

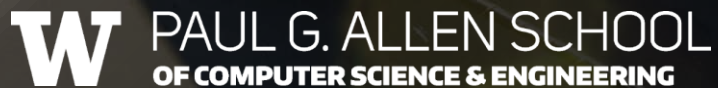
HUMAN-AI FOR PHYSICAL WORLD ACCESSIBILITY

Jon E. Froehlich

Professor, Computer Science
Core Faculty, Urban Design & Planning
Associate Director, CREATE & PacTrans

UMN Cray Colloquium

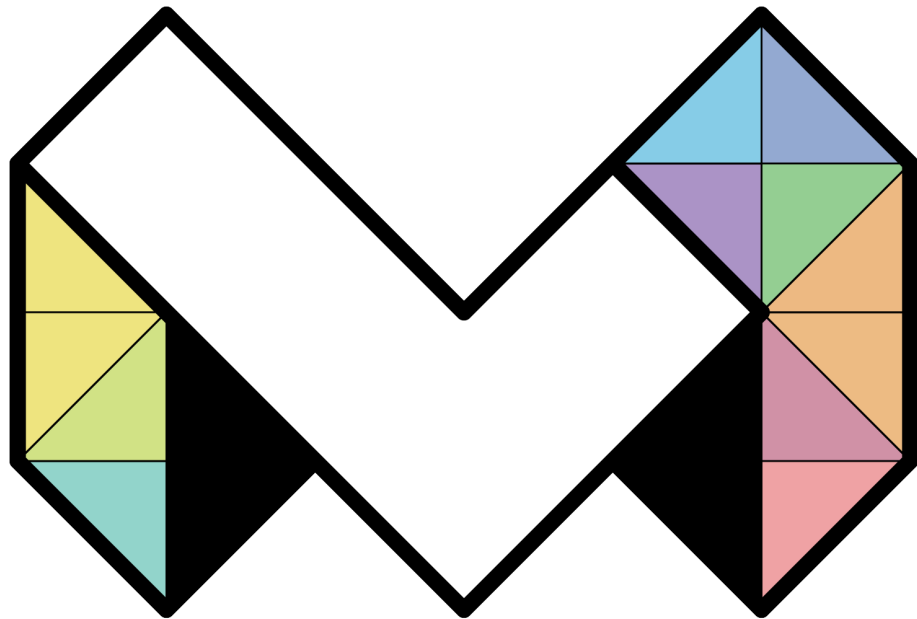
Dec 1, 2025











MAKEABILITY LAB



Mikey Saugstad
Research Scientist
UW CS



Xia Su
PhD Student
UW CS



Daniel Campos Zamora
PhD Student
UW CS



Jaewook Lee
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Davin Win Kyi
MS Student
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UW HCDE



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Tingwei Shen
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UW HCDE



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UW CprE



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Undergrad
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DU CS



Henok Assalif
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Patrick Rung
Undergrad
UW CSE



Jewoo Park
Undergrad
UW CSE



Isha Jagadish
Undergrad
UW CSE



Raiden Santos
Undergrad
UW CSE



Ria Agarwal
Undergrad
UW CSE



John O'Meara
High School Student
IHS



Our Mission

**DESIGN, BUILD, & STUDY INTERACTIVE
TOOLS & TECHNIQUES TO ADDRESS
PRESSING SOCIETAL CHALLENGES**

FOUR FOCUS AREAS



**ENVIRONMENTAL
SUSTAINABILITY**



**HEALTH
& WELLNESS**



ACCESSIBILITY



**STEM
EDUCATION**

MAKEABILITY LAB

FOUR FOCUS AREAS



ENVIRONMENTAL
SUSTAINABILITY



HEALTH
& WELLNESS



ACCESSIBILITY



STEM
EDUCATION



ENVIRONMENTAL
SUSTAINABILITY



HEALTH
& WELLNESS



ACCESSIBILITY



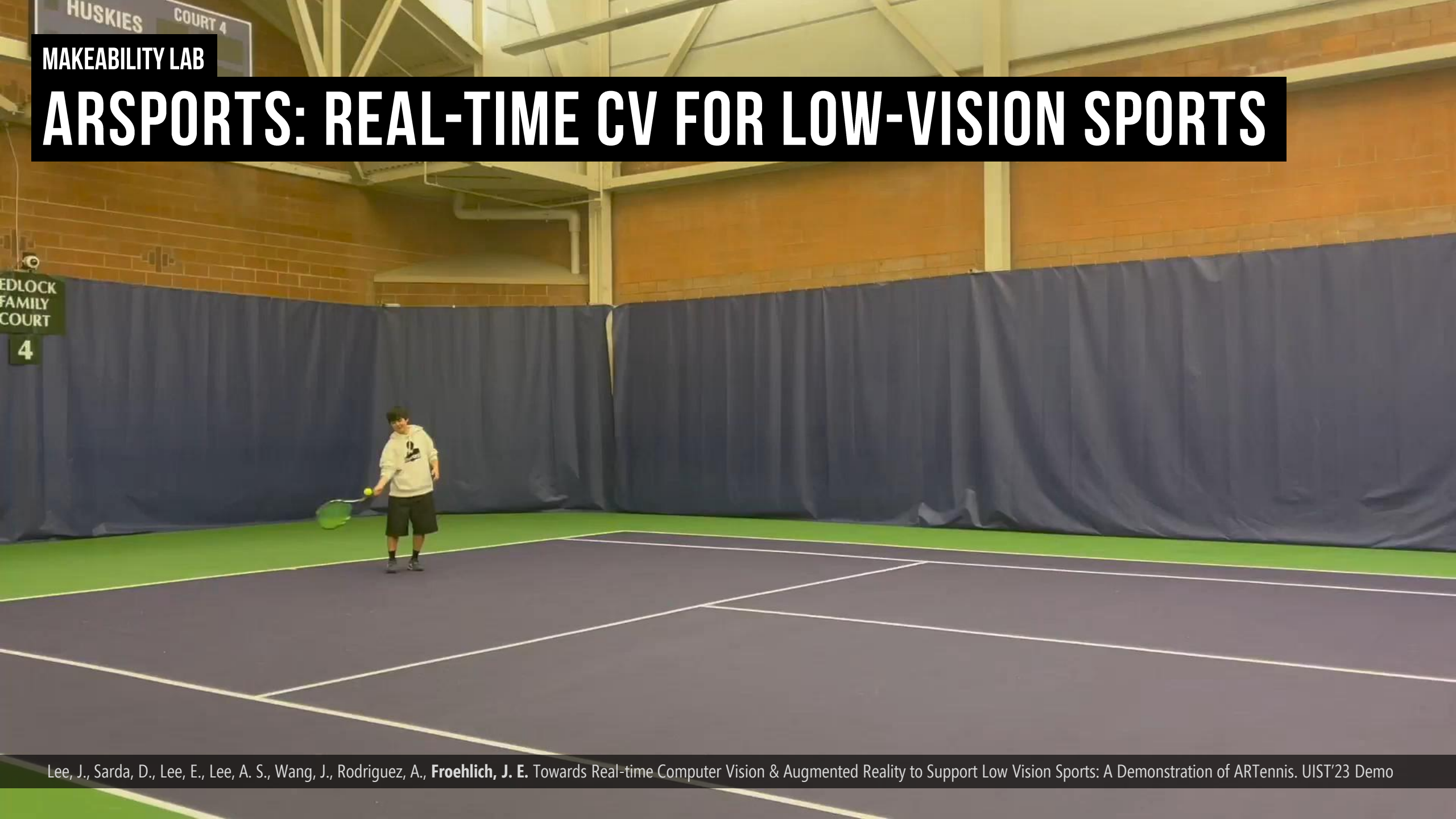
STEM
EDUCATION

How to...

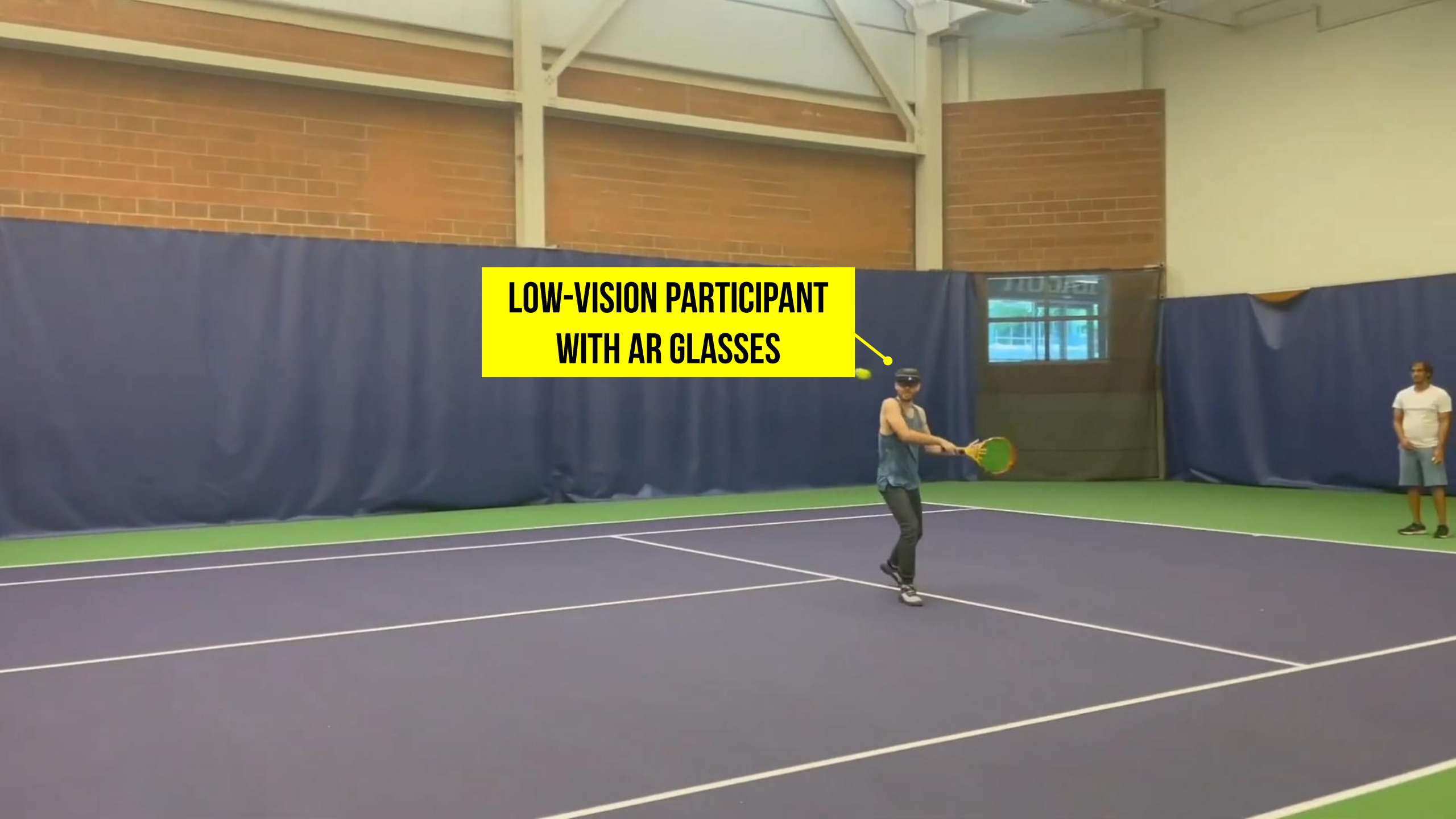
make the *physical world* more
accessible for people with disabilities

MAKEABILITY LAB

ARSPORTS: REAL-TIME CV FOR LOW-VISION SPORTS



**LOW-VISION PARTICIPANT
WITH AR GLASSES**



HUSKIES COURT 4
GUEST

EDLOCK FAMILY COURT
4



MAKEABILITY LAB

SOUNDWATCH: REAL-TIME SOUND REC FOR DHH





SoundWatch - Now
Knocking
(Loud, 77 dB)

X Snooze 10 mins

Open



HOW CAN WE TRANSFORM ACCESS TO **THE BUILT ENVIRONMENT** USING HUMAN+AI TECHNIQUES?

PROJECT SIDEWALK



STREETREADERAI



PROJECT SIDEWALK



How can we...
develop **scalable**
solutions that **assess,**
analyze, and **map** the
accessibility of
sidewalks?

A black and white photograph of a busy city sidewalk. In the foreground, a man in a dark jacket and cap walks towards the camera, wearing earbuds. To his left, a man in a plaid shirt and sunglasses walks. To his right, a woman with a cane walks. In the background, a young man is looking at his phone. The sidewalk is paved with large tiles, and a crosswalk is visible. A pedestrian signal light is mounted on a pole to the right. The scene is filled with other pedestrians in the distance, creating a sense of a bustling urban environment.

**SIDEWALKS ARE
CRITICAL PUBLIC
INFRASTRUCTURE**



WHAT'S THE **ACCESS PROBLEM** HERE?



WHAT'S THE **ACCESS PROBLEM** HERE?

NO CURB RAMPS



ROOTED
in RIGHTS





PHYSICAL OBSTACLES



INCOMPLETE SIDEWALKS

SURFACE PROBLEMS





PHYSICAL OBSTACLES

NO CURB RAMP

SURFACE DEGRADATION

How do **inaccessible sidewalks**
impact **human mobility**?

INTERVIEWS & WORKSHOPS WITH 150 STAKEHOLDERS

Combining Crowdsourcing and Google Street View to Identify Street-level Accessibility Problems

Kotaro Hara, Victoria Le, Jon E. Froehlich
Human-Computer Interaction Lab (HCIL)
Computer Science Department, University of Maryland, College Park

Improving Public Transit Accessibility for Blind Riders by Crowdsourcing Bus Stop Landmark Locations with Google Street View

Kotaro Hara¹, Shiri Azenkot², Megan Campbell², Cynthia L. Bennett², Vicki Le¹, Sean Pannella¹, Robert Moore², Kelly Minckler², Rochelle H. Ng², Jon E. Froehlich¹
¹Makeability Lab | HCIL ²DUB Group
Computer Science and Engineering

The Design of Assistive Location-based Technologies for People with Ambulatory Disabilities: A Formative Study

Kotaro Hara, Christine Chan, Jon E. Froehlich
Makeability Lab | Human-Computer Interaction Lab (HCIL)
Computer Science Department, University of Maryland, College Park
{kotaro, jonf}@cs.umd.edu; chan2017@umd.edu

ABSTRACT

In this paper, we investigate how people with mobility impairments assess and evaluate accessibility in the built environment and the role of current and emerging location-based technologies therein. We conducted a three-part formative study with 20 mobility-impaired participants: a semi-structured interview (Part 1), a design activity (Part 2), and a design workshop (Part 3) to explore how location-based technologies currently support people with mobility impairments as well as to examine desired future technologies. Our Part 1 findings highlight the need for technologies that specifically incorporate accessibility into their design. Our Part 2 findings highlight the need for technologies that provide accessibility benefits explicitly designed for such users. In particular, we synthesize 11 design requirements. We conclude with a discussion of the future of what we call *assistive location-based technologies* (ALTs)—technologies that specifically incorporate accessibility into their design. Our Part 1 findings highlight the need for technologies that provide accessibility benefits explicitly designed for such users. In particular, we synthesize 11 design requirements. We conclude with a discussion of the future of what we call *assistive location-based technologies* (ALTs)—technologies that specifically incorporate accessibility into their design.



Figure 1. To explore how location-based technologies currently support people with mobility impairments as well as to examine desired future technologies, we conducted a three-part formative study with 20 mobility-impaired participants. From (a) a semi-structured interview, (b) a design activity, and (c) a design workshop.

Never realized sidewalks were a big deal?: A Case Study of a Community-Driven Sidewalk Audit Using Project Sidewalk

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⁸Easterseals, USA
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⁹University of Illinois at Chicago, USA
dsnyde@uic.edu

Urban Accessibility as a Socio-Political Problem: A Multi-Stakeholder Analysis

MANASWI SAHA, University of Washington
DEVANSHI CHAUHAN, University of Washington
SIDDHANT PATIL, University of Washington



Article Multiple-Stakeholder Perspectives on Accessibility Data and the Use of Socio-Technical Tools to Improve Sidewalk Accessibility

Delphine Labbé¹, Yochai Eisenberg^{1,*}, Devon Snyder¹, Judy Shanley², Joy M. Hammel^{1,3} and Jon E. Froehlich⁴

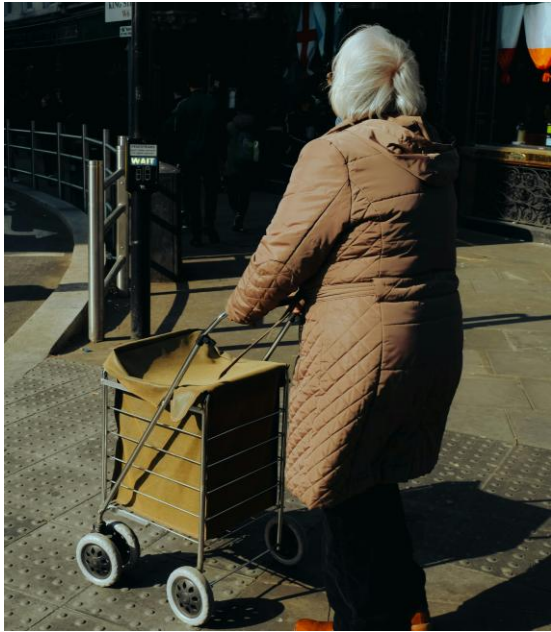
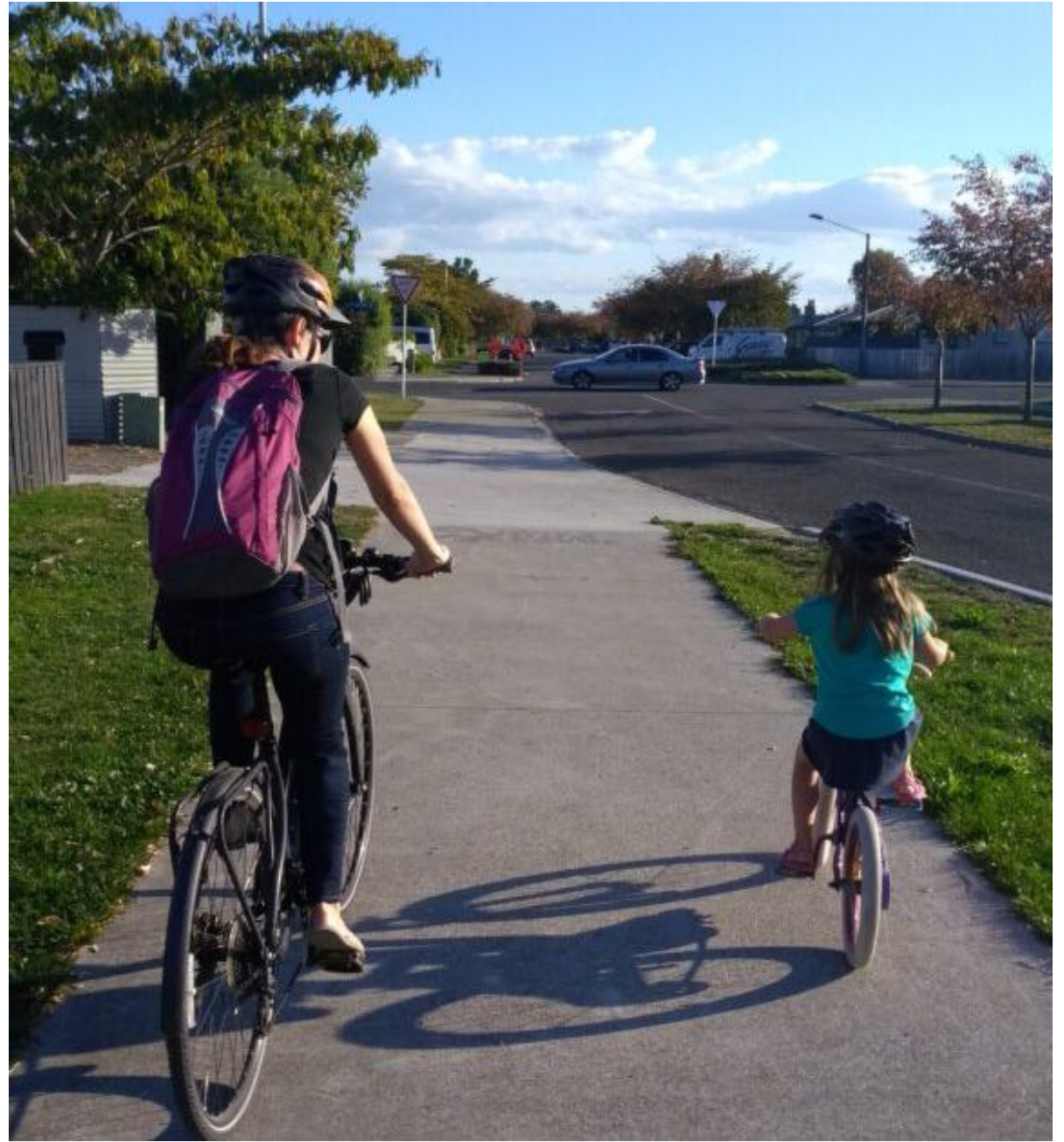
¹ Department of Disability and Human Development, University of Illinois-Chicago, Chicago, IL 60608, USA; dlabbe@uic.edu (D.L.); dsnyde@uic.edu (D.S.); hammel@uic.edu (J.M.H.)
² Easterseals, Chicago, IL 60604, USA; jshanley@easterseals.com
³ Occupational Therapy Department, University of Illinois-Chicago, Chicago, IL 60608, USA
⁴ Paul G. Allen School of Computer Science & Engineering, University of Washington, Seattle, WA 98195, USA; jonf@cs.washington.edu
* Correspondence: yeisen2@uic.edu

Abstract: For people with disabilities, accessible pedestrian infrastructure can support independence,

so I rely heavily on sidewalks



A huge challenge



THAT'S ME!





Source: RM Videos, 2021

**THE PROBLEM IS
NOT JUST A LACK
OF ACCESSIBLE
INFRASTRUCTURE
A LACK OF DATA**



The National Council on Disability notes that there is **no comprehensive information** on “the degree to which sidewalks are accessible” in US cities.



National Council on Disability, 2007

The impact of the Americans with Disabilities Act: Assessing the progress toward achieving the goals of the ADA

BACKGROUND

STUDY OF OPEN DATA ON SIDEWALKS

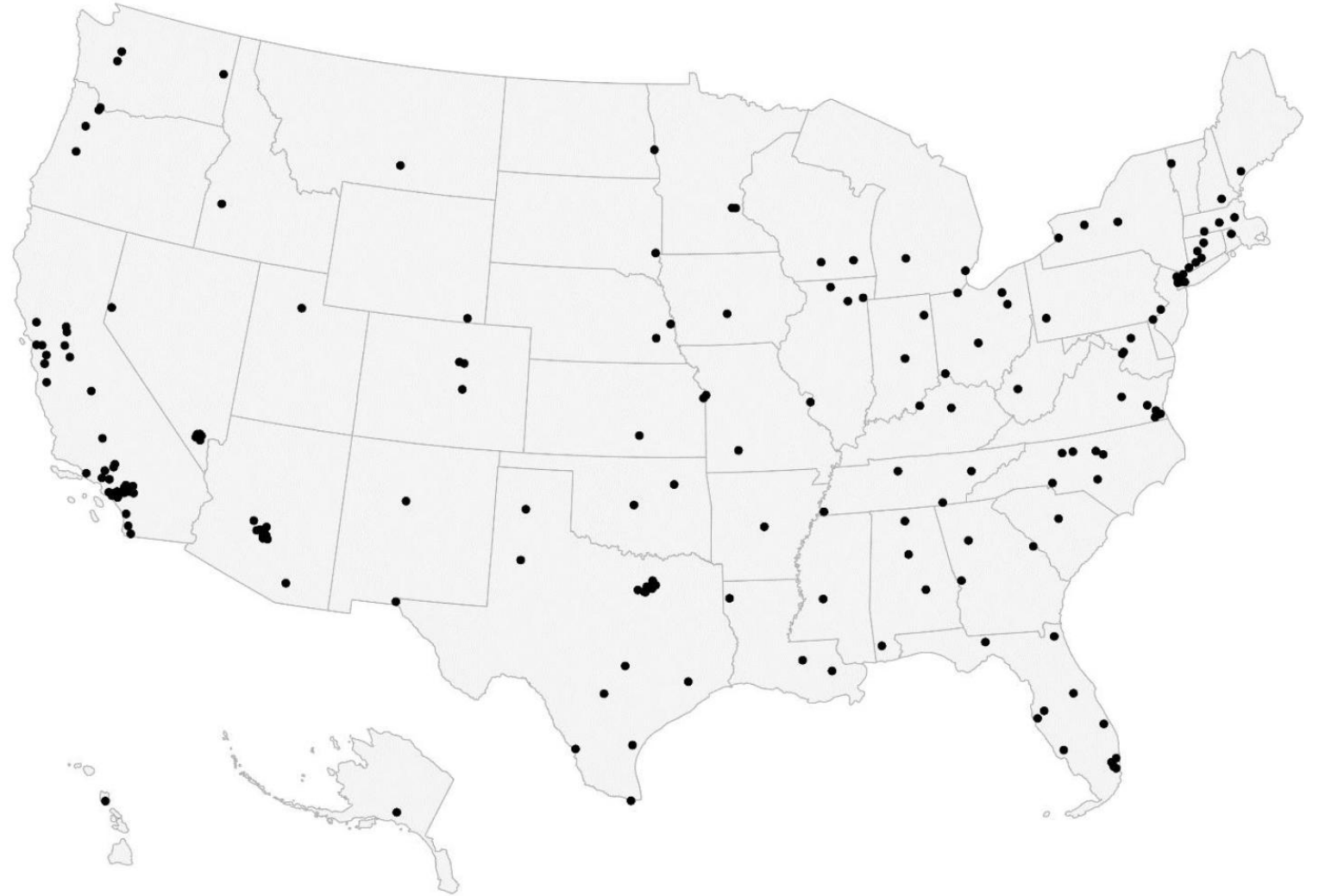
178 US CITIES

54% OPEN STREET DATA

20% SIDEWALKS

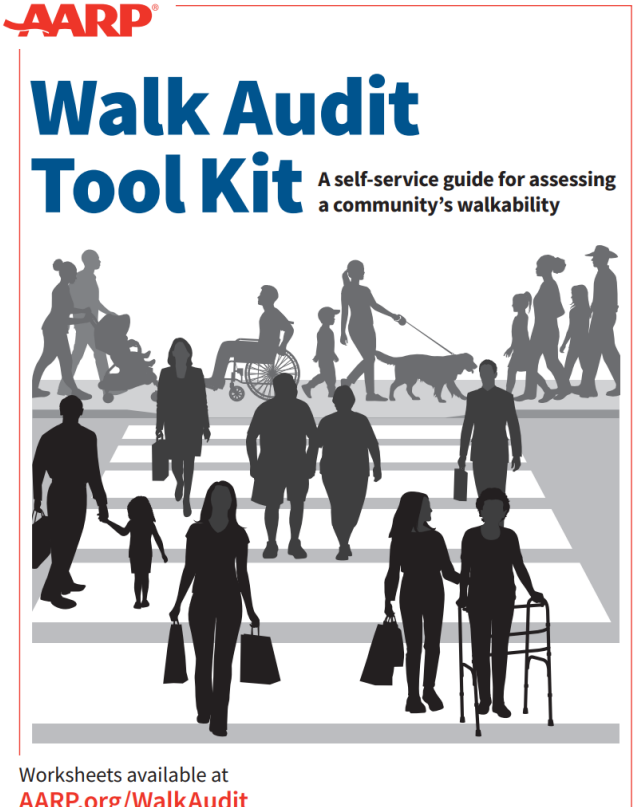
10% CURB RAMPS

<5% BASIC ACCESSIBILITY INFO



BACKGROUND

TRADITIONAL ACCESSIBILITY AUDITS



Walk Audit Toolkit
AARP



Walkability Audit
Wake County, North Carolina



Safe Routes to School Walkability Audit
Rock Hill, South Carolina

TRADITIONAL ACCESSIBILITY AUDITS TRADEOFFS



Walkability Audit
Wake County, North Carolina

Provide high-quality data but...

Laborious

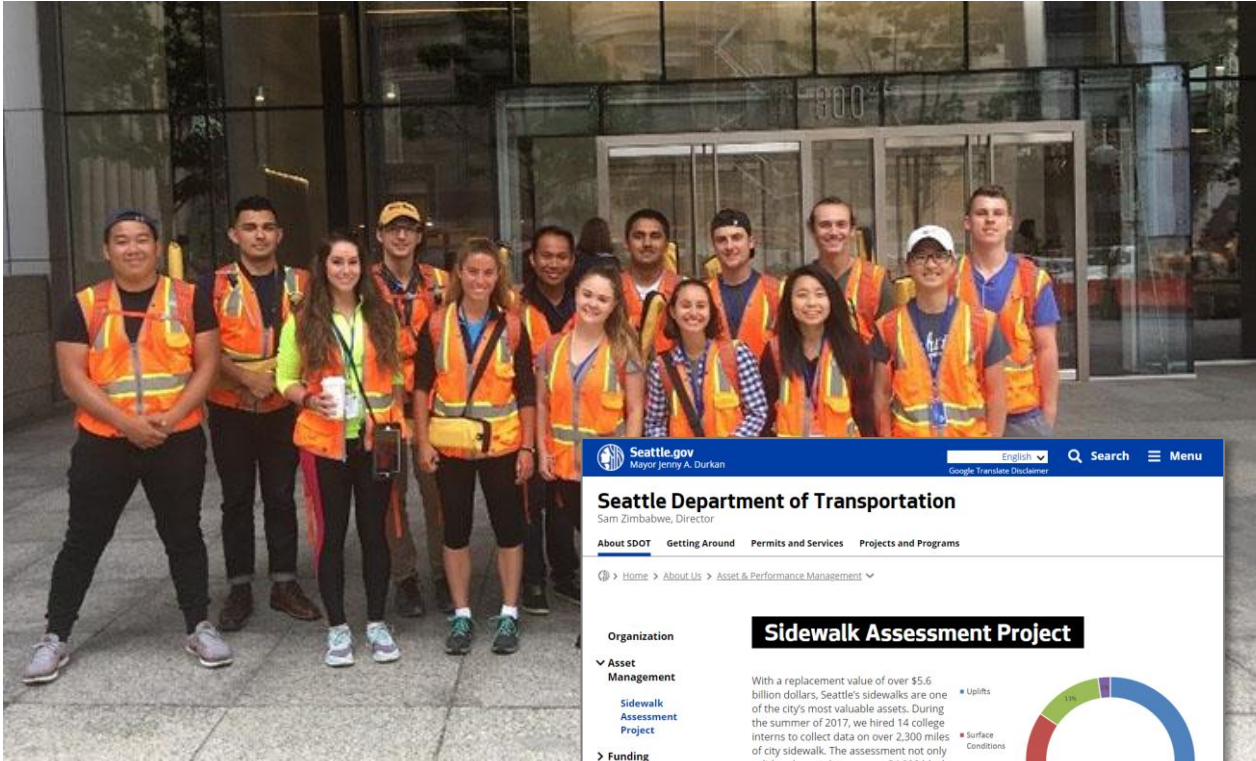
Expensive

Infrequent

Top-down

Where does data go?

SIDEWALK AUDIT SEATTLE



Seattle.gov
Mayor Jenny A. Durkan

Seattle Department of Transportation
Sam Zimbabwe, Director

About SDOT Getting Around Permits and Services Projects and Programs

Home > About Us > Asset & Performance Management

Sidewalk Assessment Project

With a replacement value of over \$5.6 billion dollars, Seattle's sidewalks are one of the city's most valuable assets. During the summer of 2017, we hired 14 college interns to collect data on over 2,300 miles of city sidewalk. The assessment not only validated asset data on over 34,000 blocks of sidewalk, but also produced information that will help inform repair efforts and develop a proactive repair program.

- Uplifts
- Surface Conditions
- Obstructions
- Cross slope

We recorded observations along all known City of Seattle sidewalks. The information collected included slab uplifts, other vertical height differences, obstructions, cross slopes, cracks, and vegetation overgrowth. We also collected the location of benches and other street furnishings, pedestrian rails, and curb bulbs. All told, over 156,000 data points were collected. Interns found over 92,000 uplifts, 38,000 surface conditions, 20,000 obstructions, and 3,600 isolated cross slope issues. Using this data, we updated our existing sidewalk inventory of over 34,000 block faces, with current field conditions and added cross slope information.

First-ever sidewalk audit in 2017

Took ~4 months

Cost \$400,000

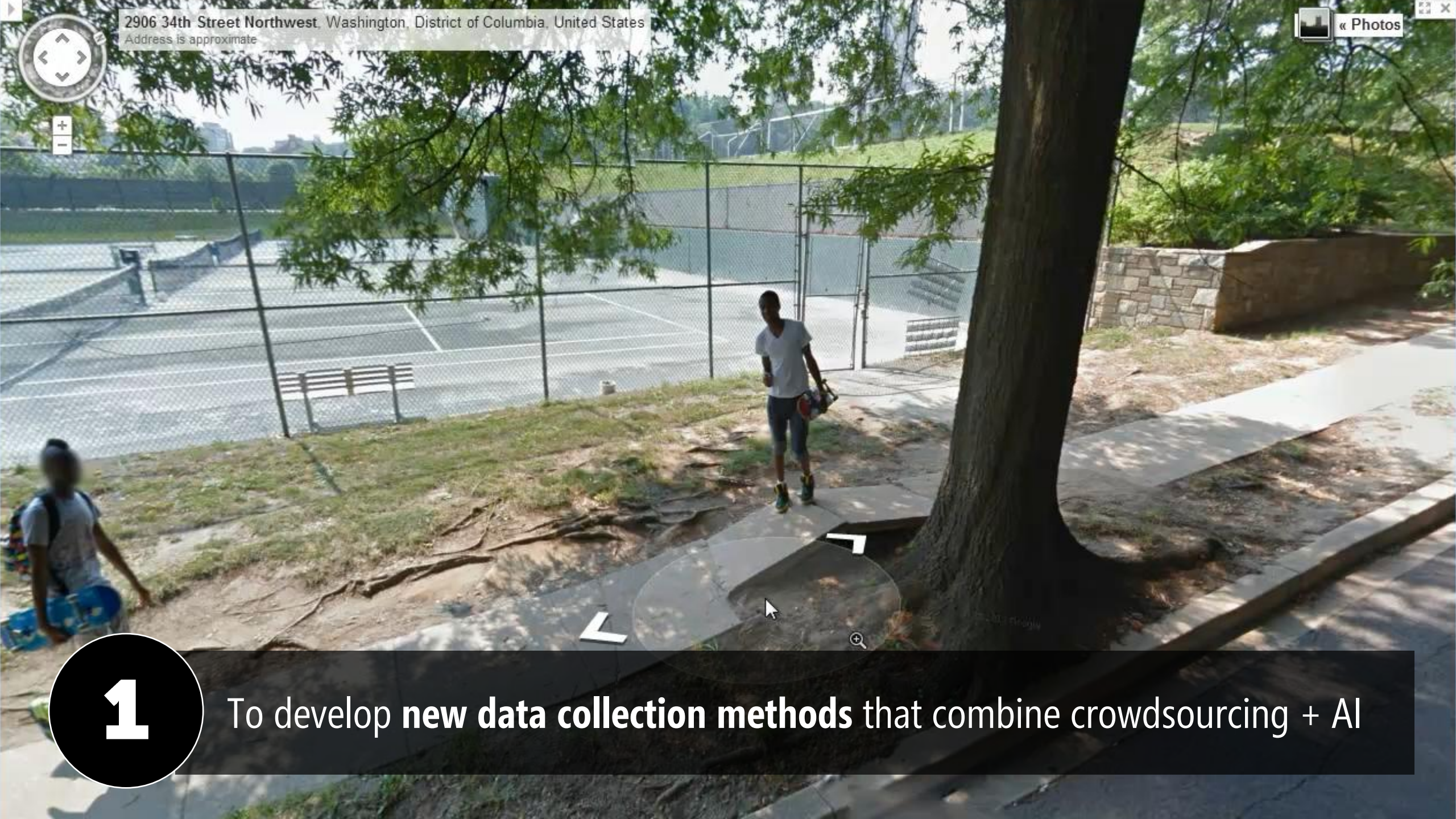
Has not been repeated

Sidewalks valued at \$5.6 billion

We are pursuing a **two-fold solution**

2906 34th Street Northwest, Washington, District of Columbia, United States
Address is approximate

Photos

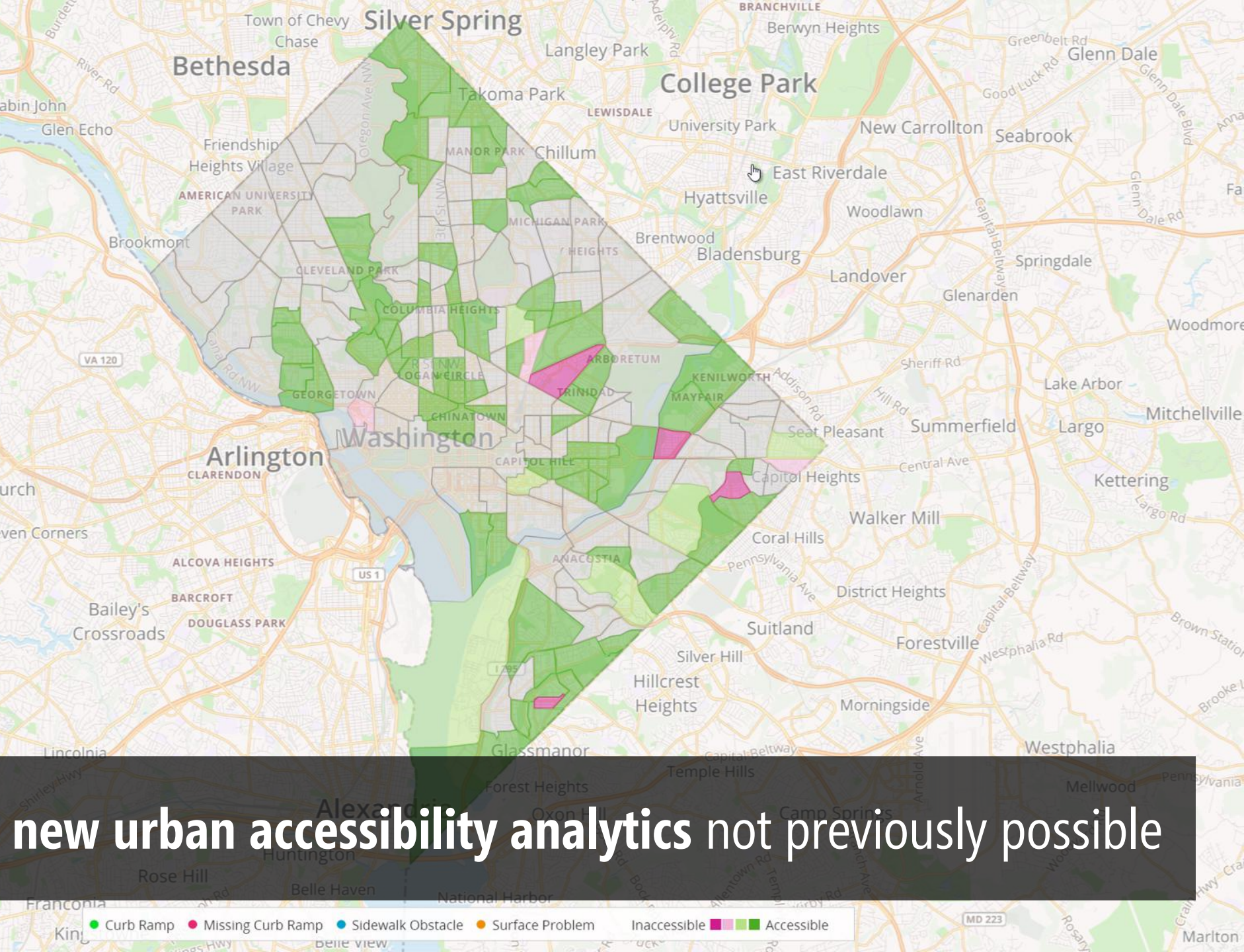
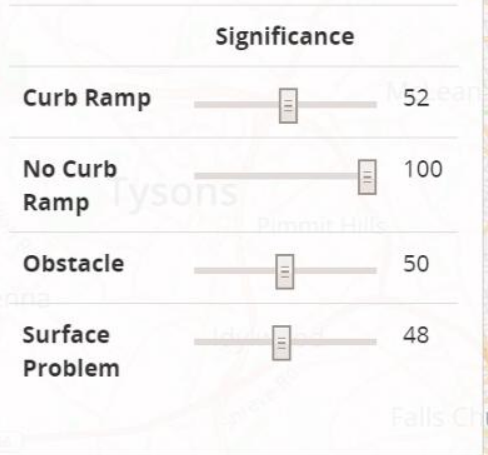


1

To develop **new data collection methods** that combine crowdsourcing + AI

Access Score^{beta}

Use the sliders below to adjust the significance of each accessibility feature.



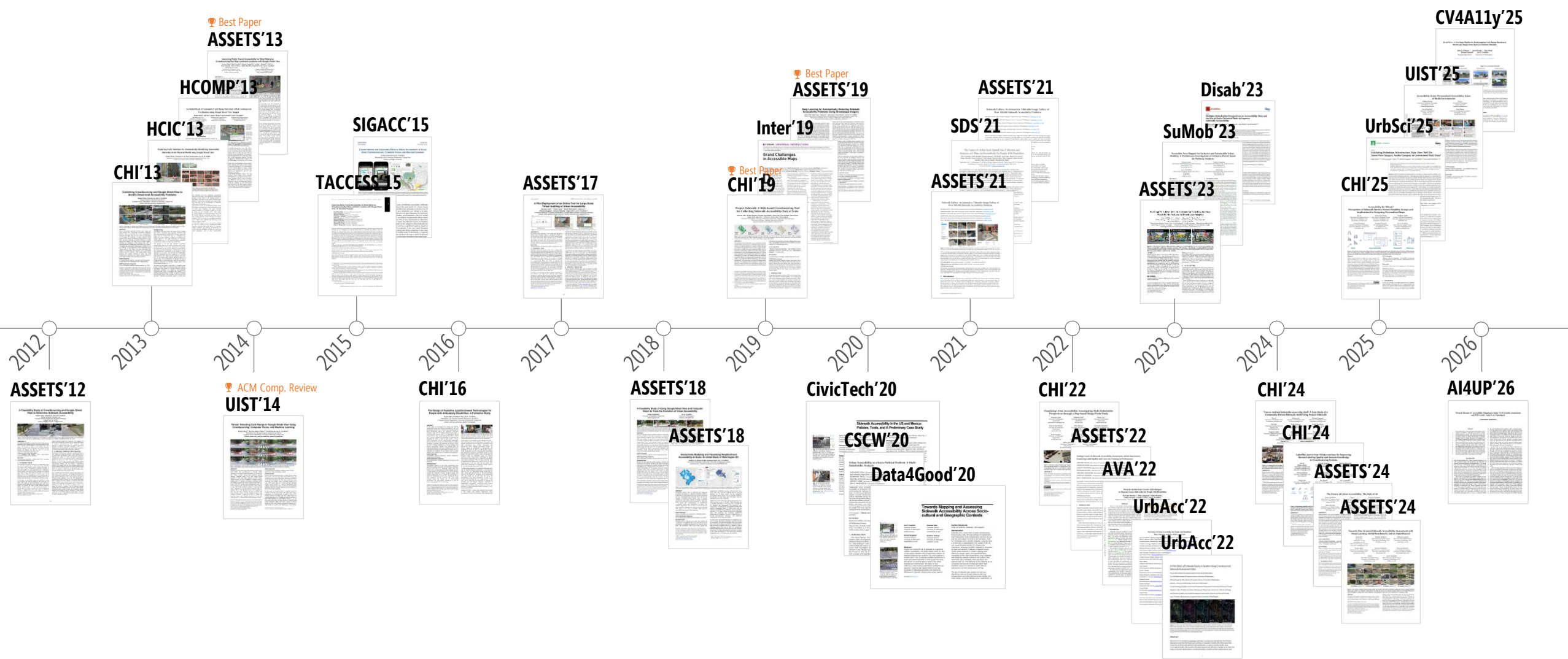
To create new urban accessibility analytics not previously possible

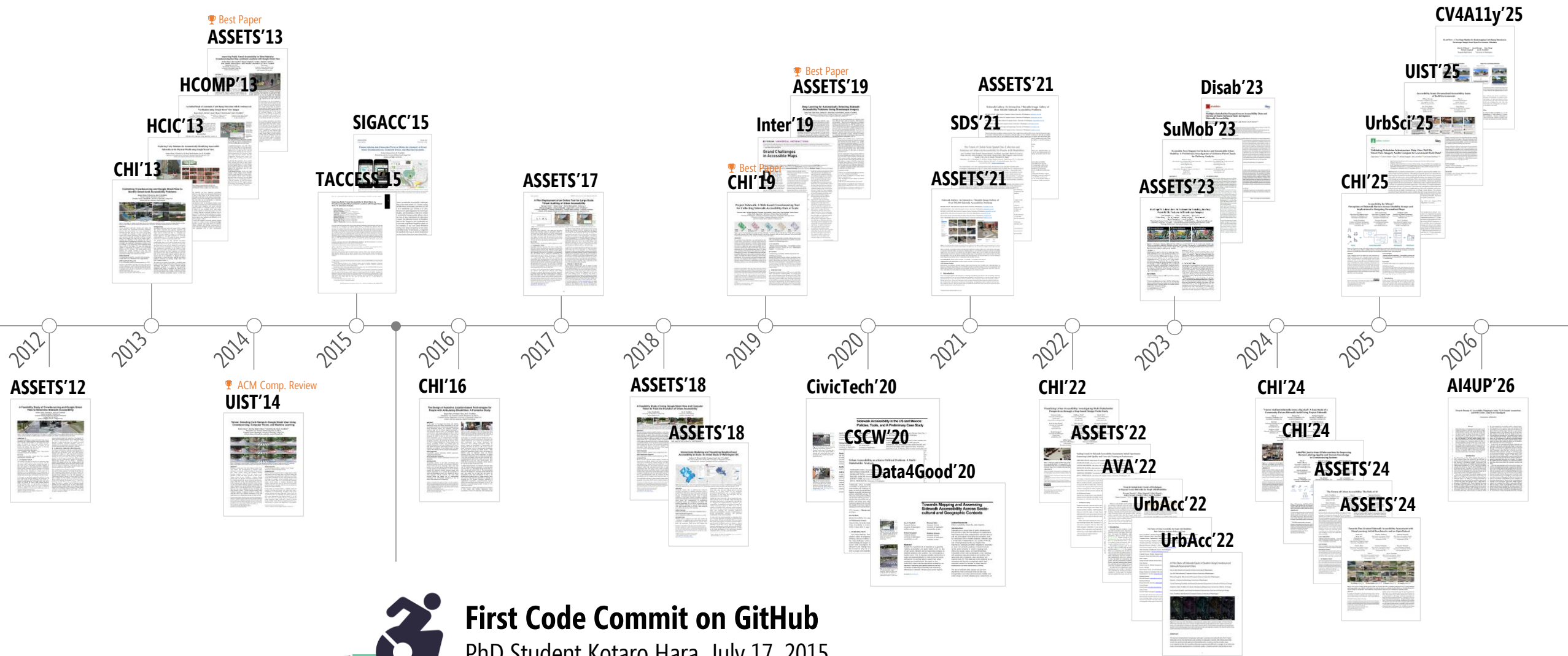


**MAP, ASSESS, & VISUALIZE
EVERY SIDEWALK IN THE**

W  **R****L****D**

URBAN ACCESSIBILITY RESEARCH TIMELINE





First Code Commit on GitHub

PhD Student Kotaro Hara, July 17, 2015

TRY IT!



**PROJECT
SIDEWALK**

<http://projectsidewalk.org>



Explore

CURB RAMP LABELS

SIDEWALK LABELS

OTHER ACCESSIBILITY LABELS



Curb Ramp



Missing Curb Ramp



Obstacle in Path



Surface Problem



No Sidewalk



Marked Crosswalk

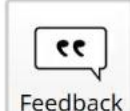
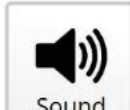


Pedestrian Signal



Other

7 LABEL TYPES



20 mph

INTERACTIVE STREETSCAPE IMAGERY

Do you see any unlabeled problems? If not,
↑ Go straight

Google Sep 2025

© 2025 Google Terms Report a problem

Overall Stats

0.05 miles

4 labels

N/A accuracy

Current Neighborhood

Lower Queen Anne, Seattle

0.05 miles

MISSION STATS

Current Mission

Explore 250 ft of this neighborhood

0% completed

0 curb ramps

0 surface problems

0 missing curb ramps

0 no sidewalks

0 obstacles

0 others

Turn 360 degrees to make sure nothing is missed.

53%

MISSION MAP

Google

Report a map error

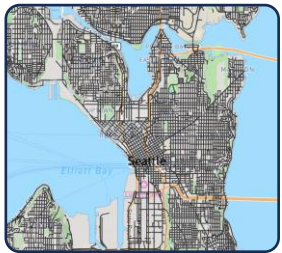
1 PREPROCESSING

Create labeling routes

OpenStreetMap



Filtered Street Network



Open Gov Data



Neighborhood Boundaries



Labeling Mission Routes



2 LABEL SIDEWALKS

Collect geo-located sidewalk assessments

Streetscape Imagery APIs



Google Street View



Meta Mapillary



iNovitas infra3D



Community Partners

Labeling Missions



CURB RAMPS



MISSING RAMP



SURFACE PROB



OBSTACLE



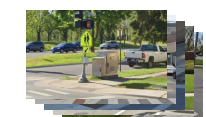
NO SIDEWALK



CROSSWALK



PED SIGNAL



3 VALIDATE LABELS

Quality control

Validation Missions

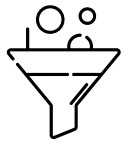
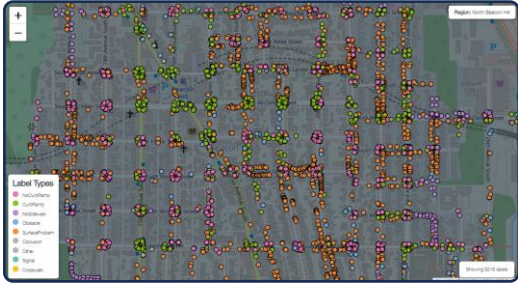
Is this a Surface Problem?



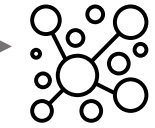
4 POSTPROCESSING

Prepare data for apps

Raw Labels

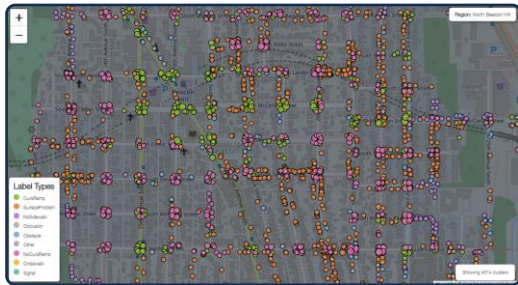


Remove poor-quality labels



Geo-cluster proximal labels

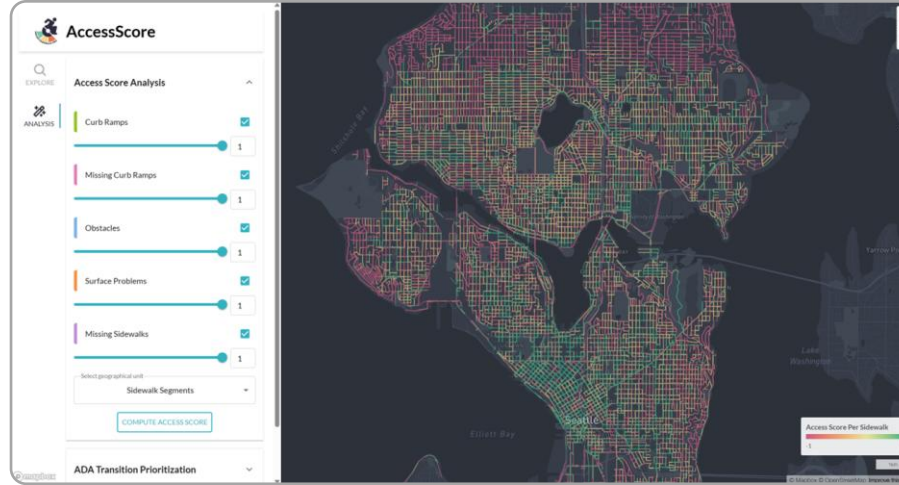
Label Clusters



5 APPLICATIONS

Analytics & mobility tools

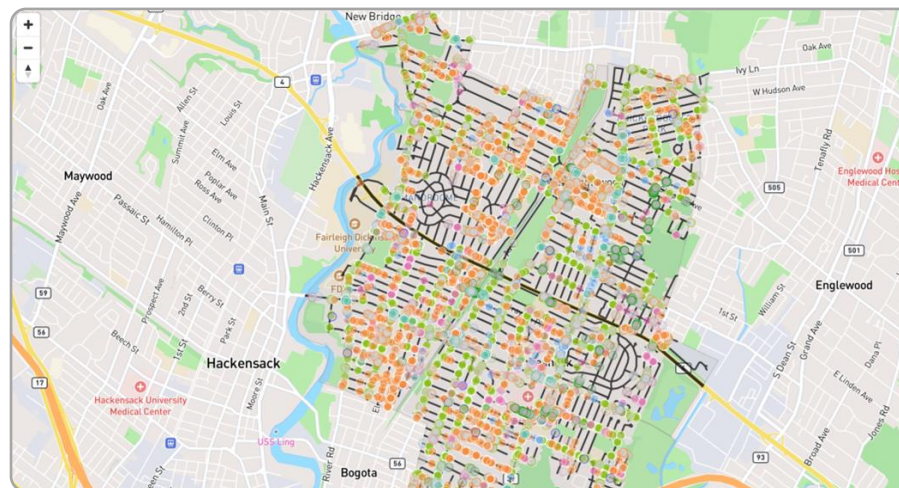
AccessScore



Gallery

A screenshot of a 'Gallery' interface. It features a filter sidebar on the left with options for 'City' (Newberg, OR), 'Label Type', 'Severity', and 'Validations'. The main area displays a grid of street view images. Each image has a label (e.g., 'Obstacle in Path', 'Missing Curb Ramp', 'Curb Ramp') and a severity indicator (a circle with a dot) and a 'Tag' button.

