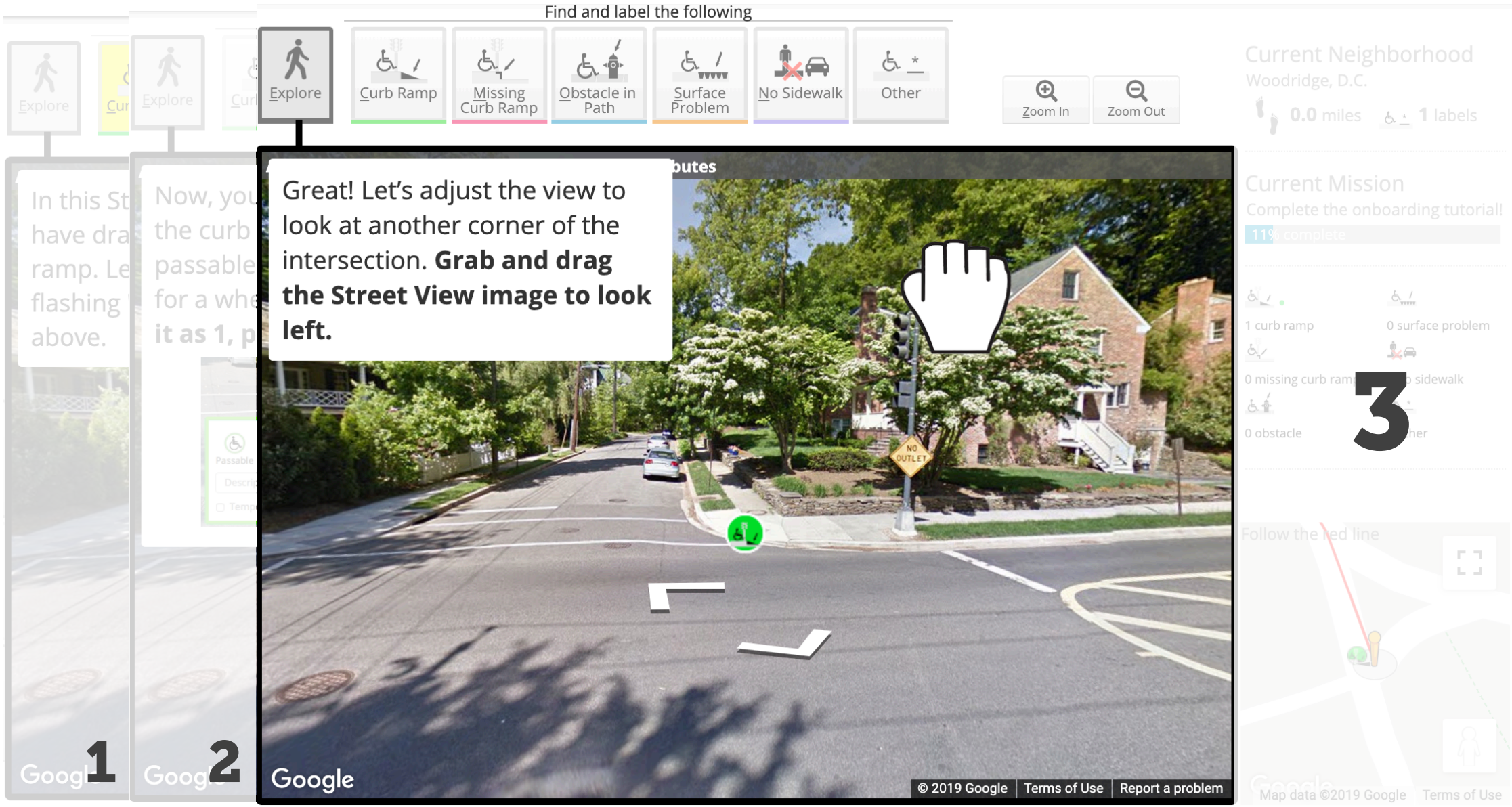
PROJECT SIDEWALK SYSTEM

INTERACTIVE TUTORIAL



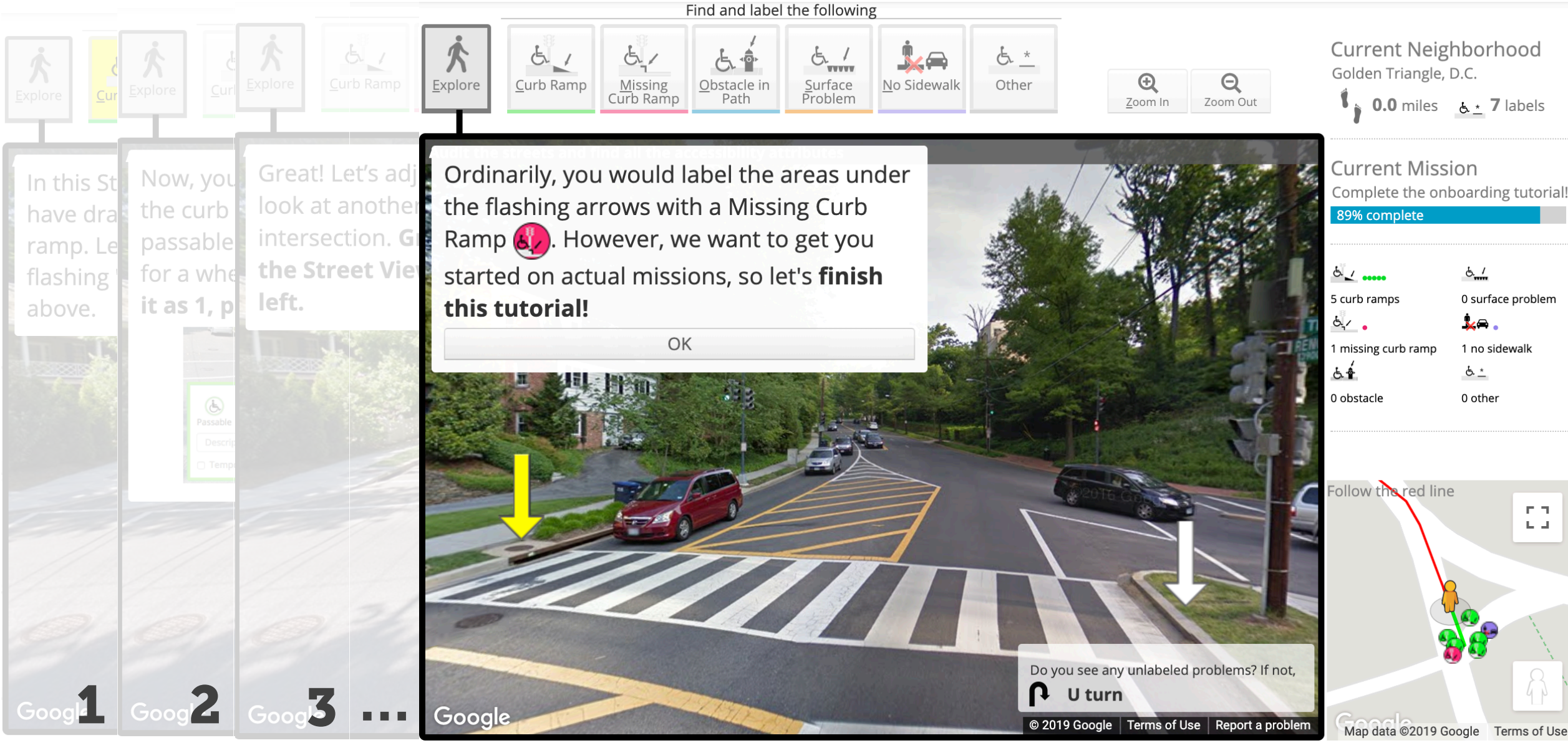
PROJECT SIDEWALK SYSTEM

INTERACTIVE TUTORIAL



PROJECT SIDEWALK SYSTEM

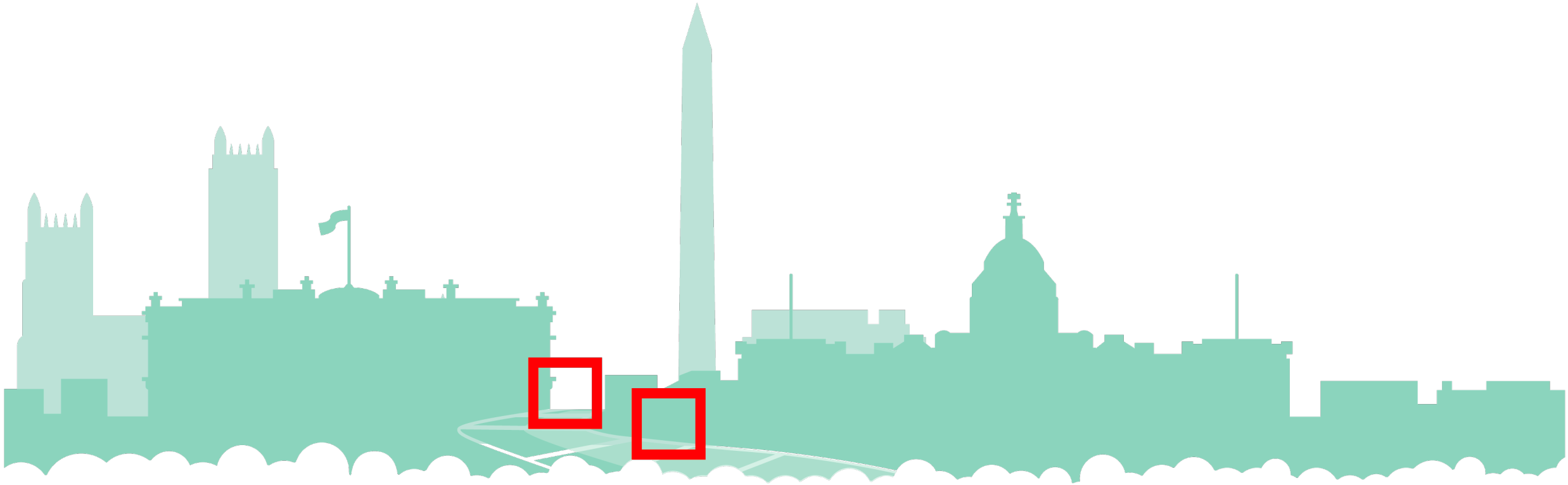
INTERACTIVE TUTORIAL



PROJECT SIDEWALK SYSTEM

DEPLOYMENT

Washington DC