LabelMap



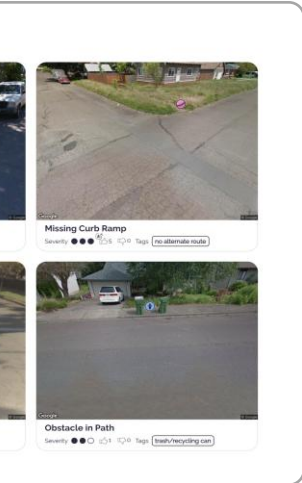
API

A screenshot of the 'Label Clusters API' documentation page. It includes sections for 'GETTING STARTED', 'METADATA APIS', 'DATA APIS', and 'STAT APIS'. The 'Label Clusters API Preview' section features a map showing clusters of labels and a note: 'The size of the circles are proportional to the number of labels in each cluster. The color of the circles corresponds to the Label Type.' Below the map is a 'Page Content' sidebar with links to various API endpoints and documentation sections.

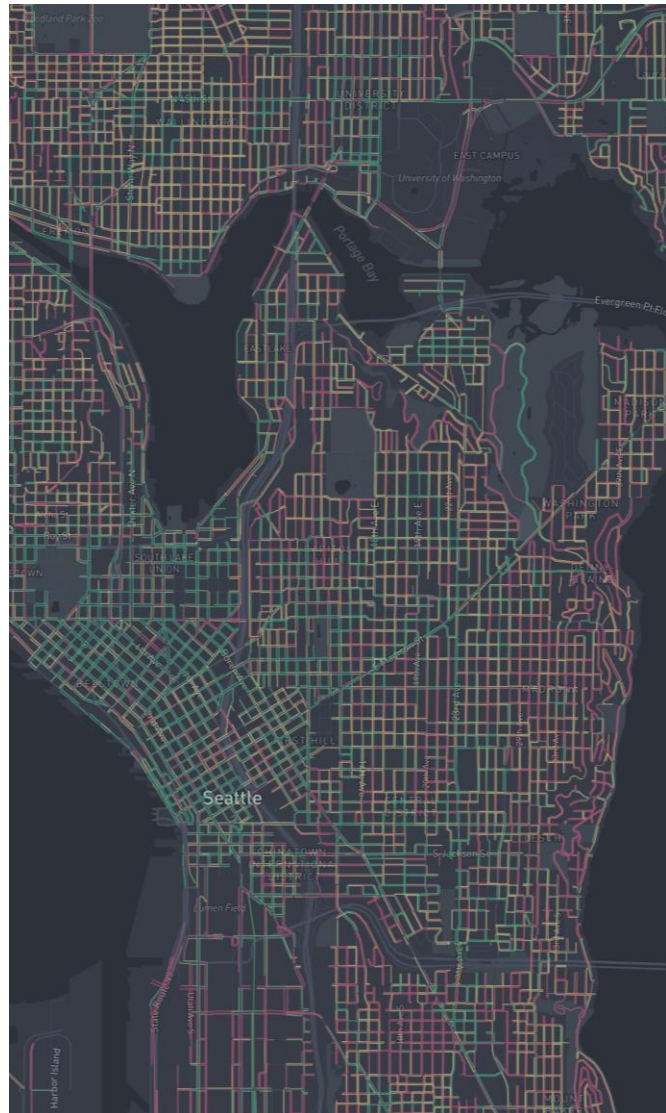
6 OUTCOMES

Research to translational

Research



Translational Impact



Open Data / Source

ProjectSidewalk

Overview Repositories 36 Projects 1 Packages Teams 2 People 20

Project Sidewalk
Our mission: map and assess every sidewalk in the world using remote crowdsourcing, artificial intelligence, and online satellite & streetscape imagery.
27 followers University of Washington, Seattle, WA http://projectsidewalk.org @projsidewalk

README.md

Welcome 🌟

This is the open-source repository for all things [Project Sidewalk](#). Our mission is to develop advanced techniques for mapping the world's sidewalks using remote crowdsourcing, artificial intelligence, and online satellite & streetscape imagery.

Some links to help you get started:

- [Our Project Sidewalk Wiki](#)
- [Considerations for deploying Project Sidewalk in your city](#)
- [The Project Sidewalk webpage repo](#)
- [Our design repo](#)

Pinned

- [SidewalkWebpage](#) Public
Project Sidewalk web page
JavaScript ⭐ 94 🗄 MIT 📄 27
- [Design](#) Public
Stores design files for branding and logos
⭐ 3 🗄 1

Repositories

Find a repository... Type Language

- [SidewalkWebpage](#) Public
Project Sidewalk web page
JavaScript ⭐ 94 🗄 MIT 📄 27 🔄 376 📄 14 Updated 2 days ago
- [Design](#) Public
Stores design files for branding and logos
⭐ 3 🗄 1 🔄 0 📄 0 Updated 2 weeks ago
- [sidewalk-auto-labeler](#) Public
Python ⭐ 1 🗄 0 🔄 0 📄 0 Updated on Sep 11
- [sidewalk-validator-ai](#) Public

On This Page

- Label Clusters API
- Label Clusters API Preview
- Examples
- Quick Download
- Query Parameters
- Reporters
- Success Response (200 OK)
- GeoJSON Format (Default)
- GeoJSON Field Descriptions
- CSV Format
- Shapefile Format
- GeoPackage Format
- Error Responses
- Error Response Body
- Data Cleaning
- Best Practices
- Terms of Use
- Contribute
- Project Sidewalk in Your City

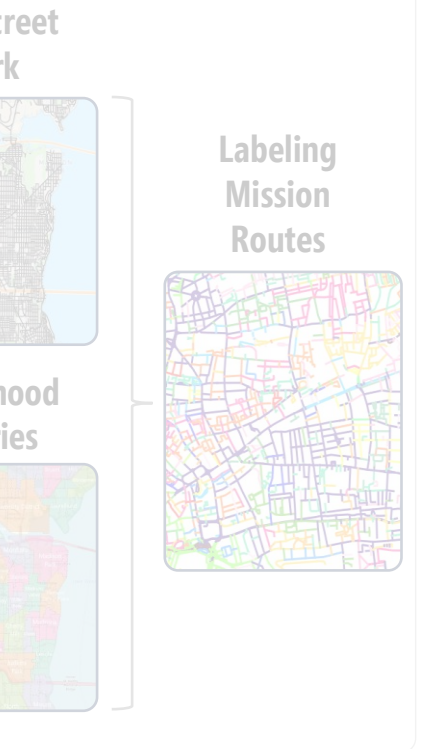
Raw Labels equivalent to see the difference load.

from all regions in the city or just a selected

PROJECT SIDEWALK

43 DEPLOYMENT CITIES





2 LABEL SIDEWALKS

Collect geo-located sidewalk assessments

Streetscape Imagery APIs



Google Street View



Meta Mapillary



iNovitas infra3D



Community Partners

Labeling Missions



CURB RAMPS



MISSING RAMP



SURFACE PROB



OBSTACLE



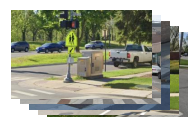
NO SIDEWALK



CROSSWALK



PED SIGNAL



3 VALIDATE LABELS

Quality control

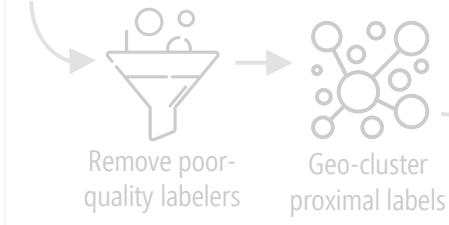
Validation Missions



4 POSTPROCESS

Prepare data for apps

Raw Labels



Label Clusters





Labeling Missions



Explore



Curb Ramp



Missing Curb Ramp



Obstacle in Path



Surface Problem



No Sidewalk



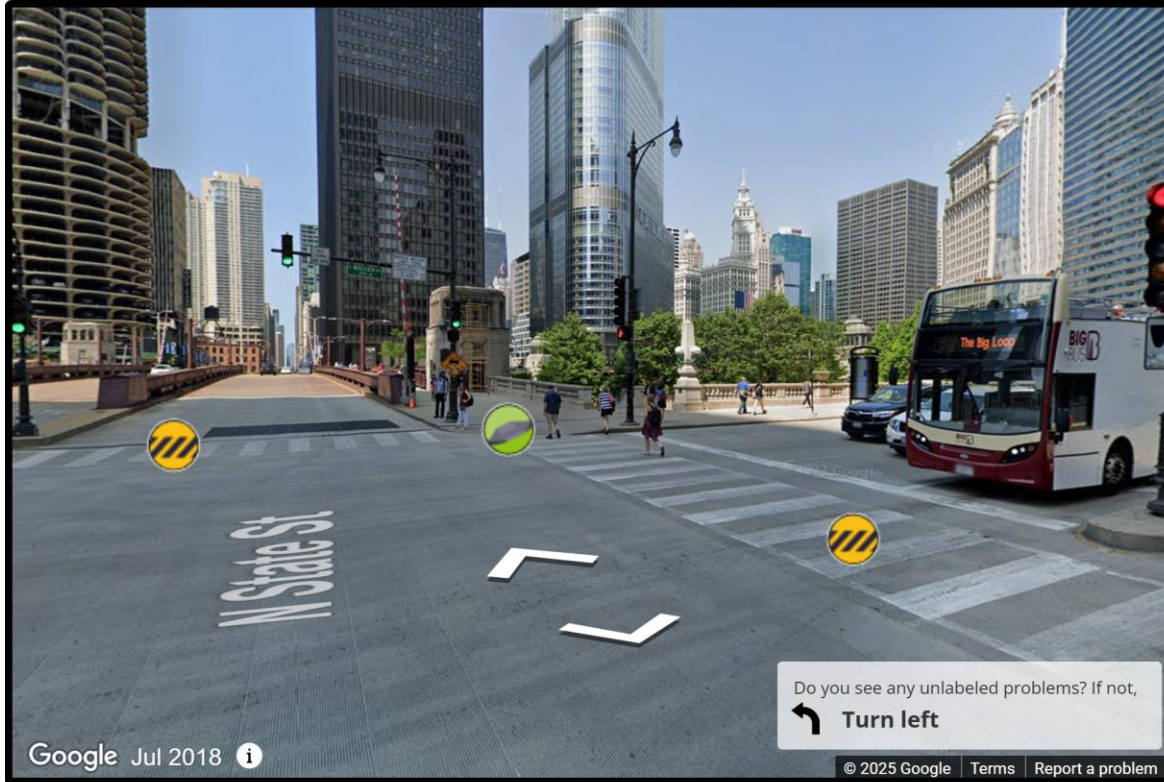
Marked Crosswalk



Pedestrian Signal



Other



CURB RAMPS



MISSING RAMP



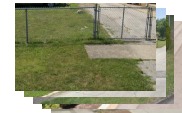
SURFACE PROB



OBSTACLE



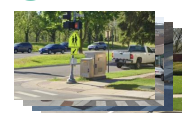
NO SIDEWALK



CROSSWALK



PED SIGNAL



Access Features



Access Barriers



About the ADA and ABA Accessibility Guidelines for the Public Right-of-Way

The Access Board has published new guidelines under the Americans with Disabilities Act (ADA) and the Architectural Barriers Act (ABA) that address access to sidewalks and streets, crosswalks, curb ramps, pedestrian signals, on-street parking, and other components of public right-of-way. These guidelines also review shared use paths, which are designed primarily for use by bicyclists and pedestrians for transportation and recreation purposes.

- Background**
- July 3, 2024 - GSA OGP [Federal Management Regulation adopts PROWAG](#).
 - August 4, 2023 - The Board [publishes final rule in the Federal Register](#).
 - February 13, 2021 - The Board publishes a [Proposed Draft Accessibility Guidelines for the Public Right-of-Way](#) in its rulemaking on public right-of-way.
 - February 13, 2013 - The Board issues a [supplemental notice to address shared use paths](#) in its rulemaking on public right-of-way.
 - December 5, 2011 - The Board issues notice [proposing proposed rule for public comment](#).
 - July 26, 2011 - The Board issues [notice of proposed rulemaking on Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way](#).
 - March 28, 2011 - The Board issues notice of [proposed rule on Shared Use Path Accessibility Guidelines](#).
 - August, 2007 - Public Rights of Way Access Advisory Committee (PROWAG) issues a [special report](#).
 - November 23, 2005 - The Board releases [revised draft guidelines](#) for purposes of gathering information for a cost analysis.
 - June 17, 2002 - The Board releases [draft guidelines](#) for public comment.
 - January 10, 2001 - The Public Rights of Way Access Advisory Committee submits its [report](#) to the Board.
 - October 20, 1999 - The Board [announces](#) the Public Rights of Way Access Advisory Committee.

Additional Resources



Access Features

Access Barriers

CURB RAMP



CROSSWALK



PED SIGNAL



MISSING RAMP



SURFACE PROB



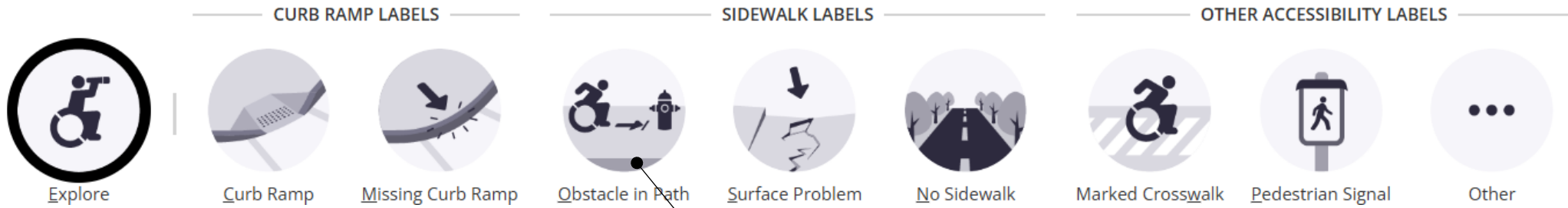
OBSTACLE



NO SIDEWALK



What do you **see** here? What **label** would you **choose**?



CURB RAMP LABELS

SIDEWALK LABELS

OTHER ACCESSIBILITY LABELS



Explore



Curb Ramp



Missing Curb Ramp



Obstacle in Path



Surface Problem



No Sidewalk



Marked Crosswalk



Pedestrian Signal



Other

Overall Stats

0.97 miles

666 labels

94.2% accuracy

Current Neighborhood

Ward 3, St. Louis

0.51 miles

457 labels

Current Mission

Explore 500 ft of this neighborhood

19% complete



0 curb ramps



2 surface problems



0 missing curb ramps



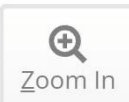
0 no sidewalks



0 obstacles

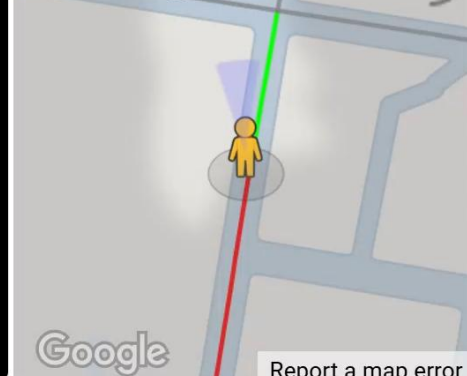


0 others



Do you see any unlabeled problems? If not, U turn

Turn 360 degrees to make sure nothing is missed. 49%



1. CHOOSE LABEL



Curb Ramp



Missing Curb Ramp



Obstacle in Path



Surface Problem



No Sidewalk



Marked Crosswalk



Pedestrian Signal



Other

CURB RAMP LABELS

SIDEWALK LABELS

OTHER ACCESSIBILITY LABELS

Overall Stats

0.97 miles

667 labels

94.2% accuracy

Current Neighborhood

Ward 3, St. Louis

0.51 miles

458 labels

Current Mission

Explore 500 ft of this neighborhood

19% complete



0 curb ramps



2 surface problems



0 missing curb ramps



0 no sidewalks



1 obstacle



0 others



Zoom In



Zoom Out



Sound



Jump



Stuck



Feedback

1. Add tags ⓘ

fire hydrant pole tree vegetation trash/recycling can
parked car (u) parked bike construction sign stairs
height difference narrow litter/garbage (x)
parked scooter/motorcycle mailbox (l)

2. Rate severity ⓘ

Low Medium High

3. Describe (optional)

Description

OK

2. TAGS

3. RATE SEVERITY

4. COMMENTS

5. FIND WHERE TO GO ON THE MAP

Do you see any unlabeled problems? If not,
 U turn

Turn 360 degrees to make sure nothing is missed. 49%



1. Add tags ⓘ



fire hydrant

pole

tree

vegetation

trash/recycling can

parked car (u)

parked bike

construction

sign

stairs

height difference

narrow

litter/garbage (x)

parked scooter/motorcycle

mailbox (l)

2. Rate severity ⓘ



Low



Medium



High

3. Describe (optional)

Description



1. Add tags ⓘ

fire hydrant pole tree vegetation trash/recycling can
parked car (u) parked bike construction sign stairs
height difference narrow litter/garbage (x)
parked scooter/motorcycle mailbox (l)

2. Rate severity ⓘ

☹️ 😞 😡
Low Medium High

3. Describe (optional)

Description



Up here with this pole,
with these barriers,



1. Add tags ⓘ

- fire hydrant
- pole**
- tree
- vegetation
- trash/recycling can
- parked car (u)
- parked bike
- construction
- sign
- stairs
- height difference
- narrow
- litter/garbage (x)
- parked scooter/motorcycle
- mailbox (l)

2. Rate severity ⓘ

- Low
- Medium
- High

3. Describe (optional)

Description

OK

OBSTACLE TAGS



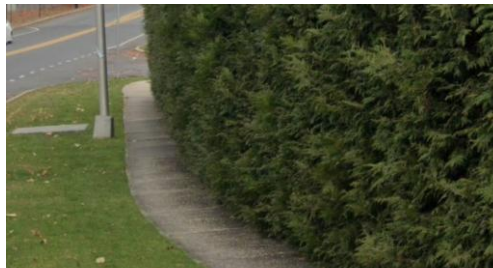
Pole



Vegetation



Parked Bike



Narrow



Trash/recycling cans



Height difference



Sign



Parked car



Tree



Litter/garbage



Construction



Mailbox

1. Add tags ⓘ

fire hydrant pole tree vegetation trash/recycling can
 parked car (u) parked bike construction sign stairs
 height difference narrow litter/garbage (x)
 parked scooter/motorcycle mailbox (l)

2. Rate severity ⓘ

☹️ ☹️☹️ ☹️☹️☹️

Low Medium High

RATE SEVERITY

3. Describe (optional)

Description

OK

 **OBSTACLE**



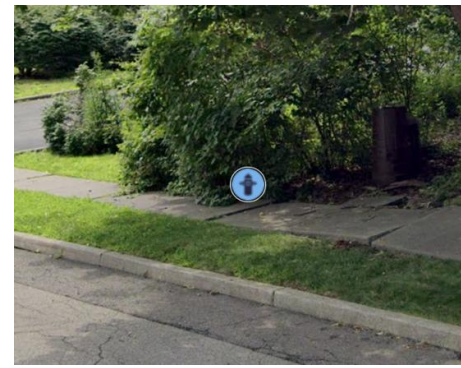
Low Severity
Passable



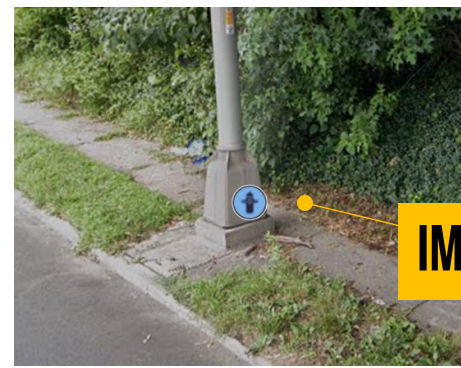
ROOM TO MANEUVER AROUND



Medium
Semi-passable



High
Not passable



IMPASSABLE BARRIER!



WORSE



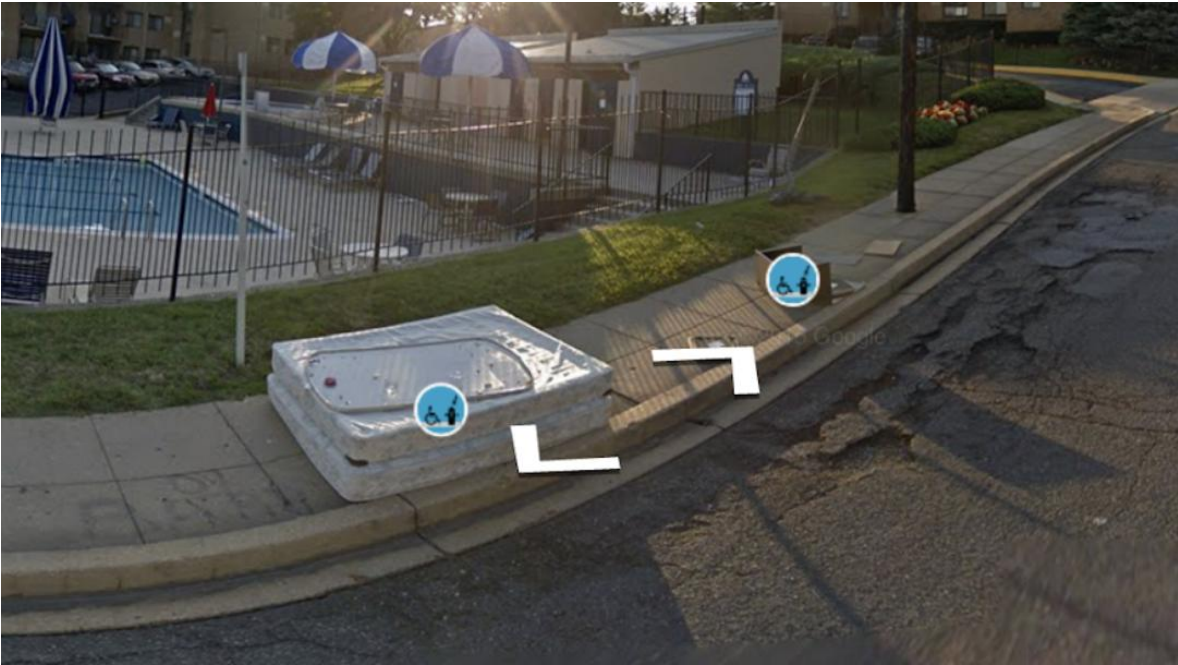
CURB RAMPS

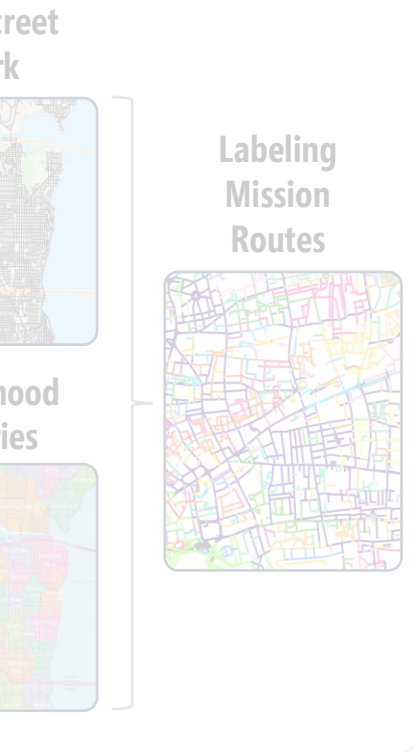
High Severity
Not passable



SIDEWALK MATTRESSES

 **OBSTACLE**
High Severity
Not passable





2 LABEL SIDEWALKS

Collect geo-located sidewalk assessments

Streetscape Imagery APIs



Google Street View



Meta Mapillary



iNovitas infra3D



Community Partners

Labeling Missions



CURB RAMPS



MISSING RAMP



SURFACE PROB



OBSTACLE



NO SIDEWALK



CROSSWALK



PED SIGNAL

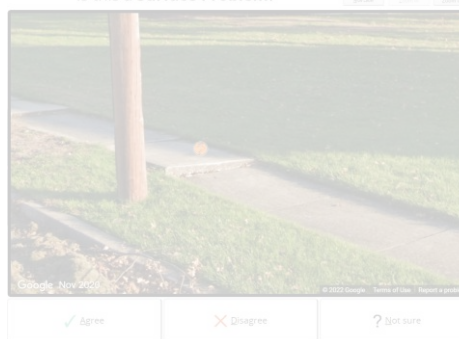


3 VALIDATE LABELS

Quality control

Validation Missions

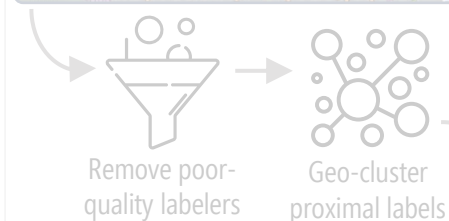
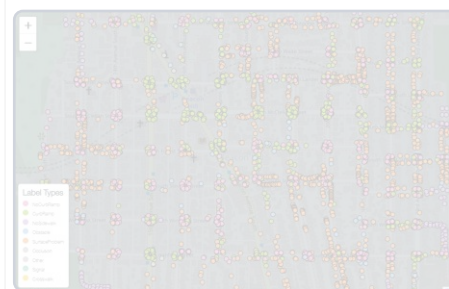
Is this a Surface Problem?



4 POSTPROCESS

Prepare data for apps

Raw Labels

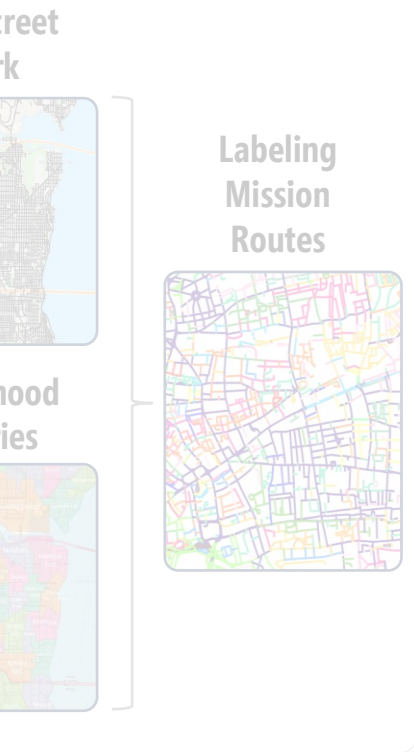


Remove poor-quality labels

Geo-cluster proximal labels

Label Clusters





2 LABEL SIDEWALKS

Collect geo-located sidewalk assessments

Streetscape Imagery APIs



Google Street View



Meta Mapillary



iNovitas infra3D



Community Partners

Labeling Missions



CURB RAMPS



MISSING RAMP



SURFACE PROB



OBSTACLE



NO SIDEWALK



CROSSWALK



PED SIGNAL



3 VALIDATE LABELS

Quality control

Validation Missions

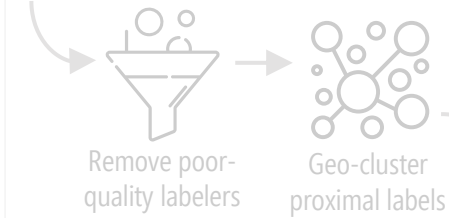
Is this a Surface Problem?



4 POSTPROCESS

Prepare data for apps

Raw Labels



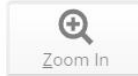
Remove poor-quality labels

Geo-cluster proximal labels

Label Clusters



Is this a **Surface Problem**?



... 3961 labels



Google Nov 2020

© 2022 Google Terms of Use Report a problem

Current Mission
Validate 10 labels



Correct Examples



Incorrect Examples



Agree

Disagree

Not sure

Add comment here...

Is this a Missing Curb Ramp?

 Hide Label

 Zoom In

 Zoom Out

 1113 labels

Current Mission
Validate 10 labels

50% complete

CORRECT Missing Curb Ramp



INCORRECT Missing Curb Ramp



Agree

Disagree

Not sure

Add comment here...

Hide Label

Is this a **Curb Ramp**?

Zoom In

Zoom Out

0 labels



Current Mission

Validate 10 labels

0% complete

Curb Ramp



NOT a Curb Ramp



✓ Agree

✗ Disagree

? Not sure

Is this a **Curb Ramp**?

Hide Label

Zoom In

Zoom Out



**THIS IS A DRIVEWAY,
NOT A CURB RAMP**

✓ Agree

✗ Disagree

? Not sure

Labeled every driveway as a curb ramp



Is this an **Obstacle**?

 Hide Label

 Zoom In

 Zoom Out

 934 labels

Current Mission
Validate 10 labels

0% complete


Correct Examples




Incorrect Examples



POLE IS NOT AN OBSTACLE HERE

 Skip

 Feedback

Google May 2019

© 2021 Google Terms of Use Report a problem

Agree

Disagree

Not sure

Add comment here...

Hide Label

Is this a **Surface Problem**?

Zoom In

Zoom Out

9 labels



Current Mission

Validate 10 labels

90% complete

Surface Problem



NOT a Surface Problem



Skip

Feedback

✓ Agree

✗ Disagree

? Not sure



Frontage
Zone

Pedestrian
Zone

Planting/
Furnishing

Curb
Zone

Bike
Facility

Buffer



ONLY MARK BARRIERS IN THE PEDESTRIAN PATH

Frontage Zone

Pedestrian Zone

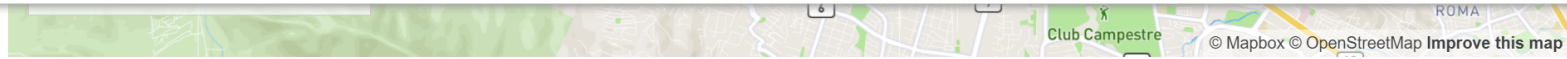
Planting/
Furnishing

Curb Zone

Bike Facility

Buffer

We also try to make Project Sidewalk **fun** and **educational**



Your missions



140

Distance



2.03 mi

Labels



568

Validations



1249

Accuracy



90.7%

Achievements

Missions

Congratulations, you've earned all mission badges!



Distance

Thanks for helping! **2.97 more miles** until your next achievement.



Labels

Great job! **432 more labels** until your next achievement.



Validations

Amazing work! **3751 more validations** until your next achievement.



PROJECT SIDEWALK

- About Us
- Terms of Use
- Help
- Labeling Guide

DEVELOPER

- Sidewalk API

CONNECT

- Github
- Twitter
- Email Us
- Facebook



Overall Leaderboard

Leaders are calculated based on their labels, distance, and accuracy

#	Username	Labels	Missions	Distance	Accuracy
1	mariana.velasco	2894	150	9.6 miles	85.3%
2	maria	1918	51	9.0 miles	89.1%
3	abarragan99	1895	81	2.7 miles	86.5%
4	marian.trevino	1543	66	9.4 miles	82.2%
5	dordaz	1483	46	3.5 miles	84.2%
6	Gerardo R	1274	86	5.4 miles	87.6%
7	mariagarza	1205	62	9.4 miles	87.2%
8	ana.alvarezc	1053	63	9.8 miles	84.8%
9	Gari01234	848	62	4.6 miles	89.1%
10	Luis Gonzalez	812	59	9.7 miles	94.1%

Want to make it into the Top 10? [Start exploring!](#)

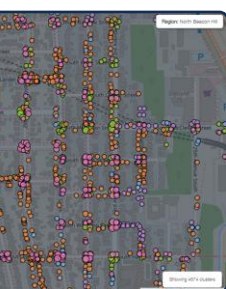
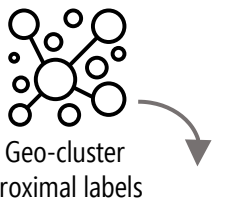
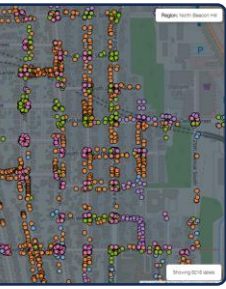
PROJECT SIDEWALK

REMOTE CROWDSOURCING



**LABELING MEXICO
CITY FROM GERMANY!**

PROCESSING

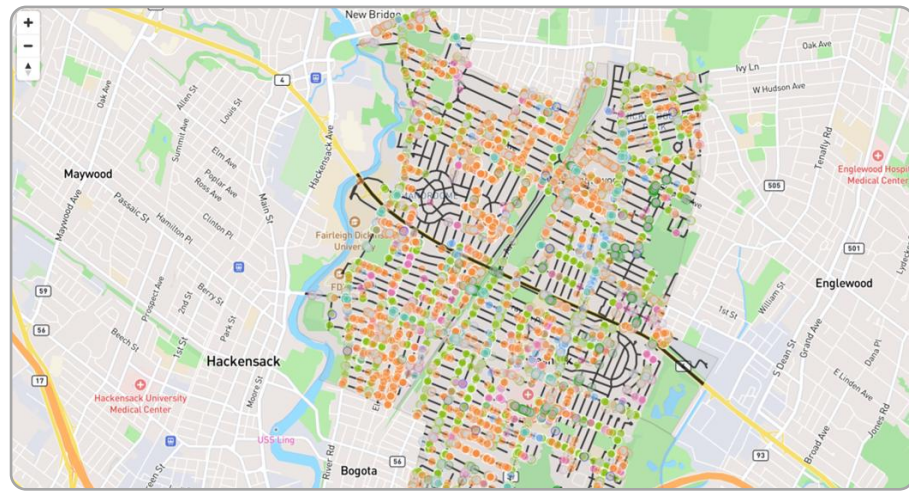


5 APPLICATIONS

Analytics & mobility tools

AccessScore

LabelMap



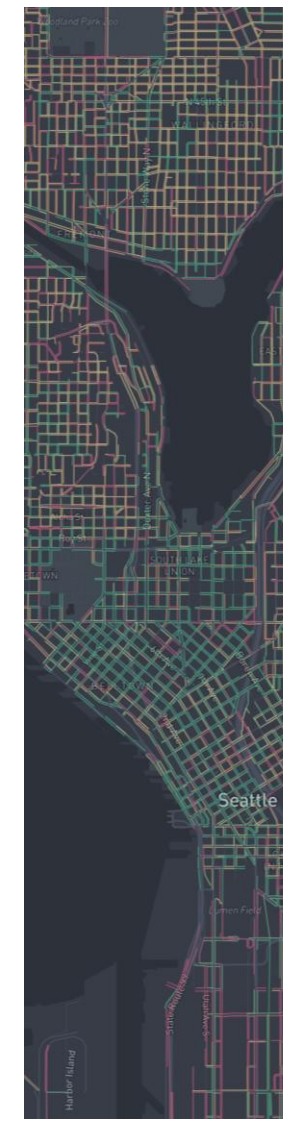
Gallery

API

6 OUTCOMES

Research to

Research





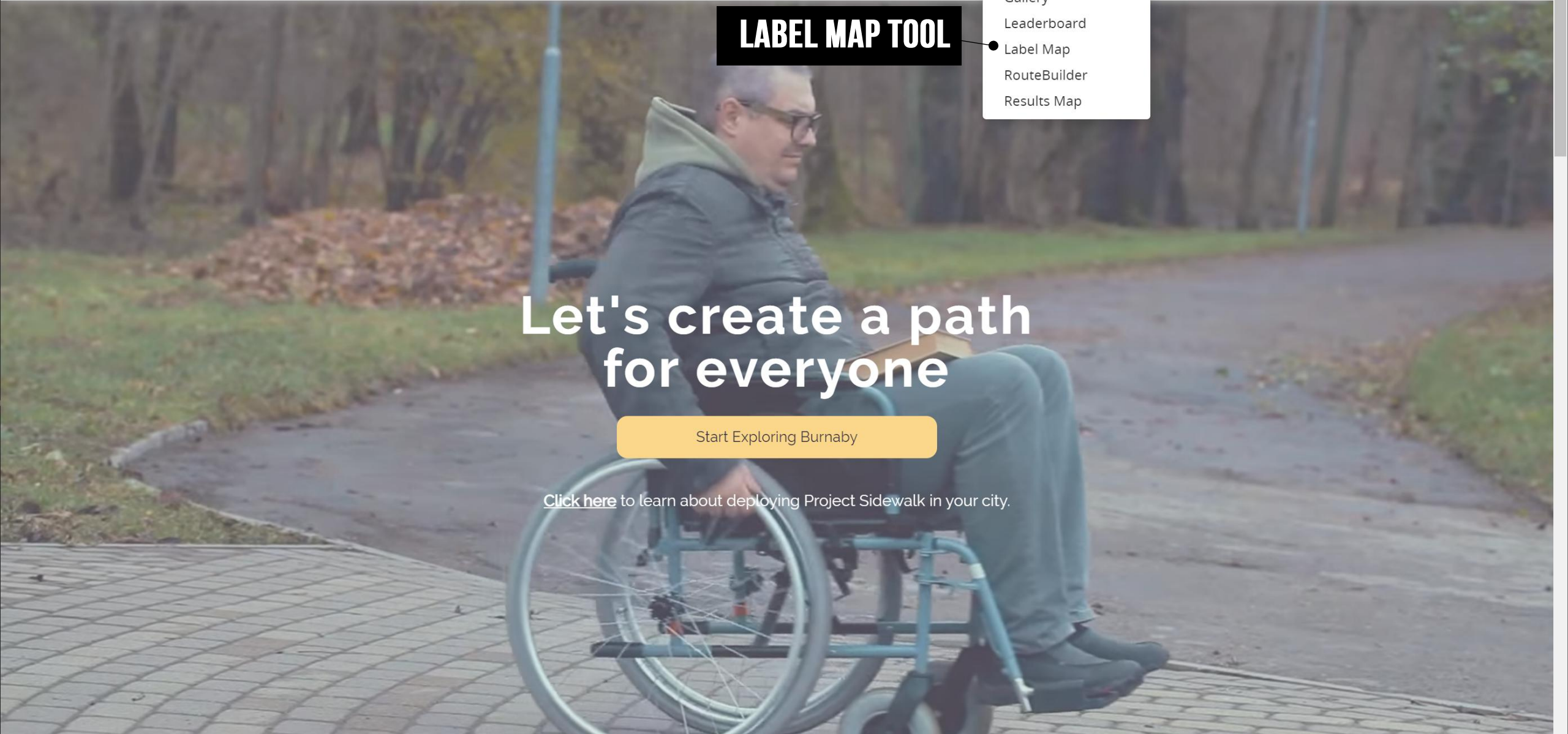
- Gallery
- Leaderboard
- Label Map
- RouteBuilder
- Results Map

LABEL MAP TOOL

Let's create a path for everyone

Start Exploring Burnaby

[Click here](#) to learn about deploying Project Sidewalk in your city.





Explore

Validate

How to Label

API

Tools

Oradell

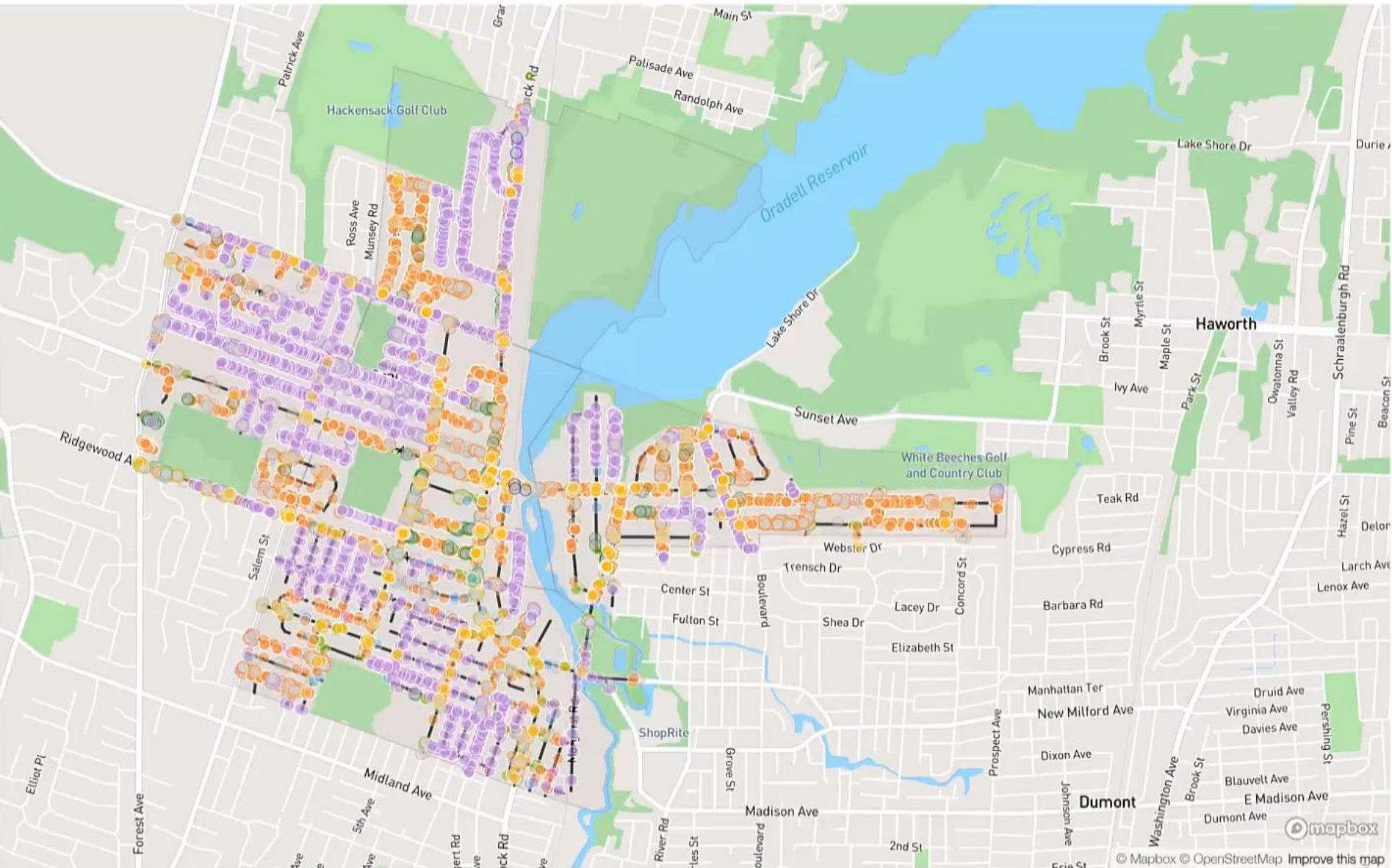
jonfroehlich

US English



Legend

Label Type	Severity	Severity	Severity
Curb Ramp	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N/A - 5
Missing Curb Ramp	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N/A - 5
Obstacle in Path	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N/A - 5
Surface Problem	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N/A - 5
No Sidewalk	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N/A - 5
Crosswalk	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N/A - 5
Other	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N/A - 5
Pedestrian Signal	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Can't See the Sidewalk	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Validated correct	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Validated incorrect	<input type="checkbox"/>	<input type="checkbox"/>	
Not Sure	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Unvalidated	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Audited Street	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Unaudited Street	<input checked="" type="checkbox"/>	<input type="checkbox"/>	





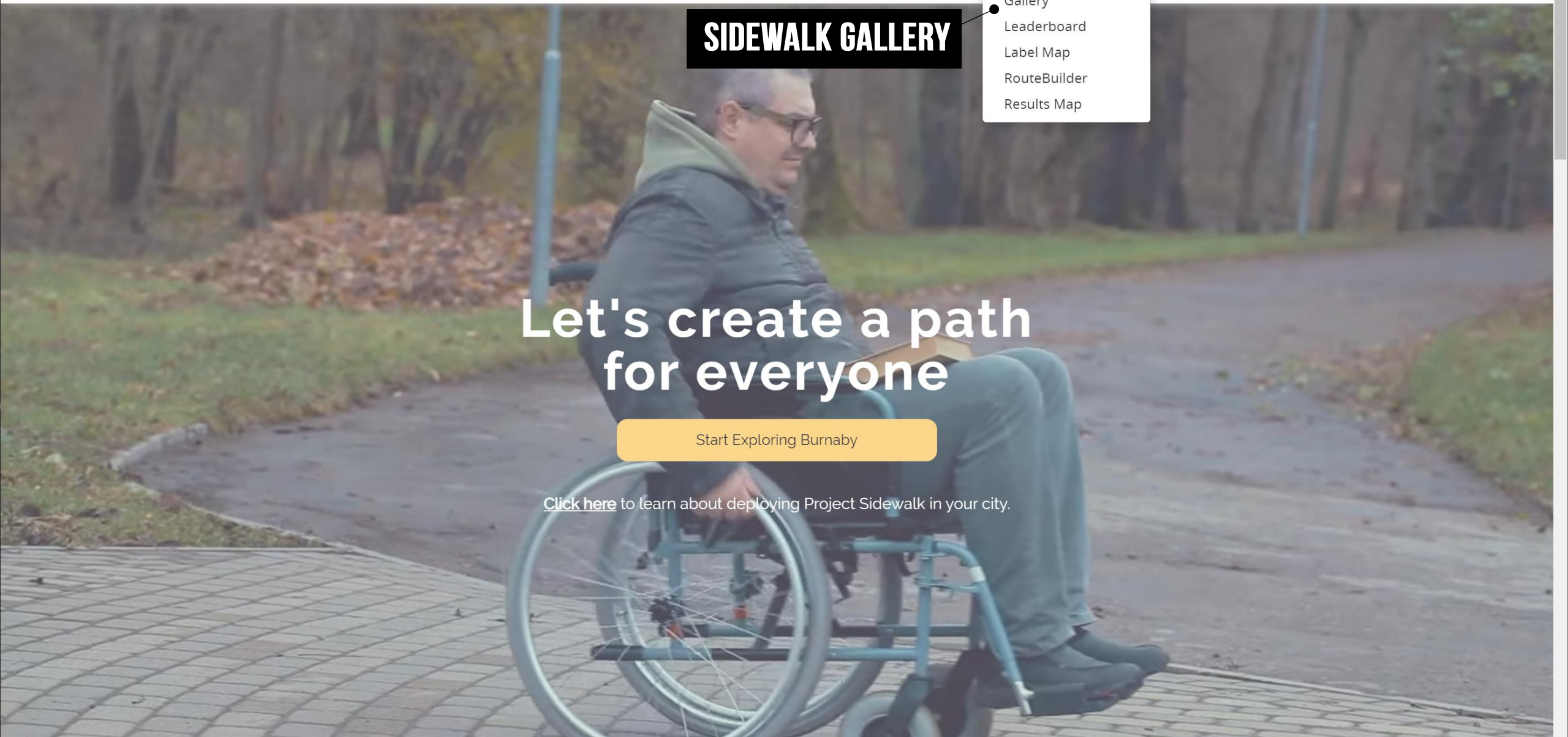
- Gallery
- Leaderboard
- Label Map
- RouteBuilder
- Results Map

SIDEWALK GALLERY

Let's create a path for everyone

Start Exploring Burnaby

[Click here](#) to learn about deploying Project Sidewalk in your city.



City

Pittsburgh, PA

Filter By

Label Type
All Label Types

Severity
☹️ 😞 😫

Validations
Validated correct
Validated incorrect
Unsure
Unvalidated



Marked Crosswalk

Severity ● ○ ○ ○ 👍 4 👎 0



Surface Problem

Severity ● ● ● ○ 👍 1 👎 0 Tags cracks



Obstacle in Path

Severity ● ● ● ● 👍 2 👎 0 Tags narrow pole



No Sidewalk

Severity ○ ○ ○ ○ 👍 0 👎 0 Tags street has no sidewalks



Curb Ramp

Severity ● ○ ○ ○ 👍 1 👎 0 Tags missing tactile warning

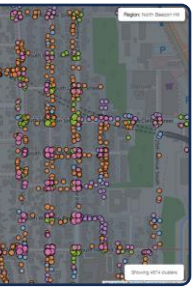
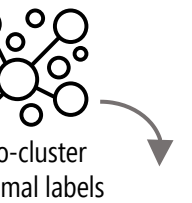
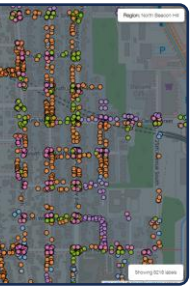


Missing Curb Ramp

Severity ● ● ● ● 👍 3 👎 1



PROCESSING



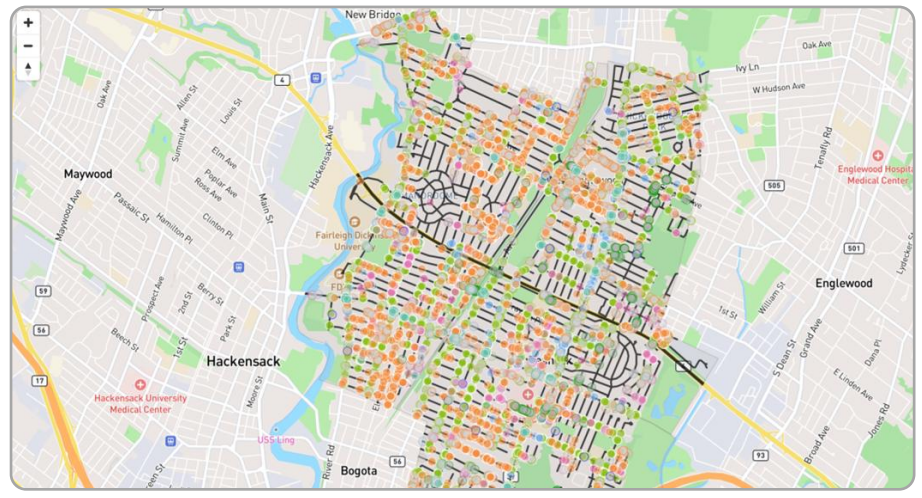
5 APPLICATIONS

Analytics & mobility tools

AccessScore

Gallery

LabelMap



API

6 OUTCOMES

Research to...

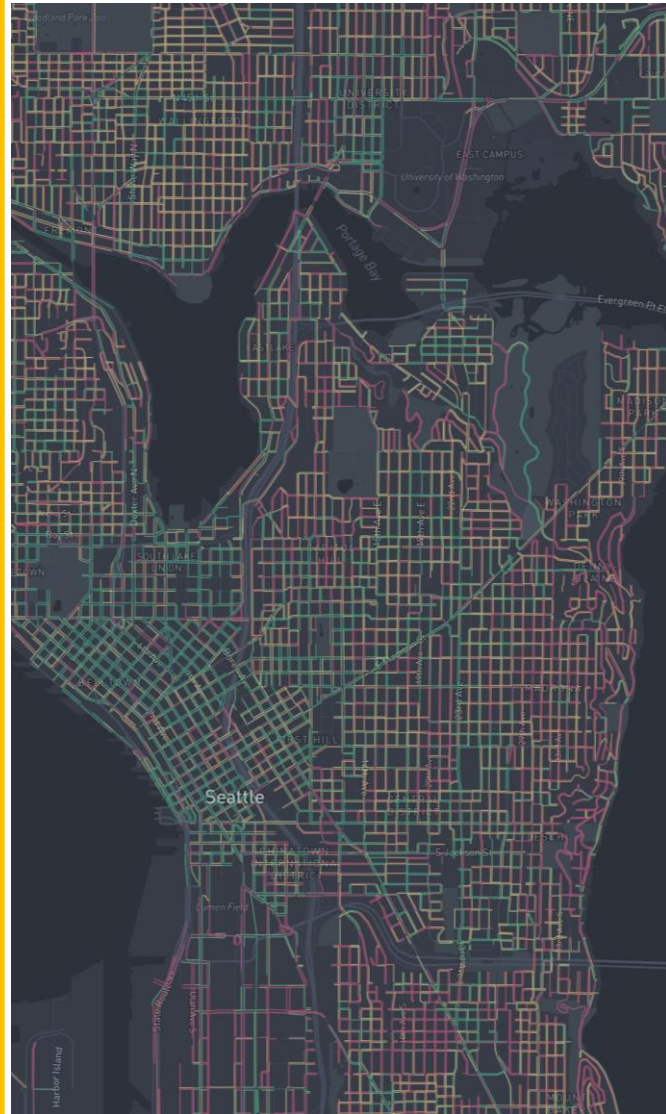
Research



6 OUTCOMES

Research to translational

Research



Translational Impact



Open Data / Source

ProjectSidewalk

Overview Repositories 36 Projects 1 Packages 0 Teams 2 People 20

Project Sidewalk

Our mission: map and assess every sidewalk in the world using remote crowdsourcing, artificial intelligence, and online satellite & streetscape imagery.

27 followers University of Washington, Seattle, WA <http://projectsidewalk.org> @projsid

README.md

Welcome

This is the open-source repository for all things **Project Sidewalk**. Our mission is to develop advanced techniques for mapping the world's sidewalks using remote crowdsourcing, artificial intelligence, and online satellite & streetscape imagery.

Some links to help you get started:

- Our [Project Sidewalk Wiki](#)
- [Considerations for deploying Project Sidewalk in your city](#)
- The [Project Sidewalk webpage repo](#)
- Our [design repo](#)

Pinned

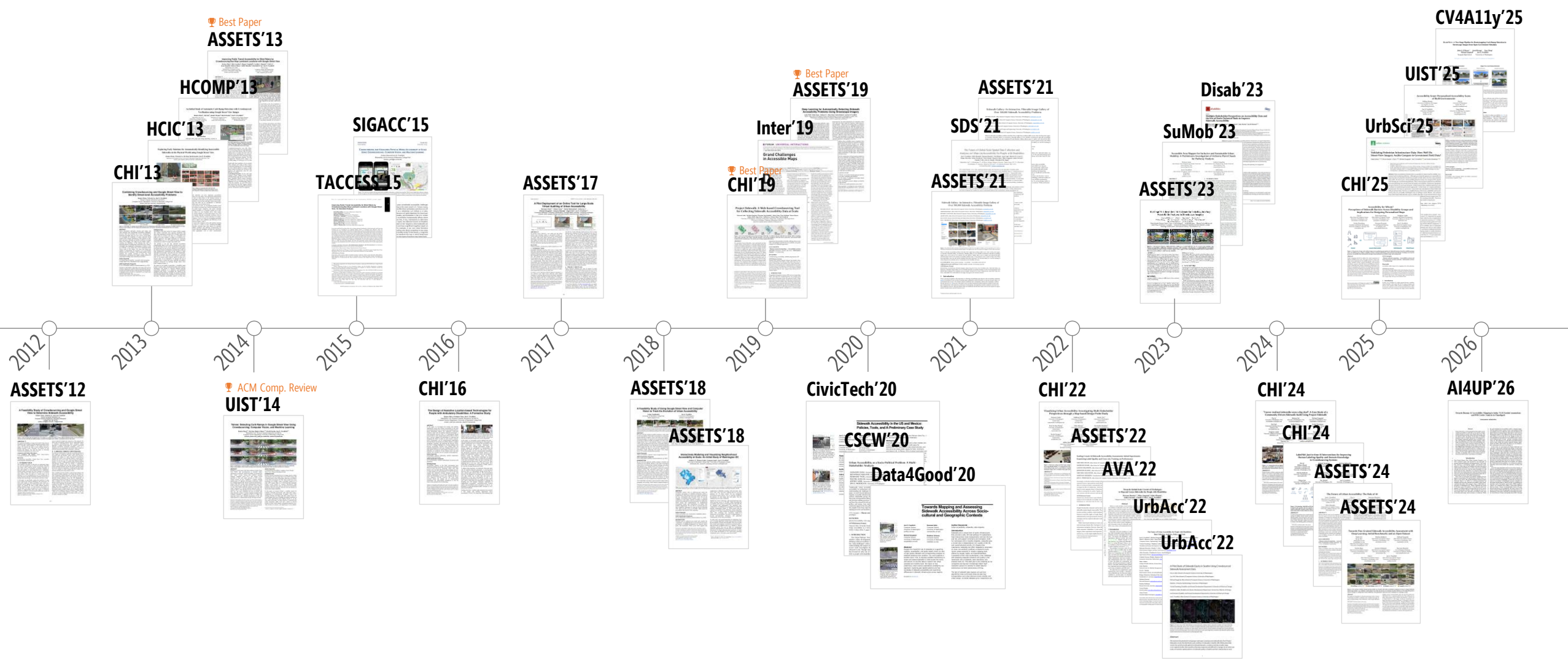
- SidewalkWebpage** Public
Project Sidewalk web page
JavaScript 94 27
- Design** Public
Stores design files for branding and logos
1 1

Repositories

Find a repository... Type Language

- SidewalkWebpage** Public
Project Sidewalk web page
JavaScript 94 MIT 27 376 14 Updated 2 days ago
- Design** Public
Stores design files for branding and logos
1 1 2 0 Updated 2 weeks ago
- sidewalk auto-labeler** Public
Python 1 0 0 0 Updated on Sep 11
- sidewalk-validator-ai** Public

URBAN ACCESSIBILITY RESEARCH TIMELINE



FORMATIVE & REFLECTIVE

DATA COLLECTION TECHNIQUES

ACCESS TOOLS

IMPACT STUDIES

Formative Studies

CHI'13 **CHI'16** **CSCW'20**

CHI'22 **CHI'25**

Thought Pieces

Inter'19 **SDS'21** **AVA'22**

UrbAcc'22 **ASSETS'24**

Manual Crowdsourcing

ASSETS'12 **CHI'13** **ASSETS'13** **TACCESS'15** **CHI'19** **UrbSci'25**

Best Paper **Best Paper**

Automated Techniques

HCIC'13 **HCOMP'13** **ASSETS'19** **SuMob'23** **ASSETS'24** **CV4A11y'25**

Best Paper

Human-AI Techniques

UIST'14 **ASSETS'18** **ASSETS'21** **ASSETS'22** **ASSETS'23** **CHI'24**

ACM Comp. Review

UIST'25

Vis Analytics & Mobility Tools

SIGACC'15 **CHI'16** **ASSETS'18**

ASSETS'21 **CHI'22** **CHI'25**

Urban Science

CivicTech'20 **UrbAcc'22** **UrbSci'25**

AI4UP'26

Deployment Studies

ASSETS'17 **CHI'19** **Data4Good'20**

Disab'23 **CHI'24** **AI4UP'26**

Best Paper

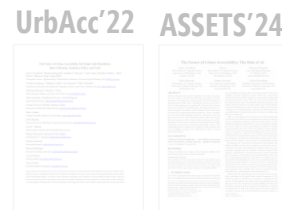
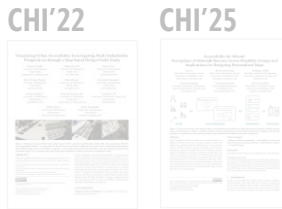
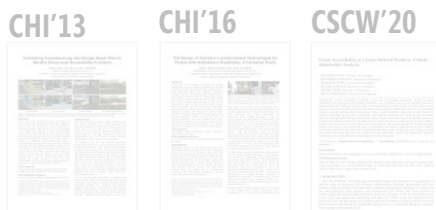
FORMATIVE & REFLECTIVE

DATA COLLECTION TECHNIQUES

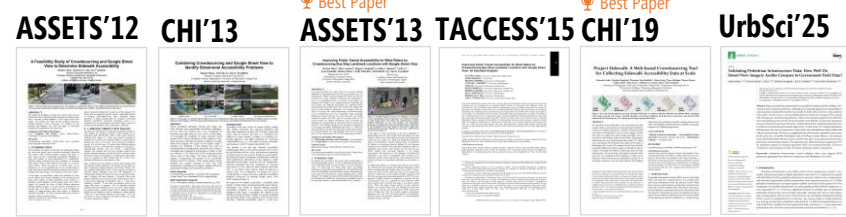
ACCESS TOOLS

IMPACT STUDIES

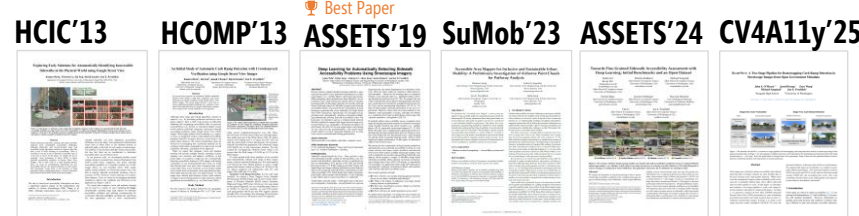
Formative Studies



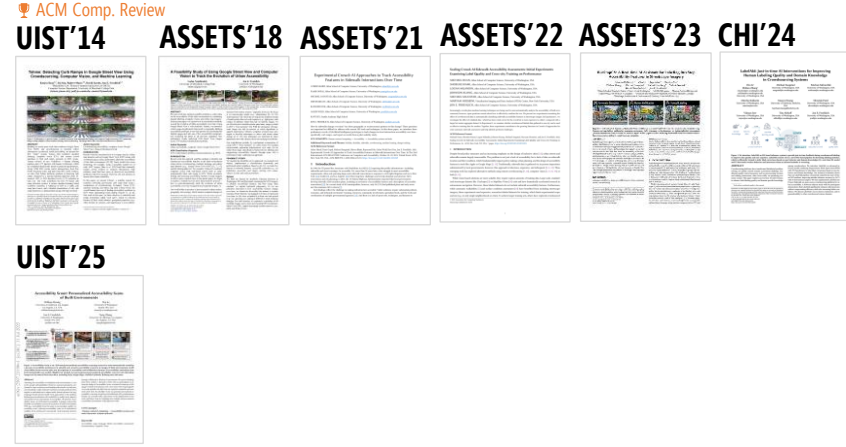
Manual Crowdsourcing



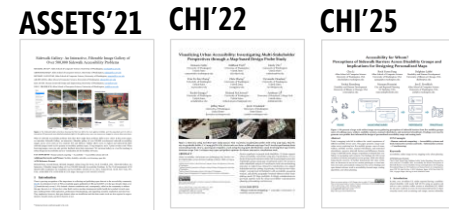
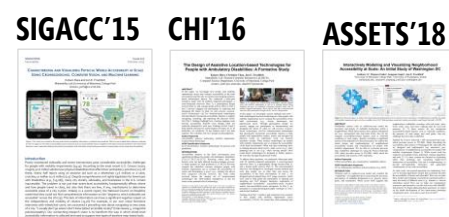
Automated Techniques



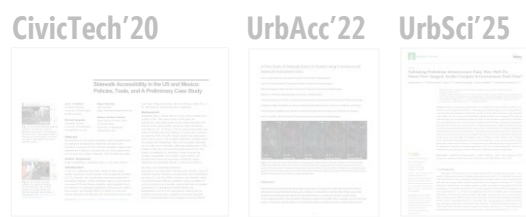
Human-AI Techniques



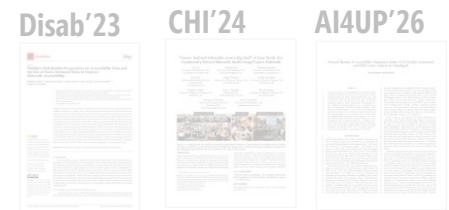
Vis Analytics & Mobility Tools



Urban Science

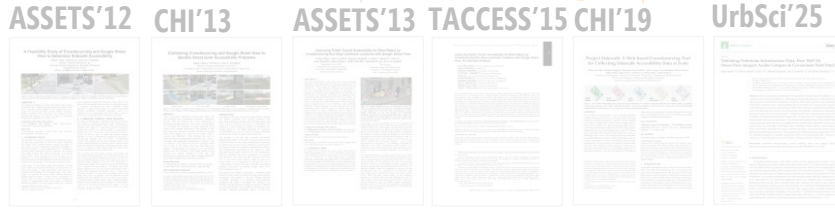


Deployment Studies

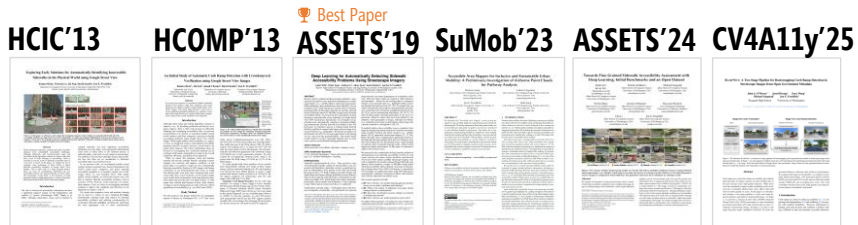


DATA COLLECTION TECHNIQUES

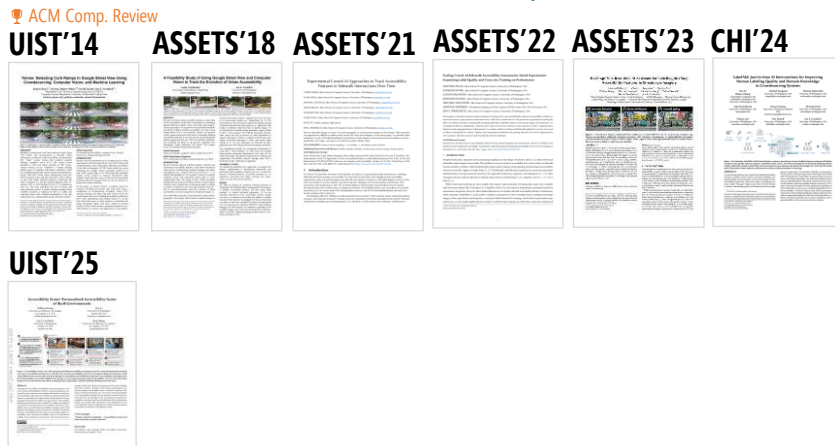
Manual Crowdsourcing



Automated Techniques



Human-AI Techniques



How can we...

Use AI techniques to improve **data collection efficiency**, **quality**, and **human performance**.

2 LABEL SIDEWALKS

Collect geo-located sidewalk assessments

Labeling Mission Routes



Streetscape Imagery APIs



Google Street View



Meta Mapillary



iNovitas infra3D



Community Partners

Human Labeling UI



AI Labeler



Custom Trained ConvNeXt V2

CURB RAMPS



MISSING RAMP



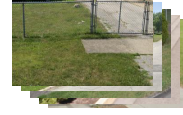
SURFACE PROB



OBSTACLE



NO SIDEWALK



CROSSWALK



PED SIGNAL

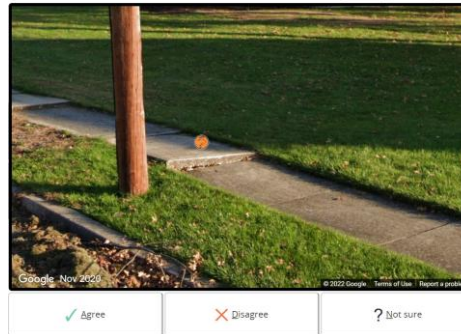


3 VALIDATE LABELS

Human-AI quality control

Human Validation UI

Is this a Surface Problem?



AI-Assisted Human Validation



Custom Trained DINOv2

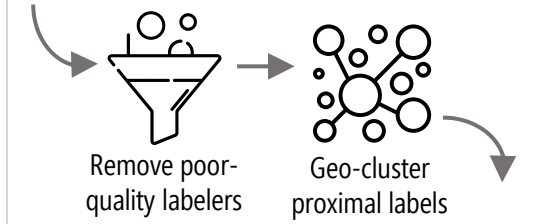
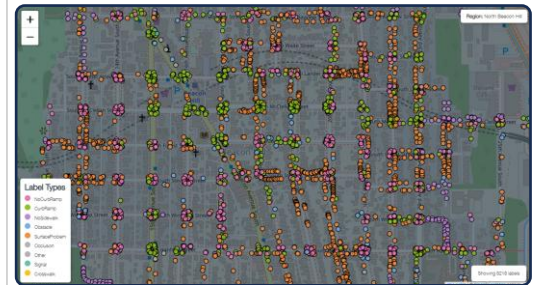
AI Validation



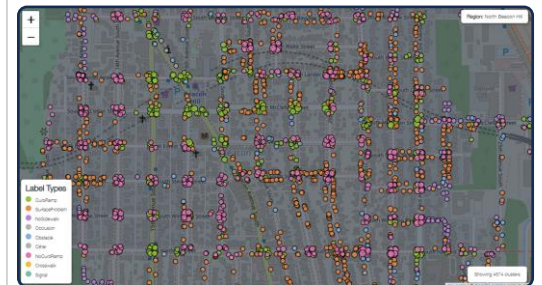
4 POSTPROCESSING

Prepare data for apps

Raw Labels



Label Clusters



2 LABEL SIDEWALKS

Collect geo-located sidewalk assessments



Community Partners

Human Labeling UI



Streetscape Imagery APIs



Google Street View



Meta Mapillary



iNovitas infra3D

AI Labeler



Custom Trained ConvNeXt V2

CURB RAMPS



MISSING RAMP



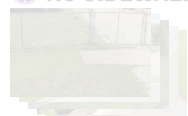
SURFACE PROB



OBSTACLE



NO SIDEWALK



CROSSWALK



PED SIGNAL

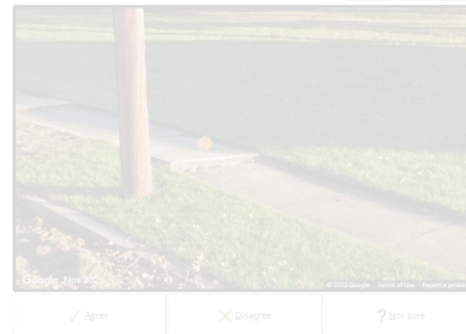


3 VALIDATE LABELS

Human-AI quality control

Human Validation UI

Is this a Surface Problem?



AI-Assisted Human Validation



Custom Trained DINOv2

AI Validation



Agree



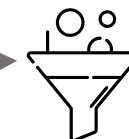
Disagree

4

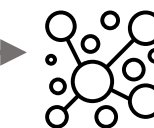
POSTPROCESSING

Prepare data for apps

Raw Labels



Remove poor-quality labels



Geo-cluster proximal labels

Label Clusters



RESEARCH AUTO-LABELING

HCIC'13

Exploring Early Solutions for Automatically Identifying Inaccessible Sidewalks in the Physical World using Google Street View

Kotaro Hara, Victoria Le, Jin Sun, David Jacobs, Jon E. Froehlich
Department of Computer Science, University of Maryland, College Park, MD 20742, USA
{hara, leon, dlevis, jinf, jcs, emd, jef}@um.edu



Figure 1. In this paper, we perform an early exploration of applying computer vision techniques to automatically identify sidewalk accessibility issues in Google Street View (GSV) imagery. Specifically, we explore the automatic identification of the presence/absence of curb ramps for “curb cuts”. We manually trained our classification/detection algorithm with positive training samples (green outlines above) and negative training samples (red outlines from GSV images).

Poorly maintained sidewalks, missing curb ramps, and other obstacles pose considerable accessibility challenges. Although pedestrian- and bicycle-oriented maps and associated routing algorithms continue to improve, there has been a lack of work focusing on accessibility. There is currently no way for a user to determine accessible areas of a city prior to travel. In this paper, we explore the use of computer vision techniques to linear SVM to detect sidewalk accessibility problems in Google Street View imagery. This is only work in a large on-going project. Here, we focus on automatically detecting one type of accessibility barrier: the presence/absence of curb ramps. Our preliminary results point to the potential of using automatic, highly-scalable approaches to extract information about physical accessibility from online map imagery.

The lack of street-level accessibility information can have a significant negative impact on the independence and mobility of citizens (Niemeyer 2008; Thapar et al. 2004). Although maintenance issues such as buckled or

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HCOMP'13

An Initial Study of Automatic Curb Ramp Detection with Crowdsourced Verification using Google Street View Images

Kotaro Hara¹, Jin Sun¹, Jonah Chazara², David Jacobs¹, Jon E. Froehlich¹
¹Mobility Lab (HCIC), Department of Computer Science, University of Maryland, College Park, {hara, jinf, jcs, and daf}

In our previous research, we examined whether automatically trained crowd workers could find, categorize, and assess sidewalk accessibility problems using Google Street View (GSV) images. This poster paper presents a first step towards creating automated methods (e.g. machine vision-based curb ramp detection) in concert with human computation to improve the overall scalability of our approach.

Introduction
Although online maps and routing algorithms continue to improve—e.g. by providing pedestrian and bicycle navigation support—there is little work focused on efficiently obtaining and integrating accessibility data. In previous research (Hara et al. 2013a), we examined whether remote crowd workers could find, categorize, and assess sidewalk accessibility problems using Google Street View (GSV) images. With simple quality control methods (e.g. majority vote), we found that workers could identify accessibility problems with 93% accuracy; however, crowd work is by nature, labor intensive. Our current explorations, then, are focused on investigating how automatic methods can be combined with human computation to improve the overall scalability, efficiency, and quality of our approach.

While we expect that computer vision and machine learning will provide multiple benefits including location triaging, view selection, and adaptive workflows, in this poster paper, we examine a single use case: automatically detecting accessibility features in GSV images with human verification. In our aforementioned past work, we found that labeling tasks were more time consuming than verifying tasks. Thus, in our work here, crowd workers simply verify results from an automatic curb ramp detection algorithm rather than provide their own labels (Figure 1). Curb ramps were selected both because of their visual salience in images (a good starting point) as well because of their significance to accessibility (e.g. see [Crist 1993]).

Study Method
We first created a test dataset defined by two geographic regions of interest in Washington DC: a 0.71 km² semi-

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Best Paper ASSETS'19

Deep Learning for Automatically Detecting Sidewalk Accessibility Problems Using Streetscape Imagery

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¹Paul Allen School of Computer Science and Engineering, University of Washington, Seattle, USA
²Department of Computer Science, University of Maryland, College Park, USA
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Abstract
Recent work has applied machine learning methods to automatically find and assess pedestrian infrastructure in online map imagery (e.g., satellite photos, streetview panoramas). While promising, these methods have been limited by two interrelated issues: small training sets and the choice of machine learning model. In this paper, aided by the recently released Project Sidewalk dataset of 300,000+ image-based sidewalk accessibility labels, we present the first examination of deep learning to automatically assess sidewalks in Google Street View (GSV) panoramas. Specifically, we investigate two application areas: automatically validating crowdsourced labels and automatically labeling sidewalk accessibility issues. For both tasks, we introduce and use a residual neural network (ResNet) modified to support both image and non-image (contextual) features (e.g., geotagging). We present an analysis of performance, the effect of our non-image features and training set size, and cross-city generalizability. Our results significantly improve on prior automated methods in some cases, meet or exceed human labeling performance.

Author Keywords
Neural networks, accessibility, sidewalks, computer vision

ACM Classification Keywords
I.2.10. Artificial Intelligence; Vision and Scene Understanding; I.2.6. Classification; Learning

INTRODUCTION
Sidewalks should benefit all of us. They provide a safe, environmentally-friendly conduit for moving about a city. For people with disabilities, sidewalks can have a significant impact on independence [17], quality of life [38], and overall physical activity [7]. While mapping tools like Google and Apple Maps have begun offering pedestrian-focused features, they do not incorporate sidewalk status or information on sidewalk accessibility [23], which limits their utility and disproportionately affects people with disabilities. A key challenge in mapping is “Where does it come from?” How is it collected? Traditionally, sidewalk audits—which gather data on the presence and quality of sidewalks—are performed via in-person

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DOI: 10.1145/3333798.3333798

ASSETS'24

Towards Fine-Grained Sidewalk Accessibility Assessment with Deep Learning: Initial Benchmarks and an Open Dataset

Xinlei Liu¹, Kevin Wu¹, Minchu Kulkarni¹, Michael Saugstad¹, Jeremy Freuburger¹, Maryam Hosseini¹, Peyton Rago¹, Allen School of Computer Science, University of Washington, USA, {liuxinlei, kwu, minchuk, msaugstad, jfreuburger, rago}@cs.washington.edu
Chun Li¹, Allen School of Computer Science, University of Washington, USA, chunli@cs.washington.edu
Jon E. Froehlich¹, Allen School of Computer Science, University of Washington, USA, jef@cs.washington.edu



Figure 1. We examine whether deep learning models can classify sidewalk accessibility conditions from pre-cropped 640x640 streetscape images—e.g., whether a curb ramp is too steep or missing a tactile indicator or if a sidewalk panel is uneven, bumpy, or composed of brick/cobblestone. The grid shows thousands of 10 conditions we attempt to infer.

Abstract
We examine the feasibility of using deep learning to infer 33 classes of sidewalk accessibility conditions in pre-cropped streetscape images, including bumpy, brick/cobblestone, cracks, height difference (up/down), narrow, uneven/level, pole, and sign. We present two experiments: first, a comparison between two state-of-the-art computer vision models, Meta (DINOv2) and OpenAI (CLIP-ViT), on a cleaned dataset of ~24k images; second, an examination of a larger but noisier crowdsourced dataset (~15k images) on the best performing model from Experiment 1. Through preliminary, Experiment 1 shows that certain sidewalk conditions can be identified with high precision and recall, such as missing tactile warnings on curb ramps and grass grown on sidewalks, while Experiment 2 demonstrates that larger but noisier training data can have a detrimental effect on performance. We conclude an open dataset and classification benchmarks to advance this important area.

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1088-0899-2024-0007-0019
https://doi.org/10.1145/3700000

CV4A11y'25

RAMPNET: A Two-Stage Pipeline for Bootstrapping Curb Ramp Detection in Streetscape Images from Open Government Metadata

John S. O'Meara^{1,2}, Jared Hwang¹, Zeyu Yang¹, Michael Saugstad¹, Jon E. Froehlich¹, Itsaquah High School¹, University of Washington²

https://github.com/ProjectSidewalk/RAMPNET

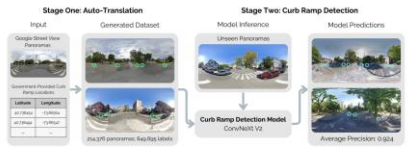


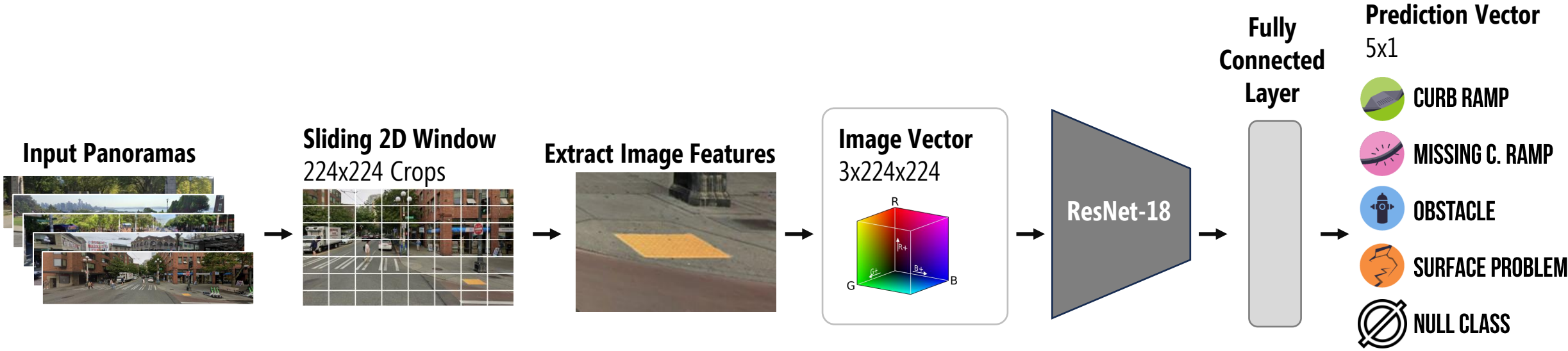
Figure 1. We introduce RAMPNET, a custom two-stage pipeline for bootstrapping curb ramp-detection models in streetscape images from open government data. In Stage 1, we auto-generate a labeled streetview curb ramp dataset by transcribing government-provided curb ramp location data (i.e., City Maps) into pixel labels on Google Street View panoramas. Stage 2 then uses this generated dataset to train a detection model that predicts curb ramp points in unseen panoramas.

Abstract
Curb ramps are critical for urban accessibility, but manually labeling panoramas. Our generated dataset achieves 94.0% precision and 92.3% recall, and our detection model reaches 89.26 AP₅₀—far exceeding prior work. Our work has attempted to improve data availability with crowd-sourced or manually labeled data; these efforts often fall short in either quality or scale. In this paper, we introduce and evaluate a two-stage pipeline to scale curb ramp detection datasets and improve model performance. In Stage 1, we generate a dataset of more than 210,000 annotated Google Street View (GSV) panoramas by auto-transcribing government-provided curb ramp location data to pixel coordinates in panoramic images. In Stage 2, we train a curb ramp detection model (modified ConvNeXt V2) from the

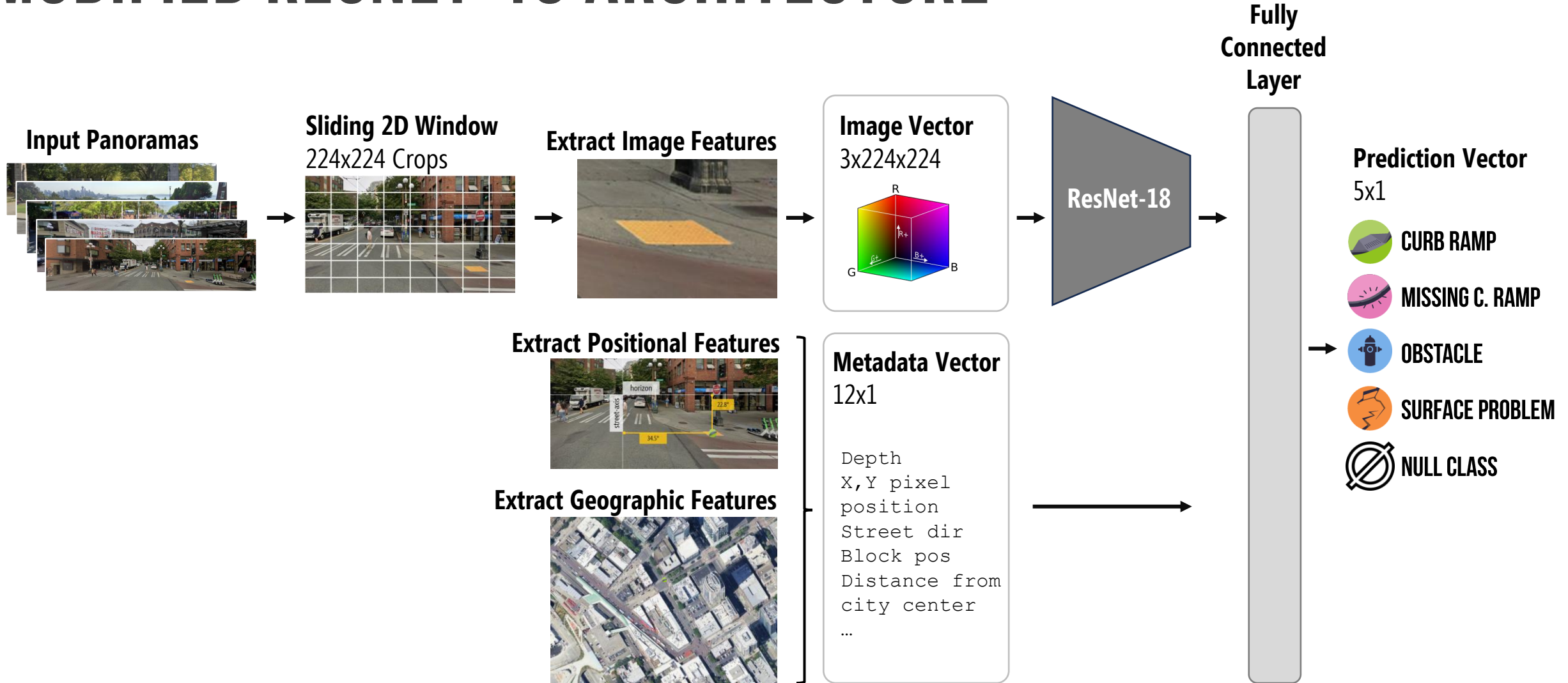
1. Introduction
Curb ramps are critical to urban accessibility [24, 13], impacting both independence [21] and well-being [18] for people with mobility disabilities. However, information regarding curb ramp location and condition is limited, making it difficult to plan and maintain accessible infrastructure.

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MODIFIED RESNET-18 ARCHITECTURE



MODIFIED RESNET-18 ARCHITECTURE



AUTO-LABELING

TRAINING DATASET

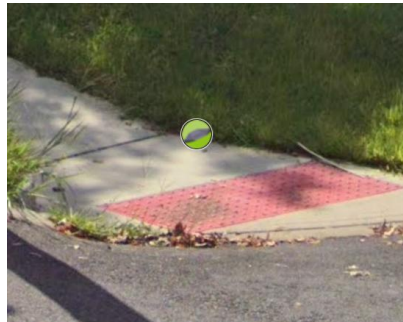
46.5K

 PANORAMAS



120K

 CURB RAMPS



15.7K

 MISSING C. RAMPS



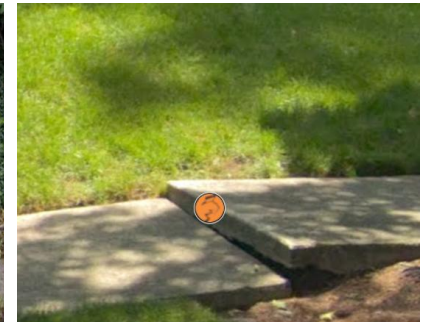
17.5K

 OBSTACLES



7.0K

 SURFACE PROBS.



AUTO-LABELING

TOTAL DATASET

 PANORAMAS

 CURB RAMPS

 MISSING C. RAMPS

 OBSTACLES

 SURFACE PROBS.

Training

46.5K

120K

15.7K

17.5K

7.0K

Validation

5.8K

14.7K

1.8K

2.3K

897

Test

224

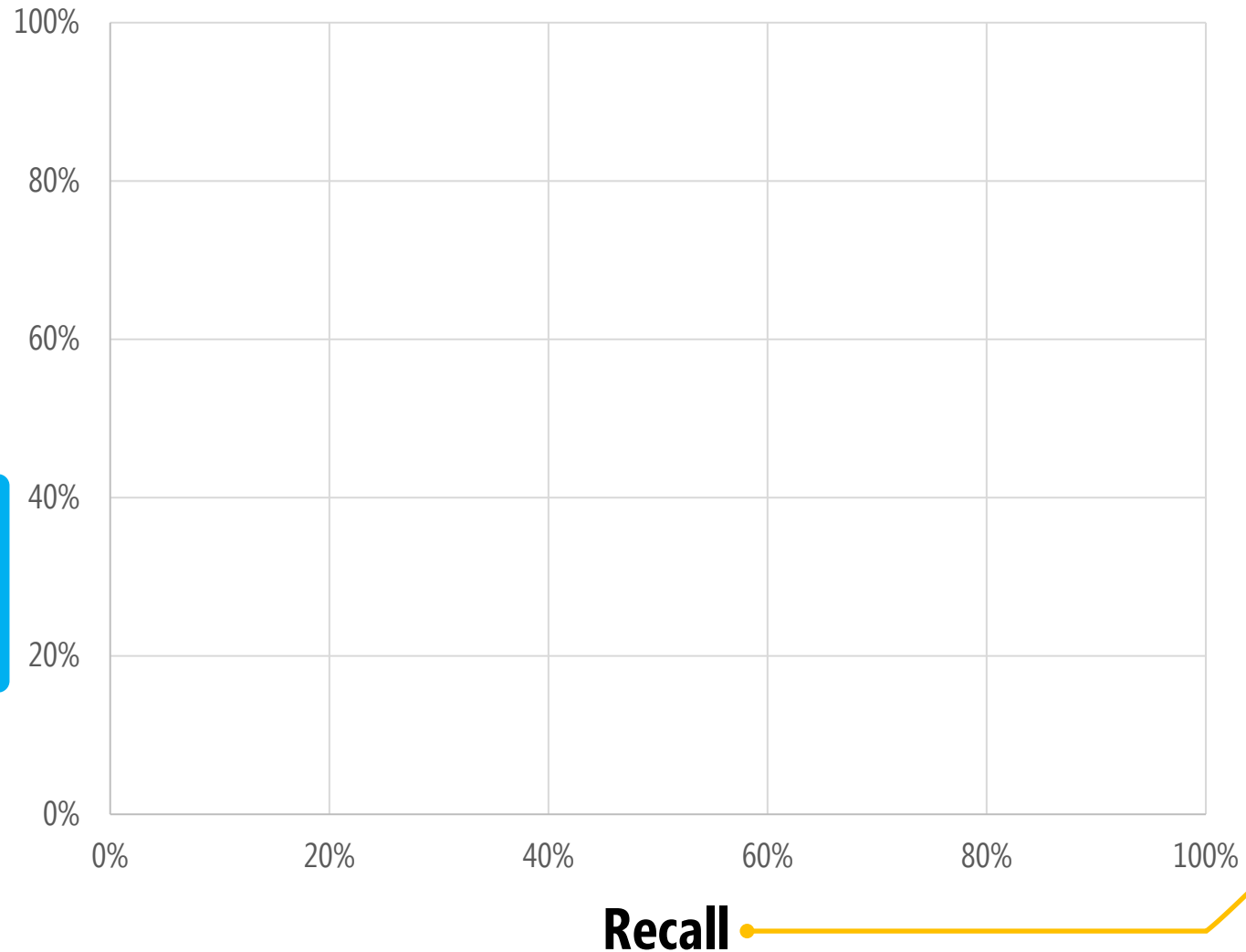
662

135

142

224

PERFORMANCE RESULTS



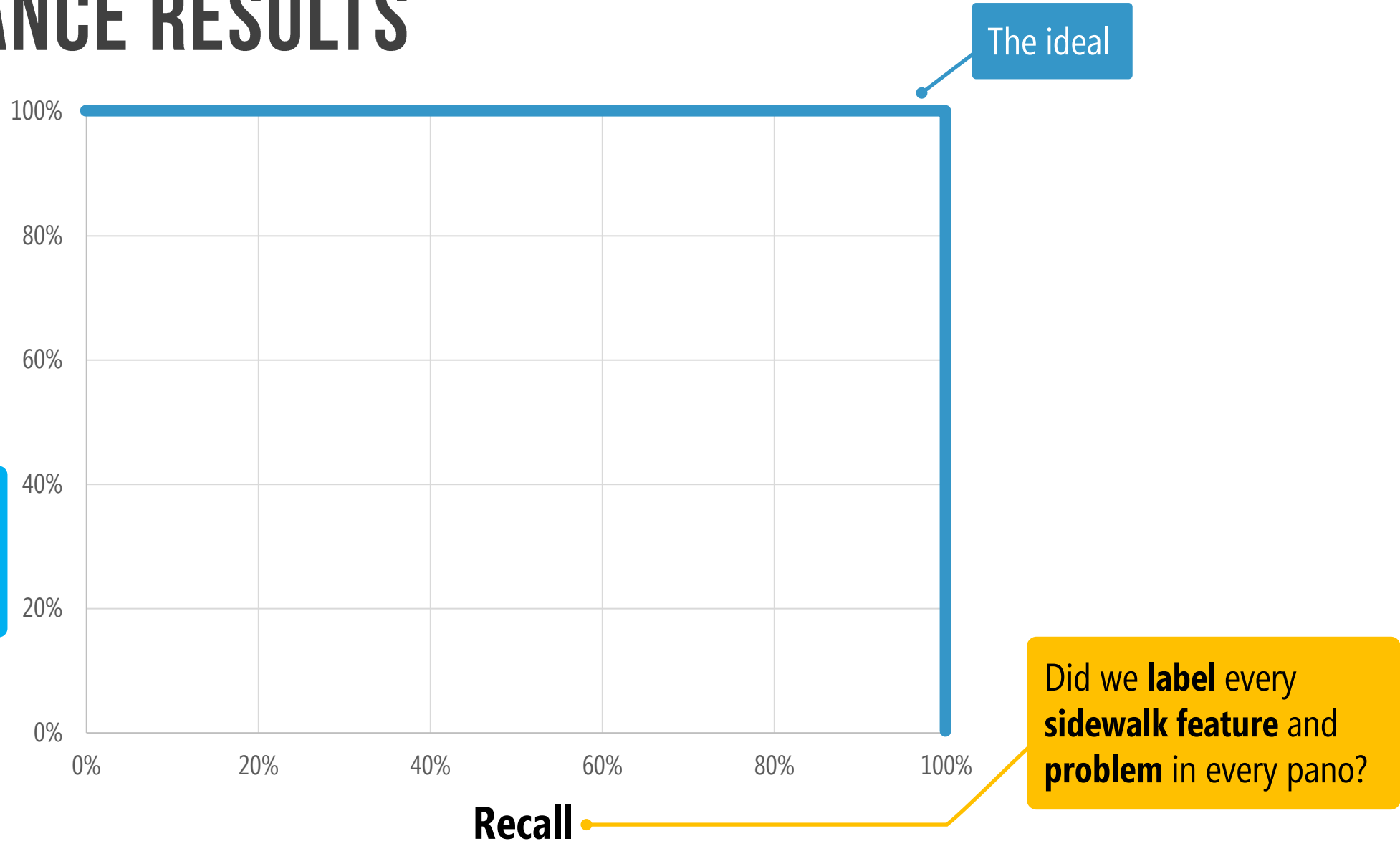
Precision

Is **everything** that we auto-labeled **actually correct**?

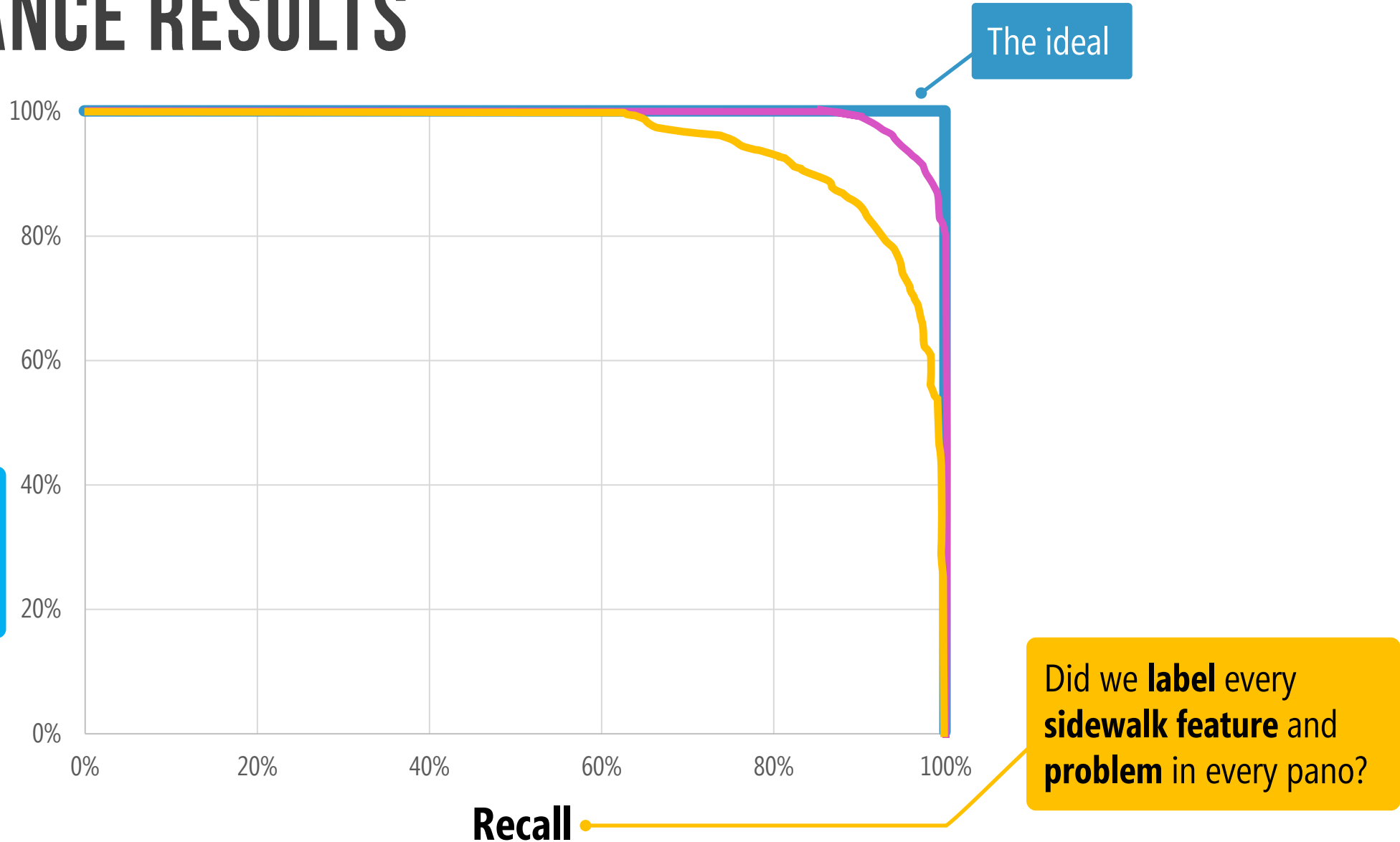
Did we **label** every **sidewalk feature** and **problem** in every pano?

Recall

PERFORMANCE RESULTS



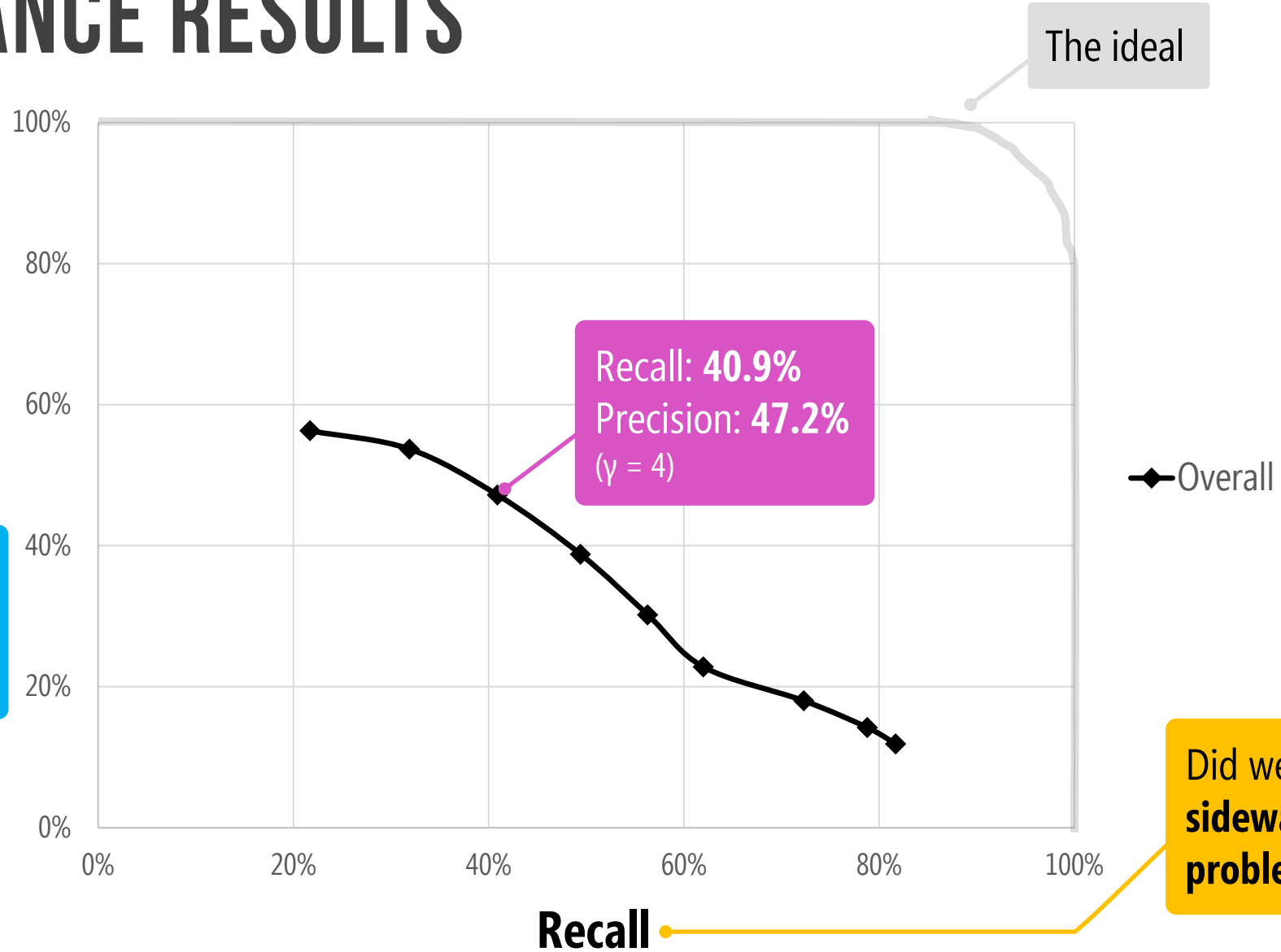
PERFORMANCE RESULTS



Is **everything** that we auto-labeled **actually correct**?

Did we **label** every **sidewalk feature** and **problem** in every pano?

PERFORMANCE RESULTS



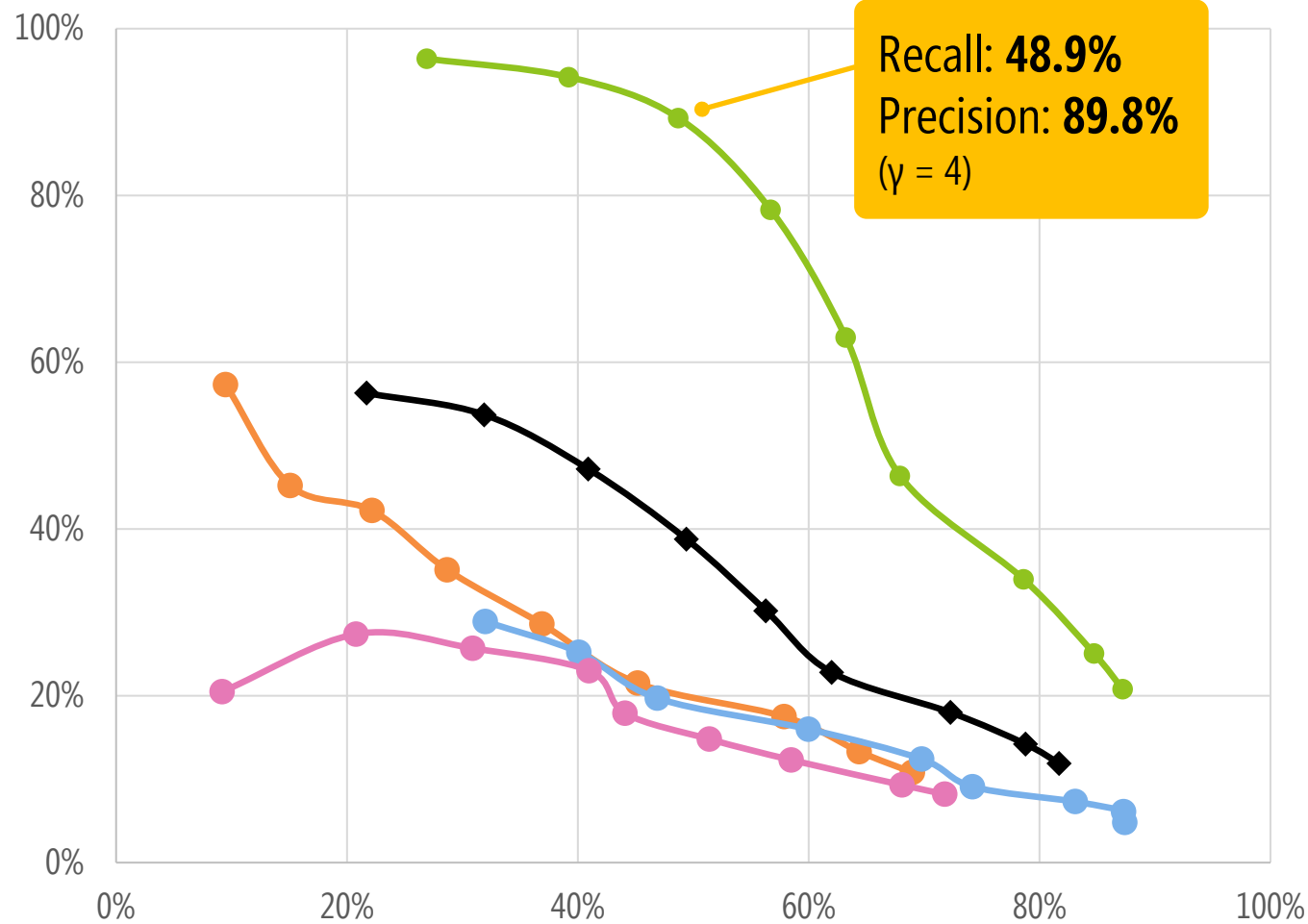
Is **everything** that we auto-labeled **actually correct**?