18-month deployment ~ Fall **2016** - Spring **2018**

DC DEPLOYMENT

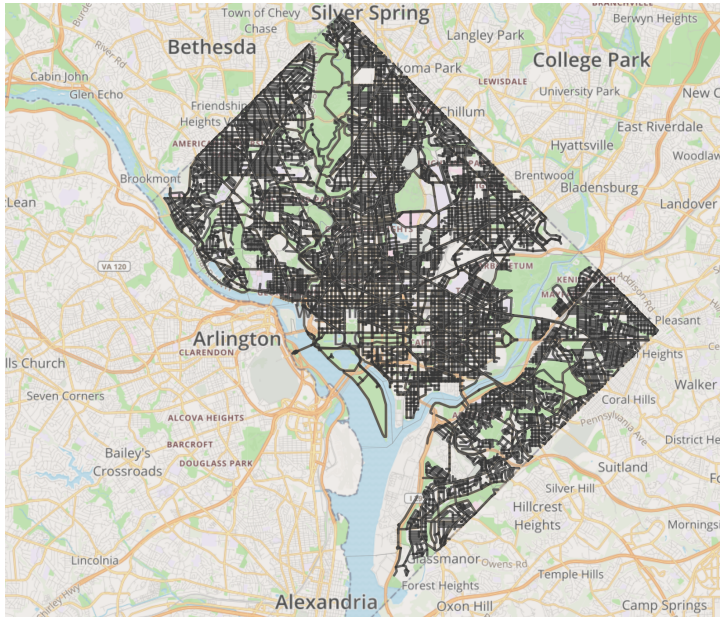
DATA COLLECTED

PROJECT SIDEWALK
HTTP://PROJECTSIDEWALK.IO

~800

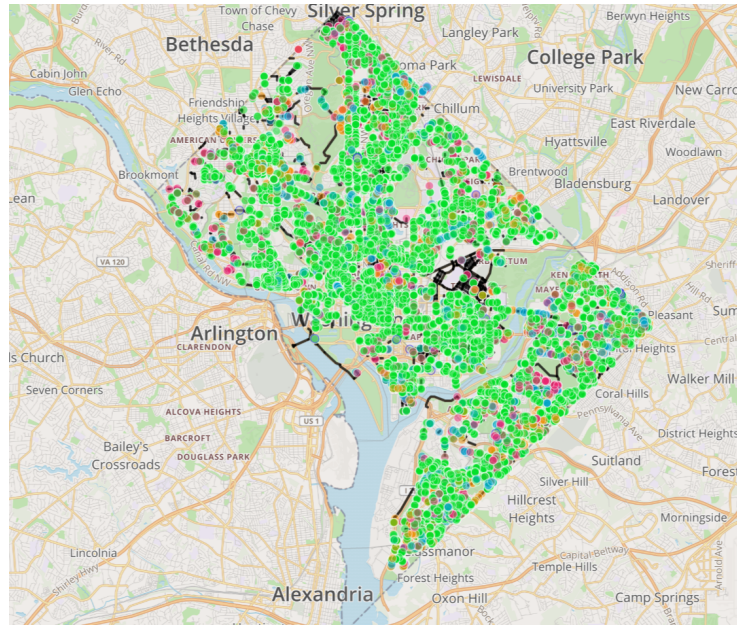
USERS

Volunteers | Turkers



~3000

MILES

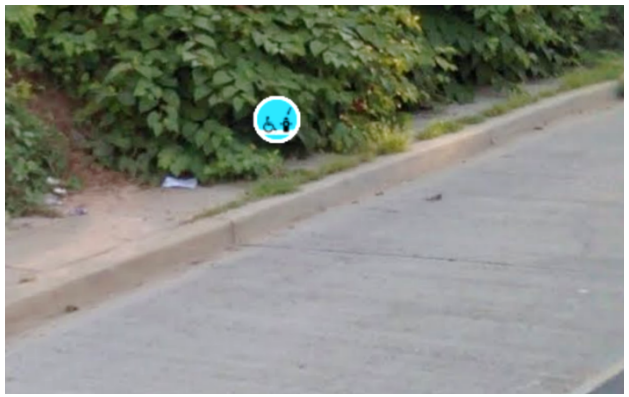
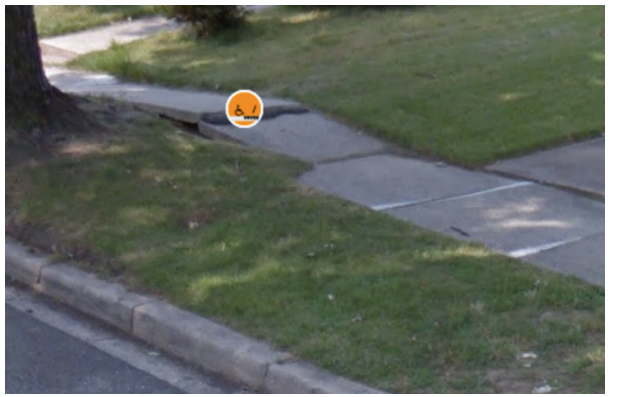