Did we **label every sidewalk feature and problem** in every pano?

PERFORMANCE RESULTS BY LABEL TYPE

Precision

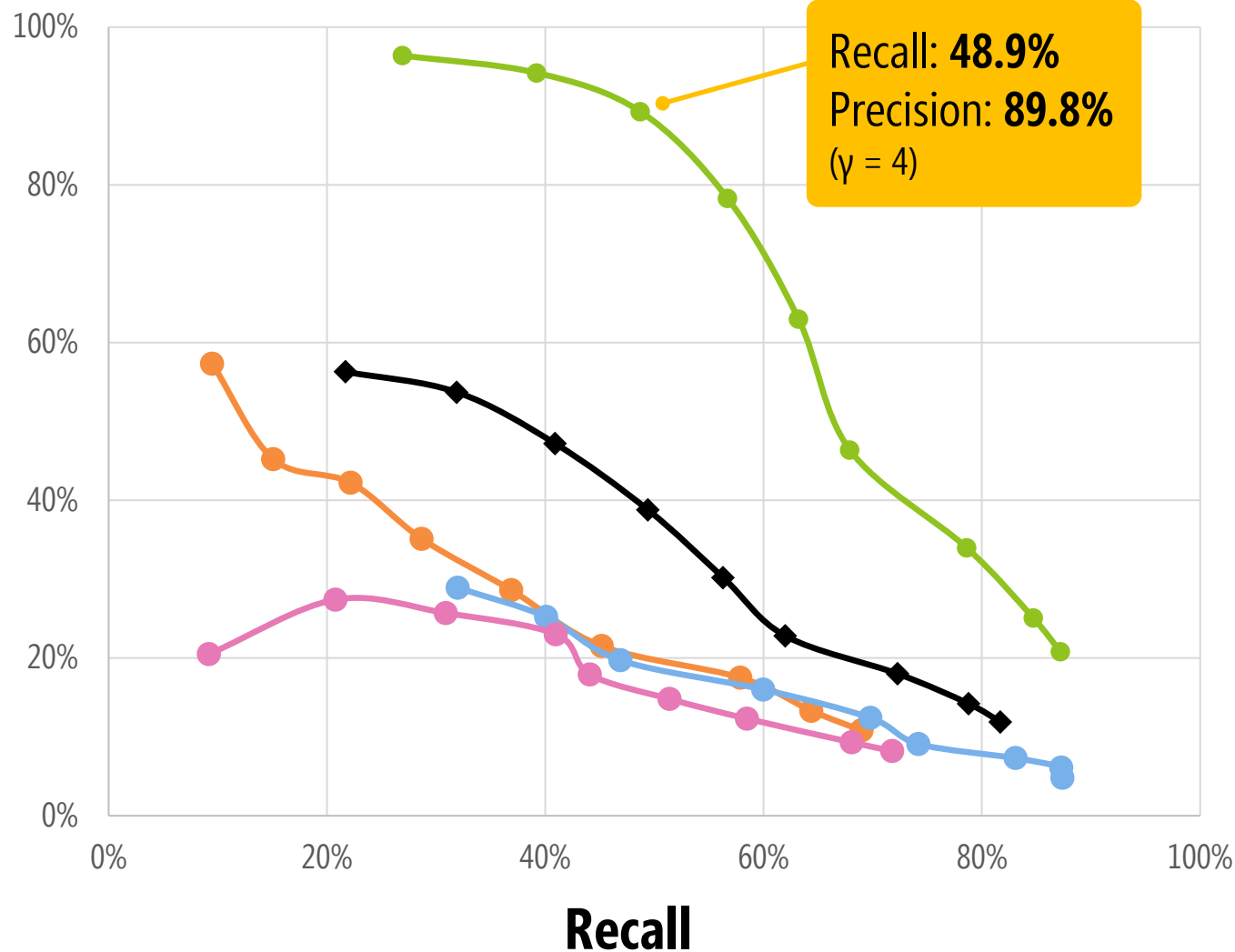
Of everything we found, was it correct?



Recall

Did we find all sidewalk features / problems?

PERFORMANCE RESULTS BY LABEL TYPE



Precision
Of everything we found, was it correct?

Did we find all sidewalk features / problems?

UIST'14






CURB RAMP PERFORMANCE













	Recall	Precision
AI (SVM)	67%	26%
Humans	85%	89%

COMMON FAILURES

False Positives

Curb Ramp	Missing Ramp	Surface Problem	Obstruction
 30% Shadows	 86% Curb	 53% Not on Path	 58% Not on Path
 27% Crosswalk	 32% Intersection	 41% Shadows	 32% Shadows
 26% Intersection	 26% Crosswalk	 35% In Roadway	 30% Greenery

False Negatives

Curb Ramp	Missing Ramp	Surface Problem	Obstruction
 41% Bad Delineation	 30% No Crosswalk	 48% Grass	 30% Low Res
 35% Low Res	 24% Not by Path	 16% Curb Ramp	 27% Temporary
 24% Tricky Angle	 20% Not at Intrsctn	 12% Low Res	 23% Partial Obst.

RESEARCH AUTO-LABELING

HCIC'13

HCOMP'13

Best Paper ASSETS'19

ASSETS'24

CV4A11y'25

Exploring Early Solutions for Automatically Identifying Inaccessible Sidewalks in the Physical World using Google Street View

Kotaro Hara, Victoria Le, Jin Sun, David Jacobs, Jon E. Froehlich

Department of Computer Science, University of Maryland, College Park, MD 20742, USA
(hara, jle, davidj, jinf@cs.umd.edu, v.le@um.edu)



Figure 1. In this paper, we perform an early exploration of applying computer vision techniques to automatically identify sidewalk accessibility issues in Google Street View (GSV). Specifically, we explore the automatic identification of the presence/absence of curb ramps (or “curb cuts”). We manually trained our classification/detection algorithm with positive training examples (green outlines above) and negative training examples (red outlines below) from GSV images.

Abstract
Poorly maintained sidewalks, missing curb ramps, and other obstacles pose considerable accessibility challenges. Although pedestrian- and bicycle-oriented maps and associated training algorithms continue to improve, there has been a lack of work focusing on accessibility. There is currently no way for a user to determine accessible areas of a city prior to travel. In this paper, we explore the use of computer vision techniques to linear SVM to detect sidewalk accessibility problems in Google Street View images. This is only work in a large on-going project. Here, we focus on automatically identifying key accessibility barriers: the presence/absence of curb ramps. Our preliminary results point to the potential of using automatic, highly-scalable approaches to extract information about physical accessibility from online map imagery.

Introduction
The lack of street-level accessibility information can have a significant negative impact on the independence and mobility of citizens (Niemeyer 2008; Thapar et al. 2004). Although maintenance issues such as buckled or

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HCIC'13, June 25-27, 2013, Pacific Grove, California, USA

An Initial Study of Automatic Curb Ramp Detection with Crowdsourced Verification using Google Street View Images

Kotaro Hara¹, Jin Sun², Jonah Chazara³, David Jacobs¹, Jon E. Froehlich¹

¹Mobility Lab (HCIC), Department of Computer Science, University of Maryland, College Park, MD 20742, USA (hara, jinf@cs.umd.edu)
²Department of Computer Science, University of Maryland, College Park, MD 20742, USA (jinsun@umd.edu)
³Computer Science Major Program, Montgomery Blair High School, Montgomery, MD 20854, USA (jchazara@gmail.com)

Abstract
In our previous research, we examined whether automatically trained crowd workers could find, categorize, and assess sidewalk accessibility problems using Google Street View (GSV) images. This paper presents a first step towards creating automated methods (e.g., machine vision-based curb ramp detectors) in concert with human computation to improve the overall scalability of our approach.

Introduction
Although online maps and routing algorithms continue to improve—e.g., by providing pedestrian and bicycle navigation support—there is little work focused on efficiently obtaining and integrating accessibility data. In previous research (Hara et al. 2013a), we examined whether trained crowd workers could find, categorize, and assess sidewalk accessibility problems using Google Street View (GSV) images. With simple quality control methods (e.g., majority vote), we found that workers could identify accessibility problems with 93% accuracy; however, crowd work is by nature, labor intensive. Our current explorations, then, are focused on investigating how automatic methods can be combined with human computation to improve the overall scalability, efficiency, and quality of our approach.

While we expect that computer vision and machine learning will provide multiple benefits including location triaging, view selection, and adaptive workflows, in this paper, we examine a single use case: automatically detecting accessibility features in GSV images with human verification. In our aforementioned past work, we found that labeling tasks were more time consuming than verifying tasks. Thus, in our work here, crowd workers simply verify results from an automatic curb ramp detection algorithm rather than providing their own labels (Figure 1). Curb ramps were selected both because of their visible salience in images (a good starting point) as well because of their significance to accessibility (e.g., see [Cristofari 1993]).

Study Method
We first created a test dataset defined by two geographic regions of interest in Washington DC: a 0.71 km² semi-

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Figure 1. We explore initial approaches to enable automatic curb ramp detection by combining automatic approaches with human computation. The figure shows our validation interface for crowd workers to verify automatically detected curb ramps.

urban mixed residential/commercial area (Mt. Pleasant-MP) and a 0.56 km² dense urban area with high pedestrian traffic (just east of the White House—WJ). We built a custom web scraping tool to (i) query the GSV API, (ii) infer the center point of street intersections, (iii) automatically download the appropriate GSV panoramic image (1312x666 px) at that intersection location. We also scraped the accompanying 3D-point cloud, which is far coarser than the RGB image (512x256 px, 0.15% of the RGB image).
To create ground truth, three members of our research team independently outlined curb ramps in these images using a custom web-based labeling tool. We used majority vote between the three labeled datasets to create a single ground truth dataset (similar to Hara et al. 2013a). In all, our dataset contained 118 intersections with 437 curb ramps (160 in MP and 277 in WJ).

Automatic Curb Ramp Detection
For the curb ramp classifier, we trained a linear Support Vector Machine (SVM) using L83VM (Chang and Liu 2011) with a Histogram of Oriented Gradients (HOG) feature descriptor (Dalal and Triggs 2005) from VLFeat.org. For more detail on this general approach, see our workshop paper (Hara et al. 2013b). To train the classifier, we used 239 positive curb ramp patches (46x19 px) and 4541 negative patches (roughly 50% of our dataset; the remaining 39 intersections are used in our test set: 198 positive and 3762 negative).

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DOI: 10.1145/3288511.3333798

Deep Learning for Automatically Detecting Sidewalk Accessibility Problems Using Streetscape Imagery

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¹Center for Computer Science and Engineering, University of Washington, Seattle, WA, USA
²Department of Computer Science, University of Maryland, College Park, USA
(wei@cs.washington.edu, alexzeng@cs.washington.edu, anthonyli@cs.washington.edu)

Abstract
Recent work has applied machine learning methods to automatically find and assess pedestrian infrastructure in online map imagery (e.g., satellite photos, streetscape panoramas). While promising, these methods have been limited by two interrelated issues: small training sets and the choice of machine learning model. In this paper, aided by the recently released Project Sidewalk dataset of 300,000+ image-based sidewalk accessibility labels, we present the first examination of deep learning to automatically assess sidewalks in Google Street View (GSV) panoramas. Specifically, we investigate two application areas: automatically validating crowdsourced labels and automatically labeling sidewalk accessibility issues. For both tasks, we introduce and use a residual neural network (ResNet) modified to support both image and non-image (contextual) features (e.g., geotagging). We present an analysis of performance, the effect of our non-image features and training set size, and cross-city generalizability. Our results significantly improve on prior automated methods in some cases, most on exceed human labeling performance.

Author Keywords
Neural networks, accessibility, sidewalks, computer vision

ACM Classification Keywords
I.2.10. Artificial Intelligence: Vision and Scene Understanding; I.2.6. Classification: Learning

INTRODUCTION
Sidewalks should benefit all of us. They provide a safe, environmentally-friendly conduit for moving about a city. For people with disabilities, sidewalks can have a significant impact on independence [17], quality of life [38], and self-physical activity [17]. While mapping tools like Google and Apple Maps have begun offering pedestrian-focused features, they do not incorporate sidewalk status or information on sidewalk accessibility [23], which limits their utility and disproportionately affects people with disabilities. A key challenge in mapping: Where does it come from? How is it collected?

Traditionally, sidewalk audits—which gather data on the presence and quality of sidewalks—are performed via in-person

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DOI: 10.1145/3288511.3333798

Towards Fine-Grained Sidewalk Accessibility Assessment with Deep Learning: Initial Benchmarks and an Open Dataset

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Feytan Rago⁴, Jeremy Freiberger⁵, Maryam Hosseini⁶
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Chu Li¹, Jon E. Froehlich¹
¹Allen School of Computer Science, University of Washington, USA (li@cs.washington.edu, jfroehlich@cs.washington.edu)



Figure 1. We examine whether deep learning models can classify sidewalk accessibility conditions from pre-cropped 640x640 streetscape images—e.g., whether a curb ramp is too steep, or missing a tactile indicator or if a sidewalk panel is uneven, bumpy, or composed of brick/cobblestone. The grid shows thousands of 0/1 conditions we attempt to infer.

Abstract
We examine the feasibility of using deep learning to infer 33 classes of sidewalk accessibility conditions in pre-cropped streetscape images, including bumpy, brick/cobblestone, cracks, height difference

(potholes), narrow, uneven/level, pole, and sign. We present two experiments: first, a comparison between two state-of-the-art computer vision models, Meta (OpenCV) and OpenAI CLIP, on a cleaned dataset of ~24k images; second, an examination of a larger but noisier crowdsourced dataset (~13k images) on the best performing model from Experiment 1. Through preliminary, Experiment 1 shows that certain sidewalk conditions can be identified with high precision and recall, such as missing tactile warnings on curb ramps and grass grown on sidewalks, while Experiment 2 demonstrates that larger but noisier training data can have a detrimental effect on performance. We conclude an open dataset and classification benchmarks to advance this important area.

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DOI: 10.1145/3288511.3333798

RAMPNET: A Two-Stage Pipeline for Bootstrapping Curb Ramp Detection in Streetscape Images from Open Government Metadata

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<https://github.com/ProjectSidewalk/RAMPNET>



Figure 1. We introduce RAMPNET, a custom two-stage pipeline for bootstrapping curb ramp detection models in streetscape images from open government data. In Stage 1, we auto-generate a labeled streetscape curb ramp dataset by translating government-provided curb ramp location data (i.e., CityShape files) into pixel labels on Google Street View panoramas. Stage 2 then uses this generated dataset to train a detection model that predicts curb ramp points in unseen panoramas.

Abstract
Curb ramps are critical for urban accessibility, but manually detecting them in images remains an open problem due to the lack of large-scale, high-quality datasets. While prior work has attempted to improve data availability with crowd-sourced or manually labeled data, these efforts often fall short in either quality or scale. In this paper, we introduce and evaluate a two-stage pipeline to scale curb ramp detection datasets and improve model performance. In Stage 1, we generate a dataset of more than 210,000 annotated Google Street View (GSV) panoramas by auto-translating government-provided curb ramp location data to pixel coordinates in panoramic images. In Stage 2, we train a curb ramp detection model (modified ConvNet V2) from the

generated dataset, achieving state-of-the-art performance. To evaluate both stages of our pipeline, we compare to manually labeled panoramas. Our generated dataset achieves 94.0% precision and 82.3% recall, and our detection model reaches 89.2% AP—for exceeding prior work. Our work contributes the first large-scale, high-quality curb ramp detection dataset, benchmark, and model.

1. Introduction
Curb ramps are critical to urban accessibility [24, 13], impacting both independence [21] and well-being [18] for people with mobility disabilities. However, information regarding curb ramp location and condition is limited, making it difficult to plan and maintain accessible infrastructure.

AUTO-LABELING RAMPNET

Stage One: Auto-Translation

Input

Google Street View
Panoramas



Government-Provided Curb
Ramp Locations

Latitude	Longitude
40.738454	-73.86564
40.738494	-73.86547
...	...

Generated Dataset



214,376 panoramas; 849,895 labels

Stage Two: Curb Ramp Detection

Model Inference

Unseen Panoramas



Curb Ramp Detection Model
ConvNeXt V2

Model Predictions



Average Precision: 0.924




AUTO-LABELING LARGE TRAINING DATASET

Stage One: Auto-Translation

Input

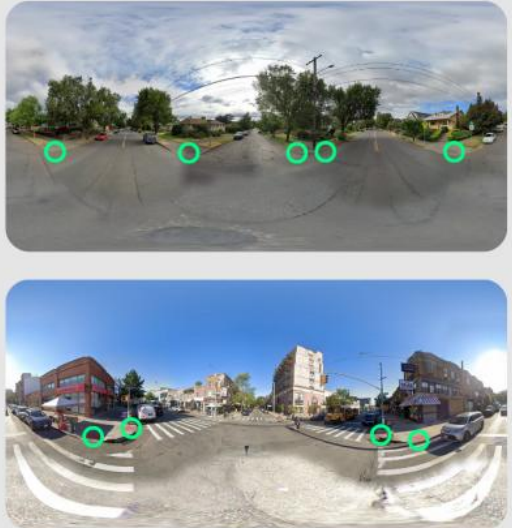
Google Street View Panoramas



Government-Provided Curb Ramp Locations

Latitude	Longitude
40.738454	-73.86564
40.738494	-73.86547
...	...

Generated Dataset




214,376 panoramas; 849,895 labels



Stage Two: Curb Ramp Detection

Model Inference

Unseen Panoramas



Model Predictions



Average Precision: 0.924

Curb Ramp Detection Model
ConvNeXt V2

RAMPNET VS. PRIOR WORK

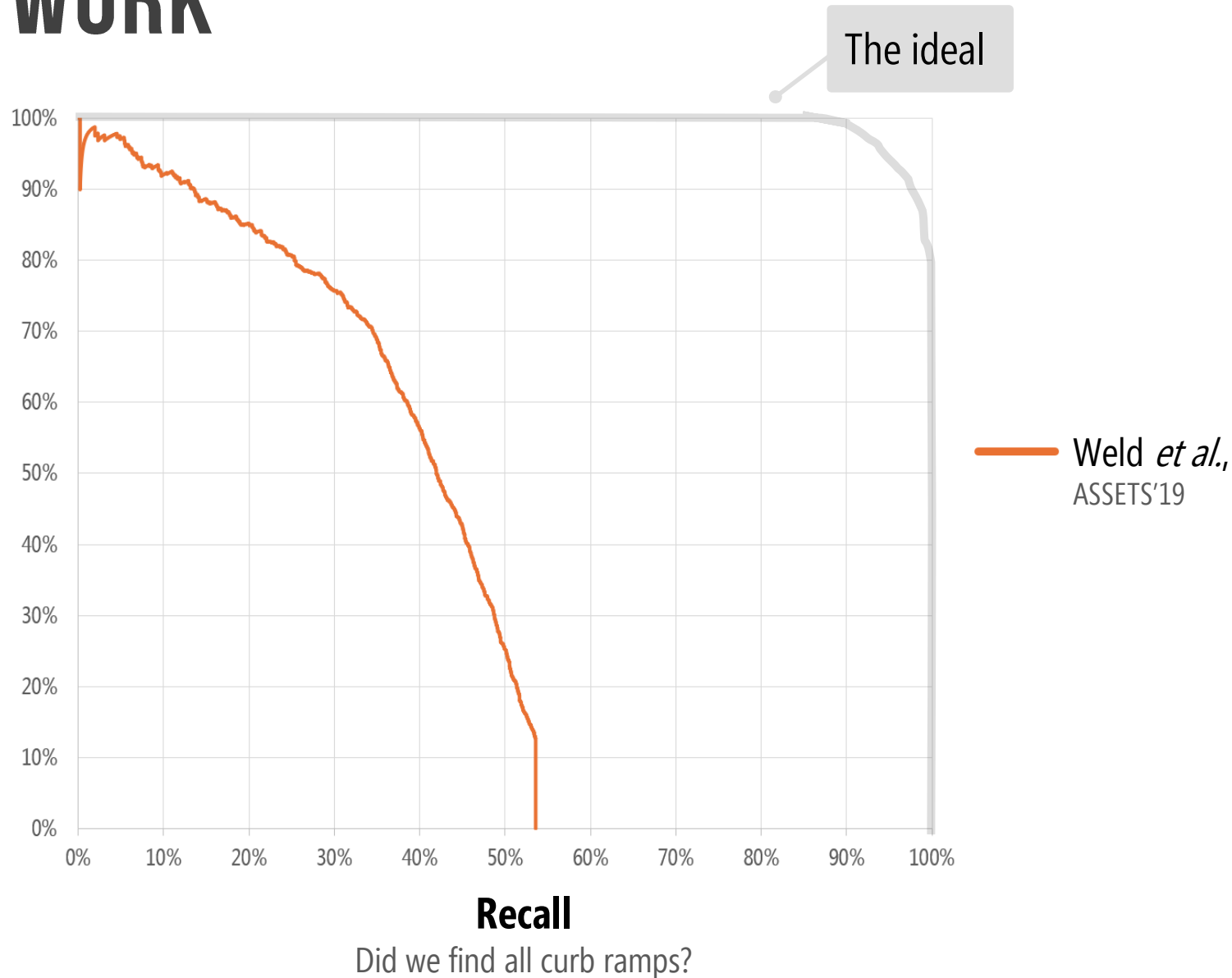
TEST DATASET

1,000 Panoramas

3,919 Curb ramp labels



Precision
Of everything found, were they all correctly curb ramps?



RAMPNET VS. PRIOR WORK

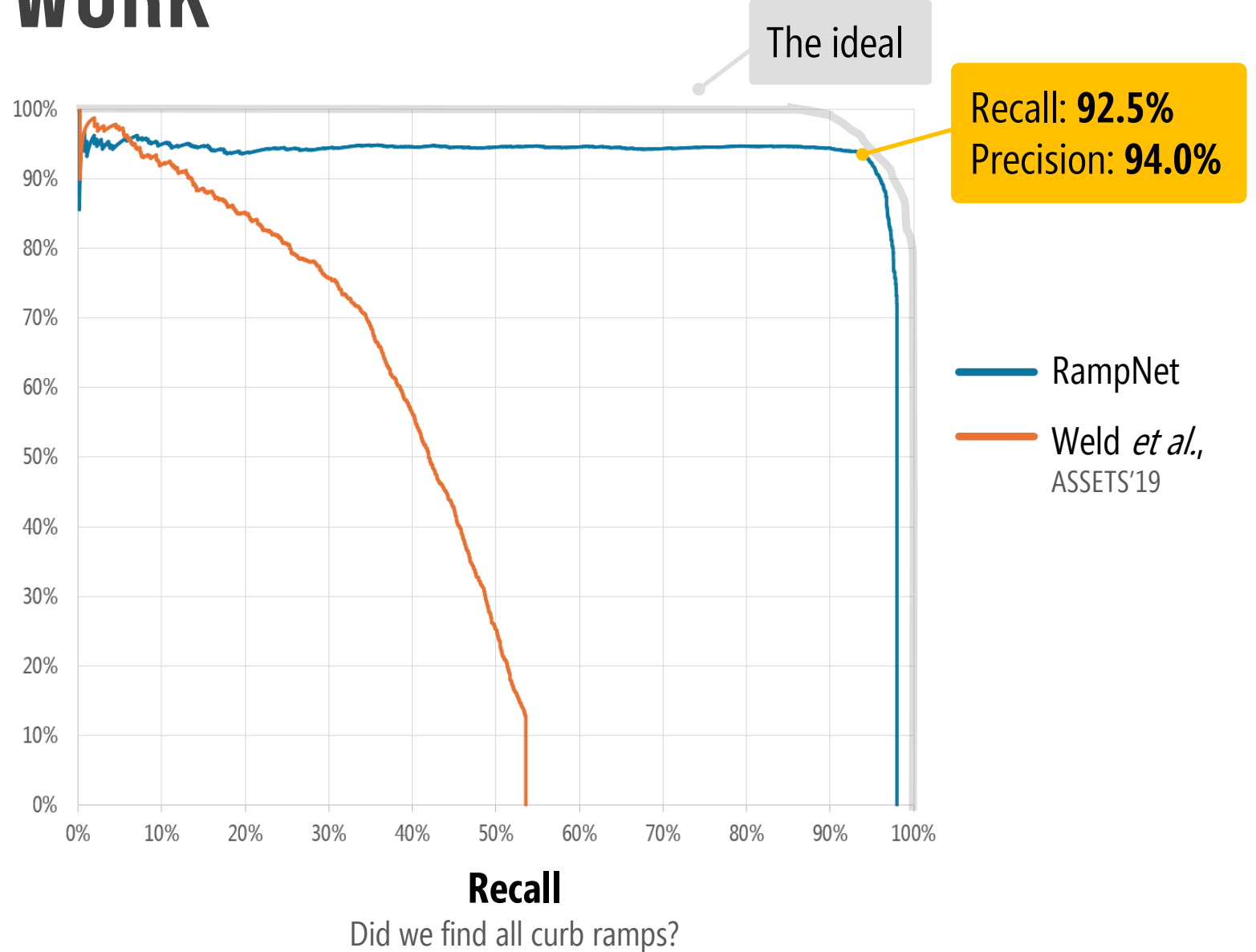
TEST DATASET

1,000 Panoramas

3,919 Curb ramp labels

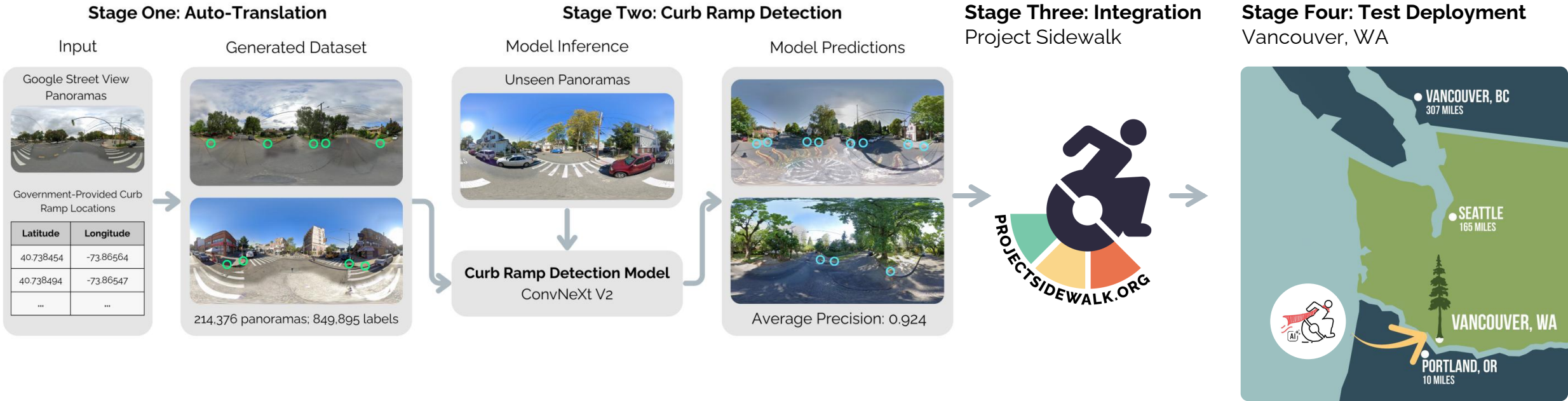


Precision
Of everything found, were they all correctly curb ramps?



AUTO-LABELING

INTEGRATING INTO PROJECT SIDEWALK



VANCOUVER, WA

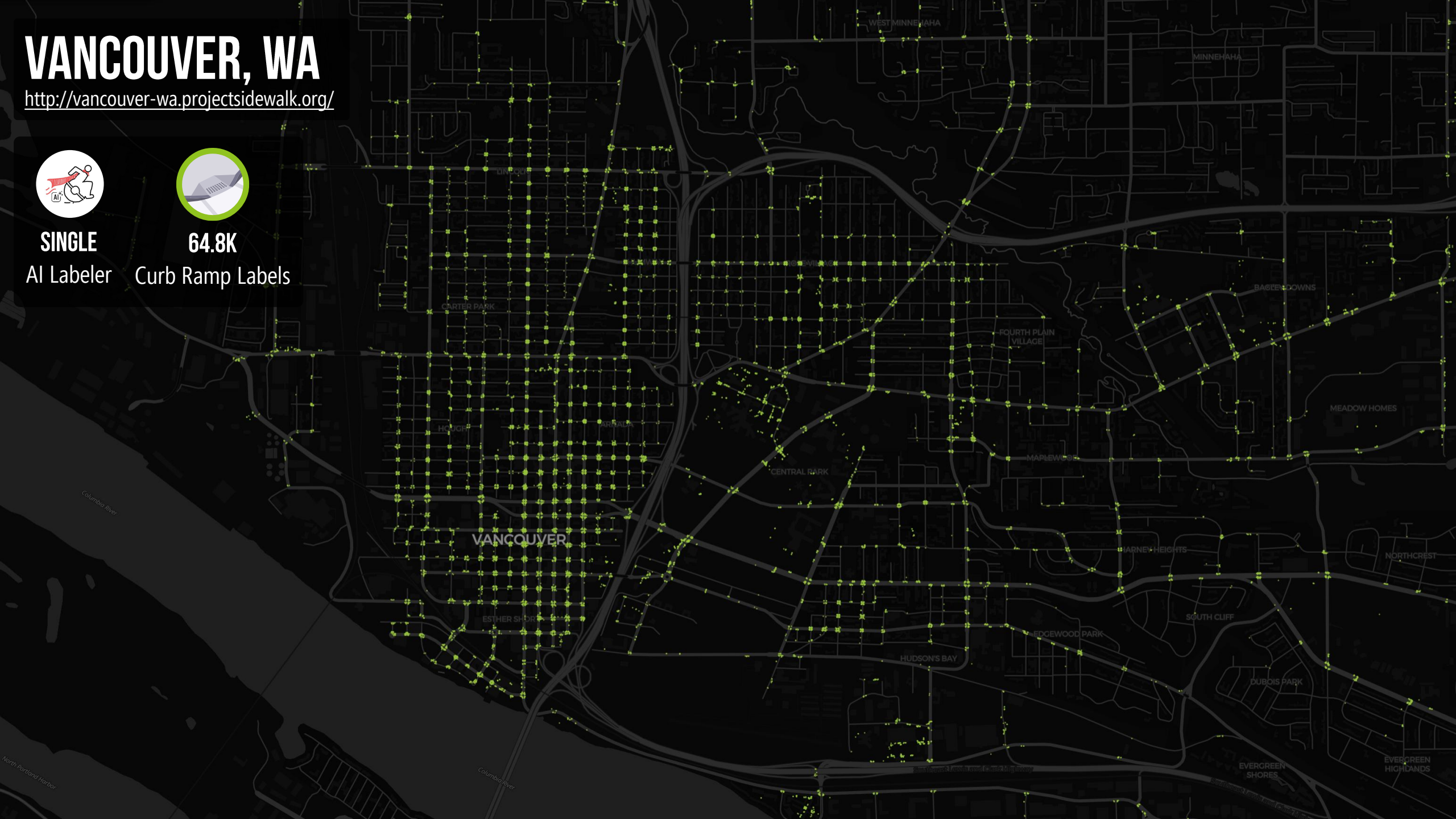
<http://vancouver-wa.projectsSidewalk.org/>



SINGLE
AI Labeler



64.8K
Curb Ramp Labels



VANCOUVER, WA

<http://vancouver-wa.projects Sidewalk.org/>



VANCOUVER, WA

<http://vancouver-wa.projectsSidewalk.org/>



**Three
Experts**

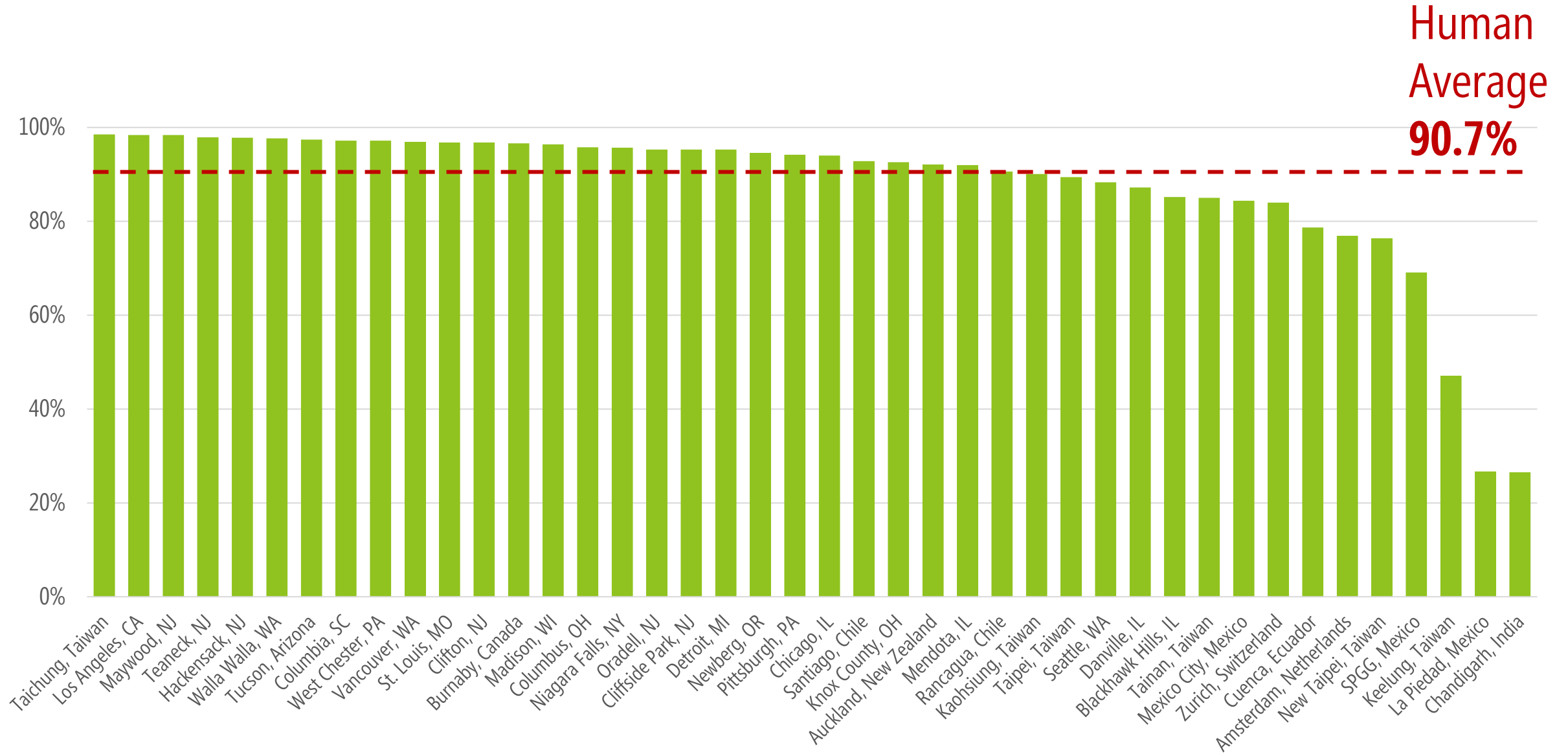


**Reviewed
2550
RampNet
Labels**

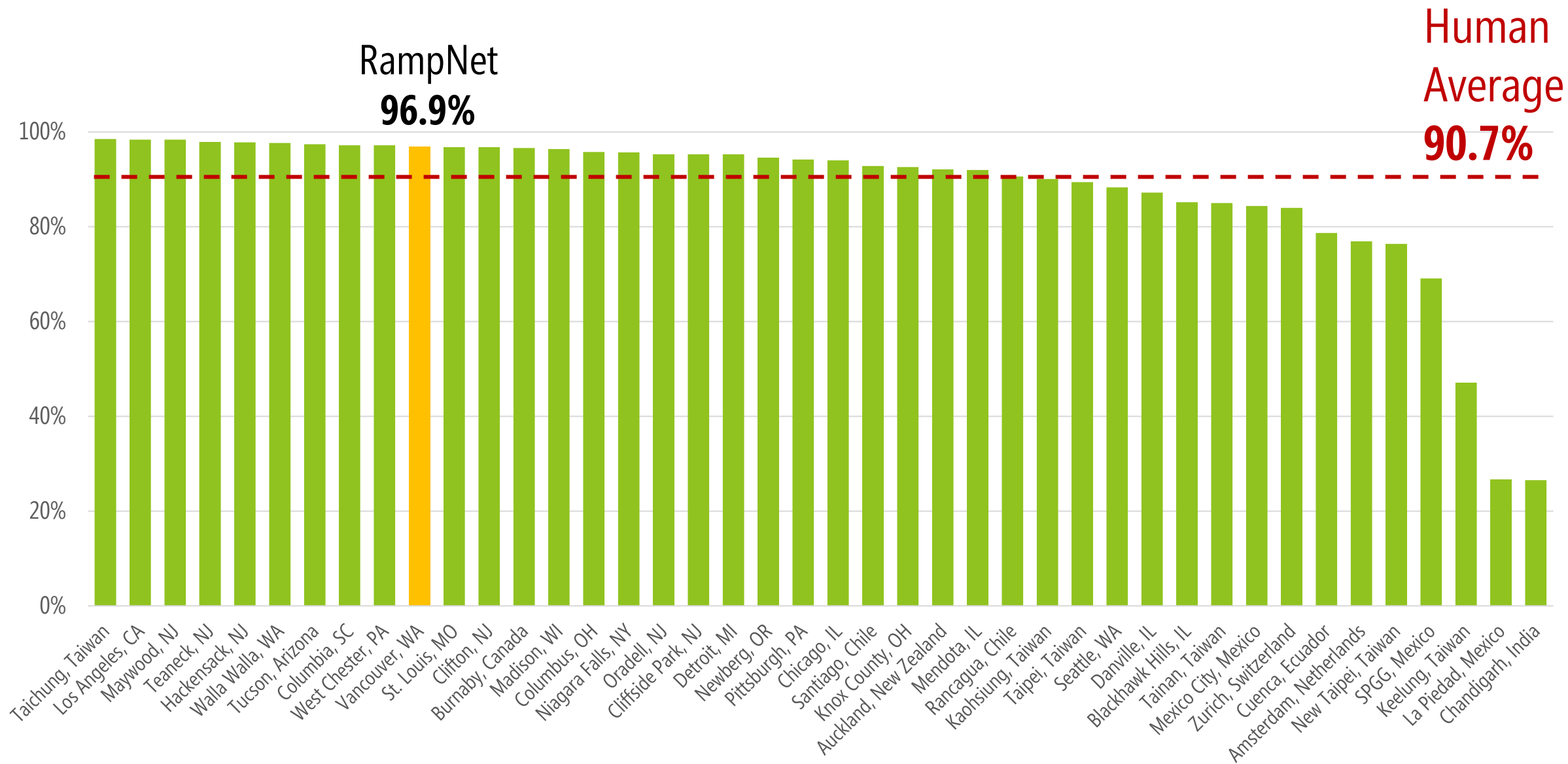


**Precision
96.9%**

CONTEXTUALIZING RAMPNET PERFORMANCE



CONTEXTUALIZING RAMPNET PERFORMANCE





LABEL ENTIRE CITIES **IN MINUTES**

1 PREPROCESSING

Create labeling routes

OpenStreetMap

Filtered Street Network



Neighborhood Boundaries



Labeling Mission Routes



Open Gov Data



2 LABEL SIDEWALKS

Collect geo-located sidewalk assessments

Streetscape Imagery APIs



Google Street View



Meta Mapillary



iNovitas infra3D



Community Partners

Human Labeling UI



AI Labeler



Custom Trained ConvNeXt V2

CURB RAMPS



MISSING RAMP



SURFACE PROB



OBSTACLE



NO SIDEWALK



CROSSWALK



PED SIGNAL



3 VALIDATE LABELS

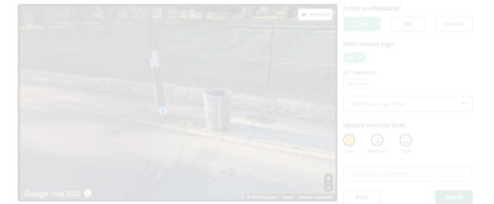
Human-AI quality control

Human Validation UI

Is this a Surface Problem?

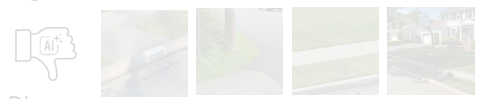


AI-Assisted Human Validation



Custom Trained DINOv2

AI Validation



1 PREPROCESSING

Create labeling routes

OpenStreetMap

Filtered Street Network



Neighborhood Boundaries



Labeling Mission Routes



Open Gov Data



2 LABEL SIDEWALKS

Collect geo-located sidewalk assessments

Streetscape Imagery APIs



Google Street View



Meta Mapillary



iNovitas infra3D



Community Partners

Human Labeling UI



AI Labeler



Custom Trained ConvNeXt V2

CURB RAMPS



MISSING RAMP



SURFACE PROB



OBSTACLE



NO SIDEWALK



CROSSWALK



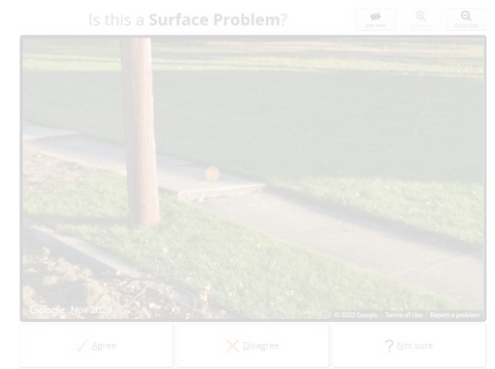
PED SIGNAL



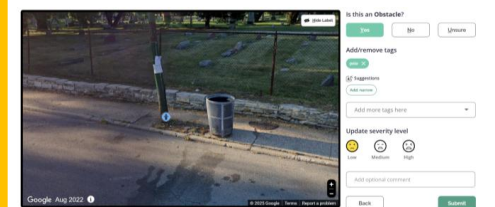
3 VALIDATE LABELS

Human-AI quality control

Human Validation UI

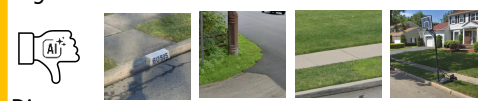


AI-Assisted Human Validation



Custom Trained DINOv2

AI Validation



Disagree

Agree

AI LABELER

Model Input
Unlabeled panos



Model Output
Fully labeled panos



Easier task

AI VALIDATOR

Model Input
Labeled crops



Model Output
Label correctness?
Missing tag?
...

Towards Fine-Grained Sidewalk Accessibility Assessment with Deep Learning: Initial Benchmarks and an Open Dataset

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Figure 1: We examine whether deep learning models can classify sidewalk accessibility conditions from pre-cropped 640x640 streetscape images—e.g., whether a curb ramp is *too steep*, *too narrow*, or *missing a tactile indicator* or if a sidewalk panel is *uneven*, *bumpy*, or composed of *brick/cobblestone*. The grid above showcases all 33 conditions we attempt to infer.

Abstract

We examine the feasibility of using deep learning to infer 33 classes of sidewalk accessibility conditions in pre-cropped streetscape images, including *bumpy*, *brick/cobblestone*, *cracks*, *height difference*

(*uplifts*), *narrow*, *uneven/slanted*, *pole*, and *sign*. We present two experiments: first, a comparison between two state-of-the-art computer vision models, Meta’s *DINOv2* and OpenAI’s *CLIP-ViT*, on a cleaned dataset of ~24k images; second, an examination of a larger but noisier crowdsourced dataset (~87k images) on the best performing model from Experiment 1. Though preliminary, Experiment 1 shows that certain sidewalk conditions can be identified with high precision and recall, such as missing tactile warnings on curb ramps and grass grown on sidewalks, while Experiment 2 demonstrates that larger but noisier training data can have a detrimental effect on performance. We contribute an open dataset and classification benchmarks to advance this important area.

*Both authors contributed equally to this research.

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<https://doi.org/10.1145/3663548.3688531>

Can we **infer tags** given a label type and image crop?



CURB RAMP LABEL



Curb Ramp Tags

Missing tactile

Narrow

Points into traffic

Pooled water

Surface problem

Steep

...

SYSTEM DIAGRAM



Cropped Image
Centered on label



Resize Crop
256x256px

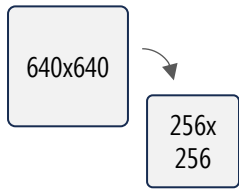
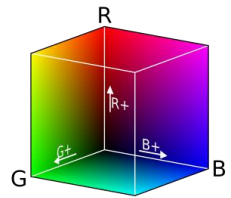
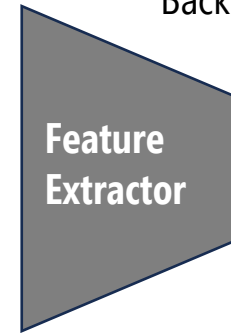


Image Tensor
3x256x256



DINOv2
ViT-B/14 Distilled Backbone



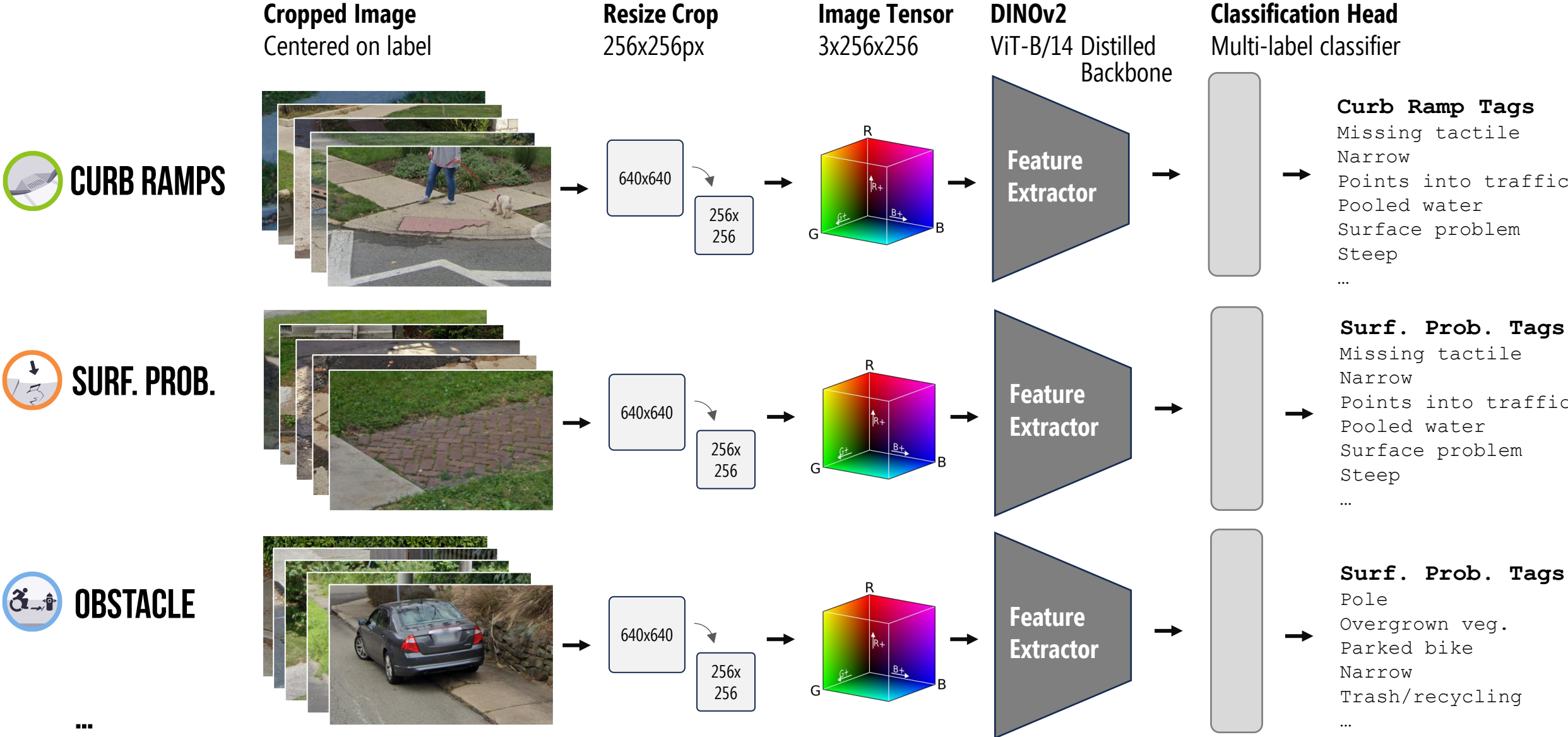
Classification Head
Multi-label classifier



Curb Ramp Tags

- Missing tactile
- Narrow
- Points into traffic
- Pooled water
- Surface problem
- Step
- ...

SYSTEM DIAGRAM



TAG INFERENCE

DATASET: 24K LABELS WITH 29K TAGS

OBSTACLE TAGS



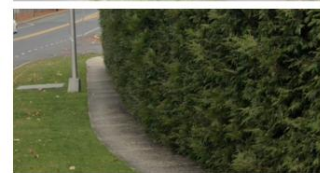
Pole



Vegetation



Parked Bike



Narrow



Trash/recycling cans



Height difference



Sign



Parked car



Tree



Litter/garbage



Construction



Mailbox

SURFACE PROBLEM TAGS



Brick/cobblestone



Bumpy



Uneven/slanted



Cracks



Grass



Height difference (uplift)



Narrow



Sand/gravel

CURB RAMP TAGS



Narrow



Points into cross traffic



Pooled water



Surface problem



Not enough landing space



Not level with street



Steep



Missing tactile warning

CROSSWALK TAGS



Paint fading



Brick/cobblestone



Bumpy



Cracks

RESULTS: SURFACE PROBLEM TAGS



SURFACE PROBLEM TAGS



Brick/cobblestone



Bumpy



Uneven/slanted



Cracks



Grass



Height difference (uplift)

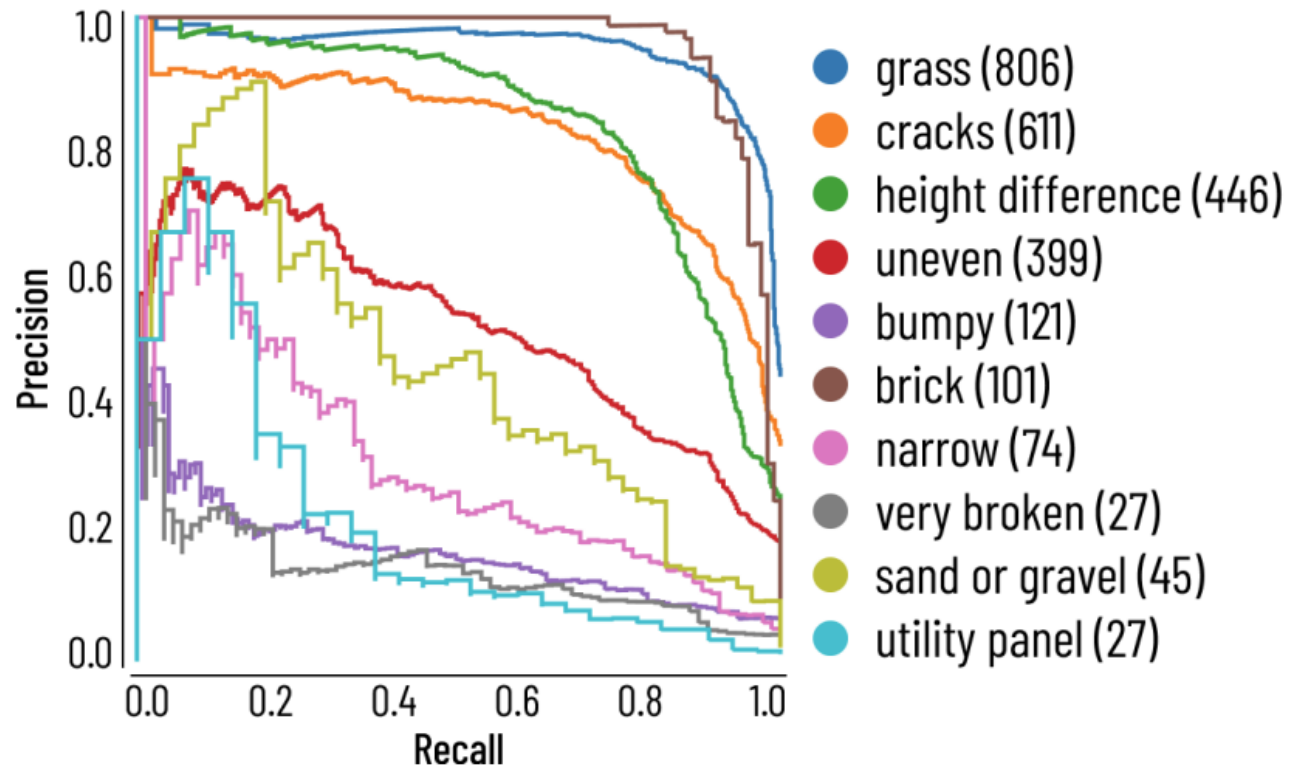


Narrow

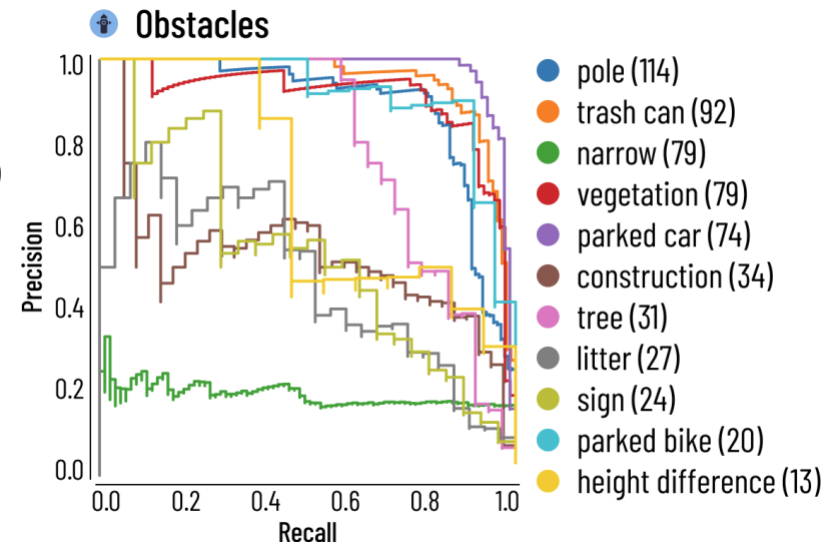
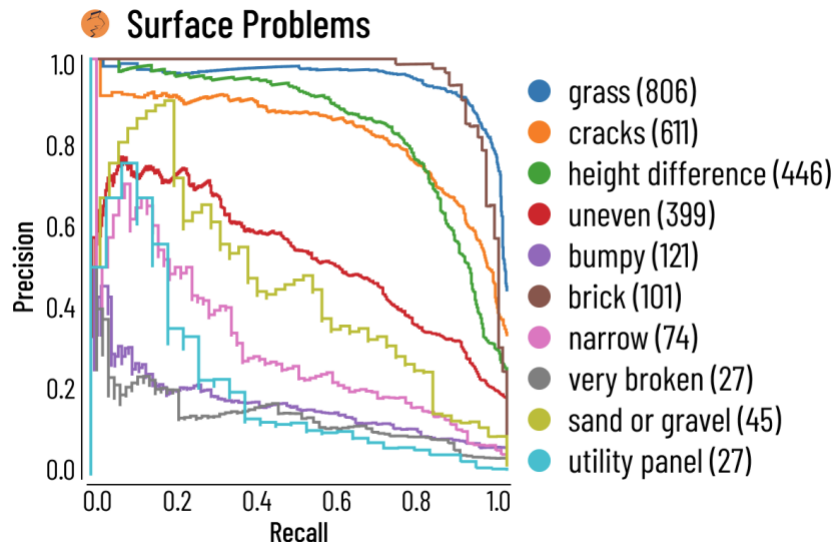
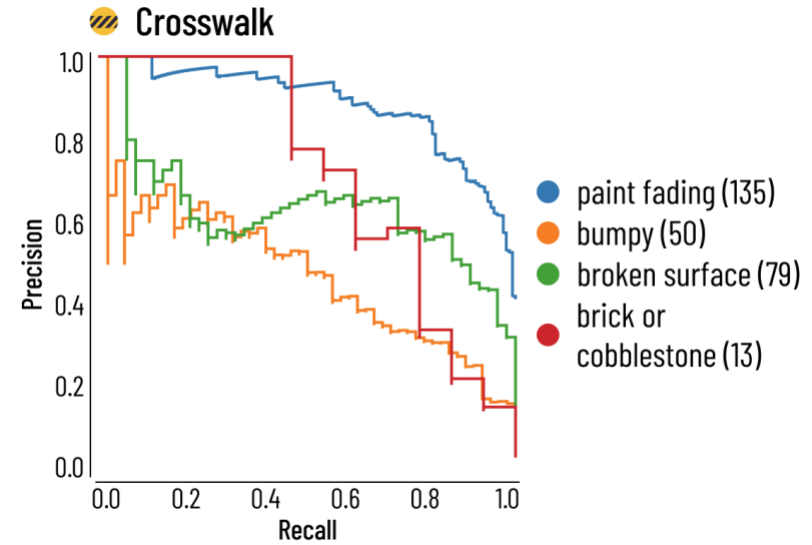
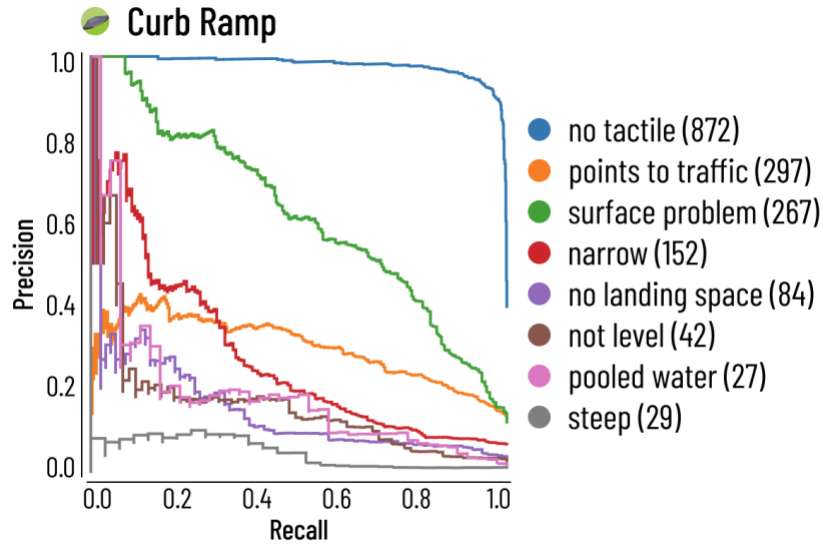


Sand/gravel

Surface Problems



TAG INFERENCE RESULTS



OBSTACLE: ADD "PARKED CAR"



Is this an **Obstacle**?

Yes

No

Unsure

Add/remove tags

AI⁺ Suggestions

Add: parked car

AI Suggestion

Add more tags here

Update severity level



Low



Medium



High

Add optional comment

Back

Submit

TAG RECOMMENDER

SURFACE PROBLEM: ADD "BUMPY"



Is this a Surface Problem?

Add/remove tags

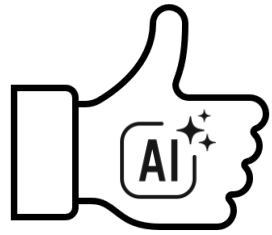
AI Suggestions

AI Suggestion

Update severity level

Low
 Medium
 High

AI VOTES ON LABEL CORRECTNESS



Agree

Is this a **curb ramp**?



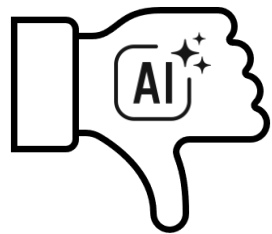
... a **missing curb ramp**?



... a **surface problem**?



... an **obstacle**?

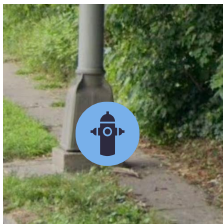


Disagree



SYSTEM DIAGRAM

Labeled crop
Image + label



Resize Crop
256x256px

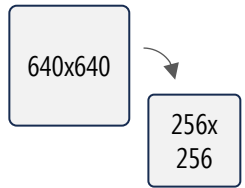
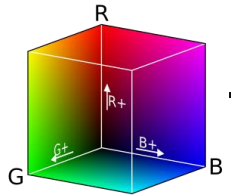


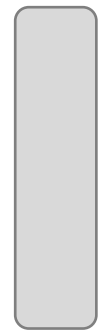
Image Tensor
3x256x256



DINOv2-Large
ViT-L/14 Distilled
Backbone



Classification Head
Binary classifier



Output
Vote



Agree



Disagree



Google

© Google

Marked Crosswalk

Severity ●○○○ AI+ thumbs up 1 thumbs down 0

AI voted **yes** on this label



Google

© Google

Marked Crosswalk

Severity ●○○  1  1  0



Google

© Google

Missing Curb Ramp

Severity ●○○  1  1  0 Tags



Google

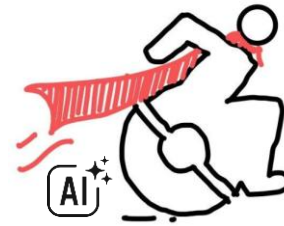
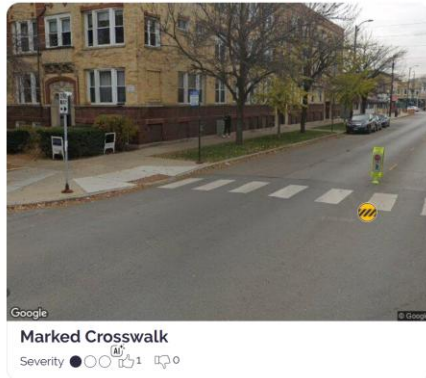
© Google

Curb Ramp

Severity ●○○  1  1  0

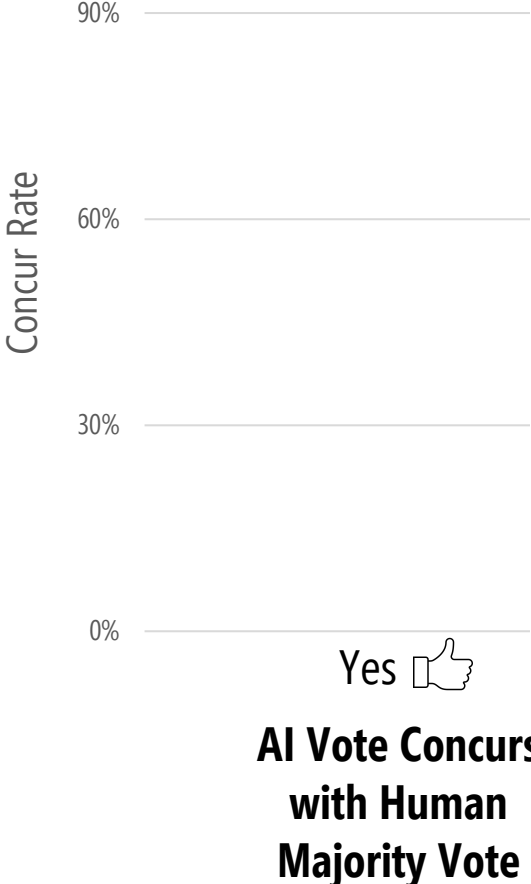
AI VALIDATOR

AUTOMATIC VALIDATION PERFORMANCE

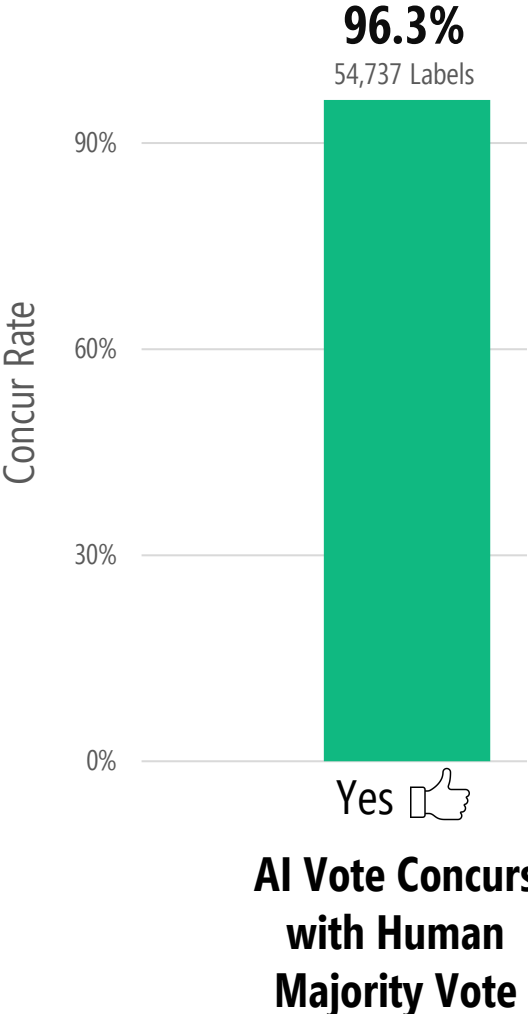


66,132 Labels
AI Votes

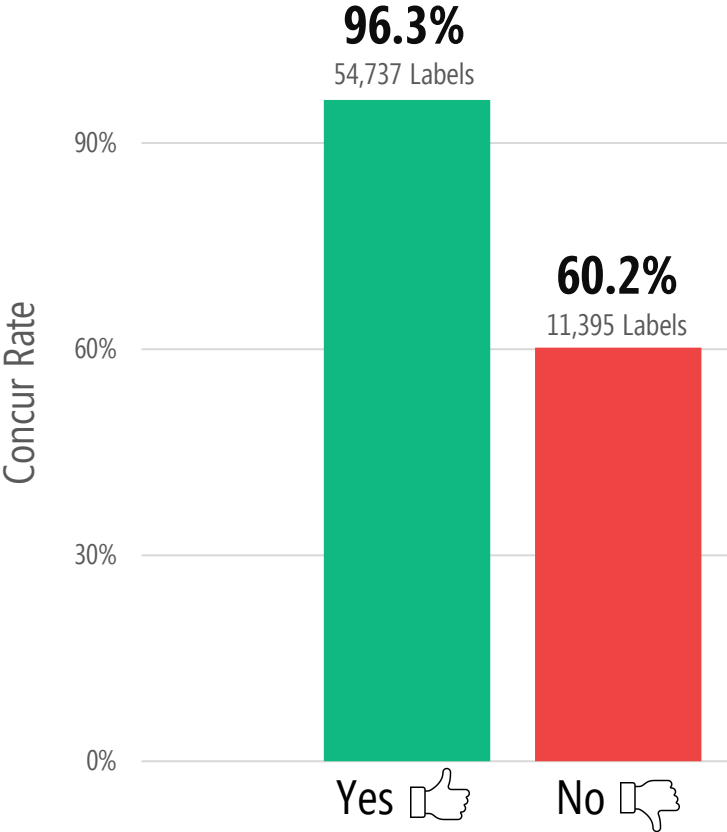
AUTOMATIC VALIDATION PERFORMANCE



AUTOMATIC VALIDATION PERFORMANCE

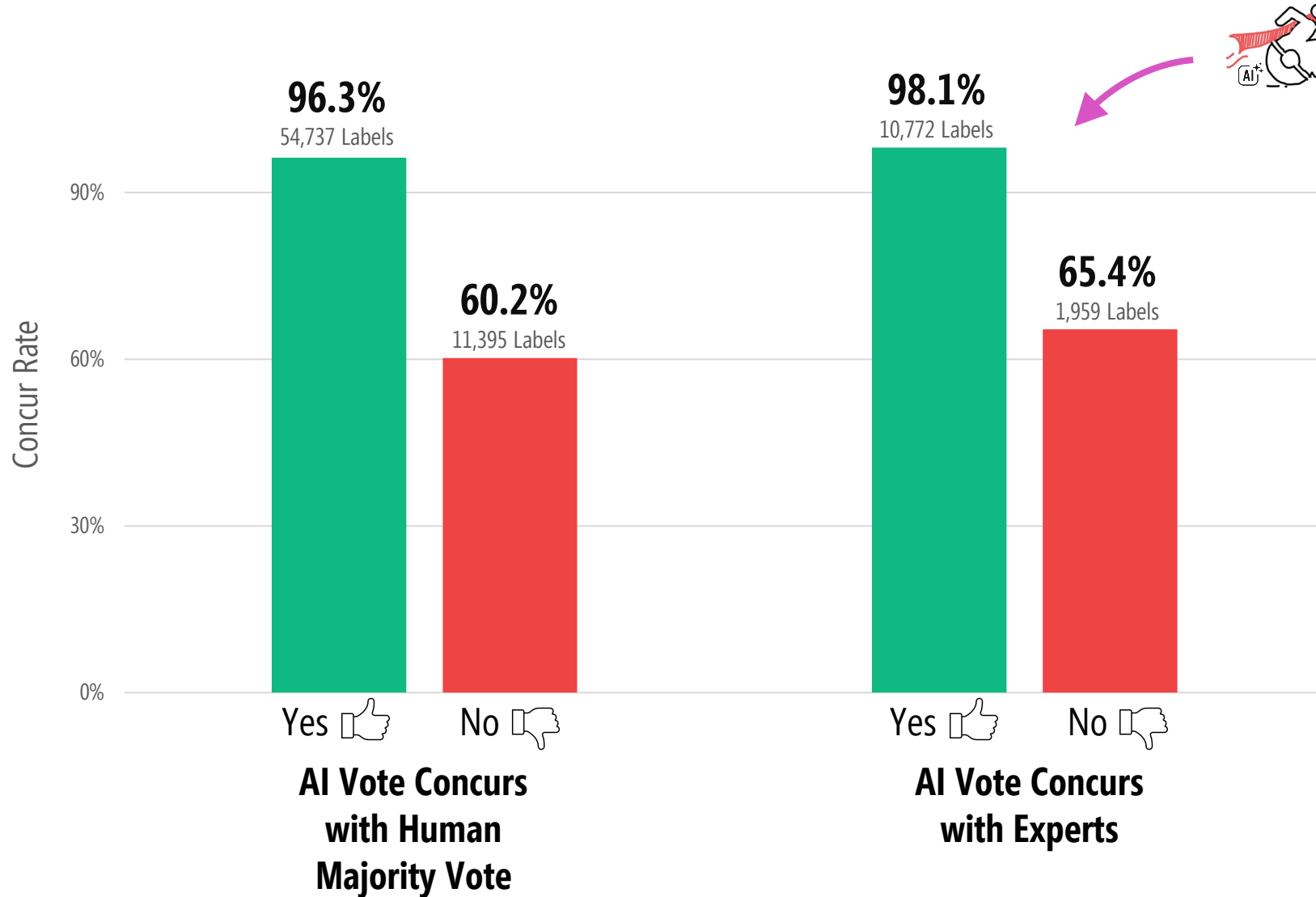


AUTOMATIC VALIDATION PERFORMANCE




**AI Vote Concurs
with Human
Majority Vote**

AUTOMATIC VALIDATION PERFORMANCE




AI concurs more with experts


CURB RAMP LABELS



Explore




Curb Ramp




Missing Curb Ramp


SIDEWALK LABELS



Obstacle in Path




Surface Problem




No Sidewalk


OTHER ACCESSIBILITY LABELS



Crosswalk





Pedestrian Signal





Other


Overall Stats


 **0.06 miles**


 **2 labels**


 **N/A accuracy**


 Zoom In

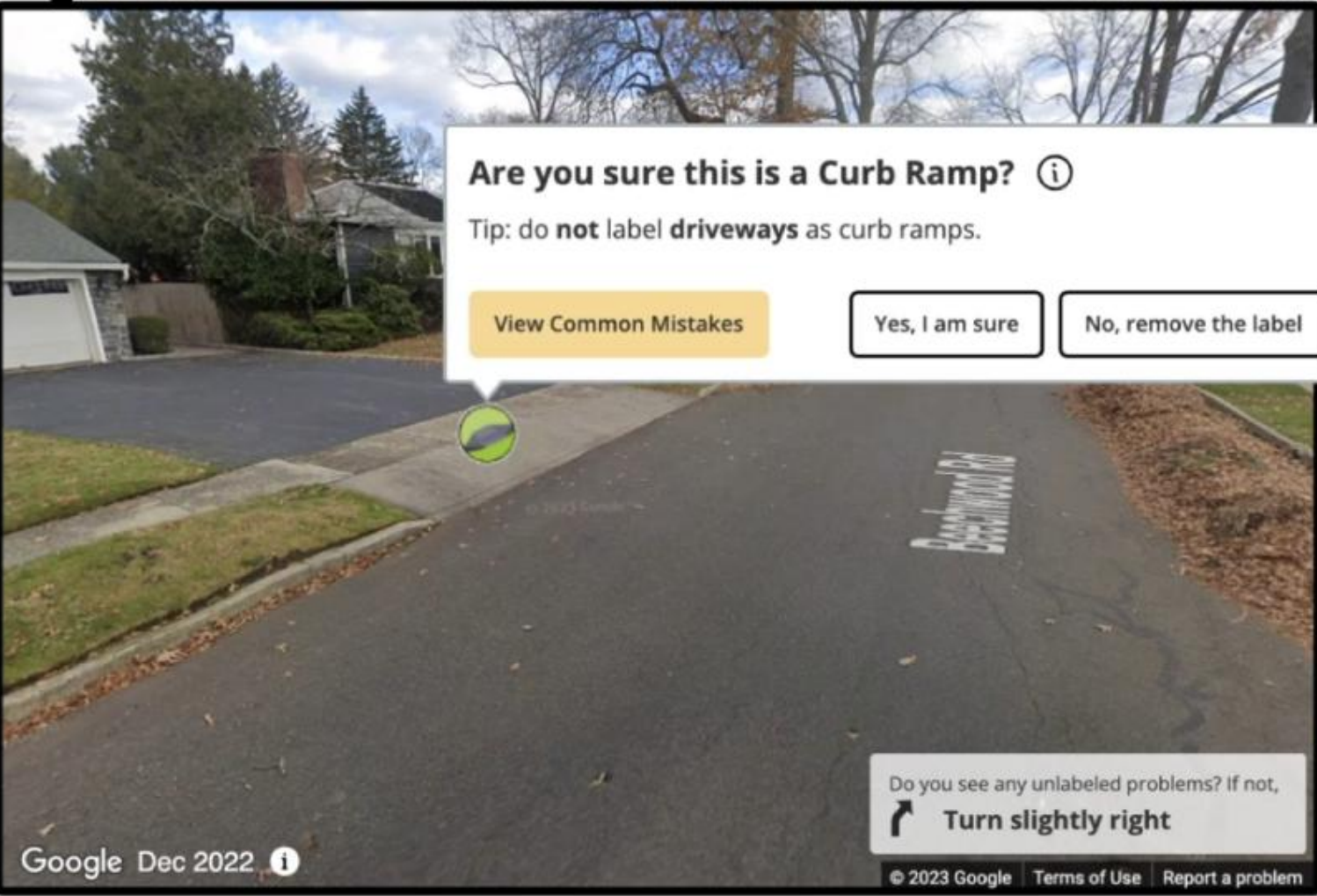
 Zoom Out

 Sound

 Jump

 Stuck

 Feedback




Are you sure this is a Curb Ramp? ⓘ


Tip: do **not** label **driveways** as curb ramps.


View Common Mistakes
Yes, I am sure
No, remove the label

Do you see any unlabeled problems? If not,

 **Turn slightly right**







Current Neighborhood
East Oradell, Seattle

 **0.06 miles**

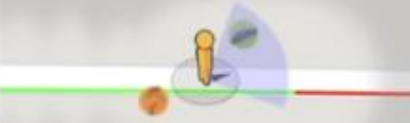
 **2 labels**

Current Mission: Route 1
Explore 250 ft of this neighborhood

6% complete

 Curb ramp	 0 surface problem
 0 missing curb ramp	 0 no sidewalk
 0 obstacle	 0 other

Follow the red line to continue the mission 100%



Google

Chu Li, *et al.* LabelAid: Just-in-time AI Interventions for Improving Human Labeling Quality and Domain Knowledge in Crowdsourcing Systems. CHI'24

KEY QUESTIONS

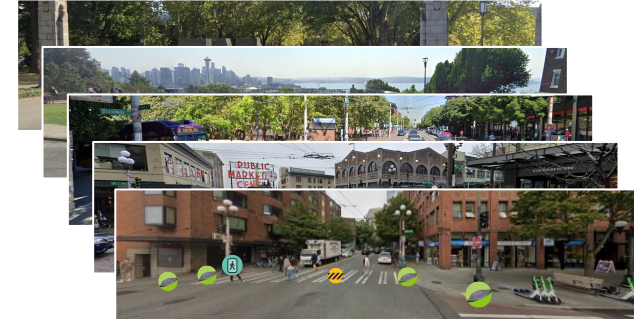
How might these **AI interventions** **shape** human perspectives?

What are the **costs of mistakes**?

How do we **balance** and **maintain** **human agency**?

How do **people feel** about these AI systems?

AI Labeler



AI-Assisted Human Validation



FORMATIVE & REFLECTIVE

Formative Studies

CHI'13 **CHI'16** **CSCW'20**

CHI'22 **CHI'25**

Thought Pieces

Inter'19 **SDS'21** **AVA'22**

UrbAcc'22 **ASSETS'24**

DATA COLLECTION TECHNIQUES

Manual Crowdsourcing

ASSETS'12 **CHI'13** **ASSETS'13** **TACCESS'15** **CHI'19** **UrbSci'25**

Best Paper *Best Paper*

Automated Techniques

HCIC'13 **HCOMP'13** **ASSETS'19** **SuMob'23** **ASSETS'24** **CV4A11y'25**

Best Paper

Human-AI Techniques

UIST'14 **ASSETS'18** **ASSETS'21** **ASSETS'22** **ASSETS'23** **CHI'24**

ACM Comp. Review

UIST'25

ACCESS TOOLS

Vis Analytics & Mobility Tools

SIGACC'15 **CHI'16** **ASSETS'18**

ASSETS'21 **CHI'22** **CHI'25**

IMPACT STUDIES

Urban Science

CivicTech'20 **UrbAcc'22** **UrbSci'25**

AI4UP'26

Deployment Studies

ASSETS'17 **CHI'19** **Data4Good'20**

Disab'23 **CHI'24** **AI4UP'26**

Best Paper

FORMATIVE & REFLECTIVE

DATA COLLECTION TECHNIQUES

ACCESS TOOLS

IMPACT STUDIES

Formative Studies

CHI'13 **CHI'16** **CSCW'20**

CHI'22 **CHI'25**

Thought Pieces

Inter'19 **SDS'21** **AVA'22**

UrbAcc'22 **ASSETS'24**

Manual Crowdsourcing

ASSETS'12 **CHI'13** **ASSETS'13** **TACCESS'15** **CHI'19** **UrbSci'25**

Best Paper *Best Paper*

Automated Techniques

HCIC'13 **HCOMP'13** **ASSETS'19** **SuMob'23** **ASSETS'24** **CV4A11y'25**

Best Paper

Human-AI Techniques

UIST'14 **ASSETS'18** **ASSETS'21** **ASSETS'22** **ASSETS'23** **CHI'24** **UIST'25**

ACM Comp. Review

Vis Analytics & Mobility Tools

SIGACC'15 **CHI'16** **ASSETS'18**

ASSETS'21 **CHI'22** **CHI'25**

Urban Science

CivicTech'20 **UrbAcc'22** **UrbSci'25**

AI4UP'26

Deployment Studies

ASSETS'17 **CHI'19** **Data4Good'20**

Disab'23 **CHI'24** **AI4UP'26**

Best Paper

Accessibility for Whom? Perceptions of Sidewalk Barriers Across Disability Groups and Implications for Designing Personalized Maps

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University of Washington, USA
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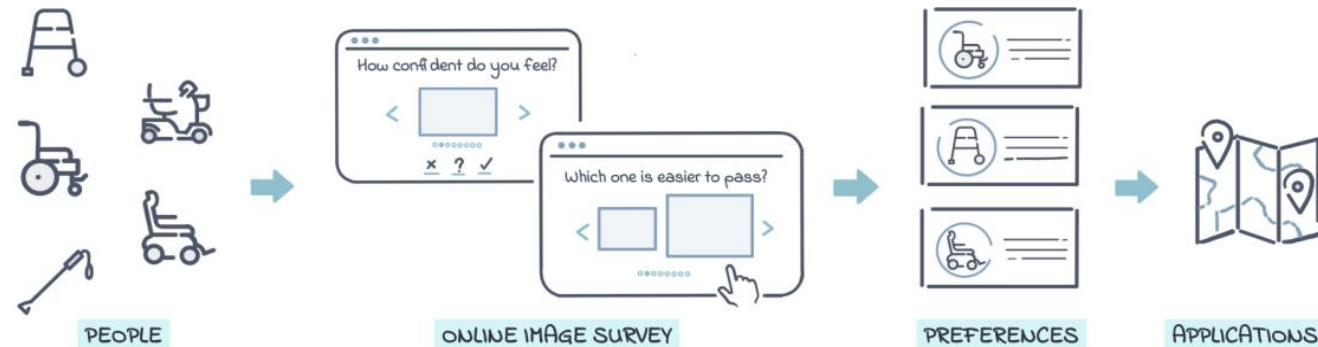


Figure 1: We present a large-scale online image survey gathering perceptions of sidewalk barriers from five mobility groups: users of walking canes, walkers, mobility scooters, manual wheelchairs, and motorized wheelchairs. Findings were used to generate user profiles that informed the design of personalized accessibility maps and routing tools.

Abstract

Today's mapping tools fail to address the varied experiences of different mobility device users. This paper presents a large-scale online survey exploring how five mobility groups—users of canes, walkers, mobility scooters, manual wheelchairs, and motorized wheelchairs—perceive sidewalk barriers and differences therein. Using 52 sidewalk barrier images, respondents evaluated their confidence in navigating each scenario. Our findings ($N=190$) reveal variations in barrier perceptions across groups, while also identifying

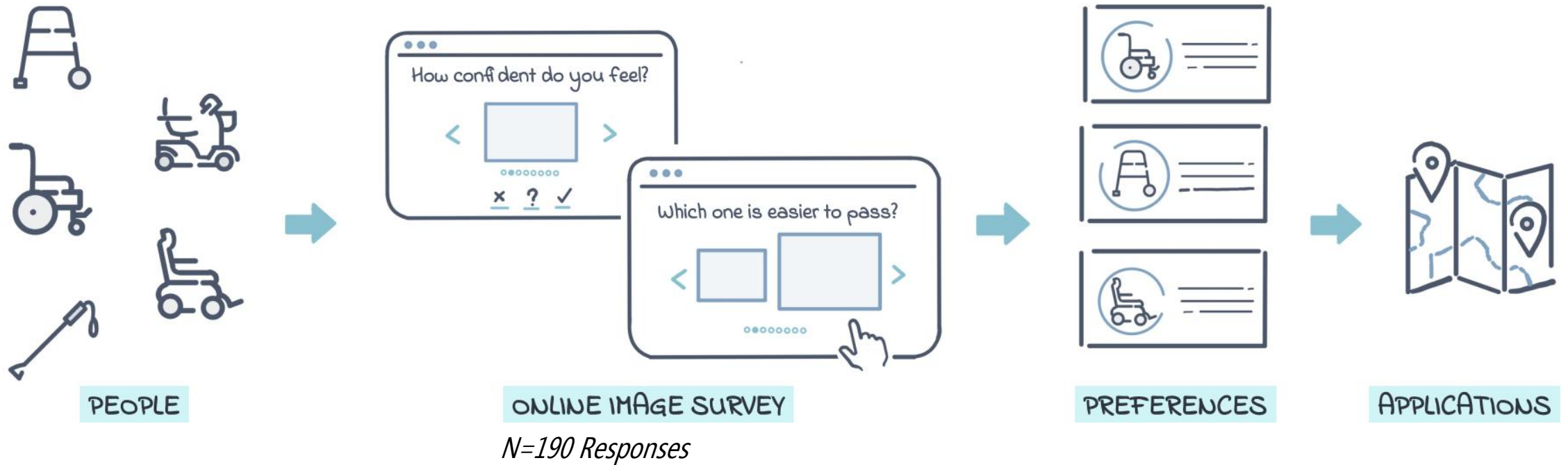
CCS Concepts

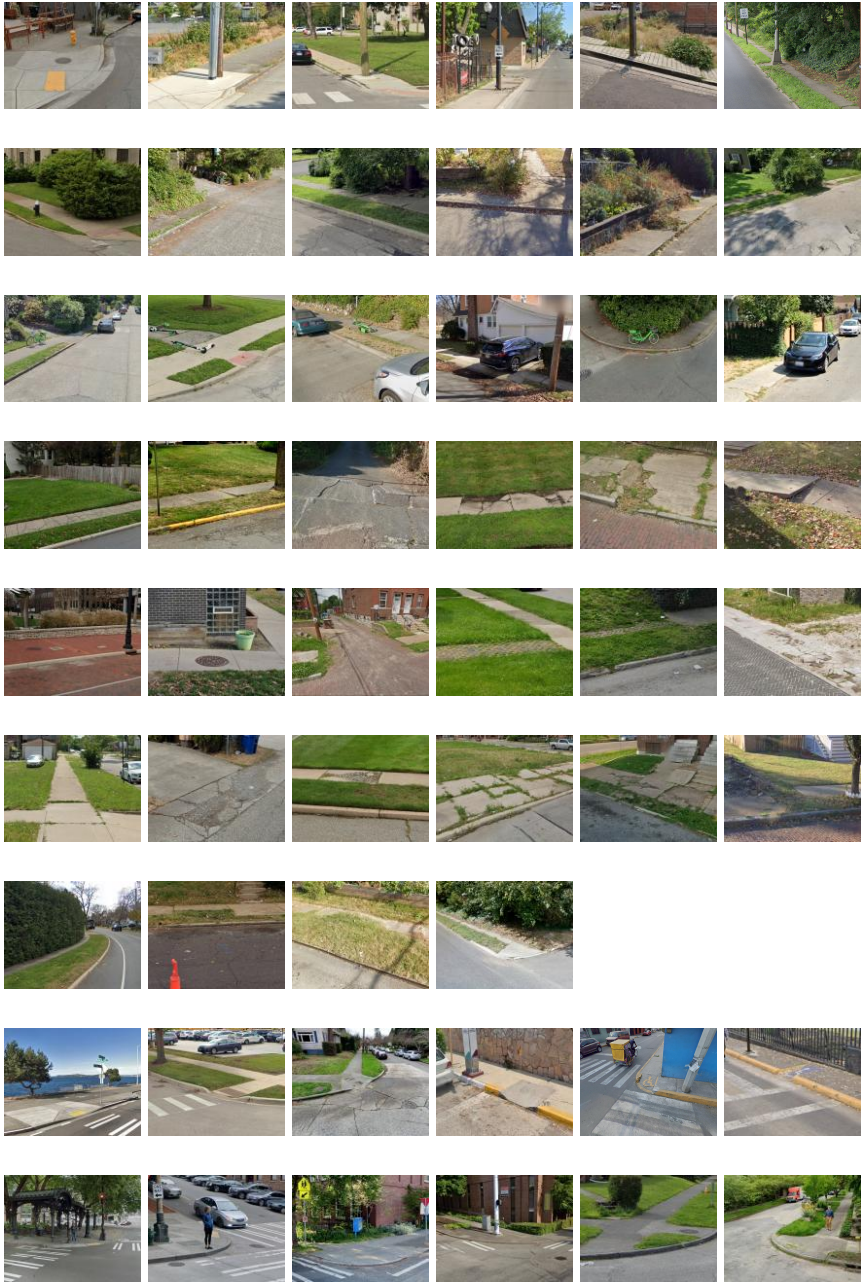
• **Human-centered computing** → **Accessibility systems and tools; Interactive systems and tools; Information systems** → **Crowdsourcing**.

Keywords

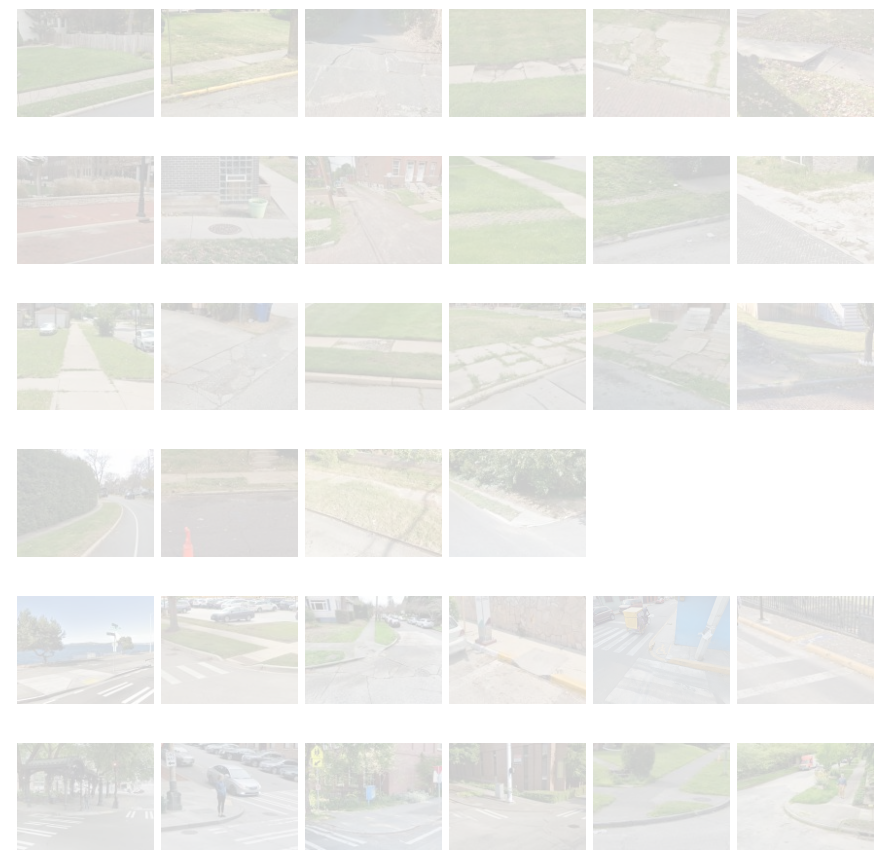
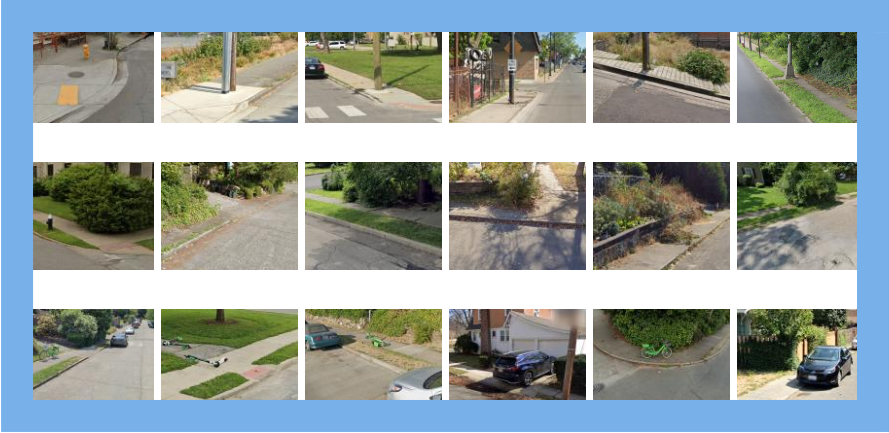
accessibility, online image survey, mapping tools, urban planning

How do **perceptions of sidewalk barriers** vary as a **function of mobility**?





52 IMAGES



OBSTACLES



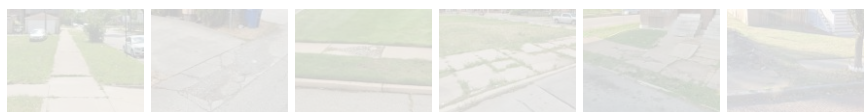


SURFACE PROBLEMS



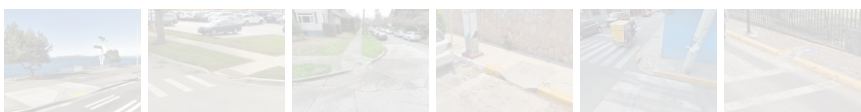
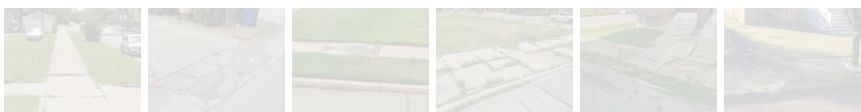


CURB RAMPS

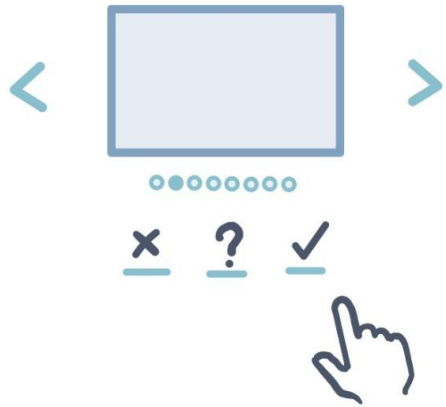




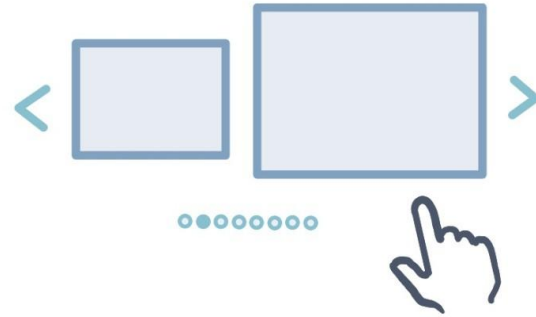
MISSING CURB RAMPS



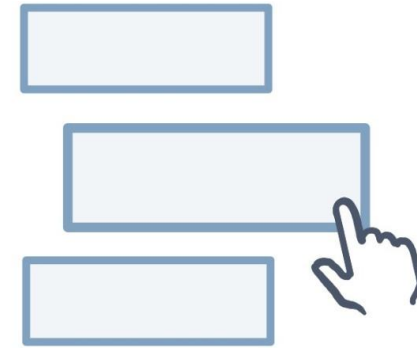
SURVEY METHODS



1. Rating

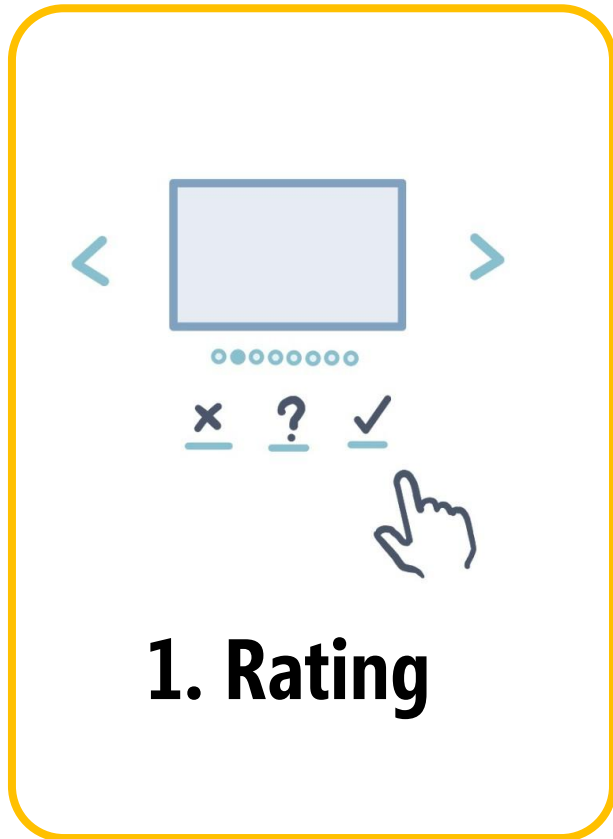


2. Pairwise



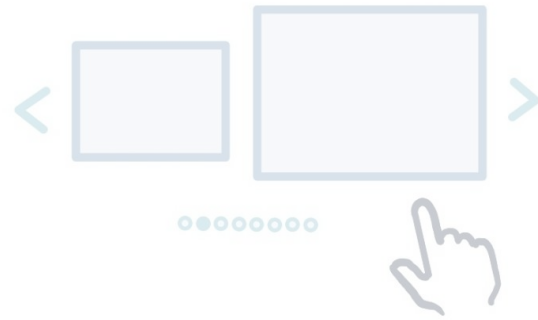
3. Ranking

SURVEY METHODS



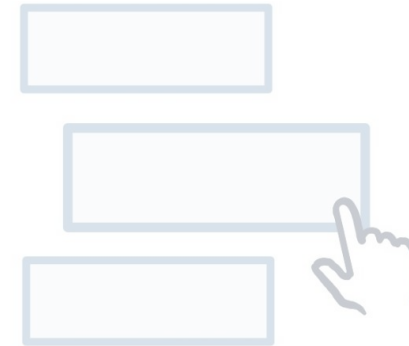
The diagram for the Rating method shows a central rectangular box representing a survey item. It is flanked by left and right arrow symbols. Below the box is a horizontal row of seven small circles, with the first one filled. Underneath the circles are three icons: an 'x', a question mark, and a checkmark, each with a horizontal line below it. A hand icon is shown pointing at the checkmark icon.

1. Rating



The diagram for the Pairwise method shows two rectangular boxes of different sizes side-by-side. They are flanked by left and right arrow symbols. Below the boxes is a horizontal row of seven small circles, with the second one filled. A hand icon is shown pointing at the second circle.

2. Pairwise



The diagram for the Ranking method shows three rectangular boxes of different sizes stacked vertically. A hand icon is shown pointing at the middle box.

3. Ranking

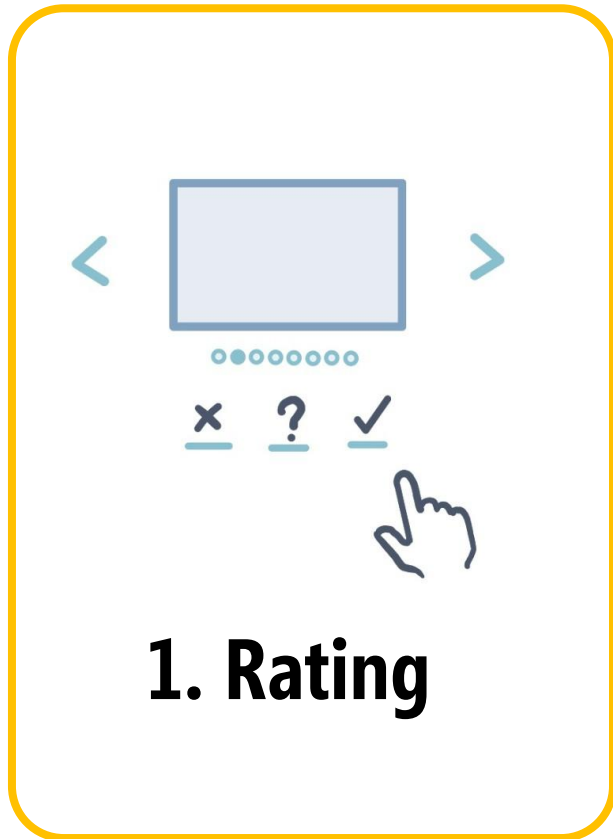
6. When using your **mobility scooter**, do you feel confident in passing this?



NO UNSURE YES

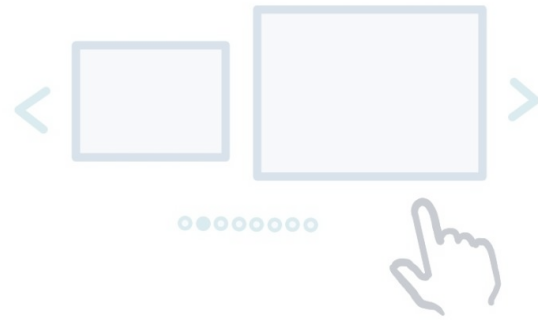


SURVEY METHODS



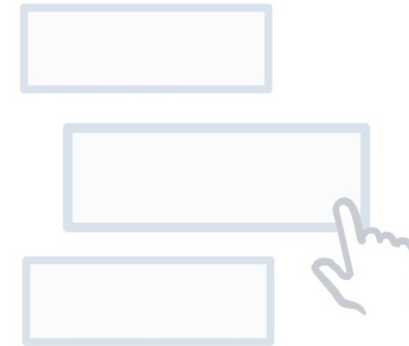
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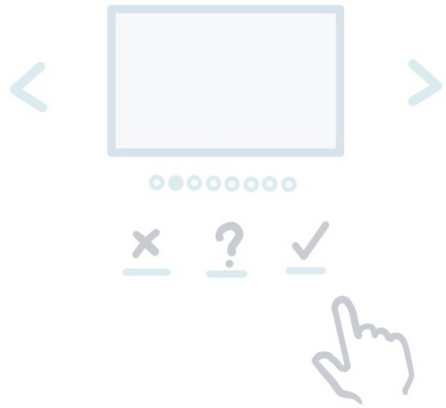
2. Pairwise



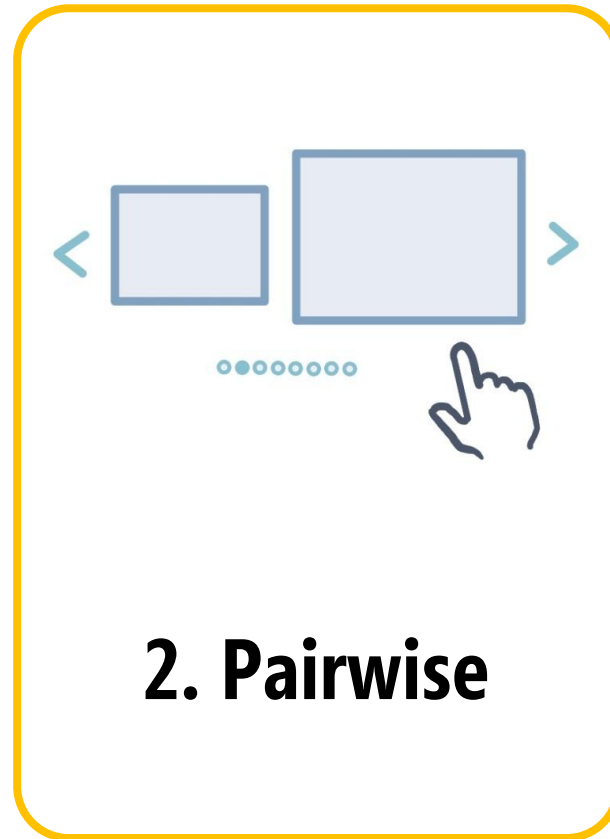
The diagram for the Ranking method shows three rectangular boxes of different lengths stacked vertically. A hand icon is shown pointing at the middle box.

3. Ranking

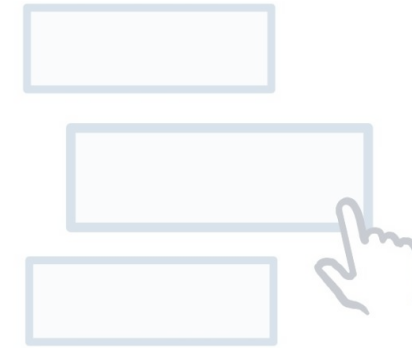
SURVEY METHODS



1. Rating



2. Pairwise



3. Ranking

7. When using your **manual wheelchair**, which one do you feel more confident in passing?

If not confident in passing either, please select 'the same'.