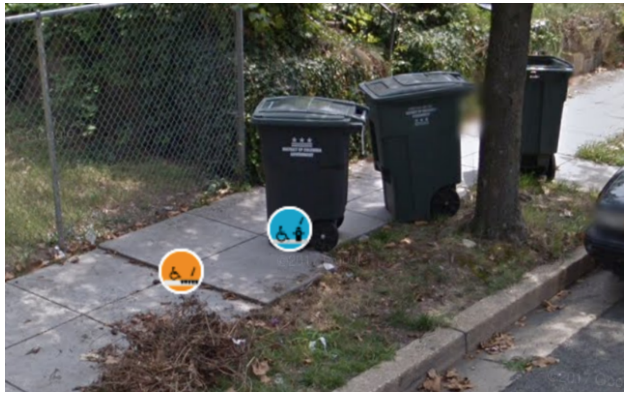
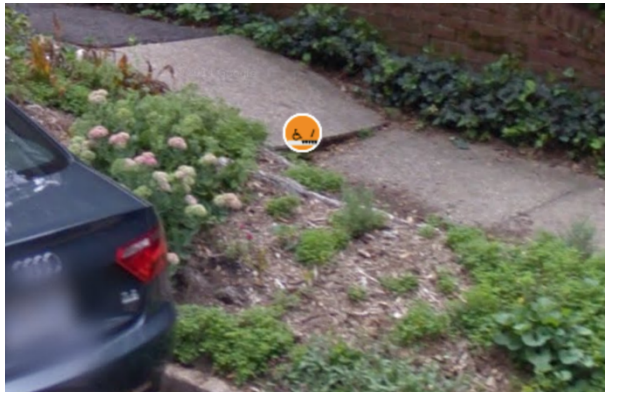
250,000+

LABELS

DEPLOYMENT

LABEL EXAMPLES

142,835 Curb Ramps	18,719 Missing Curb Ramps	21,736 Obstacles	8309 Surface Problems

DEPLOYMENT

MORE CITIES!

Seattle, WA

37%

Seattle mapped

685+

miles covered

78,500+

labels

DEPLOYMENT

MORE CITIES!