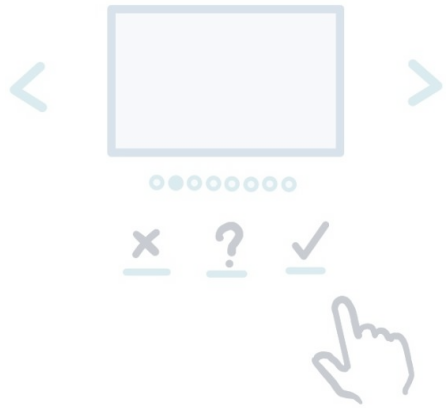
← LEFT IMAGE

↓ THE SAME

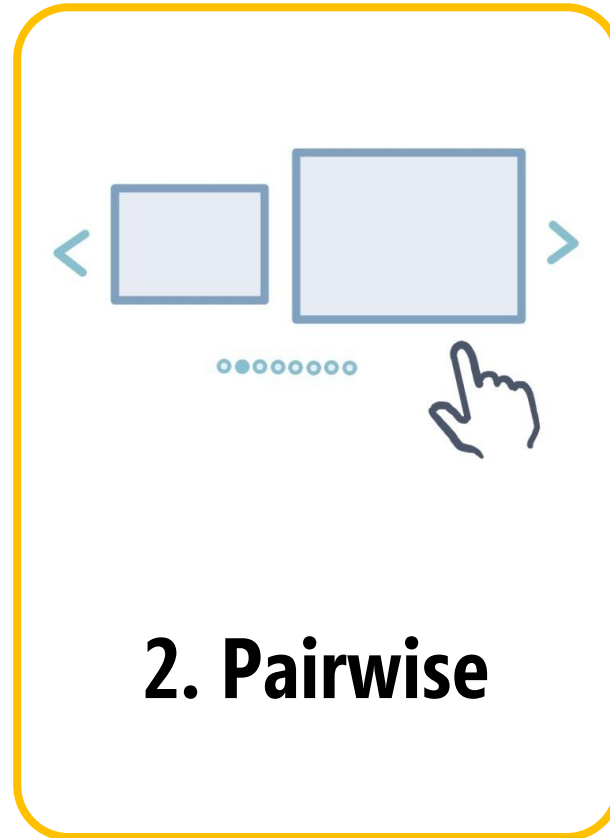
→ RIGHT IMAGE



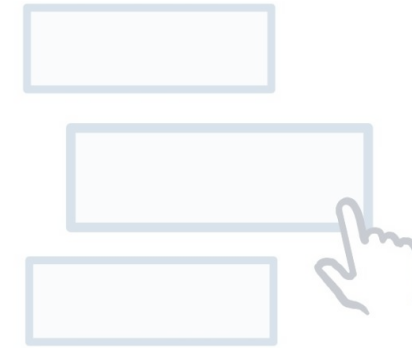
SURVEY METHODS



1. Rating

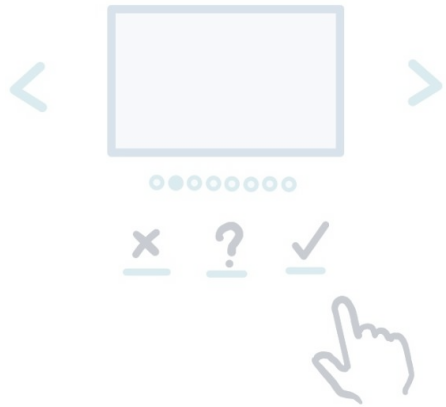


2. Pairwise

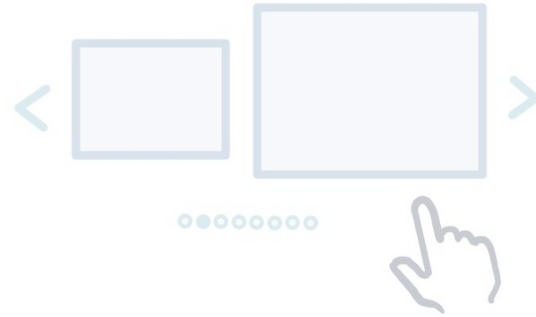


3. Ranking

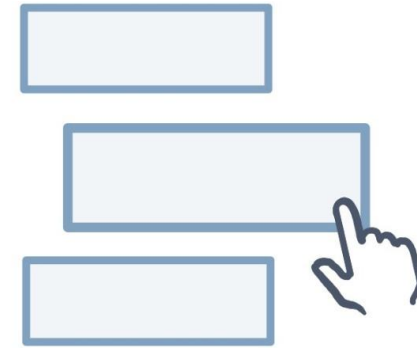
SURVEY METHODS



1. Rating



2. Pairwise



3. Ranking

33. When using your **manual wheelchair**, please rank the following barriers based on passibility, with 1 being the most difficult and 9 being the easiest.*

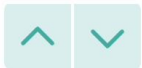
Drag and drop the options to rank them. You may click on the image icon to see an example.

difficult

- 1 Grass surface 
- 2 Missing curb ramp at intersections 
- 3 Steep slope (sidewalk incline greater than 5%) 
- 4 Manholes on sidewalk 
- 5 Sand or gravel surface 
- 6 Broken surface or cracks on sidewalk 
- 7 Brick or cobblestone surface 
- 8 Uneven sidewalk panels 
- 9 Narrow sidewalk (width less than 1.2m / 4 ft) 

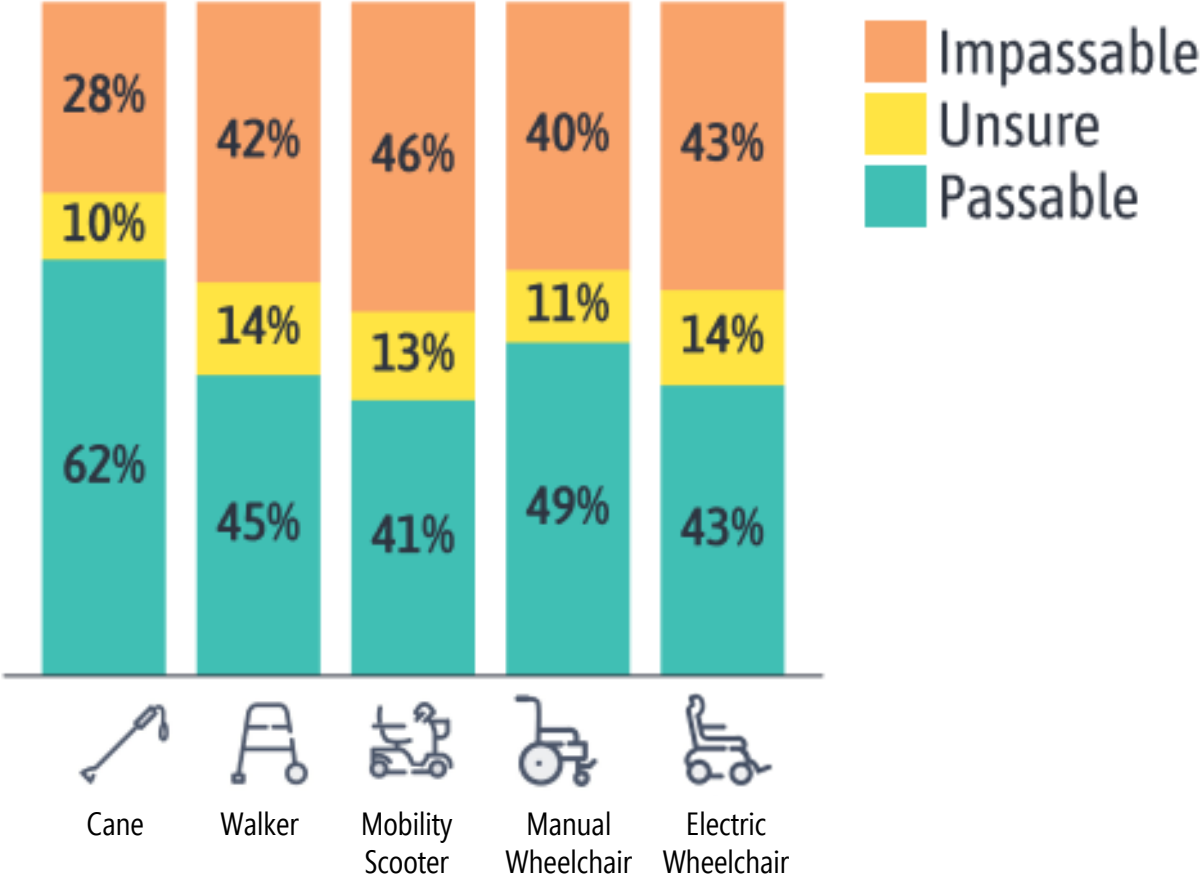
easy

OK press Enter ↵



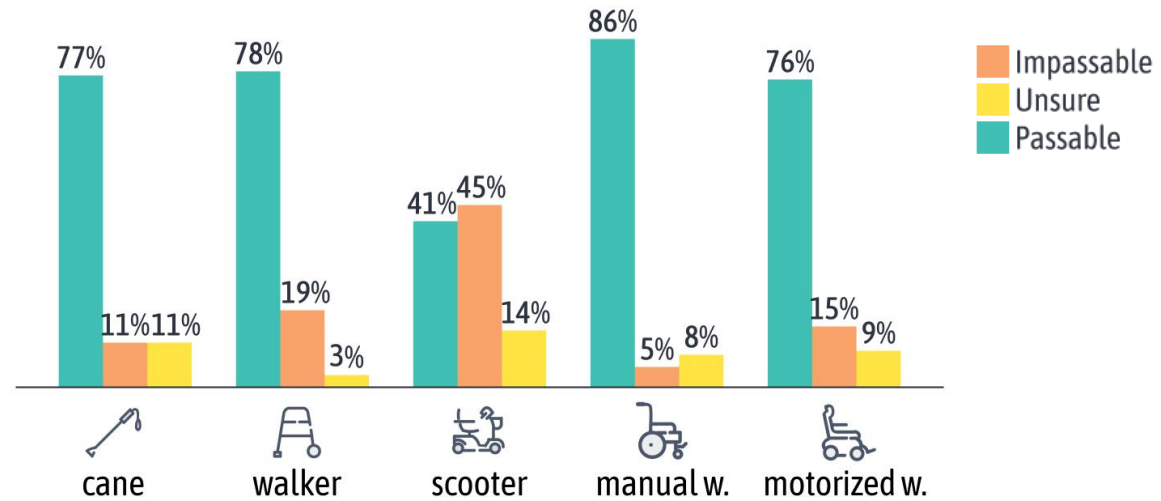
**SIGNIFICANT DIFFERENCE BETWEEN MOBILITY
AID USAGE AND BARRIER PASSABILITY**

OVERALL FINDINGS



Do you feel **confident** in **passing** this with your **mobility aid**?

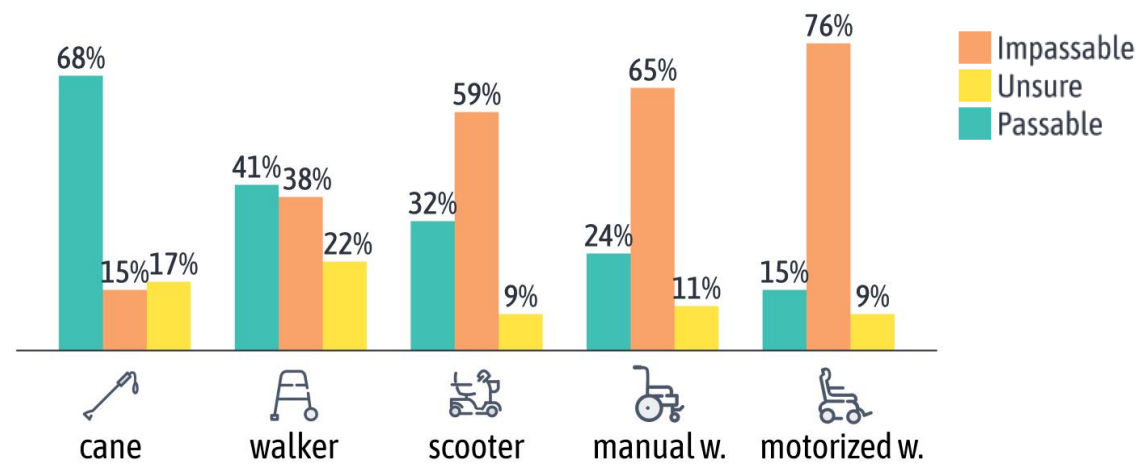
 **CURB RAMP**



Do you feel **confident** in **passing** this with your **mobility aid**?



MISSING RAMP



“Missing curb cuts still **require a lot of energy** and can be very difficult to navigate.”

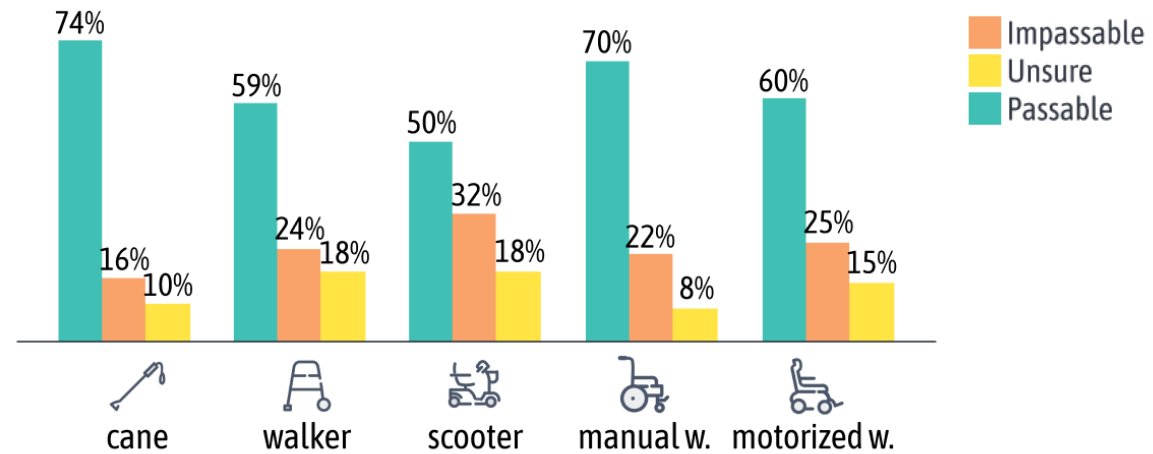
- **WALKER RESPONDENT**



Do you feel **confident** in **passing** this with your **mobility aid**?



SURFACE PROBLEM



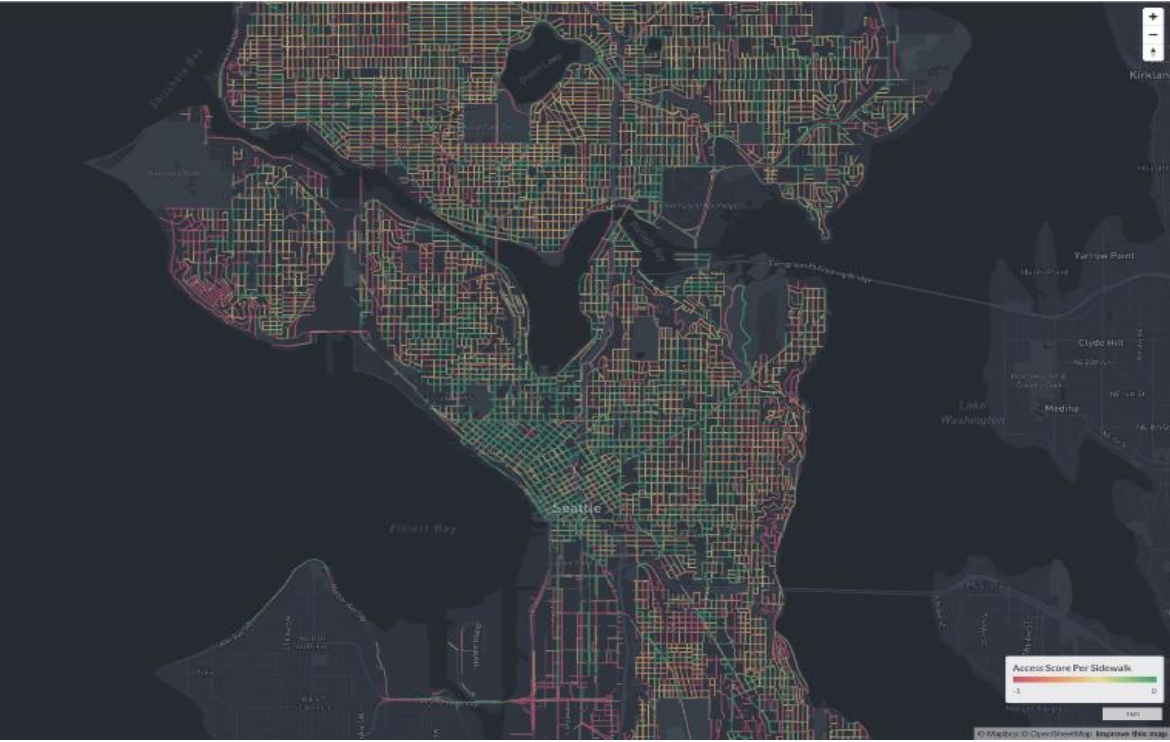
“The **cracks** between sidewalk segments cause a **constant, uncomfortable bumping** that also shakes my legs off the wheelchair’s footplate. Roads are kept smooth. Sidewalks are not.”

- **MANUAL WHEELCHAIR RESPONDENT**



ACCESSIBILITY FOR WHOM

PERSONALIZED APPLICATIONS



AccessScore

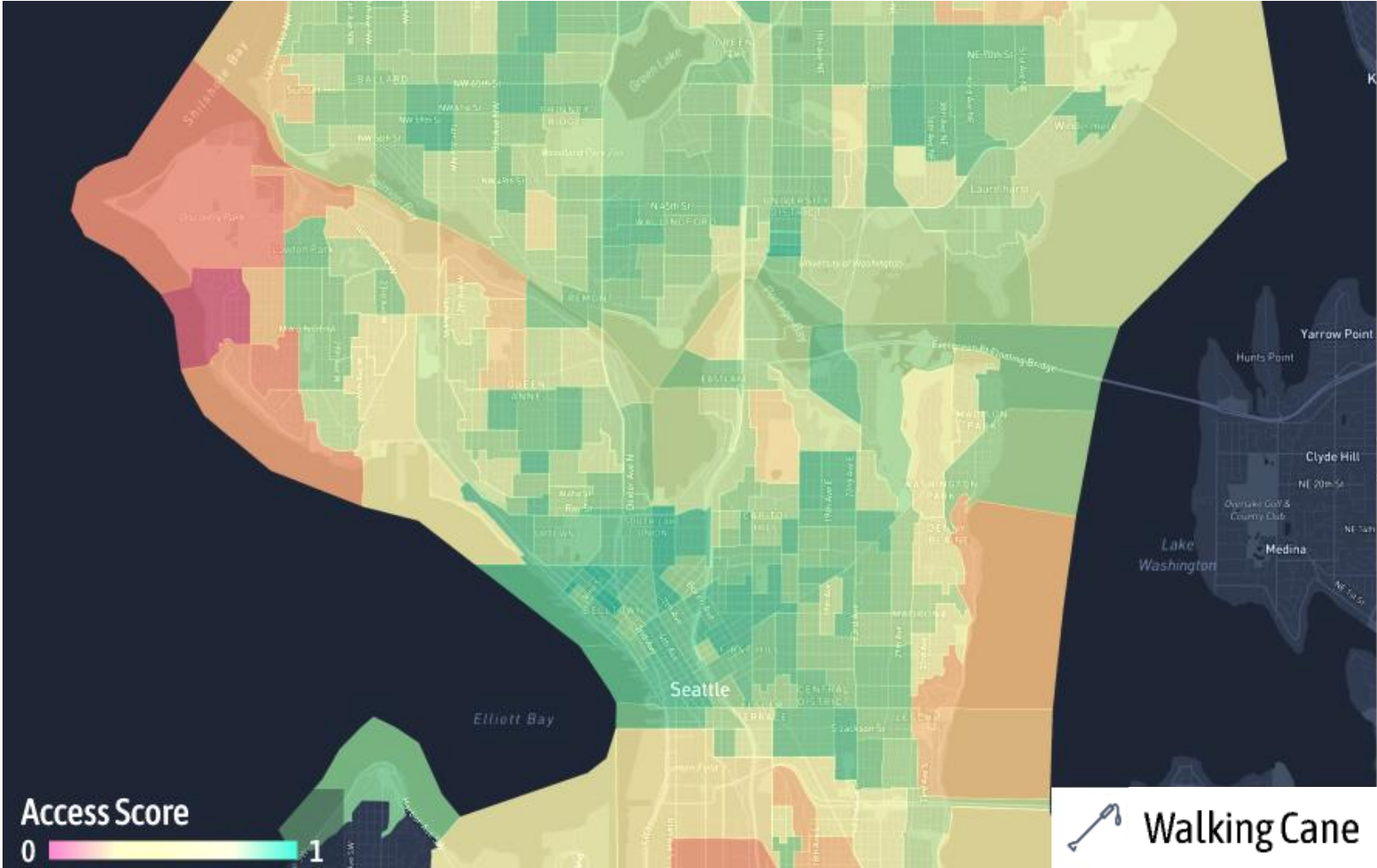


Personalized Routing

Li, C., et al. Accessibility for Whom? Perceptions of Mobility Barriers Across Disability Groups and Implications for Designing Personalized Maps. CHI 2025.

ACCESSIBILITY FOR WHOM

ACCESS SCORE

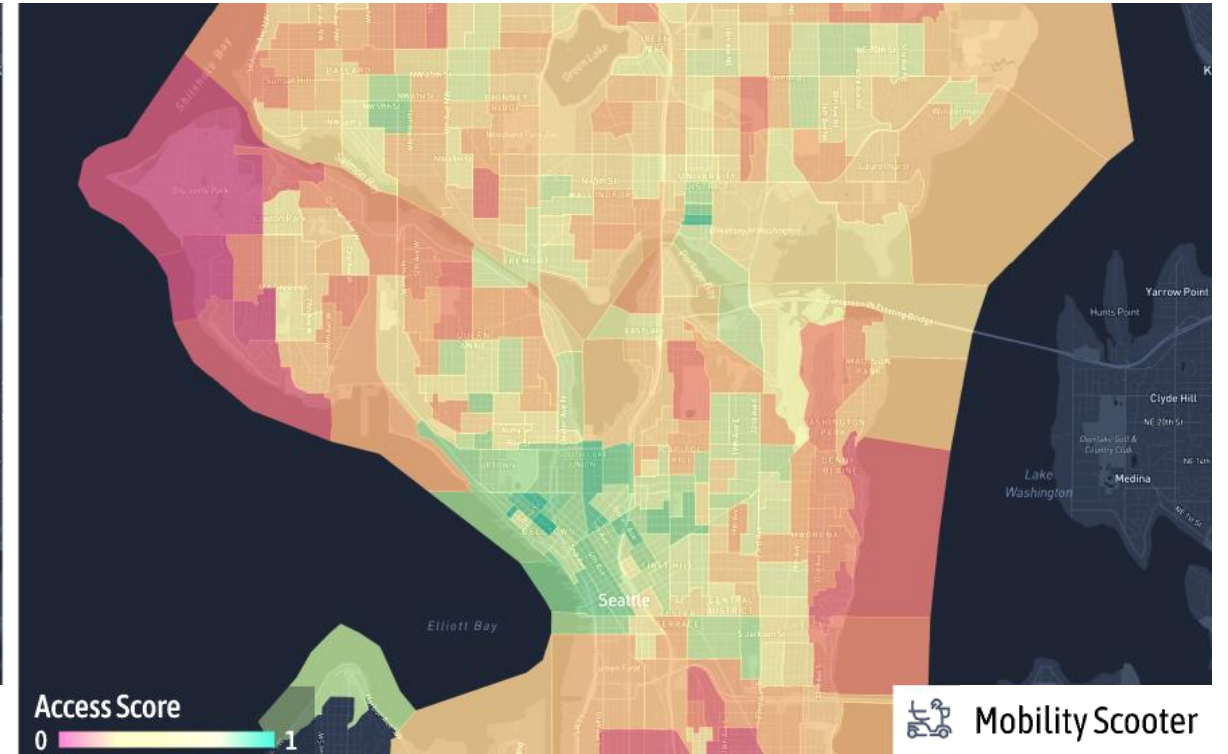
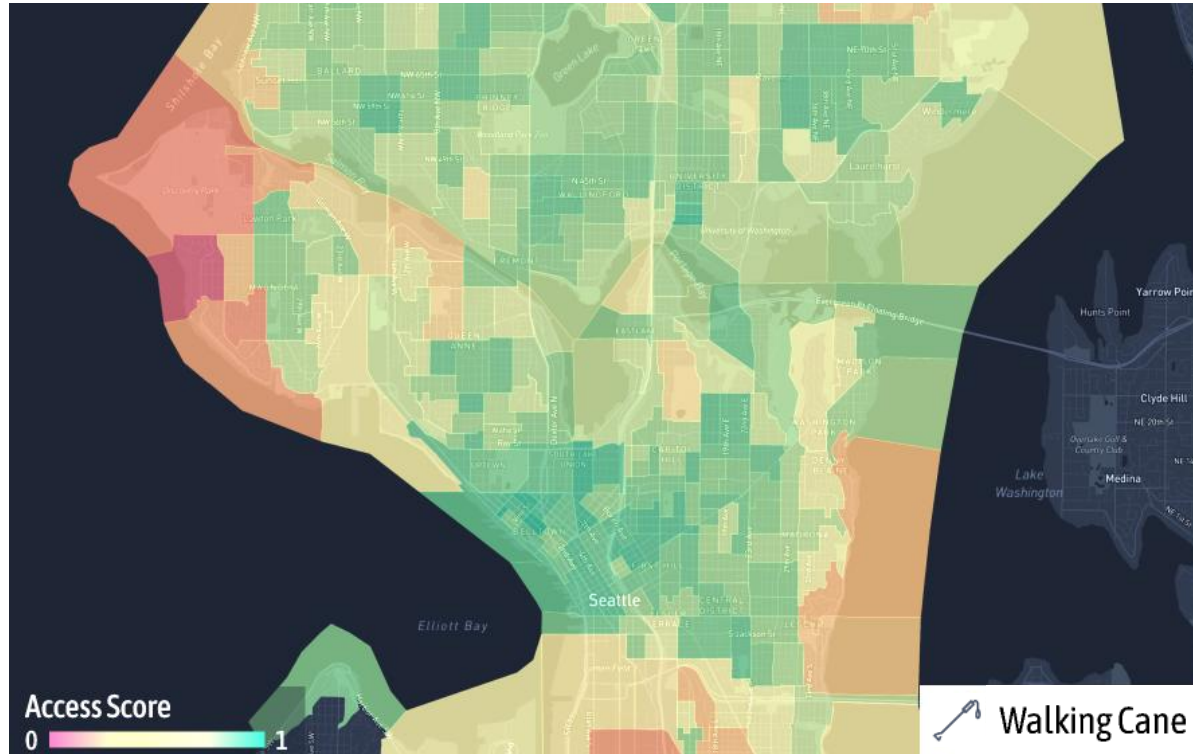


Li, C., et al. Accessibility for Whom? Perceptions of Mobility Barriers Across Disability Groups and Implications for Designing Personalized Maps. CHI 2025.

ACCESSIBILITY FOR WHOM

ACCESS SCORE

Seattle **less accessible** for mobility scooters



Access Score Analysis



Curb Ramps



Missing Curb Ramps



Obstacles



Surface Problems



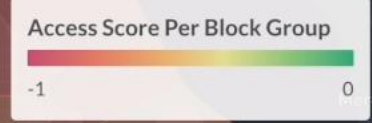
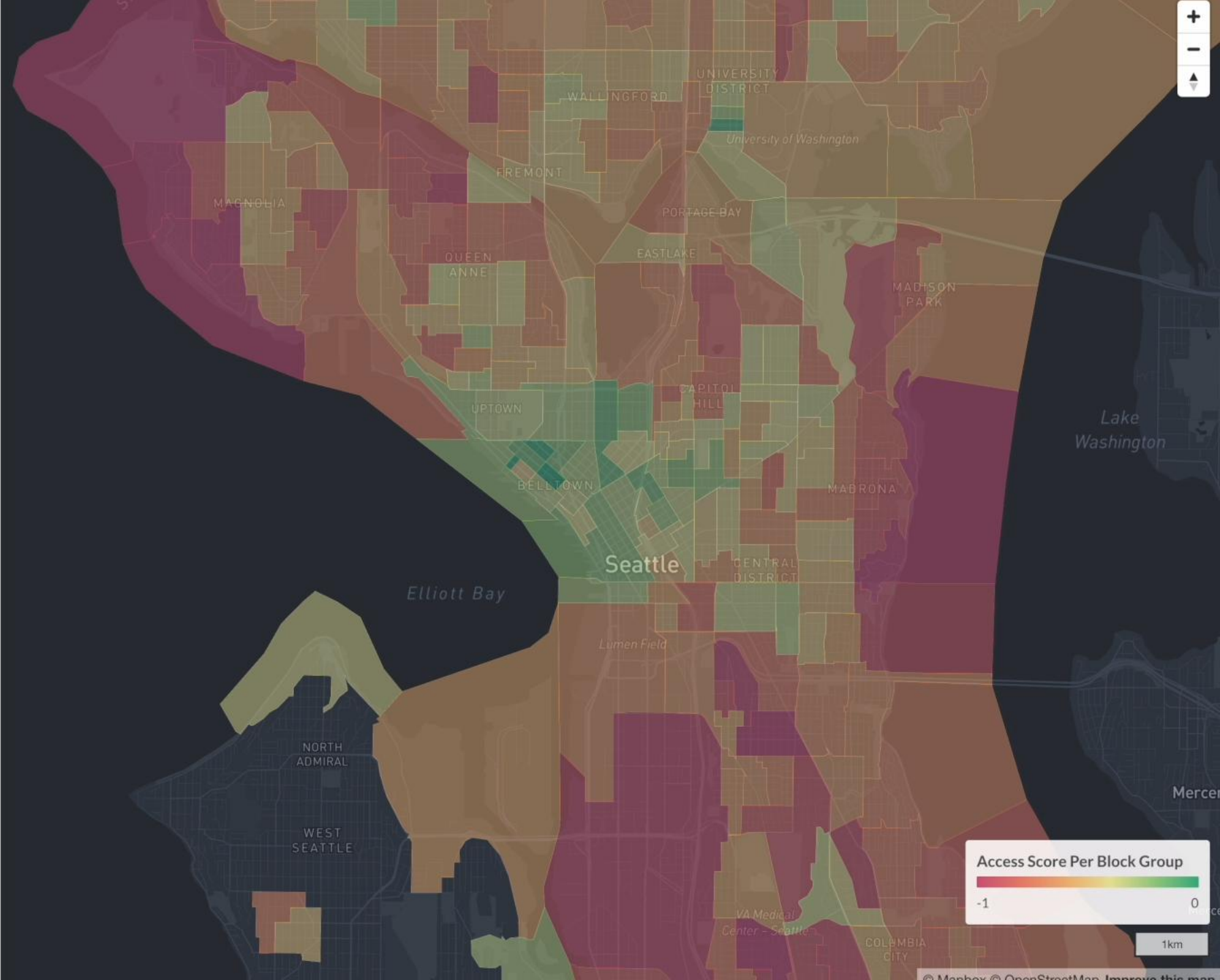
Missing Sidewalks



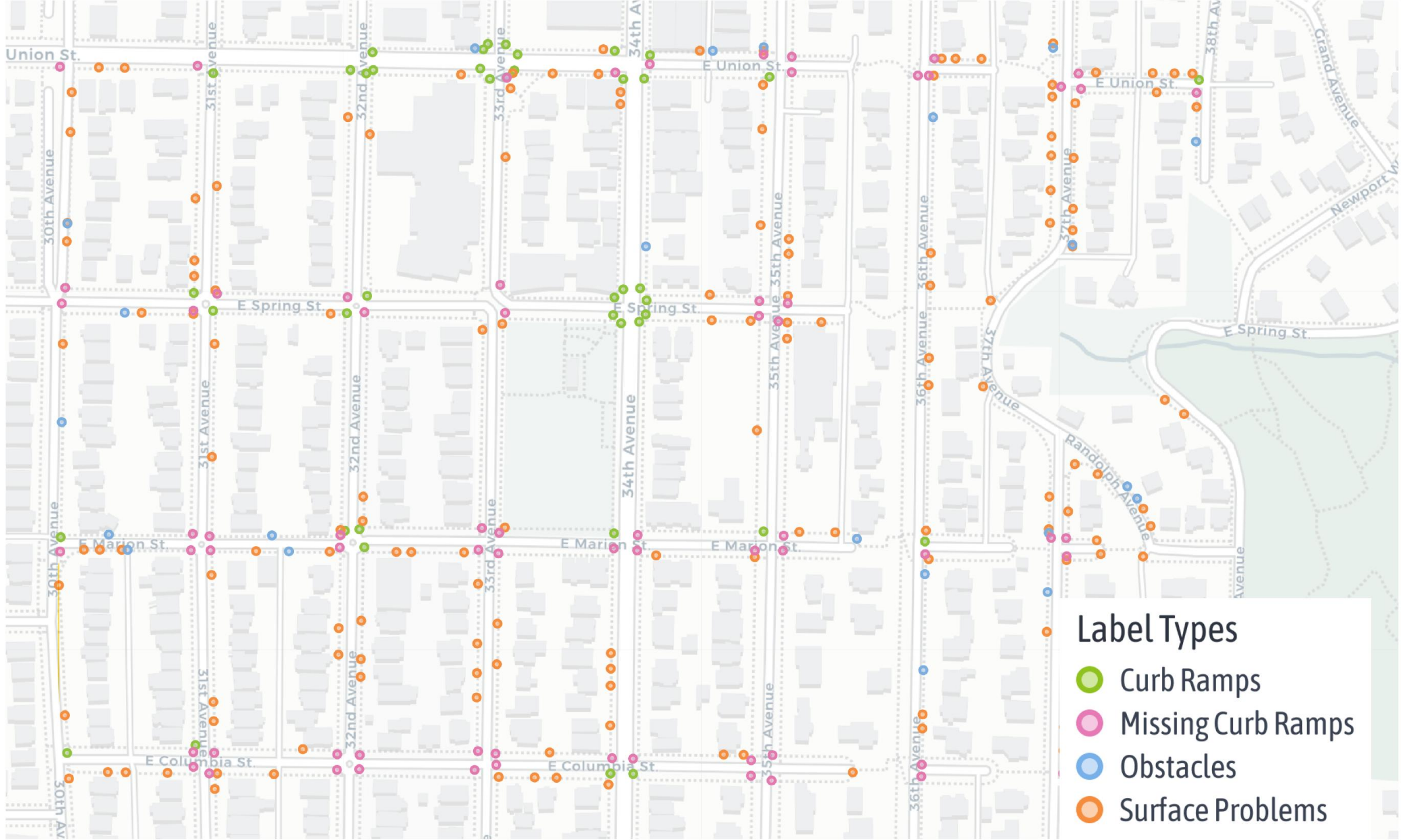
Select geographical unit

Census Block Group

COMPUTE ACCESS SCORE

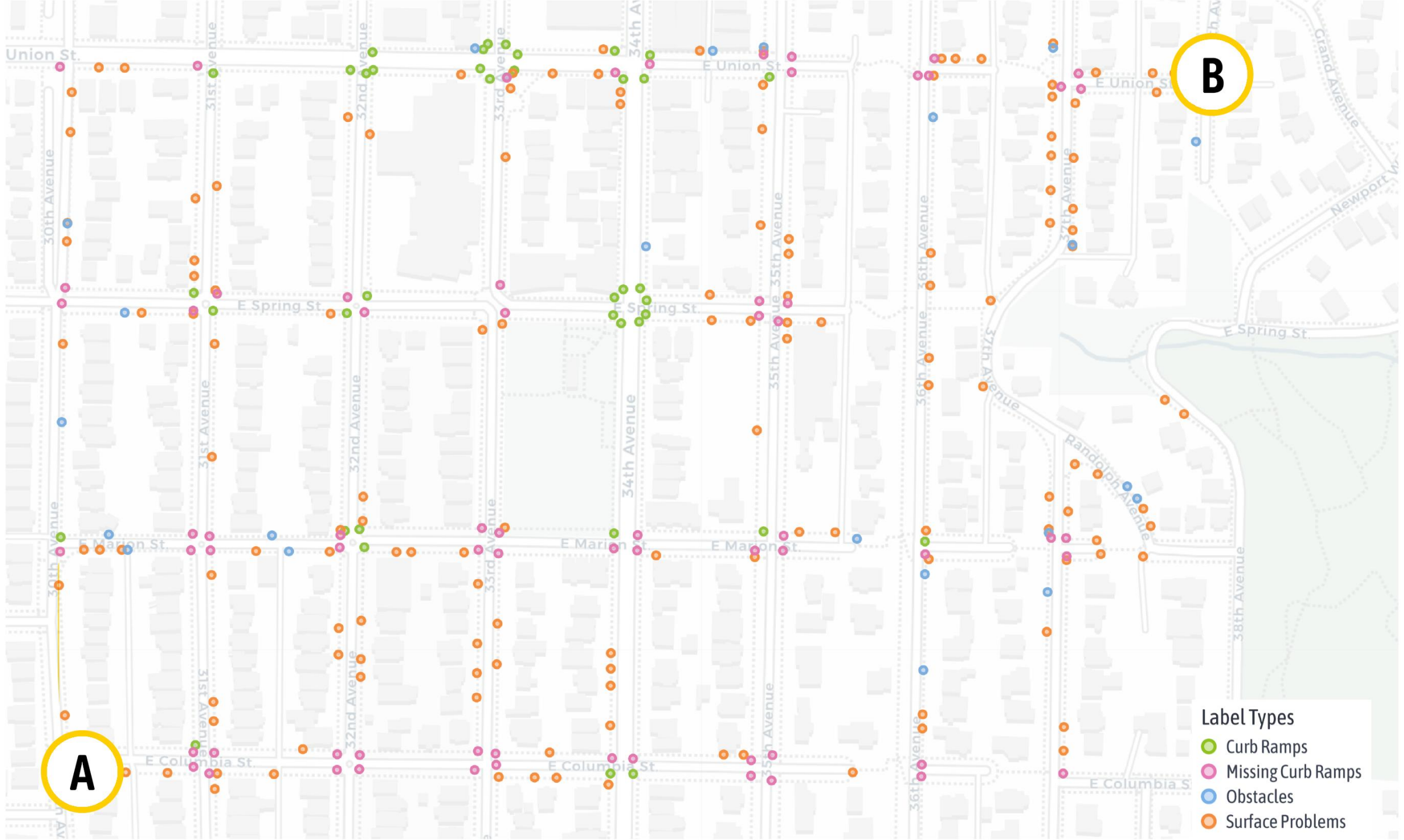


1km



Label Types

- Curb Ramps
- Missing Curb Ramps
- Obstacles
- Surface Problems



A

B

- Label Types
- Curb Ramps
 - Missing Curb Ramps
 - Obstacles
 - Surface Problems

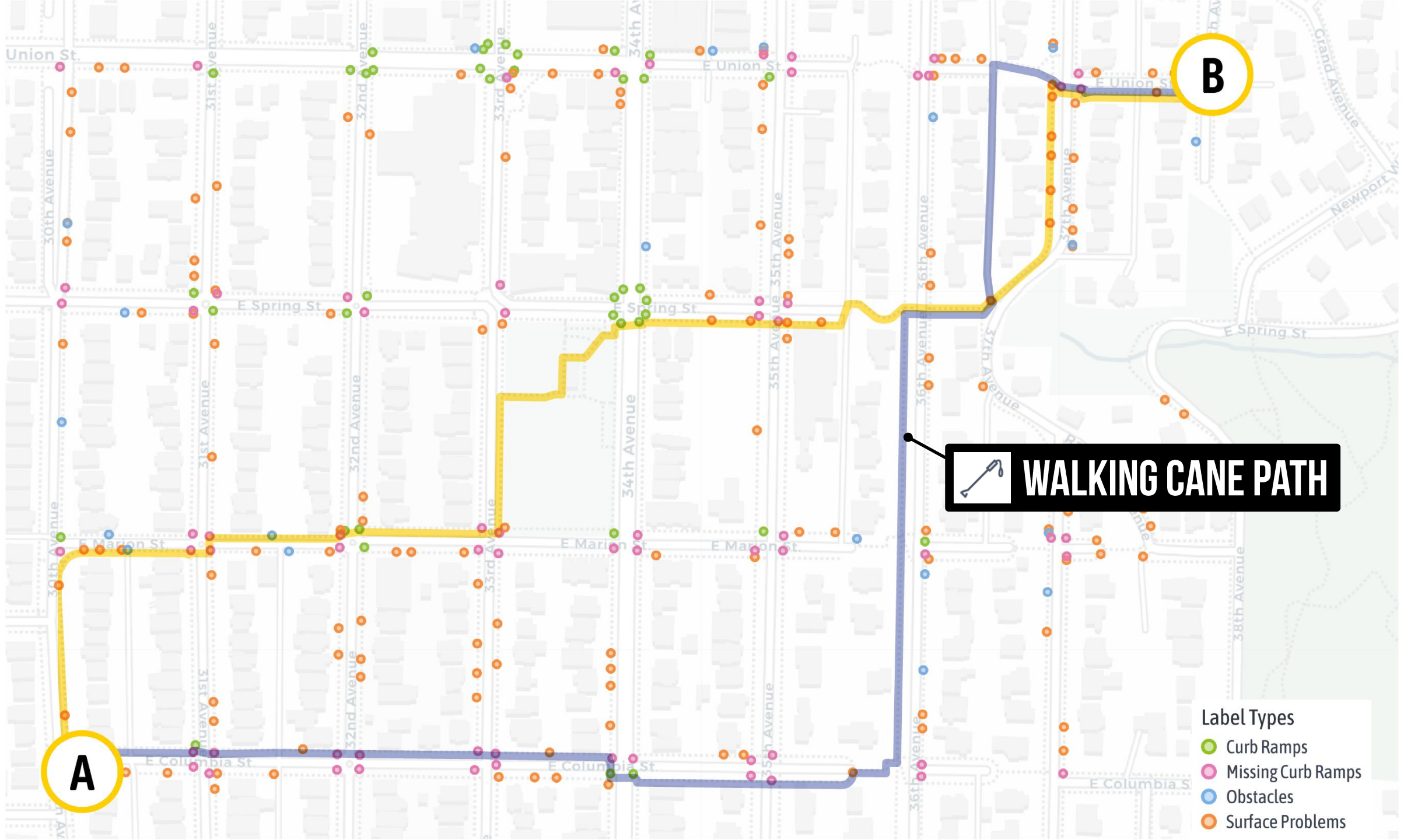


SHORTEST PATH

B

A





- Label Types**
- Curb Ramps
 - Missing Curb Ramps
 - Obstacles
 - Surface Problems



B

A

 **WALKING CANE PATH**

- Label Types
-  Curb Ramps
 -  Missing Curb Ramps
 -  Obstacles
 -  Surface Problems

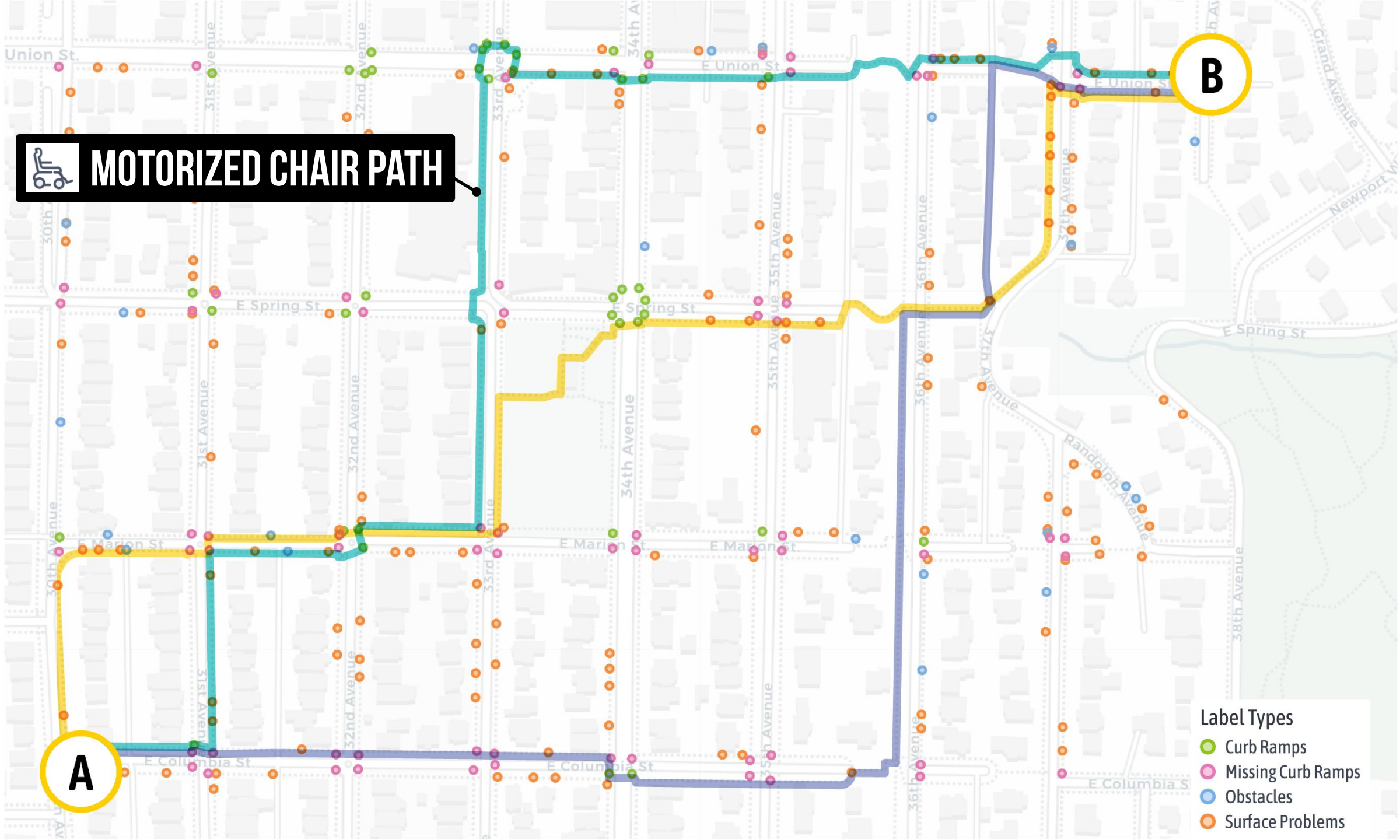


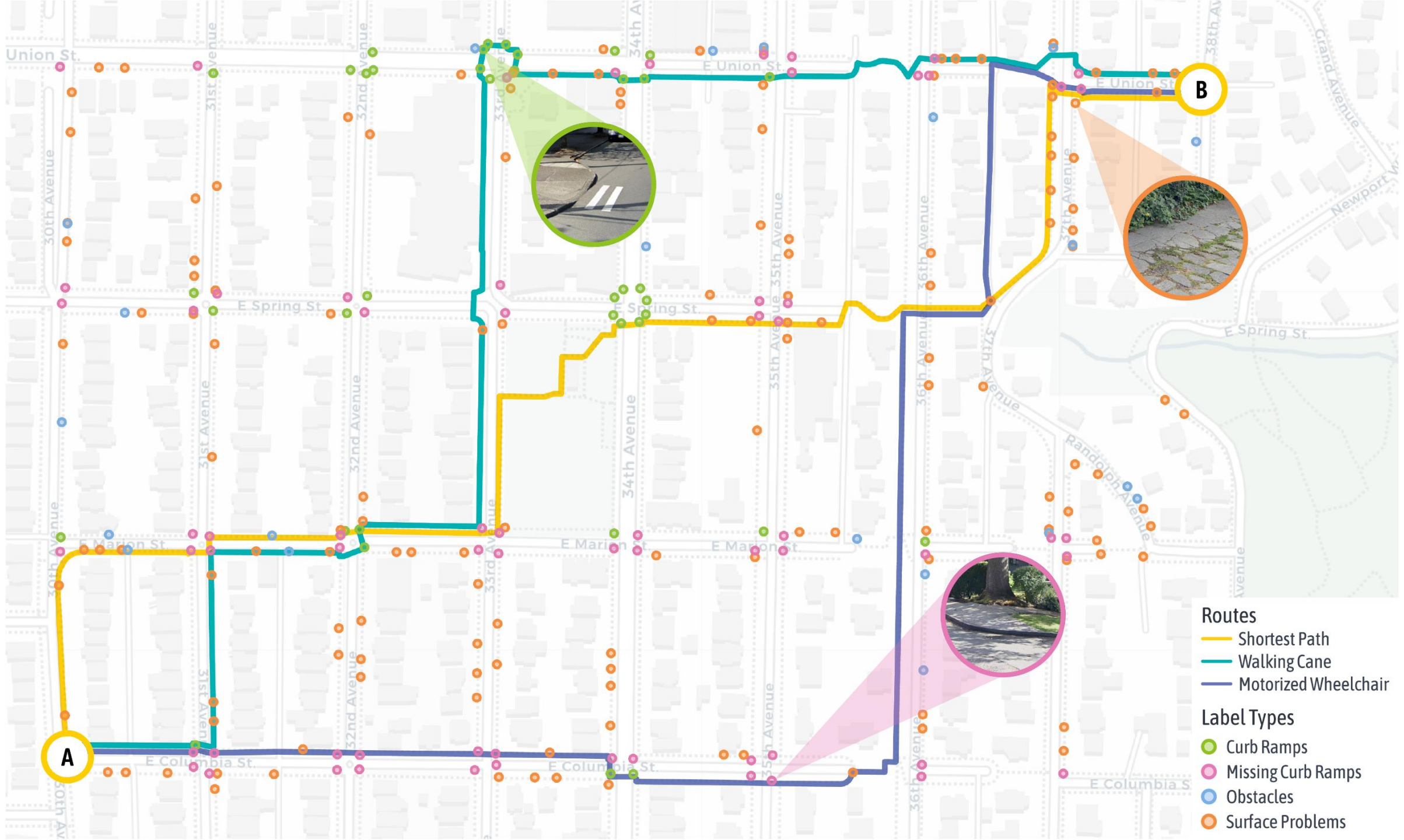
MOTORIZED CHAIR PATH

A

B

- Label Types
- Curb Ramps
 - Missing Curb Ramps
 - Obstacles
 - Surface Problems





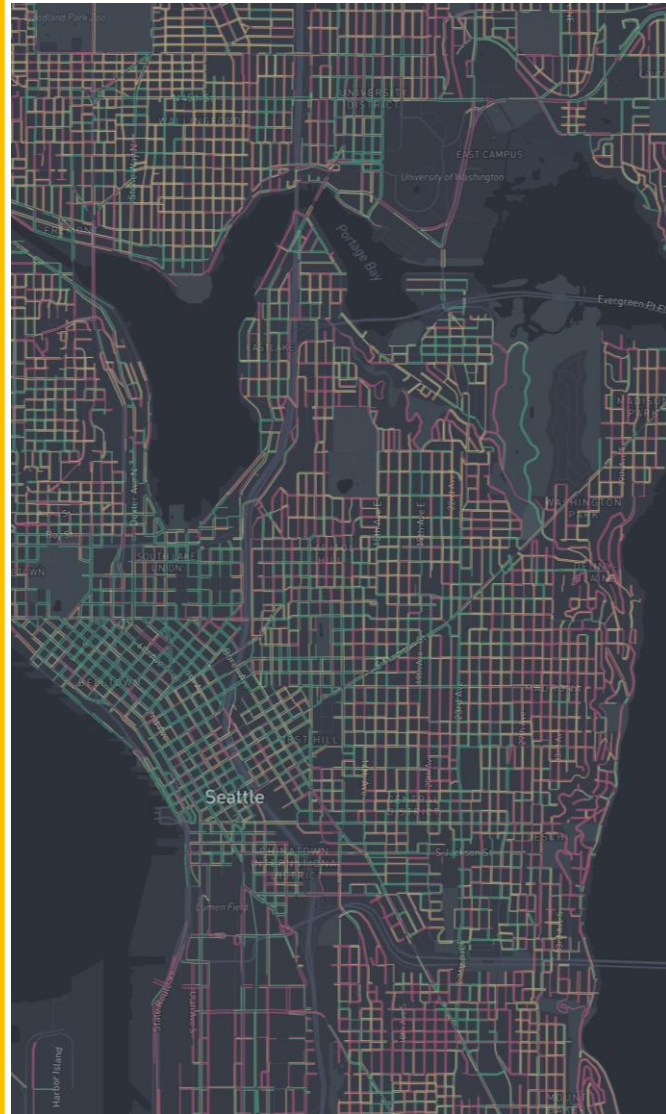
- Routes**
- Shortest Path
 - Walking Cane
 - Motorized Wheelchair

- Label Types**
- Curb Ramps
 - Missing Curb Ramps
 - Obstacles
 - Surface Problems

6 OUTCOMES

Research to translational

Research



Translational Impact



Open Data / Source

ProjectSidewalk

Overview Repositories 36 Projects 1 Packages 0 Teams 2 People 20

Project Sidewalk

Our mission: map and assess every sidewalk in the world using remote crowdsourcing, artificial intelligence, and online satellite & streetscape imagery.

27 followers University of Washington, Seattle, WA <http://projectsidewalk.org> @projsid

README.md

Welcome

This is the open-source repository for all things Project Sidewalk. Our mission is to develop advanced techniques for mapping the world's sidewalks using remote crowdsourcing, artificial intelligence, and online satellite & streetscape imagery.

Some links to help you get started:

- Our Project Sidewalk Wiki
- Considerations for deploying Project Sidewalk in your city
- The Project Sidewalk webpage repo
- Our design repo

Pinned

- SidewalkWebpage** Public
Project Sidewalk web page
JavaScript 94 27
- Design** Public
Stores design files for branding and logos
1 1

Repositories

Find a repository... Type Language

- SidewalkWebpage** Public
Project Sidewalk web page
JavaScript 94 MIT 27 376 14 Updated 2 days ago
- Design** Public
Stores design files for branding and logos
1 1 2 0 Updated 2 weeks ago
- sidewalk auto-labeler** Public
Python 1 0 0 0 Updated on Sep 11
- sidewalk-validator-ai** Public

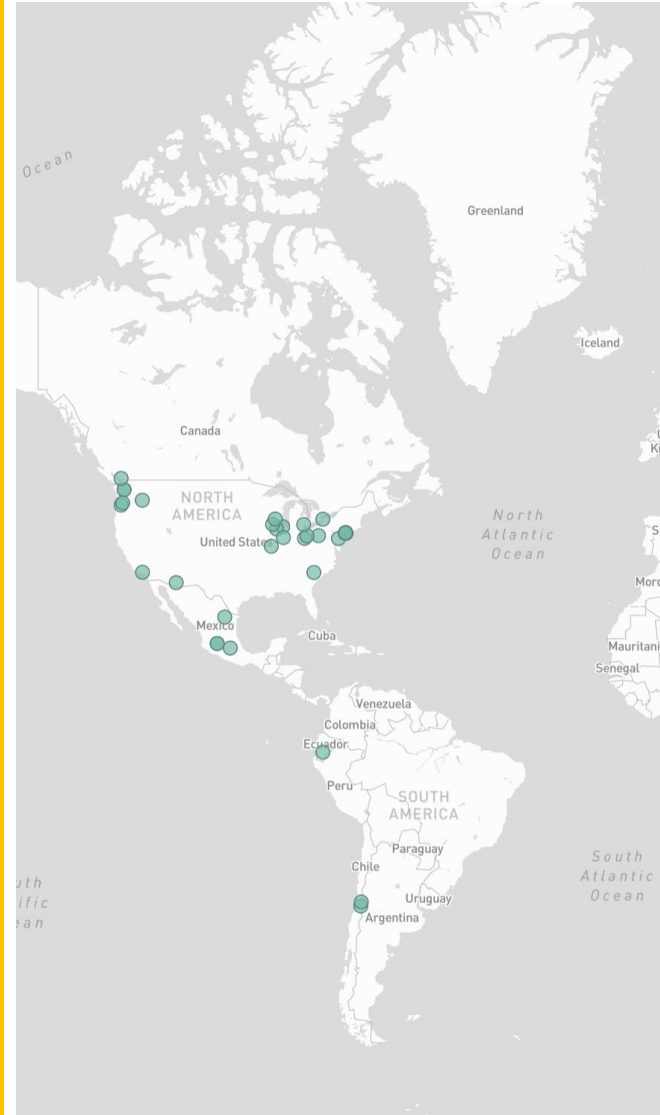
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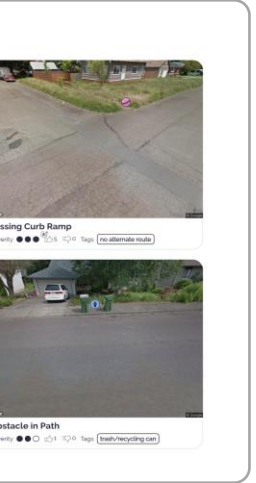
Pinned

- SidewalkWebpage** Public Project Sidewalk web page JavaScript 94 27
- Design** Public Stores design files for branding and logos 3 1

Repositories

Find a repository... Type Language

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- sidewalk-validator-ai** Public







On This Page

- Label Clusters API
- Label Clusters API Preview
- Endpoints
- Examples
- Quick Download
- Query Parameters
- Responses
- Success Response (200 OK)
- Default JSON Format (Default)
- GeoJSON Point Descriptions
- CSV Format
- Shapefile Format
- GeoPackage Format
- Error Responses
- Error Response Body
- Data Cleaning
- Best Practices
- Terms of Use
- Credits
- Project Sidewalk in Your City

DEPLOYMENTS

43 CITIES ACROSS 10 COUNTRIES



Deployments	Streets Explored	Labels	Validations
			
43 Cities	16,255 mi	1.5 million	1.4 million

路緣坡道標籤

人行道標籤

其他可及性標籤



探索E



路緣斜坡C



無路緣斜坡M



障礙物Q



鋪面問題S



無實體人行道N



有標記的行人穿越道W



行人號誌P



其他

整體統計數據

0.11 公里

50 標記

74.5% 精準度

目前所在的鄰里

水錦里, 基隆市

0.03 公里

0 標記

目前的任務

探索75公尺並找到所有人行道可及性選項

9% 完成



0 路緣斜坡



0 鋪面問題



0 缺路緣斜坡



0 無實體人行道



0 有障礙物



0 其他

旋轉 360 度以確保沒有遺漏任何內容。

30%



Google

回報地圖錯誤



放大Z



縮小



音效



跳過



卡住



回饋



Google May 2024



© 2025 Google 條款 回報問題

您有看到尚未標記的問題嗎？若無，請

↑ 向前走

TROTTOIR OPRIT LABELS

TROTTOIR LABELS

ANDERE TOEGANKELIJKHEIDSLABELS



Ontdek



Trottoir Oprit (C)



Ontbrekende Trottoir Oprit



Obstakel in het Pad



Oppervlakteprobleem (S)



Geen Trottoir



Gemarkeerde oversteekplaats (W)



Verkeerslicht (P)



Anders

Algemene statistieken

3,06 kilometer

526 labels

74,4% nauwkeurigheid

Huidige Wijk

Leliegracht e.o., Amsterdam

0,95 kilometer

235 labels

Huidige Missie

Zoek 150 m voor deze wijk

0% voltooid



0 stoep oprit



0 oppervlakte problemen



0 ontbrekende stoep oprit



0 geen trottoirs



0 obstakels



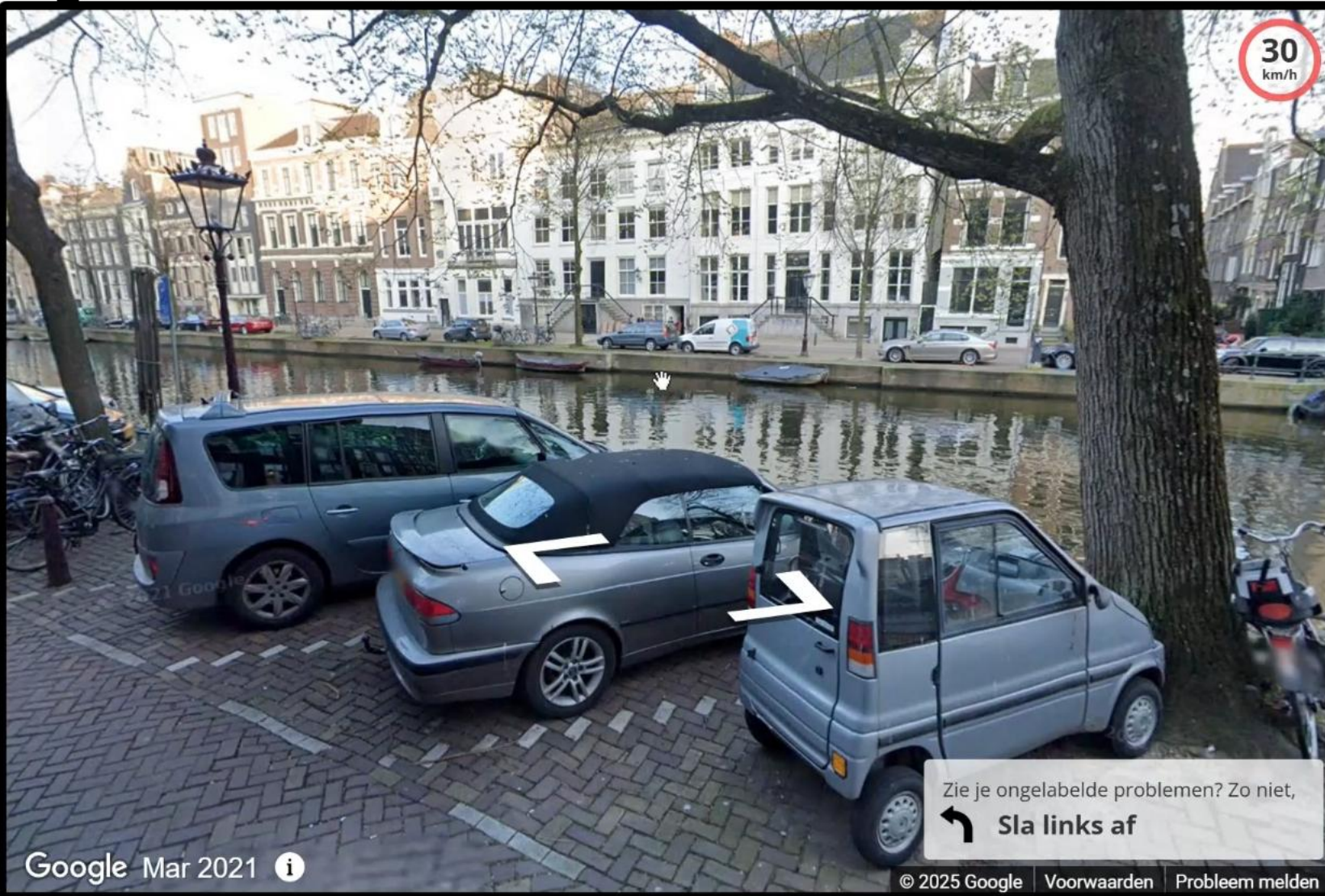
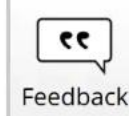
0 anders

Draai 360 graden om er zeker van te zijn dat u niets mist.

51%



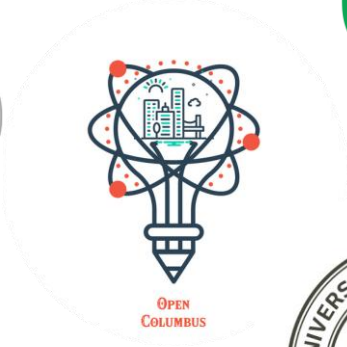
Google



Zie je ongelabelde problemen? Zo niet, Sla links af

Google Mar 2021

© 2025 Google Voorwaarden Probleem melden



Oradell Girl Scouts

Hackensack Meridian School of Medicine



UW Disability & D/deaf Cultural Center



Universität Zürich UZH



Vitruvius / give it strength make it useful deliver it beautifully



公民幫推 People Nudge



Denny International Middle School



Great Lakes Center

A Member of the ADA National Network

National Multiple Sclerosis Society Bergen Multiple Sclerosis Community Council

sidewalk condition data collection External

Tue, Dec 5, 2023, 12:17 PM



to jonf

Hello Jon,

My name is [redacted] and I am with a Texas based non-p through a USDA planning grant, and one of the needs identifie

I understand that y likely have a simpl

If it is not feasible

I appreciate your

Best,

[redacted]

Thursday, February 1st



Hey Jon, thanks for a great webinar just now! I'm excited to explore more about how BikePGH can engage our network of advocates in making the most of this tool, and also expanding it to other municipalities in Allegheny County.

On Sun, Nov 14, 2021 at 6:50 PM Fujii, Kie <kie.fujii@hmn.org> wrote:

This message was sent securely using Zix®

Dear Dr. Froehlich,

My name is Kie Fujii, and I am a third-year medical student at Hackensack Meridian School of Medicine in Nutley, NJ. I am a wheelchair user and I am currently working on a project at school to raise awareness and promote accessibility in my community. Since a local multiple sclerosis organization started an accessibility challenge to document obstructions of sidewalks, I have partnered with them to work on this project. While I was looking at different resources, I came across your work, Project Sidewalk, which aligns with what we are working on. If it is possible, we would like to implement your work in Bergen County of New Jersey. The multiple sclerosis organization has a monthly virtual meeting which the next meetings will be 12/15 and 1/19 at 7 PM EST. If you happen to be available on one of those days, we would love to hear more about your work. If not, I would like to still schedule an appointment with you.

Thank you so much for your time. I look forward to hearing from you soon.

Sincerely,
Kie

--

Kie Fujii|M.D. Candidate, Class of 2023

Hackensack Meridian School of Medicine

Kie.Fujii@hmn.org

Pronouns: She, Her, Hers



WHAT'S THE IMPACT?

PROJECT SIDEWALK

TRANSLATIONAL IMPACT



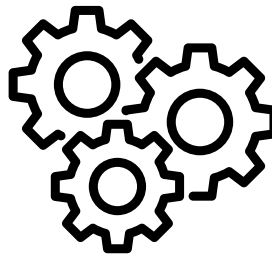
Informing Policy



Urban Planning



Service Learning



Research Engine



PROJECT SIDEWALK

TRANSLATIONAL IMPACT



Informing Policy



Urban Planning



Service Learning



Research Engine

NEWBERG, OREGON



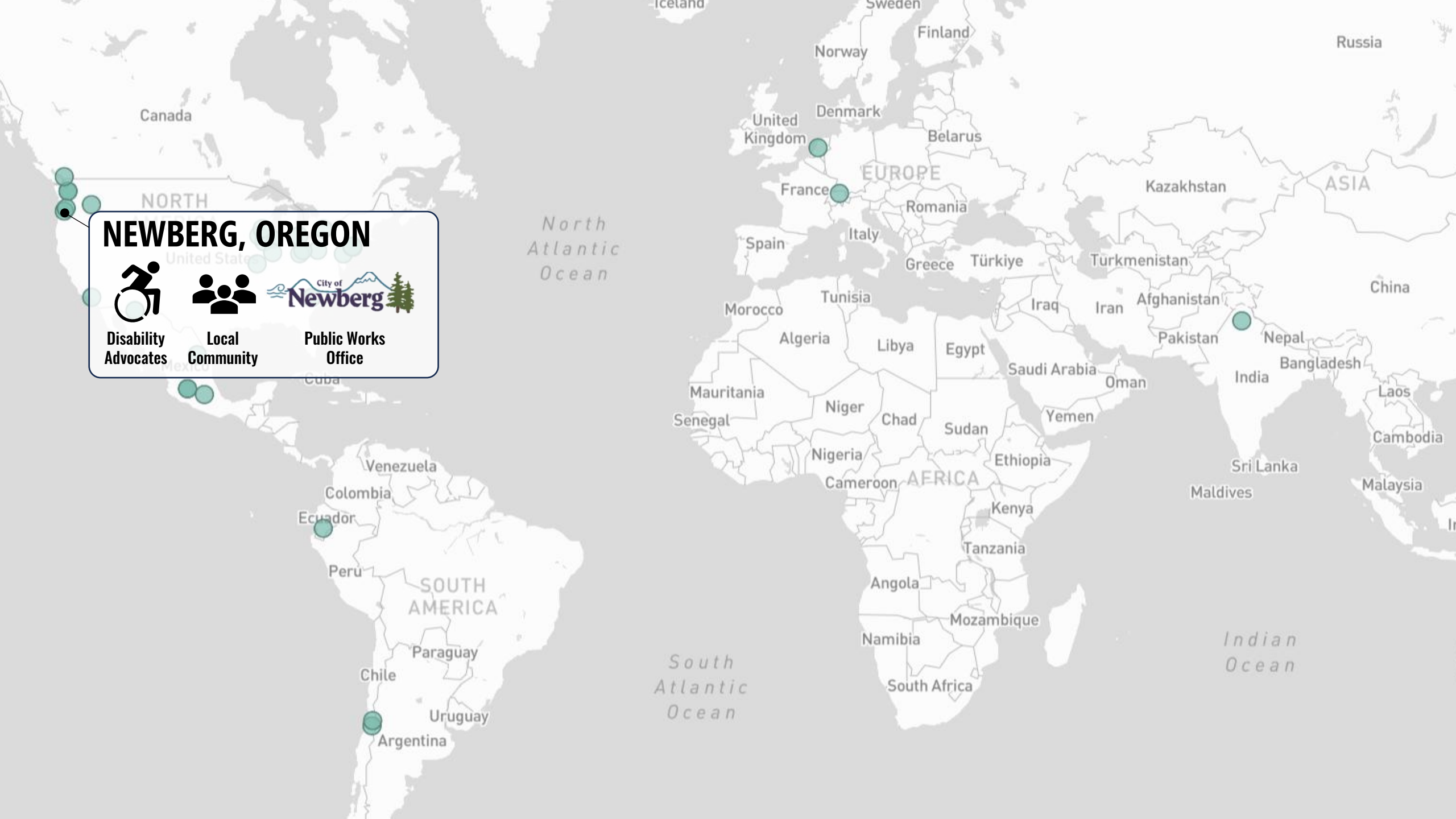
Disability
Advocates



Local
Community



Public Works
Office



Project Sidewalk



AS OF 2019 100% OF STREETS HAVE HAD A 1st REVIEW AND 62% HAVE HAD THE 2nd CALLED "VERIFICATION"

WE NEED YOUR HELP TO LOG IN AND "VERIFY" LABELS OTHERS HAVE ENTERED. Over 300 people have participated so far! Newberg will be the first city in Oregon to map its entire pedestrian network with Project Sidewalk!

Click this [link to begin](#).

Newberg has over 116 miles of pedestrian pathways used for travel to work and school; for exercise and business; and community events. For people with sensory or mobility restrictions it is critical that sidewalks are safe and accessible.

A lack of current information makes it difficult to track conditions and plan improvements.

Enter [Project Sidewalk](#)

A learning computer database managed by the University of Washington Computer/Engineering Dept. that uses interactive "crowd sourcing" to collect data. It is already in use in Seattle and Washington D.C and now its been made available in Newberg!

This is a perfect activity anyone who lives, works or visits Newberg. From any [desktop or laptop computer](#) you can "virtually" explore sidewalks in Newberg and label conditions you find.

Click this [link to begin](#) assessing local sidewalks.

Public Works

Jay Harris, PE.
Public Works Director
PO BOX 970 Newberg, OR 97132
jay.harris@newbergoregon.gov

Engineering (503) 537-1273

Maintenance (503) 537-1234

Operations (503) 537-1252

Compost (503) 537-1252

Report damage 24hr (503) 538-8321

Utility Billing (503) 537-1205

+ Engineering

Maintenance

Operations

Optional Sewer and Water line insurance

Current Projects

Surplus Stock

Frequently Asked Questions- Who do I Contact ?

Project Sidewalk



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62% HAVE HAD THE 2nd CALLED "VERIFICATION"

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This is a perfect activity anyone who lives, works or visits Newberg.

From any [desktop or laptop computer](#) you can "virtually" explore sidewalks in Newberg and label conditions you find.

Click this [link to begin](#) assessing local sidewalks.



City of Newberg

January 30 at 9:29 AM · 🌐

👍 Like Page

Congratulations and THANK YOU to the citizens of Newberg for putting in the work to map 100% of Newberg through [Project Sidewalk](#). That's over 107 miles covered with 264 local users who contributed to the data.

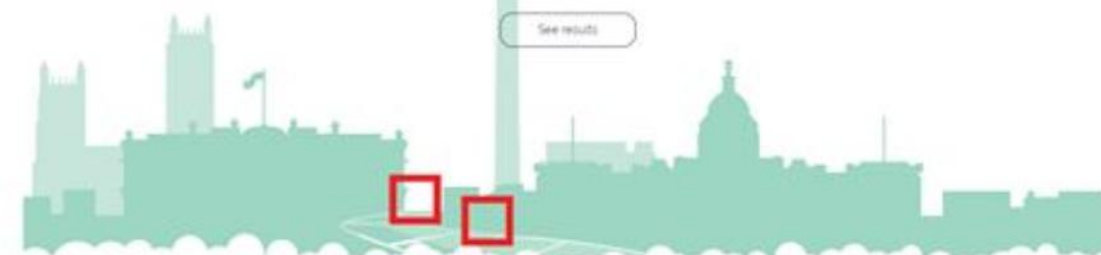
This information will be used to identify areas in Newberg that need sidewalks, need sidewalk repairs, and need to be updated to become more accessible. Through your efforts, Newberg can become a safer, more accessible community.

Looking to help? Verifications are still needed for the collected data. Click the link below to learn more.

Your work is making a
difference

We did it! Users like you have mapped all 107 miles of Newberg, OR. However, we are not done. The more users who contribute, the better quality data. So start exploring today!

[See results](#)



100.0%

of Newbera mapped

107.5

miles covered

16,930

labels

11,237

validation



[SIDEWALK-NEWBERG.CS.WASHINGTON.EDU](#)

[sidewalk-newberg.cs.washington.edu](#)

NEWBERG, OR

<http://newberg.projectsideshow.org>



324

Users



180.2

Miles



17.3K

Labels



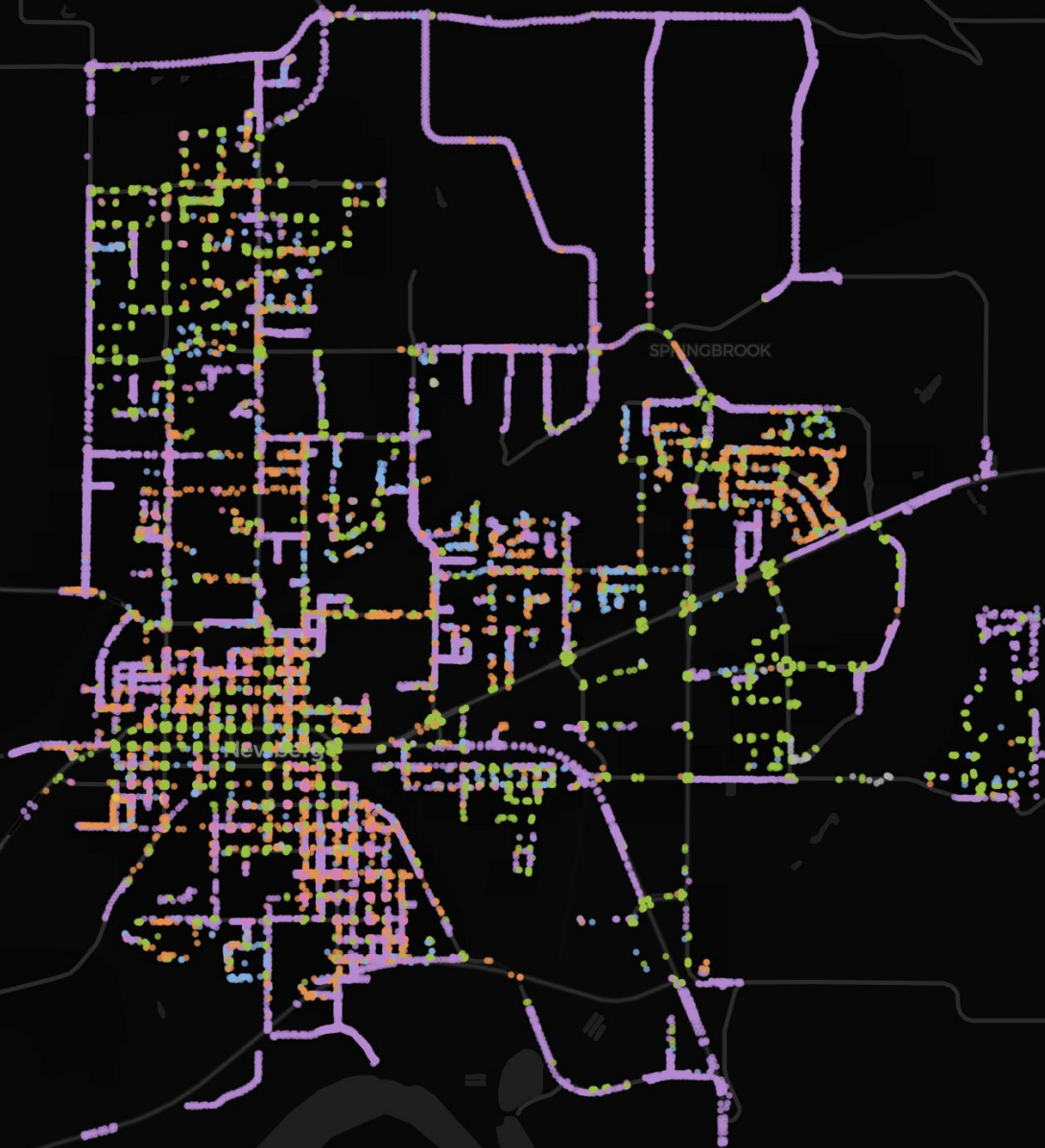
22.6K

Validations

SUNNYCREST

SPRINGBROOK

Chehalem



NEWBERG, OR

<http://newberg.projectsideshow.org>



324
Users



180.2
Miles



17.3K
Labels



22.6K
Validations

SUNNYCREST

Newberg

SPRINGBROOK

Chehalem



NEWBERG, OR

<http://newberg.projectsideshow.org>



324
Users



180.2
Miles



17.3K
Labels



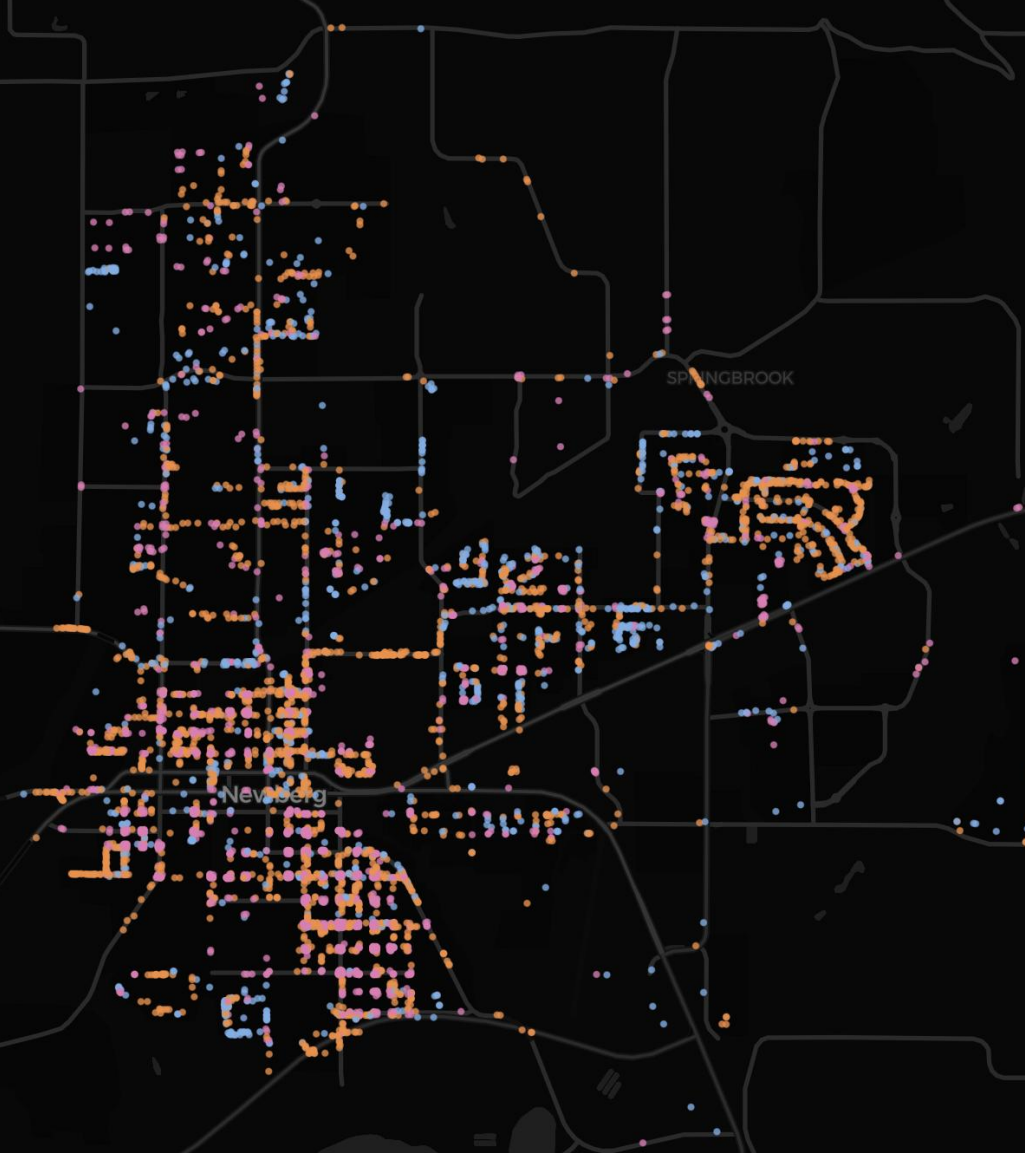
22.6K
Validations

SUNNYCREST

Newberg

SPRINGBROOK

Chehalem



NEWBERG, ORG

NEW SIDEWALK PROGRAMS



SIDEWALK REPAIR PROGRAM

RESIDENTIAL GRANT AND LOAN APPLICATION PACKET

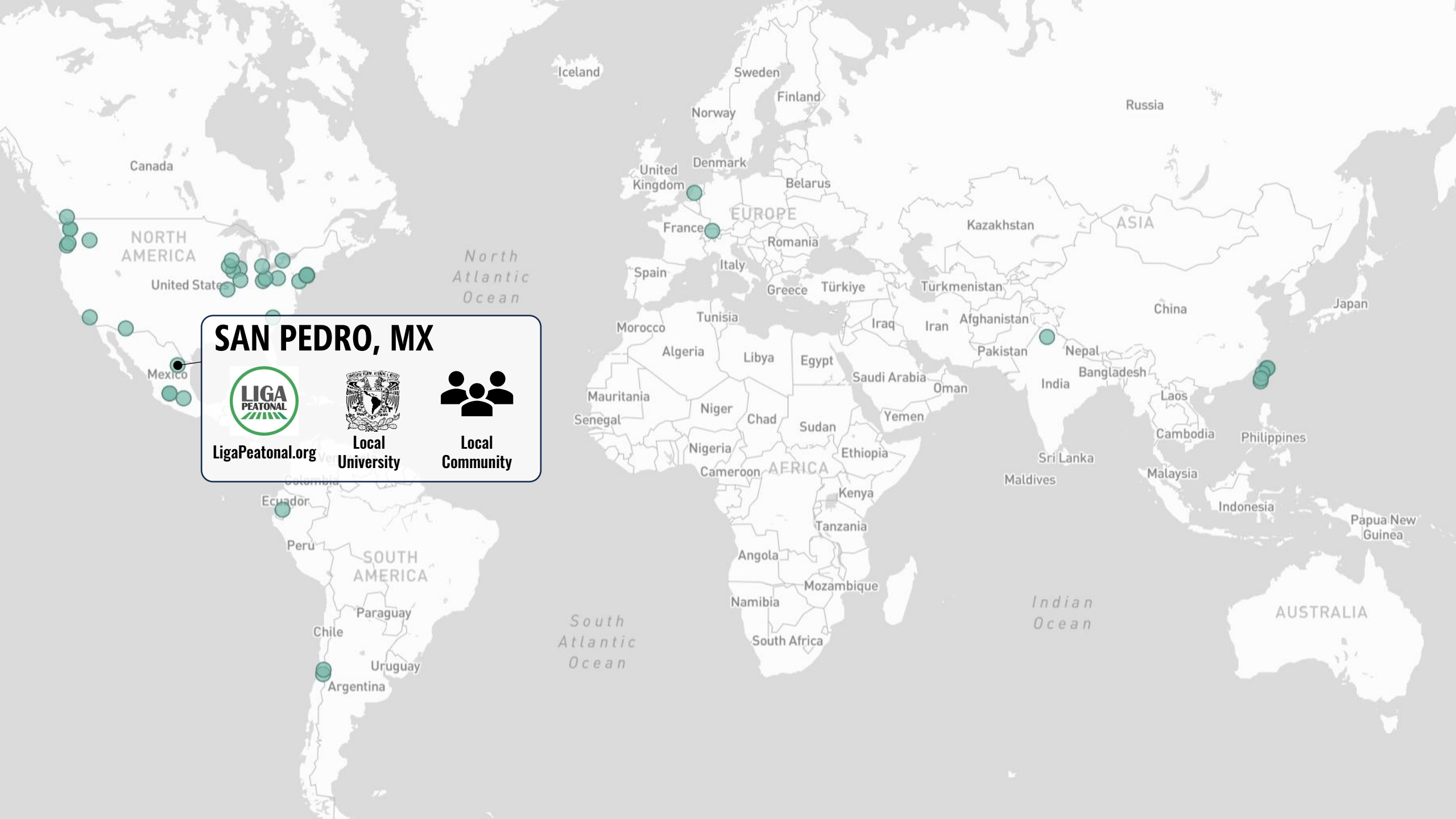


Sidewalks are for Everybody

Sidewalks make the entire community accessible, are required under the Federal ADA regulations, and enhance your home's value and curb appeal.

City Engineer's Office: Email: sidewalkrepairprogram@newbergoregon.gov | 503.537.1273 | PO Box 970

Newberg City Hall | 414 E. First Street | Newberg, OR 97132 | (503) 538-9421 | M-F 8:30-4:30PM



SAN PEDRO, MX



LigaPeatonal.org



Local University

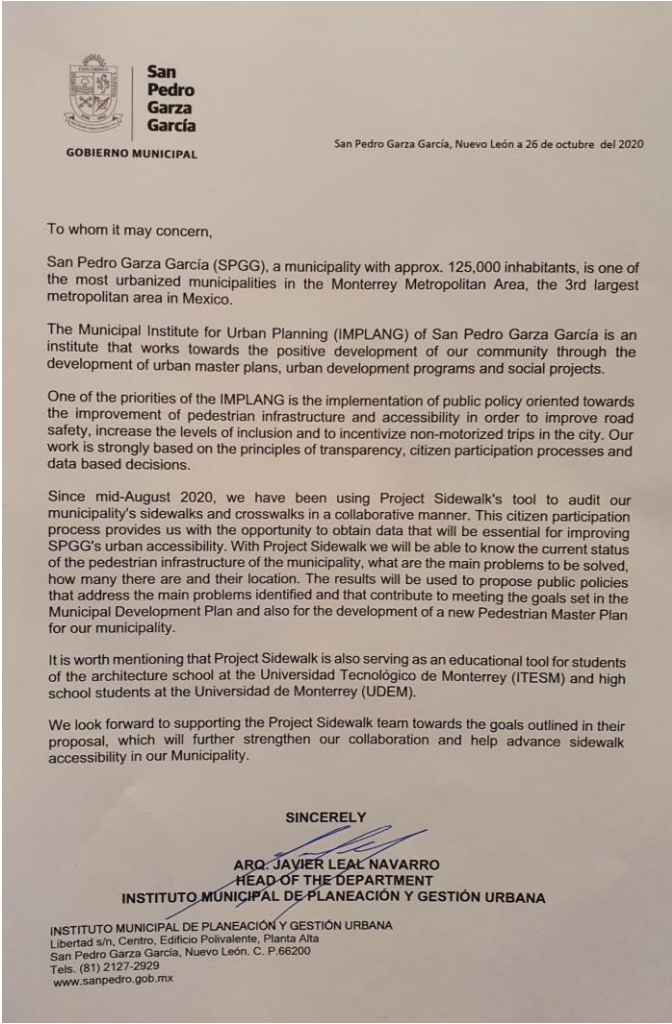


Local Community

PROJECT SIDEWALK MEXICO
SAN PEDRO, MX



Project Sidewalk provides us with data that is **essential to improving San Pedro's urban accessibility**. With Project Sidewalk, we **know the main problems** to be solved, how many problems there are, and their location... The results will be used to inform a **new Pedestrian Master Plan** for our municipality.



San Pedro Garza García

GOBIERNO MUNICIPAL

ETIQUETAS DE RAMPA PEATONAL

ETIQUETAS DE BANQUETA

OTRAS ETIQUETAS DE ACCESIBILIDAD



Explorar



Rampa peatonal (C)



Rampa peatonal ausente (M)



Obstáculo en la banqueta



Problema en superficie



No hay banqueta



Cruce peatonal marcado (W)



Semáforo peatonal



Otro

Estadísticas generales

2,11 kilómetros

233 etiquetas

92,1% de precisión

Colonia actual

Centro de Azcapotzalco, CDMX

0,01 kilómetros

10 etiquetas

Misión actual

Explora 75 m y encuentra todos los atributos de accesibilidad de la banqueta

25% completado



3 rampas peatonales



2 problemas en superficie



3 rampas peatonales ausentes



no hay banquetas



2 obstáculos



0 otros

Sigue la línea roja para continuar la misión

100%



Acercar (Z)

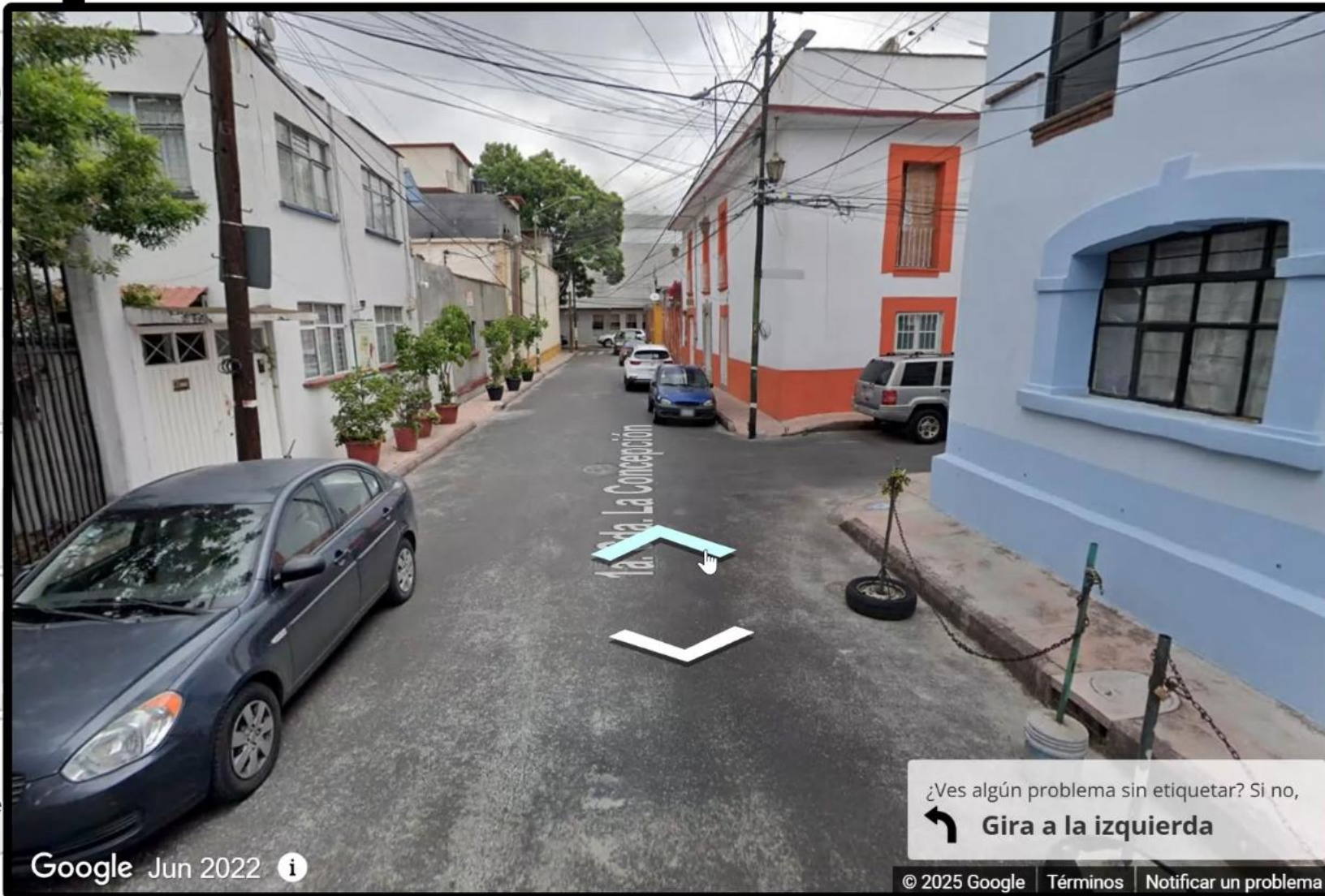
Alejar

Sonido

Saltar

Atorado

Retroalimentación



Google Jun 2022

© 2025 Google Términos Notificar un problema

SAN PEDRO, MX

<http://spgg.projects Sidewalk.org/>



1.8K
Users



912
Miles



104K
Labels



65.4K
Validations



SAN PEDRO, MX

<http://spgg.projects Sidewalk.org/>



1.8K
Users



912
Miles



104K
Labels



65.4K
Validations



1.



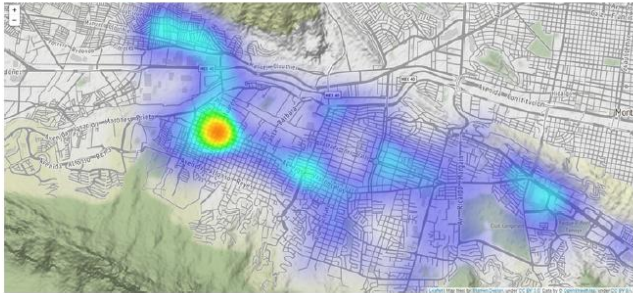
1.

Vis
poi
cat

C
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tra
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**ACCIDENTS
(PEDESTRIANS)**



We did not find a relationship with areas where there are accidents involving pedestrians. A pattern was found, where there are more points with a severity of 3+ in the west of the city.



Missing Curb Ramp (3+)



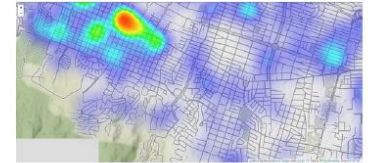
No sidewalk (3+)



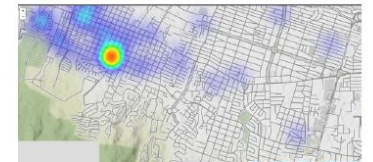
Obstacle in Path (3+)



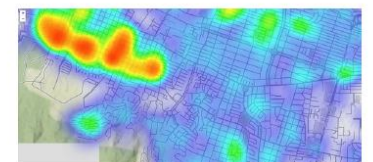
Curb Ramp (3+)



Other (3+)

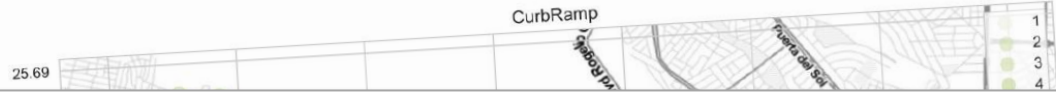


Surface Problem (3+)



HEATMAPS

SAN PEDRO GARZA GARCÍA



E

ENFOQUE ACTIVISTA

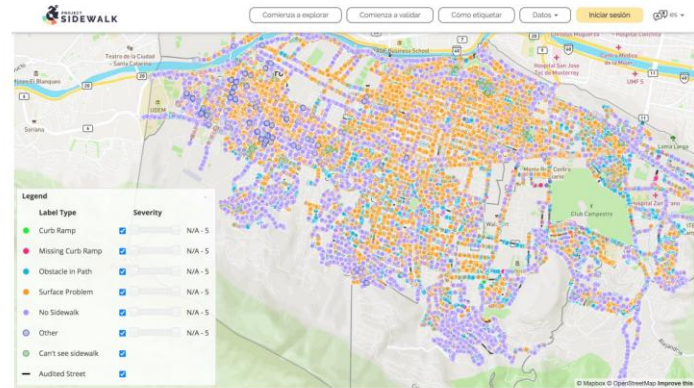
EvaluANDO: del activismo peatonal a la colaboración comunitaria para el registro de obstáculos en las banquetas

Escrito por
Claudina de Gyves y Ana Rodríguez

Ubicación
San Pedro Garza García, México

Palabras clave
activismo peatonal, movilidad sostenible, infraestructura peatonal, participación remota

Participación comunitaria en proyectos de espacio público y diseño urbano durante la pandemia COVID-19: experiencias y reflexiones de Iberoamérica y el Caribe

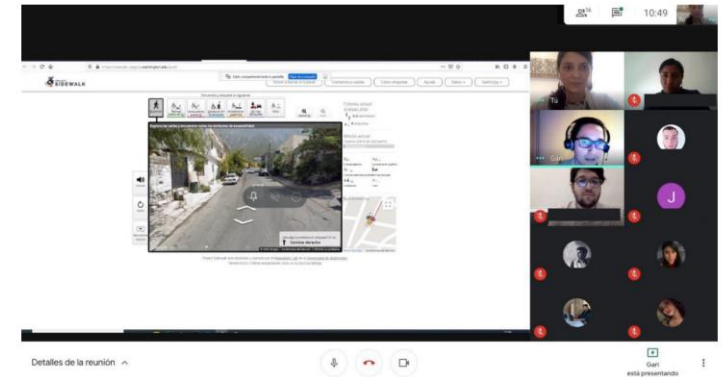


Fotografía 2. Mapa de etiquetas en Project Sidewalk
Fuente: Liga Peatonal (2021).

La vinculación fue posible gracias a que ya había un historial de activismo peatonal en la metrópoli y el acercamiento no fue solo con la Liga Peatonal como ONG, sino de la mano de Makeability Lab, un actor técnico-académico que mostró disposición a contextualizar su plataforma a las necesidades de las calles mexicanas. Aunado a este proceso, la situación por la COVID-19 detonó una serie de intervenciones en el espacio público por parte del municipio de San Pedro Garza García, enfocadas en promover la movilidad sostenible, destacando las ciclovías emergentes y la aceleración de otros proyectos en el espacio público que estaban en puerta. Todo esto generó un escenario adecuado para la colaboración de EvaluANDO SPGG, en la que todos los actores involucrados estaban conscientes de la importancia de contar con información precisa sobre las condiciones de las calles en el municipio. Recientemente, en mayo de 2021, tras 9 meses de trabajo y con la participación de 1099 personas se lograron cubrir los 570.2 km de vialidades que tiene el municipio de SPGG y se generaron 105 177 etiquetas (Makeability Lab, 2021) en un ejercicio inédito a nivel nacional de participación ciudadana para ubicar los obstáculos de movilidad peatonal.

El caso de EvaluANDO SPGG destaca no solo por haber completado el mapeo del municipio y ser resultado de una colaboración multisectorial entre gobierno local, sociedad civil y academia, sino porque los resultados son ahora insumos valiosos del municipio para la creación de nuevos planes y proyectos. Los planes en proceso de elaboración, tanto de movilidad activa como de seguridad vial, con los resultados de EvaluANDO, ayudarán a identificar estrategias aterrizadas a la realidad y fomentar una mayor participación ciudadana, al involucrar a la población desde su diagnóstico y permitir la descarga de los datos generados en formato editable.

Participación comunitaria en proyectos de espacio público y diseño urbano durante la pandemia COVID-19: experiencias y reflexiones de Iberoamérica y el Caribe



Fotografía 4. Mapatón San Pedro Garza García
Fuente: Liga Peatonal (2021).

En el proceso de levantamiento de información, Liga Peatonal trató de complementar el trabajo asincrónico e individual con cuatro eventos donde varias personas se conectaban de manera simultánea a probar la herramienta y resolver dudas sobre su funcionamiento. Se convocó a dos sesiones dirigidas a las personas ciudadanas del municipio, con el nombre de Mapatones, y otras dos orientadas a estudiantes universitarios, en formato de talleres en los que se les introdujo al tema de movilidad peatonal y donde se generaron propuestas para atender los problemas principales.

Si bien este proceso ha permitido el involucramiento de adolescentes y jóvenes en el análisis crítico de su entorno urbano, todavía presenta oportunidades de mejora en la inclusión de personas que no tienen acceso a dispositivos de internet. Ante esta situación, sería conveniente explorar el ejercicio analógico del mapeo in situ con herramientas impresas y más con el fin de fortalecer la convivencia vecinal y promover la organización, que con la precisión del levantamiento. En estos escenarios de atención a la población en condición de vulnerabilidad, tal

vez destacan otros elementos a mapear no tan relacionados con ser un obstáculo en las banquetas, sino ya más encaminados a una ausencia de infraestructura como la misma pavimentación de las calles, las banquetas o la falta de conectividad con otros sectores. Además, en las reflexiones en torno al uso de la herramienta y las necesidades para el diagnóstico urbano incluyente, se identificó como área de oportunidad un mapeo con perspectiva de género, que pudiera incluir no solamente obstáculos en los trayectos identificados, sino también situaciones y elementos propios de la infraestructura que provocan una sensación de inseguridad, pero que no representan como tal un obstáculo, como si lo hacen los muros ciegos, la falta de luminarias, los recovecos o terrenos baldíos.