Newberg, OR

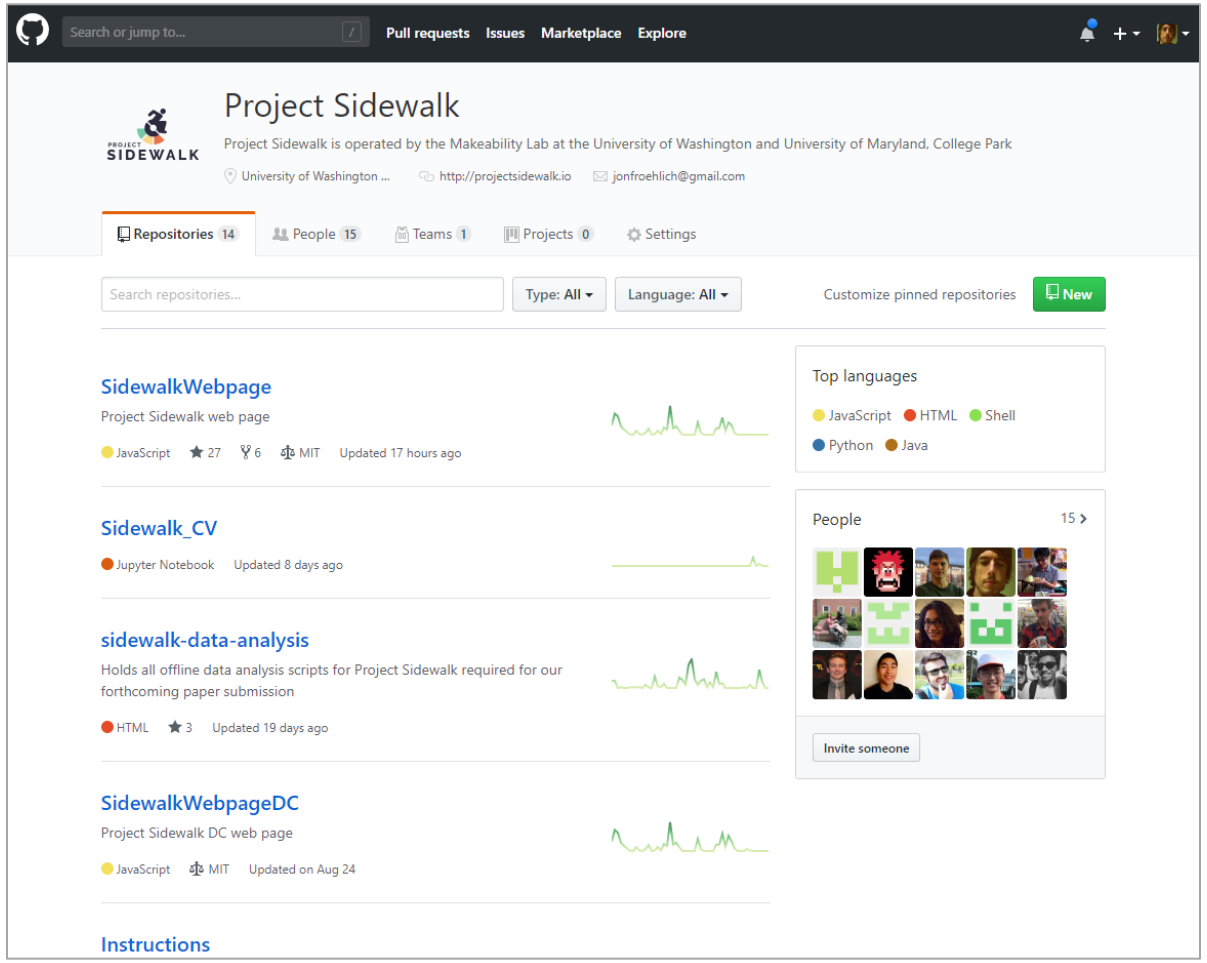
~50%
Newberg mapped

52
miles covered

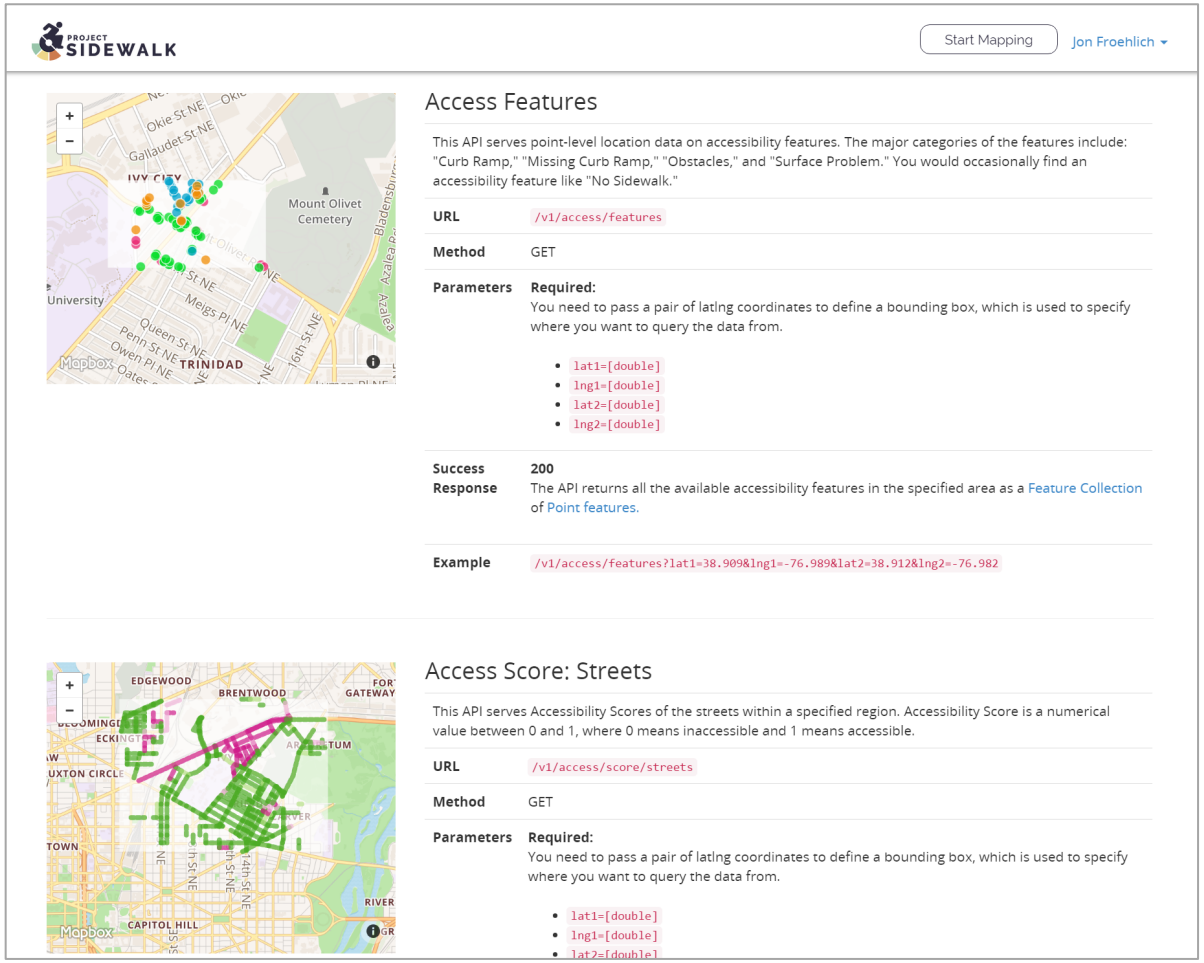
6,825
labels

PROJECT SIDEWALK

OPEN SOURCE & OPEN DATA



https://github.com/ProjectSidewalk



http://projectsidewalk.io/api

STAKEHOLDER PERCEPTIONS AND CONCERNS

Perceived Value

Usability

Concerns

STAKEHOLDER PERCEPTIONS AND CONCERNS

KEY STAKEHOLDERS

People with Mobility Impairments

Caregivers

STAKEHOLDER PERCEPTIONS AND CONCERNS

KEY STAKEHOLDERS

Accessibility Advocates

.gov

Government Officials

STAKEHOLDER PERCEPTIONS AND CONCERNS

KEY STAKEHOLDERS

Accessibility Advocates

Government Officials

Elected Officials
and other policymakers

DOTs

WHAT ARE THE STAKEHOLDERS' PERCEPTIONS AND CONCERNS?

Perceived Value

Enabled rapid data collection

Gathered diverse perspectives about accessibility

Helped engage citizens in thinking about urban design

WHAT ARE THE STAKEHOLDERS' PERCEPTIONS AND CONCERNS?

Perceived Value

> *It's really good for a starting point. This is a first observation, and when you send somebody out in the field, they can see those observations and pick up more information. It's just neat!*
>
> -G4

WHAT ARE THE STAKEHOLDERS' PERCEPTIONS AND CONCERNS?

Concerns

Data age i.e., outdated GSV imagery or labels

Data reliability

Conflicted data

WHAT ARE THE STAKEHOLDERS' PERCEPTIONS AND CONCERNS?

Concern: *Conflicting Perspectives*

> *My concern as a user [is that] someone said this was accessible and I got there and it wasn't accessible, because everyone has different opinions on accessibility.*
>
> -MI1

WHAT ARE THE STAKEHOLDERS' PERCEPTIONS AND CONCERNS?

Concern: *Data Reliability*

> *I would have more confidence if different people did it, did the same street.*
>
> -G4

DATA VALIDATION

DEALING WITH MISLABELING

Is this a **Curb Ramp**?

Is this an **Obstacle in Path**?

DATA VALIDATION

VALIDATION INTERFACES

Hide Label

Is this an **Obstacle in Path**?

Zoom In | Zoom Out

6 labels

Skip

Feedback

✓ Agree

✗ Disagree

? Not sure

Current Mission

Validate 10 labels

60% complete

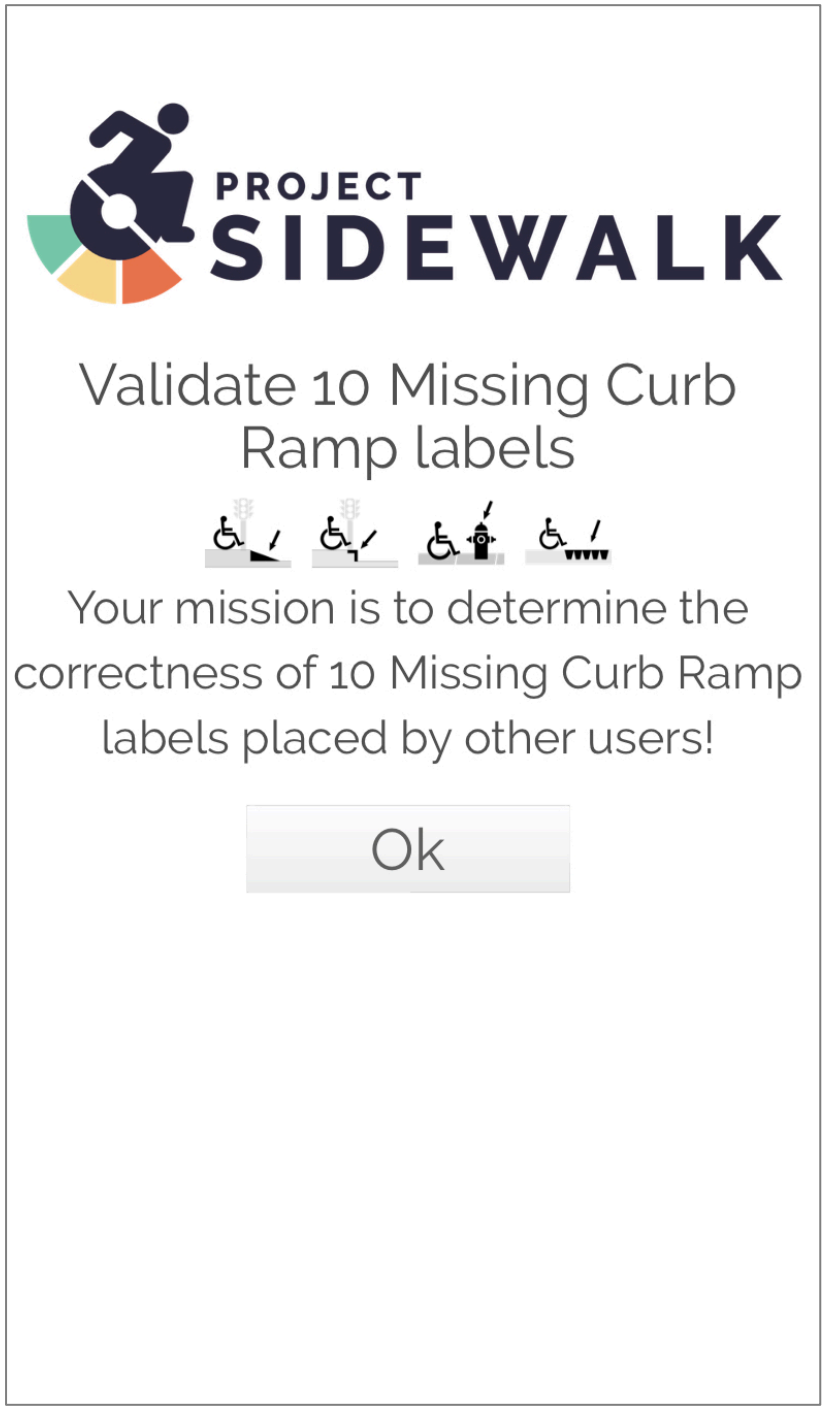
Obstacle in Path

NOT an Obstacle in Path

DATA VALIDATION

MOBILE VALIDATION – TRY IT!

Go to **projectsidewalk.io** on your phones



Crowdsourced
Data Collection

Automated
Data Collection

Accessibility-aware
Application Design

Crowdsourced
Data Collection

Automated
Data Collection

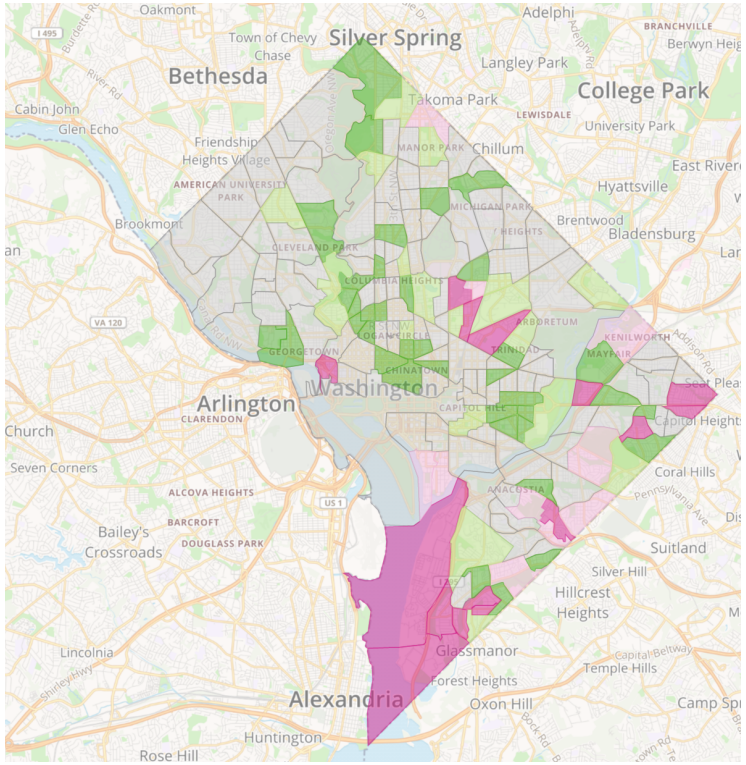
Accessibility-aware
Application Design

1. What location-based applications should we design with the collected accessibility data?
2. How do we design these interactive GIS applications?

INTERACTIVE GIS TOOLS

ACCESSIBILITY-AWARE APPLICATIONS

Smart routing for people with impairments



City accessibility visualizations

DC

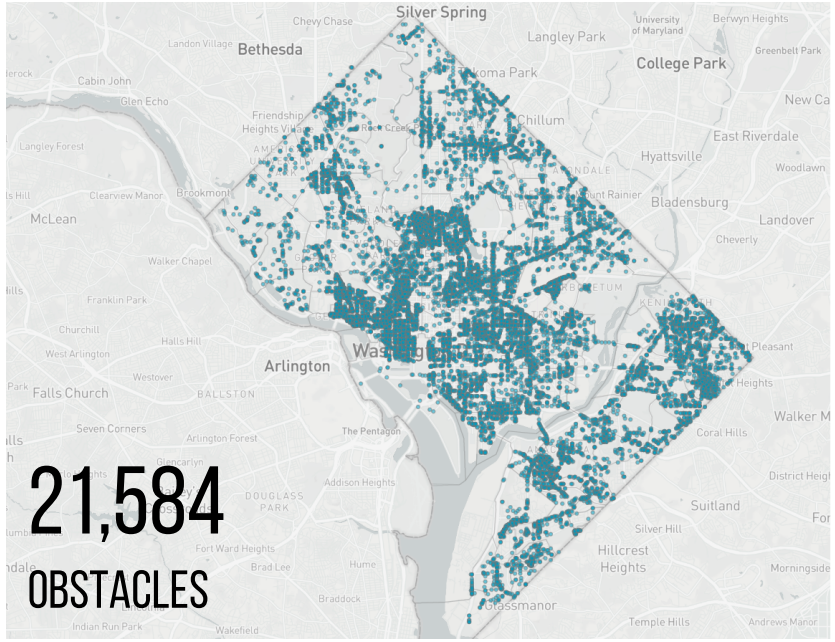
vs

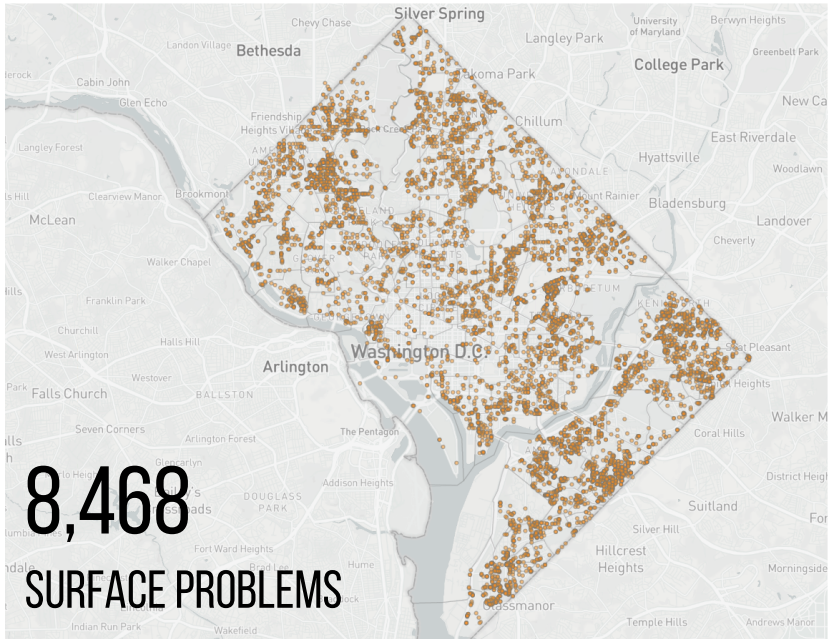
Seattle

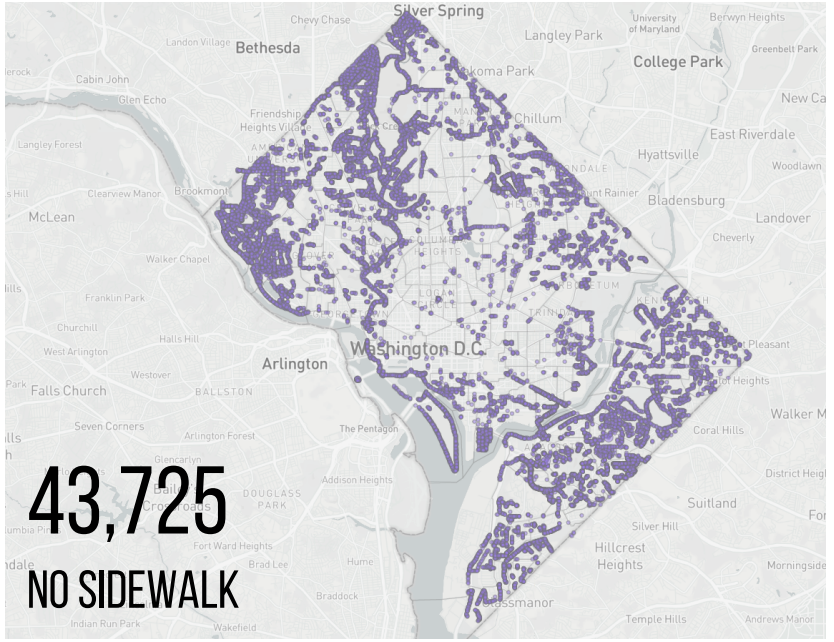
Cross-city comparison tools

INTERACTIVE GIS TOOLS

VISUALIZING ACCESSIBILITY







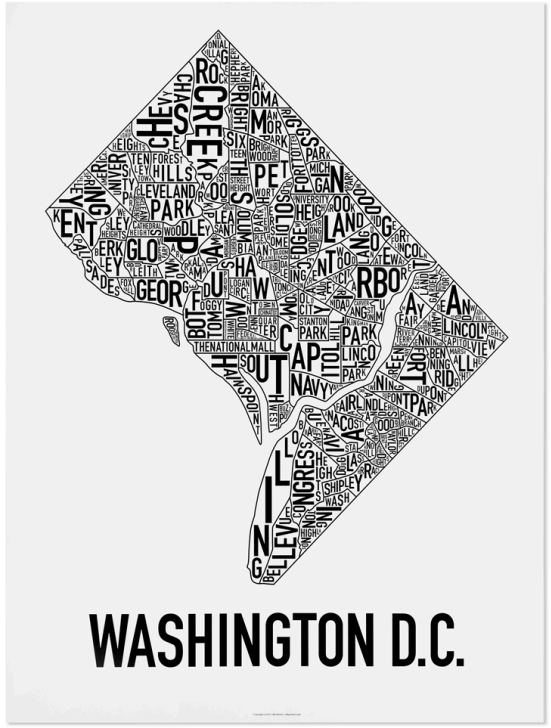
What are the (in)accessible areas of the city?

Why are they (in)accessible?

Where are the areas with highest repair needs?

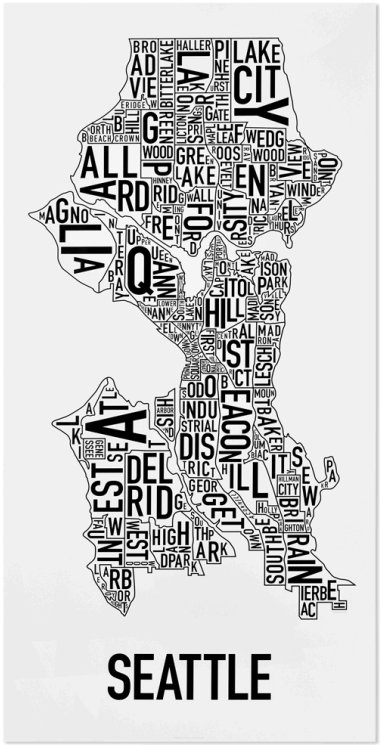
INTERACTIVE GIS TOOLS

MODELING ACCESSIBILITY



vs

vs



What are the correlates to accessibility?

How do we compare accessibility across cities?

WHAT ARE THE STAKEHOLDERS' PERCEPTIONS AND CONCERNS?

Concern: *Conflicting Perspectives*

> *My concern as a user [is that] someone said this was accessible and I got there and it wasn't accessible, because everyone has different opinions on accessibility.*
>
> -MI1

INTERACTIVE GIS TOOLS

ACCESS SCORE: PERSONALIZING ACCESSIBILITY MODELS

Interactively Modeling and Visualizing Neighborhood Accessibility at Scale: An Initial Study of Washington DC

Anthony Li[1], Manaswi Saha[2], Anupam Gupta[2], Jon E. Froehlich[2]
[1]University of Maryland, College Park, [2]University of Washington, Seattle
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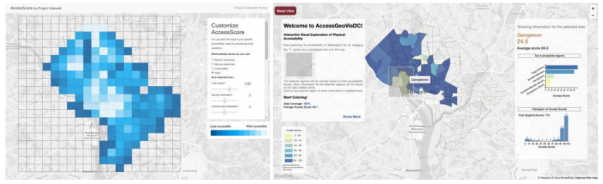

Figure 1. In this poster paper, we explore the initial design and implementation of two interactive geo-visualizations of neighborhood accessibility for people with mobility impairments: **(a)** *AccessScore* and **(b)** *AccessVisDC*. Both prototypes model and visualize accessibility using Project Sidewalk's API [9].

ABSTRACT
Walkability indices such as walkscore.com model the proximity and density of walkable destinations within a neighborhood. While these metrics have gained widespread use (*e.g.*, incorporated into real-estate tools), they do not integrate accessibility-related features such as sidewalk conditions or curb ramps—thereby excluding a significant portion of the population. In this poster paper, we explore the initial design and implementation of neighborhood accessibility models and visualizations for people with mobility impairments. We are able to overcome previous data availability challenges by using the Project Sidewalk API, which provides access to 255,000+ labels about the accessibility and location of DC sidewalks.

Author Keywords
Urban accessibility; geo-visualization; walkability indices

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI)

INTRODUCTION
Websites such as walkscore.com model and visualize the "walkability" of neighborhoods by measuring the proximity and density of walkable destinations (*e.g.,* grocery stores, parks, and restaurants). While recent work suggests that neighborhood walkability correlates with real estate value, lower crime rates, and more walking trips for non-work purposes [3, 7], these metrics do not incorporate accessibility-related features such as sidewalk conditions, the presence of curb ramps, and road grade. One key challenge has been data availability.

Enabled by *Project Sidewalk's* API (projectsidewalk.io/api), which provides access to 255,000+ labels describing the accessibility and location of Washington DC sidewalks [9], we designed and implemented two interactive geo-visualizations of neighborhood accessibility for people with mobility impairments (Figure 1). While recent work has explored accessibility-aware pedestrian routing algorithms and tools [1, 11], these systems are focused on *wayfinding* rather than modeling and visualizing higher-level abstractions of accessibility. Our aim is complementary: to provide personalizable, interactive, and glanceable visualizations of city-wide accessibility.

As early work, our research questions are exploratory: how can we develop algorithmic models that accurately describe the accessibility of streets and sidewalks? How can we make these models and resulting visualizations parameterizable to meet the needs of different users (*e.g.,* manual *vs.* electric wheelchair users)? How can we make our visualizations responsive and interactive over the web (even with 100,000+ data points)? To begin addressing these questions, we report on the initial development of two open-source prototype visualization tools: *AccessScore* and *AccessVisDC*[1].

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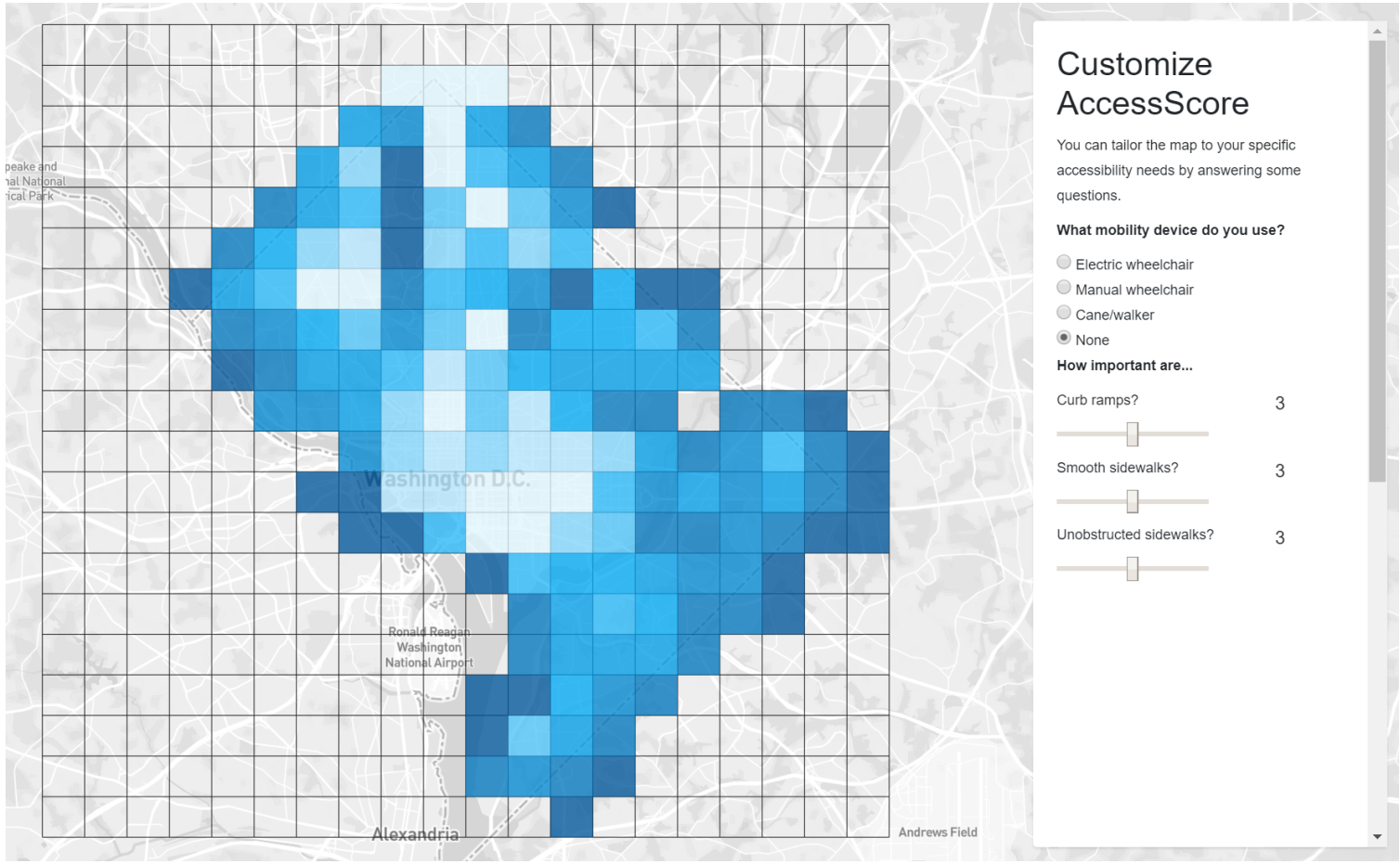
https://doi.org/10.1145/3234695.3241000

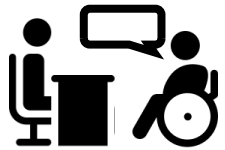
[1] Source code and live demos for AccessScore: https://goo.gl/doMR3G and AccessVisDC: https://goo.gl/yn93RZ.



[ASSETS'18 Poster]

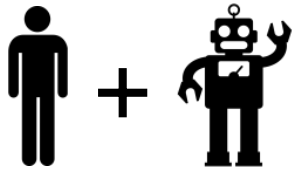
Crowdsourced
Data Collection

Automated
Data Collection



Accessibility-aware
Application Design

Crowdsourced
Data Collection

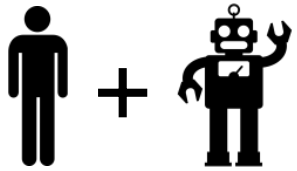


Automated
Data Collection

Accessibility-aware
Application Design

1. How can we use computer vision to automatically and accurately detect accessibility attributes?
2. How can we combine crowdsourcing and computer vision to increase the data collection efficiency?

Crowdsourced
Data Collection



Automated
Data Collection

Accessibility-aware
Application Design

1. How can we use computer vision to automatically and accurately detect accessibility attributes?

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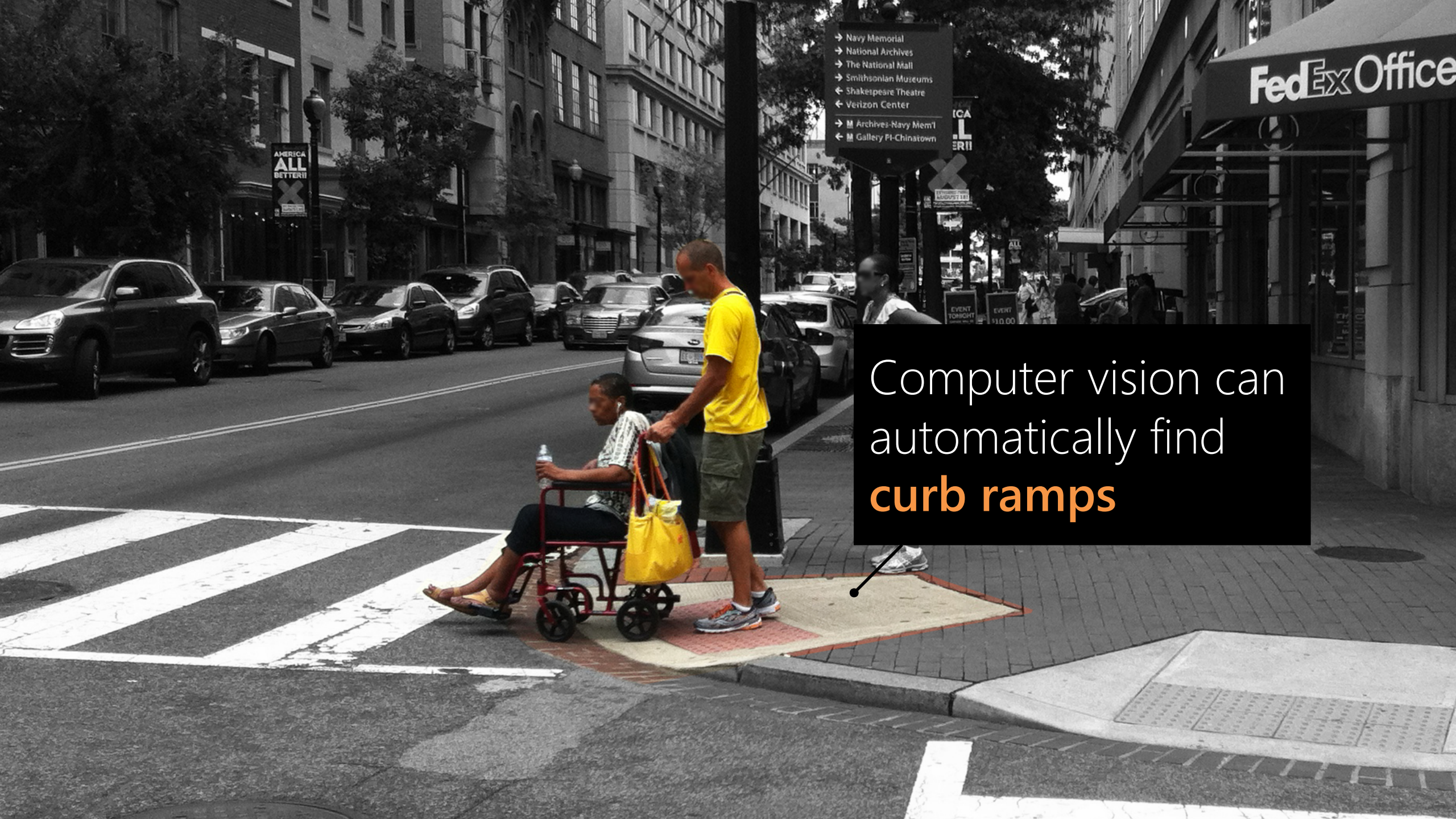

Navy Memorial
National Archives
The National Mall
Smithsonian Museums
Shakespeare Theatre
Verizon Center
Archives-Navy Mem'l
Gallery Pl-Chinatown
FedEx Office
Computer vision can automatically find
curb ramps

OTHER TOOLS

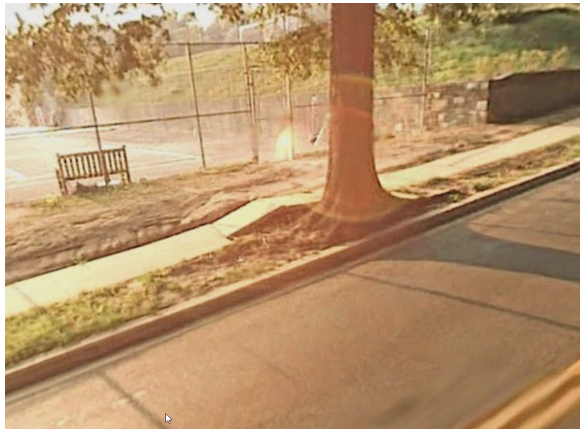
AUTOMATING DATA COLLECTION USING COMPUTER VISION

What **more**?

2906 34th St NW
Washington, District of Columbia
Street View - Sep 2007
Temporal Tracking: Tools for tracking sidewalk infrastructure over time using computer vision
34th St NW
Garfield St NW
Back to Map
Google
© 2014 Google
Image capture: Sep 2007 © 2014 Google Terms Privacy Report a problem

OTHER TOOLS

TRACKING ACCESSIBILITY INFRASTRUCTURE OVER TIME



Sept 2007

Jul 2009

May 2011

June 2011

May 2014

Aug 2014

Nov 2016

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PROJECT SIDEWALK TEAM

Jon Froehlich

Manaswi Saha

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Galen Weld

Ather Sharif

Hanuma Teja Maddali

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Hank Tadeusaik

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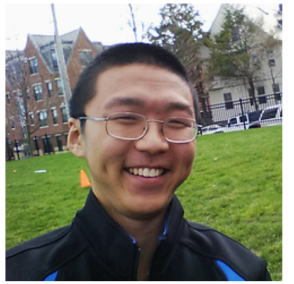
Marianne Aubin Le Quéré



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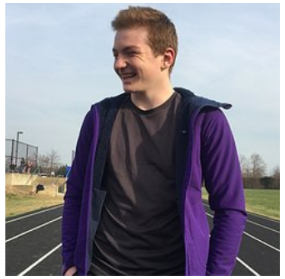
Steven Bower



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IBM

Google

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Help make the world more accessible for everyone!

Join us. Contact manaswi@cs.uw.edu manaswisaha

https://github.com/ProjectSidewalk http://projectsidewalk.io/api

PROJECT SIDEWALK

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Any Questions?

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