PROJECT SIDEWALK

TRANSLATIONAL IMPACT



Informing Policy



Urban Planning

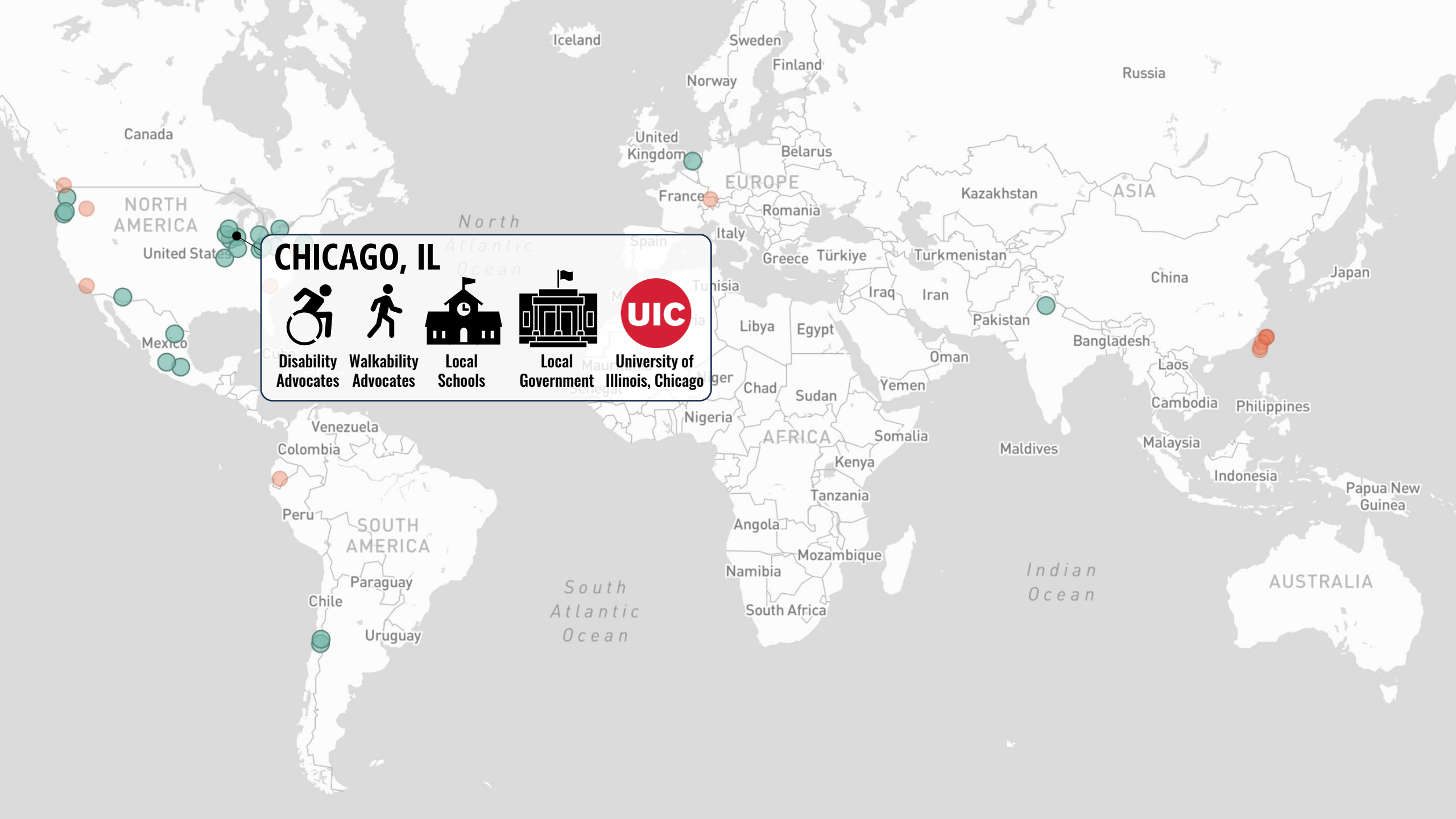


Service Learning



Research Engine





CHICAGO, IL



Disability
Advocates



Walkability
Advocates



Local
Schools



Local
Government



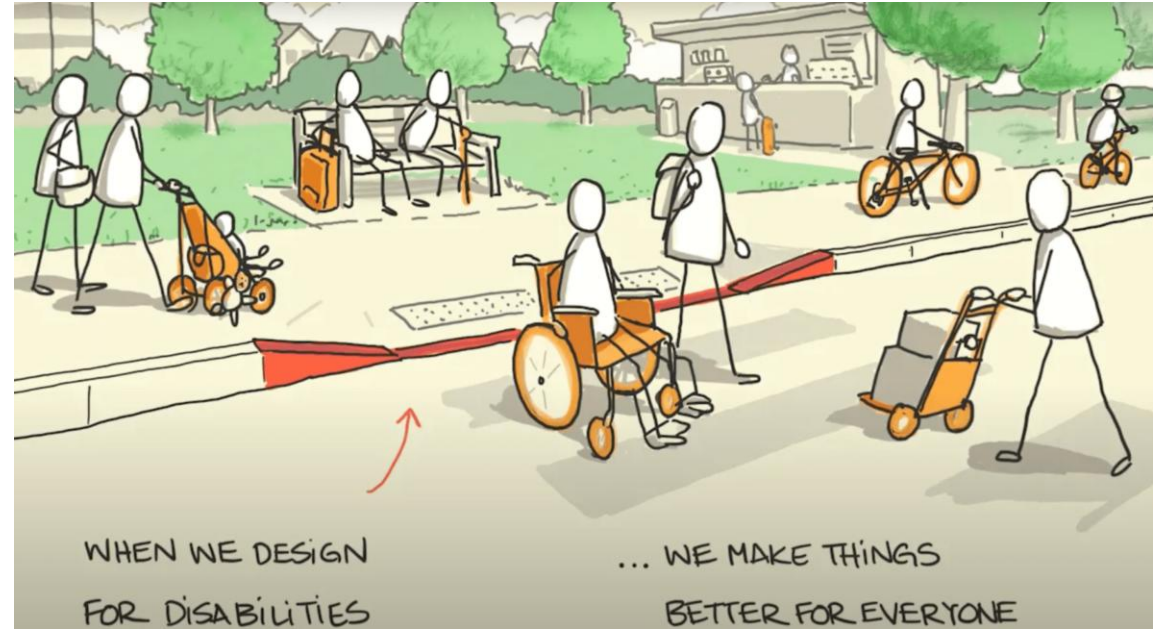
University of
Illinois, Chicago

\$1.5M

in "menu" funds for pedestrian
infrastructure improvements

\$1.5M

in "menu" funds for pedestrian infrastructure improvements



GOAL

Identify issues and **prioritize investments** in a way that is **equitable** and **efficient**

CHICAGO, IL

<http://chicago.projects sidewalk.org/>



2.8K
Users



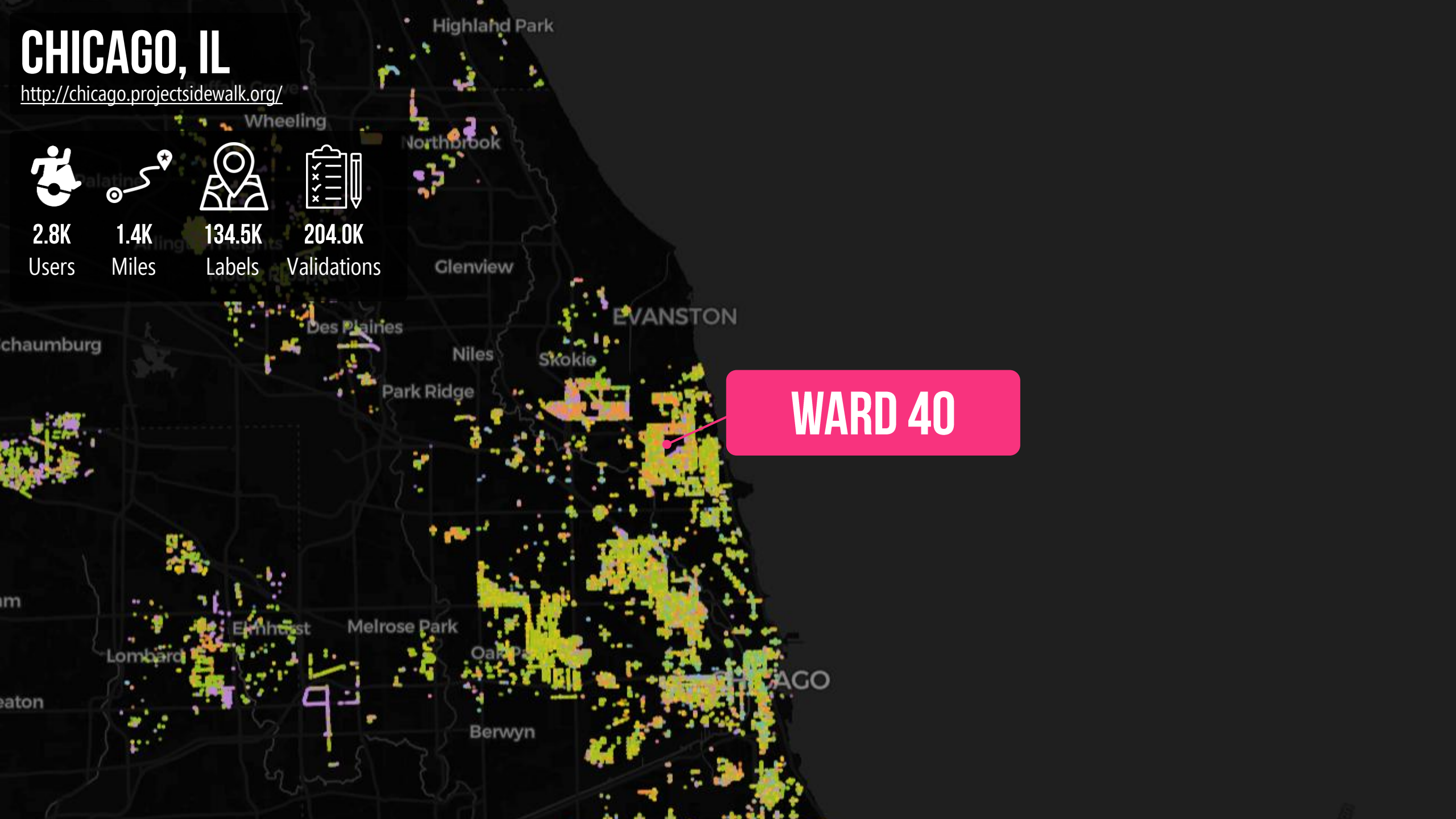
1.4K
Miles



134.5K
Labels



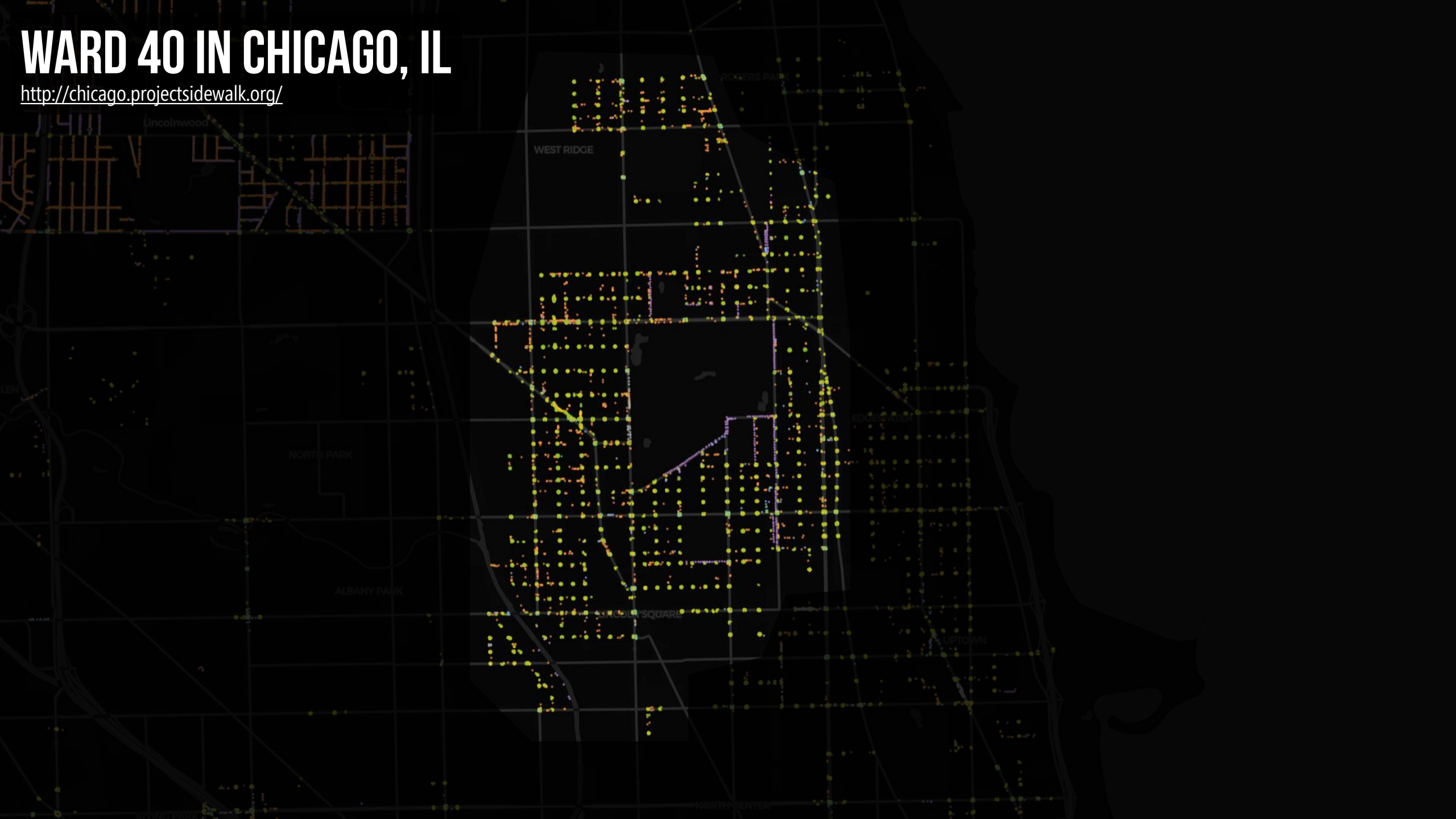
204.0K
Validations



WARD 40

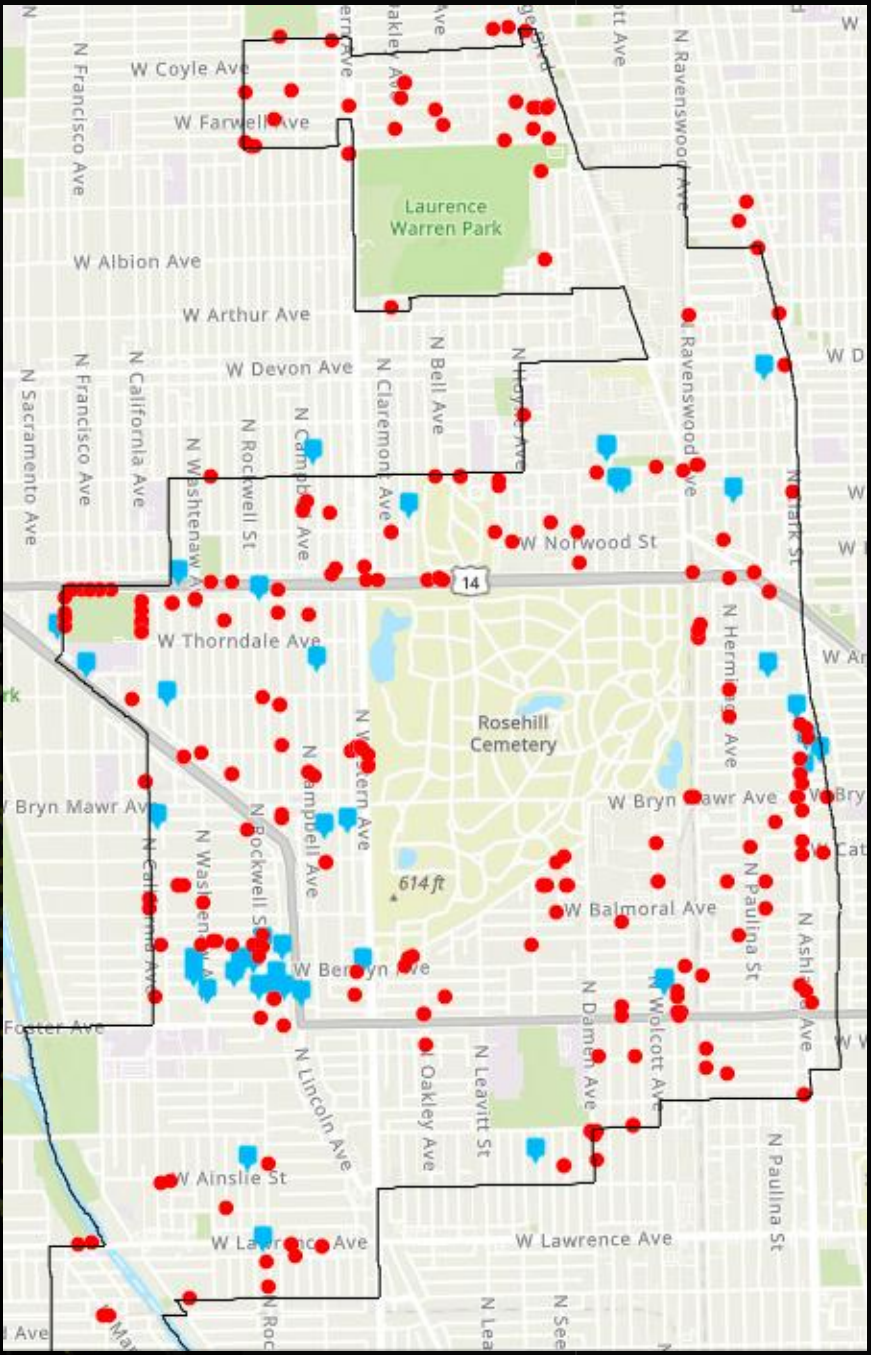
WARD 40 IN CHICAGO, IL

<http://chicago.projectsSidewalk.org/>





WARD 40 IN CHICAGO, IL

<http://chicago.projects Sidewalk.org/>



LEGEND

-  **Surface Problems from Project Sidewalk High-Severity**
-  **Resident Requests for Sidewalk Improvements**

“Project Sidewalk helped us **make better decisions** in how to **prioritize our \$1.5m infrastructure spending** as well as alert appropriate **city departments** to **high-priority accessibility issues.**”

- ALISON MURPHY

Director of Communications & Development
40th Ward of Chicago

PROJECT SIDEWALK

TRANSLATIONAL IMPACT



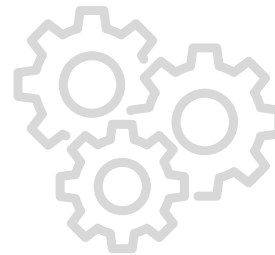
Informing Policy



Urban Planning



Service Learning



Research Engine



PROJECT SIDEWALK

TRANSLATIONAL IMPACT



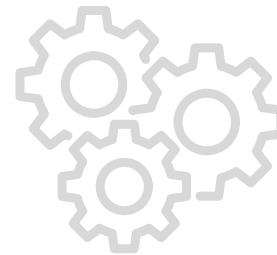
Informing Policy



Urban Planning



Service Learning

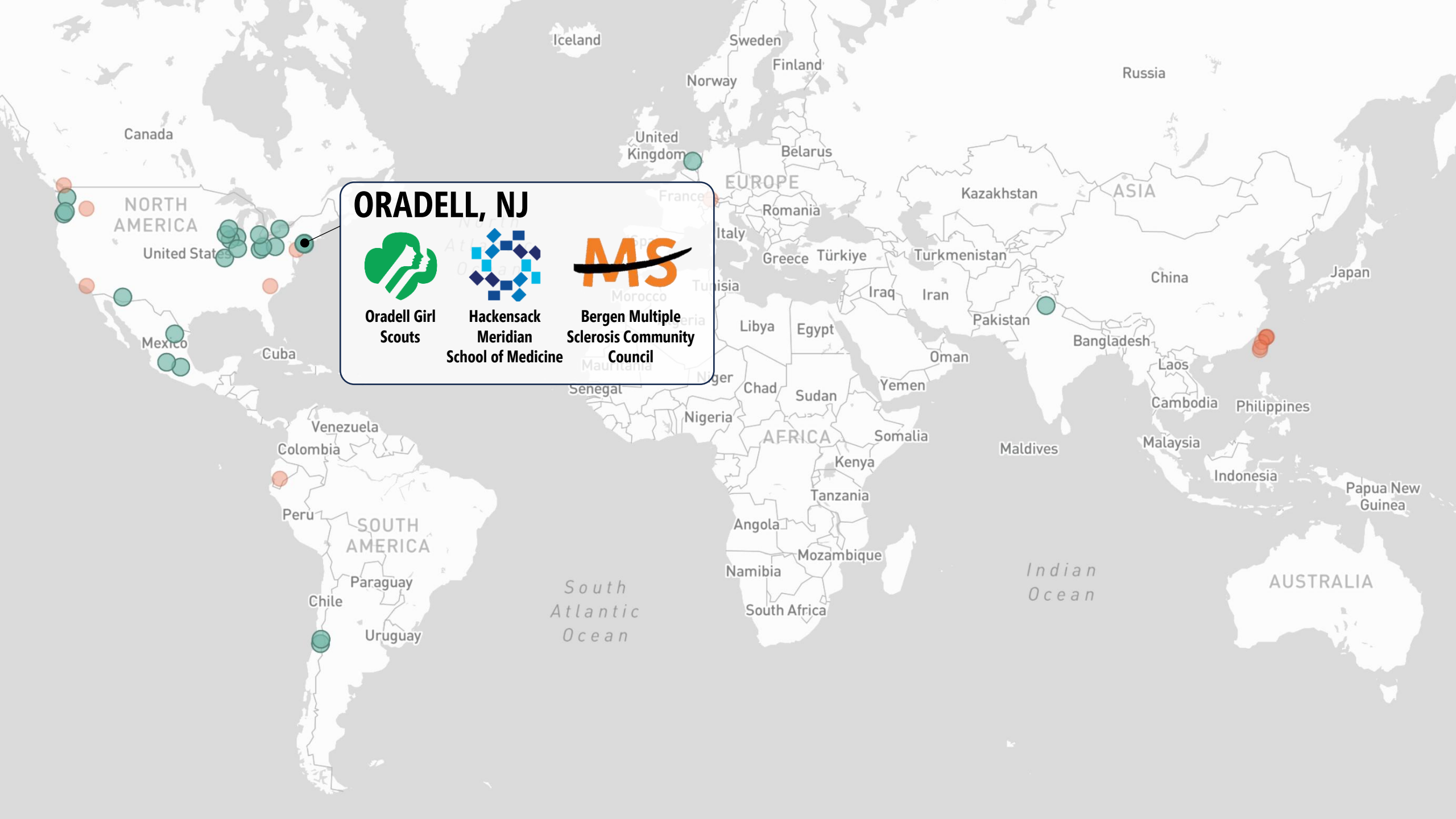


Research Engine








HOW CAN PROJECT SIDEWALK BE A PLATFORM FOR
LEARNING WHILE ALSO PROVIDING VALUABLE DATA?



ORADELL, NJ

 **Oradell Girl Scouts**

 **Hackensack Meridian School of Medicine**

 **Bergen Multiple Sclerosis Community Council**

We're going to have the Girl Scouts
do their presentation



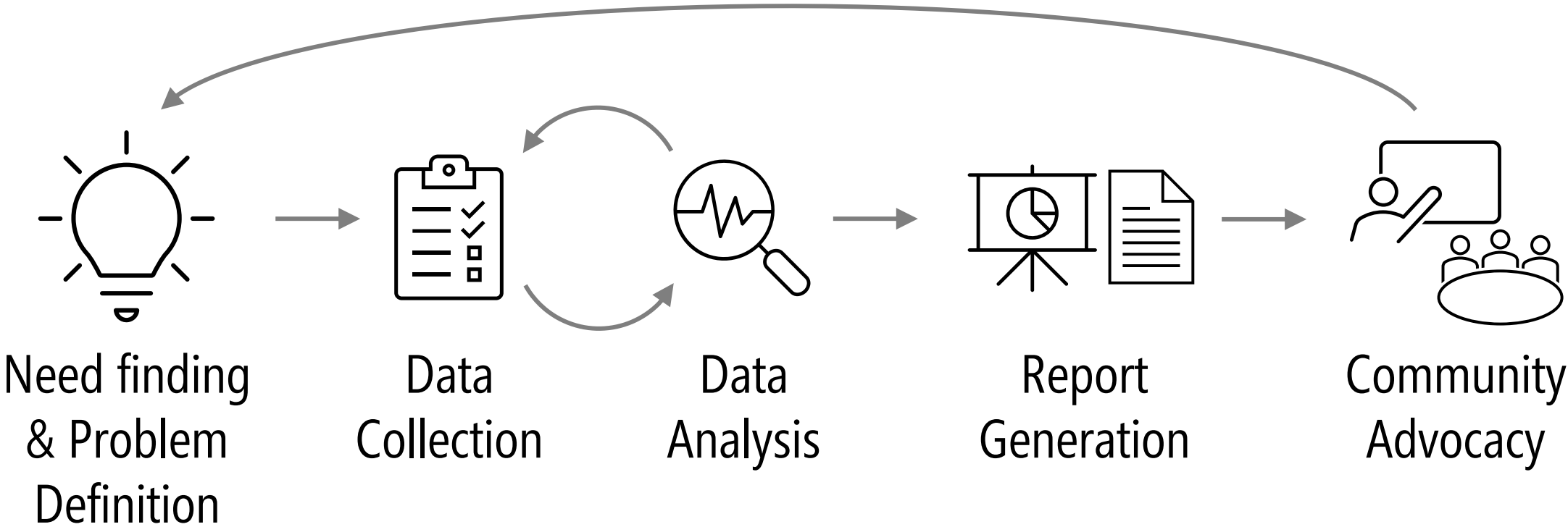
Dianne Camelo Didio
Mayor



MC Regular Meeting

Jan 31, 2023

SERVICE LEARNING



“I never realized sidewalks were a big deal”: A Case Study of a Community-Driven Sidewalk Audit Using Project Sidewalk

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chuchuli@cs.washington.edu

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Jon E. Froehlich
University of Washington, USA
jonf@cs.washington.edu



Figure 1: A community-driven digital civics project using Project Sidewalk, an open-sourced accessibility tool, to conduct sidewalk accessibility assessments in the town of Oradell, NJ. Images show community members mapping, analyzing, and presenting the collected data to the City Council over the course of the project.

ABSTRACT

Despite decades of effort, pedestrian infrastructure in cities continues to be unsafe or inaccessible to people with disabilities. In this paper, we examine the potential of community-driven digital civics to assess sidewalk accessibility through a deployment study of an open-source crowdsourcing tool called Project Sidewalk. We explore Project Sidewalk’s potential as a platform for civic learning

*Both authors contributed equally to this research.

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CHI '24, May 11–16, 2024, Honolulu, HI, USA
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ACM ISBN 979-8-4007-0330-0/24/05.
https://doi.org/10.1145/3613904.3642003

and service. Specifically, we assess its effectiveness as a tool for community members to learn about human mobility, urban planning, and accessibility advocacy. Our findings demonstrate that community-driven digital civics can support accessibility advocacy and education, raise community awareness, and drive pro-social behavioral change. We also outline key considerations for deploying digital civic tools in future community-led accessibility initiatives.

CCS CONCEPTS

• Human-centered computing → Accessibility systems and tools; Interactive systems and tools; • Information systems → Crowdsourcing.

KEYWORDS

accessibility, digital civics, community science, service learning, crowdsourcing



Figure 5: Timeline showing dates of partnership formations and key project events in the Oradell Sidewalk Project.

Hackensack Meridian School of Medicine), and a local Girl Scouts troop.²

3.2.2 In-person Field Audits. In September 2021, the advocacy group and the Scouts held several meetings to generate ideas on how to improve Oradell’s urban accessibility for people with disabilities. They first discussed topics such as what constitutes an “accessibility issue” and general impressions of Oradell’s accessibility levels across neighborhoods, and then decided on conducting in-person field audits to document accessibility barriers. From October

to November 2021, advocacy group representatives and the Scouts took photographs of accessibility issues around their neighborhood, including barriers such as missing curb ramps, uneven surfaces, walkway obstructions (e.g., utility poles, overgrown greenery), and obstructed entrances to municipal buildings (e.g., library, post office, town hall). They identified ~30 issues with a location, picture, and description across ~1 miles of sidewalks (Figure 7).

In early November, an advocacy group member (P3 in Table 1) discovered Project Sidewalk online and initiated a meeting to discuss adopting this new approach for identifying accessibility issues. With the Project Sidewalk team’s support, they decided to deploy and use this web tool in Oradell (<https://oradell.projectsidewalk.org/>).



Figure 6: (A) Diagram showing the deeply intertwined interactions between stakeholders in the Oradell Sidewalk Project, including the local medical center (Hackensack Meridian), MS (Multiple Sclerosis) group, and Girl Scouts troop who started the initiative, then engaged with Project Sidewalk and their research team to assess all sidewalks in Oradell, NJ. (B) Image from the initial City Council meeting in March 2022. (C) Image from the first Scouts meeting with local advocates in September 2021.

²Girl Scouts is a youth organization for girls in the United States with a mission to “build girls of courage, confidence, and character, who make the world a better place” through activities such as camping, community service, and practical skill-building like first aid [87].

3.2.3 Assessing Oradell with Project Sidewalk. After obtaining geographic neighborhood boundary data, Project Sidewalk was set up and deployed in Oradell in April 2022. Initial tests and contributions were from the advocacy group and Project Sidewalk team. To broaden community involvement and provide additional training, the organizers planned and held two mapathons and began advertising campaigns within their communities. Figure 9 shows a temporal plot of label and validation contributions over time.

First mapathon. The first mapathon was on April 22, 2022 at the administration building of the local government (Oradell Borough Hall). The event was organized by the local Scout troop leaders, representatives from the National Multiple Sclerosis Society, and students and faculty from Hackensack Medical. The mapathon’s goal was to familiarize participants with Project Sidewalk, motivate contributions, and advance understanding of how the built environment can affect people with disabilities.

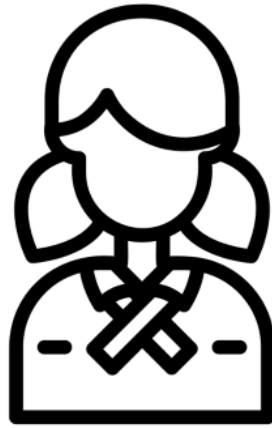


Figure 7: Examples of sidewalk accessibility issues photographed by advocacy group representatives and Scout members during in-person audits in their neighborhoods.

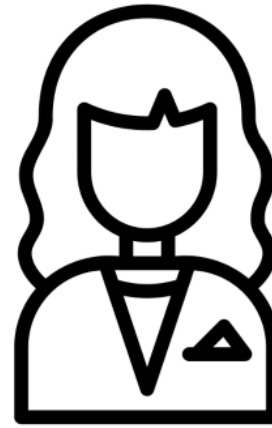
POST-HOC INTERVIEWS IN ORADELL (N=19)



Disability
Advocates



Girl Scouts



Parents



Medical
Professionals

“Before Project Sidewalk, **I never realized how important curb ramps** are for people with disabilities...”

- **GIRL SCOUT (GS4)**

Post-study interview



“Now when they walk down the street and see something [inaccessible], they quickly notice and say **“This is wrong!”**”

- **PARENT**

Post-study interview



“This experience gave me a new perspective that I can use **to help change the world.**”

- **GIRL SCOUT (GS7)**

Post-study interview



PROJECT SIDEWALK

TRANSLATIONAL IMPACT



Informing Policy



Urban Planning



Service Learning



Research Engine



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WPI



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SMU



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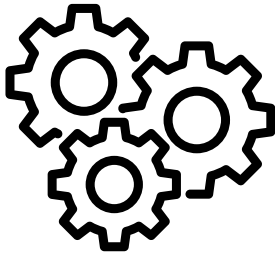
Informing Policy



Urban Planning



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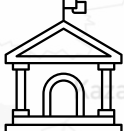



Research Engine

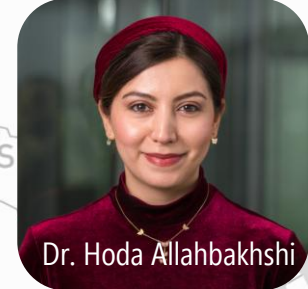




ZURICH, SWITZERLAND

Disability Community **Local Government** **University of Zurich**



NORTH AMERICA

SOUTH AMERICA

AFRICA

AUSTRALIA

North Atlantic Ocean

South Atlantic Ocean

Indian Ocean

Navigation Challenges in Urban Areas for Persons with Mobility Restrictions

Hoda Allahbakhshi¹ ✉

Digital Society Initiative, University of Zurich, Switzerland
Department of Geography, University of Zurich, Switzerland
University Research Priority Program "Dynamics of Healthy Aging", University of Zurich, Switzerland

Annina Ardiser ✉

Department of Geography, University of Zurich, Switzerland

Abstract

The Sustainable Development Goals (SDGs) promote making the world better for everyone, with a focus on creating cities that are inclusive and sustainable, as outlined in SDG 11. Spatial accessibility plays a pivotal role in fostering age-friendly and inclusive urban environments. However, there is still a lack of complete data on accessibility essential for providing mobility services to individuals with restricted mobility, mainly due to the high costs. While some participatory initiatives like OpenStreetMap (OSM) have made progress in this area, there is still a significant gap in data about sidewalk accessibility.

To address this gap, we used a citizen science approach to gather information and improve our understanding of sidewalk accessibility in District 1 of Zurich. Eighteen individuals from diverse population groups took part in our study. Using the Project Sidewalk web tool (PRSW), participants collected sidewalk features like curb ramps and surface problems by virtually inspecting street view images.

In this paper, we present preliminary results derived from participatory data collection. The findings show the variances in accessibility labels concerning their frequency, spatial distribution, and severity levels attributed by participants. Furthermore, we provide insights into the accuracy of the data, verified through validation by experts in geographical knowledge using PRSW.

Our approach allowed for broader participation and diverse perspectives in collecting sidewalk accessibility data. We believe that the provided dataset has the potential to address unanswered questions about spatial accessibility. For instance, the distribution of accessibility within specific population groups or across a city can be explored. This information can help policymakers develop interventions that tackle accessibility inequalities and ensure equitable access, especially for those with mobility impairments.

2012 ACM Subject Classification Social and professional topics

Keywords and phrases Navigation, Mobility-restrictions, Inclusive mobility, Spatial accessibility, Citizen science

Digital Object Identifier 10.4230/LIPICs.COSIT.2024.22

Category Short Paper

Acknowledgements We thank the University of Zurich, the Digital Society Initiative, and Smart City Zurich for partially financing this research.

¹ corresponding author

Towards an Inclusive Urban Environment: A Participatory Approach for Collecting Spatial Accessibility Data in Zurich

Hoda Allahbakhshi ✉

Digital Society Initiative, University of Zurich, Switzerland
Department of Geography, University of Zurich, Switzerland

Abstract

The unprecedented rate of urbanization, along with the increase in the aging and disabled populations, bring about an increasing demand for public services and an inclusive urban environment that allows easy access to those facilities. Spatial Accessibility is a measure to assess how inclusive a city is and how easily public facilities can be reached from a specific location through movement in physical space or built environment.

A detailed geodata source of accessibility features is needed for reliable spatial accessibility assessment, such as sidewalk width, surface type, and incline. However, such data are not readily available due to the huge implication costs. Remote crowdsourcing data collection using Street View Imagery, so-called 'virtual audits' have been introduced as a valid, cost-efficient tool for accessibility data enrichment at scales compared to conventional methods because it enables involving more participants, saving more time by avoiding field visits and covering a larger area.

Therefore, in our pilot project, ZuriACT: Zurich Accessible CITY, with the help of digital tools that allow for virtual inspections and measurements of accessibility features, we want to contribute to collecting and enriching accessibility information in the city of Zurich embedded in a citizen science project that will have both scientific and social impacts.

With the help of additional accessibility data produced in this project, the issues of an inclusive urban environment can be demonstrated by mapping the potential spatial inequalities in access to public facilities for disabled or restricted people in terms of mobility. Thus, this project provides helpful insight into implementing policy interventions for overcoming accessibility biases to ensure equitable services, particularly for people with disabilities, and contributes to creating an inclusive and sustainable urban environment. It goes without saying that an inclusive city is beneficial and impacts the quality of life of not only the population groups mentioned above but also the society at large.

2012 ACM Subject Classification Social and professional topics

Keywords and phrases Spatial accessibility, virtual audits, digital tools, mobility disability, citizen science, inclusive city, Zurich

Digital Object Identifier 10.4230/LIPICs.GIScience.2023.13

Category Short Paper

Funding I thank the University of Zurich, the Digital Society Initiative, and Smart City Zurich for partially financing this research.

1 Introduction

It is projected that by 2050, about 70 percent of the world's population will live in urban environments, 15 percent of them will live with disabilities [10]. Moreover, the prediction shows that by 2050, the number of older people will reach 2 billion worldwide [12]. The unprecedented rate of urbanization, along with the increase in the aging and disabled populations, bring about an increasing demand for public services and access to those facilities. Depending on the infrastructure and design, the urban environment and physical

Developing enriched pedestrian networks using accessibility features

Alexandra-Ioana Georgescu^{1,2,3}, Hoda Allahbakhshi^{1,2,3}, Robert Weibel^{2,3}

¹Digital Society Initiative, University of Zurich, Zurich, Switzerland

²Department of Geography, University of Zurich, Zurich, Switzerland

³Healthy Longevity Centre, University of Zurich, Zurich, Switzerland

Correspondence: Alexandra-Ioana Georgescu (alexandra-ioana.georgescu@geo.uzh.ch)

Abstract. Accessibility studies often focus on the general population, overlooking individual differences in mobility capacities and the role of external factors. Microscale street elements such as stairs, high kerbs, and sidewalk cracks can significantly impact urban mobility for individuals with restricted movement capacities. This study introduces a workflow to integrate different detailed accessibility information, such as barriers and facilitators for pedestrian mobility, with sidewalk data to create an enriched pedestrian network. Using this network, we evaluate each segment by computing an impedance score to quantify accessibility. Furthermore, we demonstrate how the network can be tailored to individual mobility needs and highlight its potential as a decision-making tool for urban planners and civil engineers to identify and prioritise targeted interventions for vulnerable populations.

Submission Type. Analysis

BoK Concepts. [AM11] Network analysis, [AM11-7] Accessibility modelling, [AMS-3] Spatial cluster analysis

Keywords. Spatial accessibility, Microscale elements, Mobility restriction, Pedestrian networks, Urban environment

1 Introduction

Ensuring equitable and adequate access for all to public facilities in urban areas is an essential target included in various Sustainable Development Goals such as 10 and 11 (United Nations, 2022). This is especially important since by 2050 it is projected that approximately two-thirds of

the world's population is expected to reside in urban areas (United Nations, 2019), and currently 16% of the global population worldwide is believed to live with some sort of disability (World Health Organisation, 2022).

Spatial accessibility refers to how easily destinations, such as public facilities, can be reached through movement in physical space (Allahbakhshi, 2023). It is highly context-dependent and influenced by various factors (Lid & Solvang, 2016), including microscale street elements such as poles, stairs, cobblestones, kerb ramps, or pedestrian signals. These elements can either restrict or facilitate pedestrian movement, significantly impacting access to certain areas and services (Hammel et al., 2015) and contributing to social exclusion (Svensson, 2010).

Physical barriers are especially important for individuals with mobility restrictions, as they can increase perceived distance (Vale et al., 2016), reduce the number of available opportunities (Achuthan et al., 2010) and force individuals to stay at home or in familiar places (Mao & Chen, 2022). Additionally, as individuals have different mobility needs, the impact of these elements varies (Georgescu et al., 2024). For example, a high kerb may be a barrier for a wheelchair user but can serve as a facilitator, marking the edge of the sidewalk, for a visually impaired individual. Therefore, such elements become vital in assessing spatial accessibility.

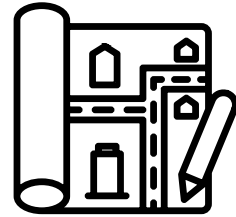
However, despite their significance, research on microscale elements and their impact on individuals with varying mobility capacities remains limited. Most of these studies rely on field visits to collect data on the various accessibility features that affect pedestrian movement. These features are then recorded in spatial databases, where each element is linked to its corresponding

PROJECT SIDEWALK

TRANSLATIONAL IMPACT



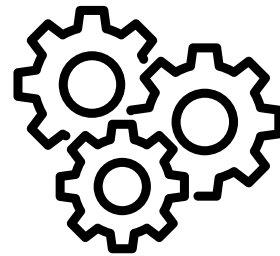
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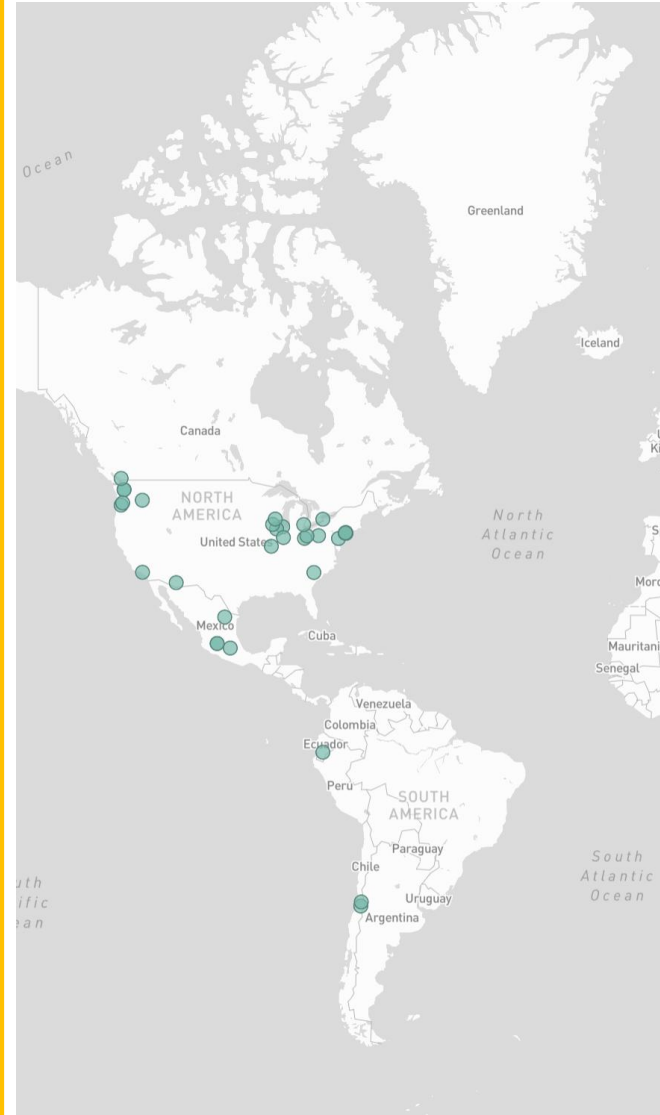
6 OUTCOMES

Research to translational

Research



Translational Impact



Open Data / Source

ProjectSidewalk

Overview Repositories 36 Projects 1 Packages 2 Teams 2 People 20

Project Sidewalk

Our mission: map and assess every sidewalk in the world using remote crowdsourcing, artificial intelligence, and online satellite & streetscape imagery.

27 followers University of Washington, Seattle, WA <http://projectsidewalk.org> @proj

README.md

Welcome

This is the open-source repository for all things **Project Sidewalk**. Our mission is to develop advanced techniques for mapping the world's sidewalks using remote crowdsourcing, artificial intelligence, and online satellite & streetscape imagery.

Some links to help you get started:

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- [Considerations for deploying Project Sidewalk in your city](#)
- The [Project Sidewalk webpage repo](#)
- Our [design repo](#)

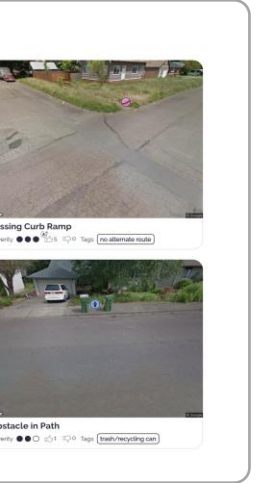
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- SidewalkWebpage** Public Project Sidewalk web page JavaScript 94 27
- Design** Public Stores design files for branding and logos 3 1

Repositories

Find a repository... Type Language

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- Design** Public Stores design files for branding and logos 3 1 2 0 Updated 2 weeks ago
- sidewalk auto-labeler** Public Python 1 0 0 0 Updated on Sep 11
- sidewalk-validator-ai** Public



On This Page

- Label Clusters API
- Label Clusters API Preview
- Endpoints
- Examples
- Quick Download
- Query Parameters
- Responses
- Success Response (200 OK)
- Default JSON Format (Default)
- GeoJSON Point Descriptions
- CSV Format
- Shapefile Format
- GeoPackage Format
- Error Responses
- Error Response Body
- Data Cleaning
- Best Practices
- Terms of Use
- Credits
- Project Sidewalk in Your City

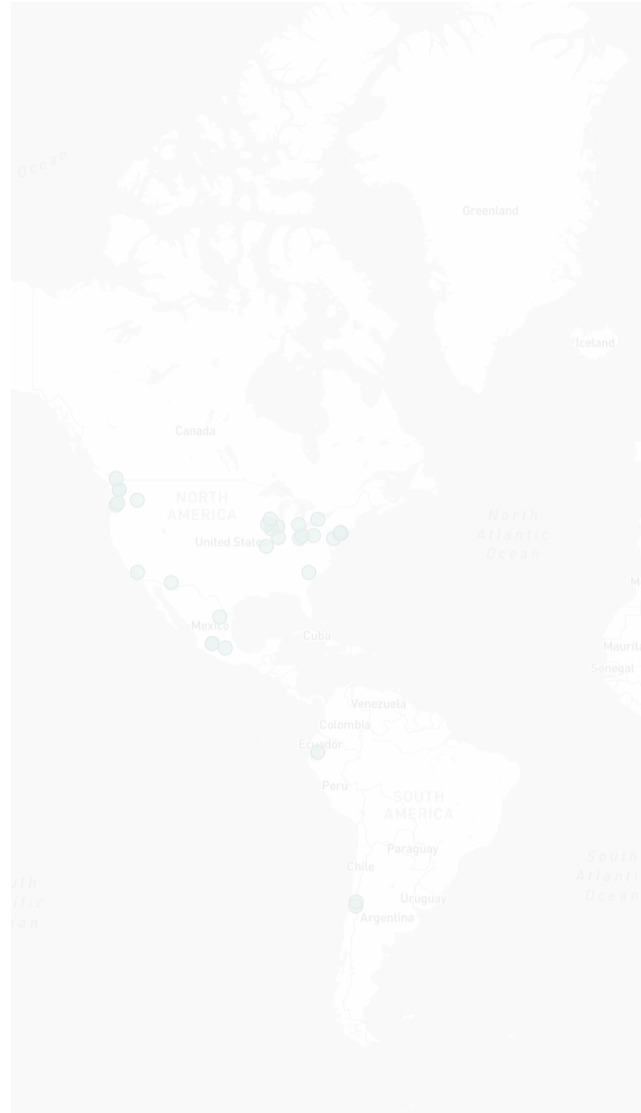
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OUTCOMES

OPEN SOURCE / DATA

The screenshot shows the GitHub repository page for Project Sidewalk. At the top, the repository name "Project Sidewalk" is displayed with a profile picture and a "Follow" button. Below this is the repository description: "Our mission: map and assess every sidewalk in the world using remote crowdsourcing, artificial intelligence, and online satellite & streetscape imagery." The page includes a README section with a "Welcome" message and a list of links to help get started. There are also sections for "Pinned" repositories, "Repositories" (listing SidewalkWebpage, Design, sidewalk-auto-labeler, and sidewalk-validator-ai), "People" (a grid of contributor avatars), and "Top languages" (Python, JavaScript, HTML, Shell). The right sidebar shows "Discussions" and "Most used topics" like accessibility, curb-ramps, google-streetview, object-detection, and osm.

<https://github.com/ProjectSidewalk/>

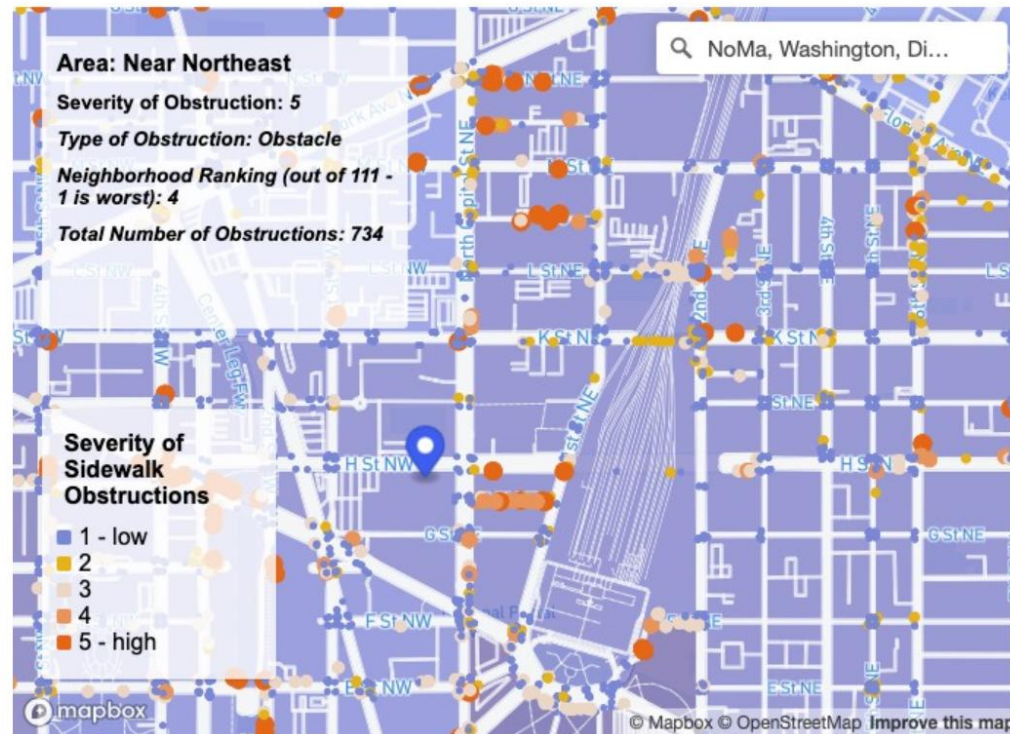
The screenshot shows the "Raw Labels API" documentation page on the Project Sidewalk website. The page has a navigation bar with buttons for "Explore", "Validate", "How to Label", "Cities", "API", "Tools", "Tucson", and a user profile "jonfroehlich". The main content area is titled "Raw Labels API" and includes an introduction, a "Raw Labels API Preview" section with a map of Tucson, Arizona, and a note about the API's capabilities. The map shows a grid of streets with various colored markers representing different sidewalk features. A legend titled "Label Types" lists categories like Sidewalk, NoCurbRamp, SurfaceProblem, CurbRamp, Obstacle, Occlusion, Crosswalk, Signal, and Other. The right sidebar contains a "On This Page" table of contents with links to "Raw Labels API", "Raw Labels API Preview", "Endpoint", "Examples", "Quick Download", "Query Parameters", "Responses", "Success Response (200 OK)", "GeoJSON Format (Default)", "GeoJSON Field Descriptions", "CSV Format", "Shapefile Format", "GeoPackage Format", "Error Responses", "Error Response Body", "Terms of Use", "Contribute", and "Project Sidewalk in Your City!".

<https://projectsidewalk.org/api>

A city is only as accessible as its sidewalks. This map shows DC's are often blocked.

WALKING By Barbara Moreno (Guest Contributor) September 10, 2019 32

SHARE



A snapshot of sidewalk obstructions on NoMa's streets. by the author.

When Washingtonians like myself look for new apartments, we pay close attention to [the walk score](#) of a neighborhood. Any score upwards of 90 on a hundred point scale marks an area as a “walker’s paradise,” meaning major needs such as grocery stores and transit are within walking distance. However, what is *not* factored into the walkability score is the actual condition of the sidewalks.

ALSO OF INTEREST

WALKING

A pedestrian-only block in Alexandria may become a reality this spring 8

TRANSIT ANALYSIS

The good, the bad and the unexplained: what you need to know about the WMATA budget 27

DEVELOPMENT

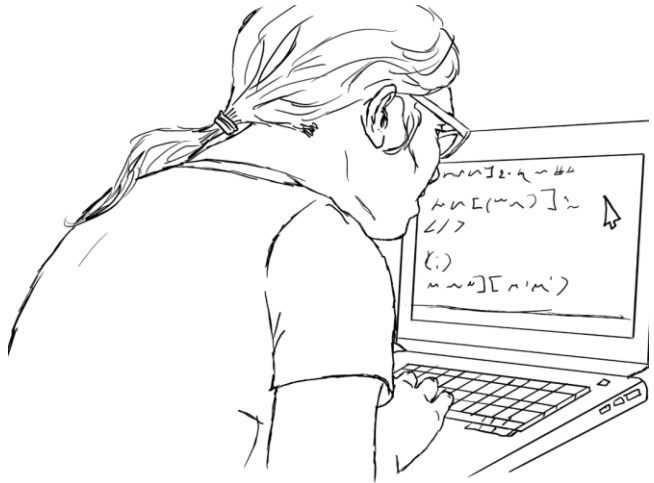
Innovation Center Metro won't get a corporate name (for now), but a lot is already happening there. 17

TRANSIT

Baltimore's transit system is not meeting residents' needs. Can this plan change that? 17

Get daily updates via email

TEACHING ALGORITHMS WITH PROJECT SIDEWALK




Computers should be accessible to everyone. Let's teach every computer scientist how.

Teaching Accessible Computing
 edited by Alannah Oleson, Amy J. Ko, Richard E. Ladner
 1st edition

For computing to work for everyone, it must be accessible to everyone. Alas, it is not: people with disabilities in mobility, vision, hearing, learning, attention, and more regularly face software that is hard or impossible for them to use. One reason for this is that when we educate future software engineers, we rarely teach them anything about accessibility. This limits their ability to find and fix accessibility defects and advocate to their organization to prioritize those fixes. More importantly, it limits the capacity of software organizations to design software that is accessible from day one.

This book addresses this problem by offering concrete pedagogical ideas for educators about how to integrate accessibility into their computer science classes. It teaches basic foundations of accessibility that are relevant to major areas of computer science teaching, and then presents teaching methods for integrating those topics into course designs. Our hope is that computer science teachers will be able to read the first few introductory chapters, and the chapters relevant to their teaching, and use their learning to teach accessible computing in their classes.



Even something as abstract as data types have relevance to concrete problems of accessibility.

Courses
Data Structures + Accessibility
 by Catherine M. Baker, Yasmine N. Elglaly, Kristen Shinohara

Introduction

Data structures offer a timely approach to infusing accessibility in computing, both topically and pedagogically. Topically, data structures can connect with concrete implementations where accessible solutions may be rooted. Pedagogically, including accessibility in lessons about data structures may be a first opportunity to expose students to accessible solutions, one that can be built on in later courses. It also enables instructors to utilize real-world examples in concert with data structures instruction.

Despite these benefits, few common curricular approaches to data structures incorporate accessibility concepts. In fact, many rely on abstract concepts or toy examples while focusing on implementation mechanics. Computing curriculum that omits accessibility except in courses about web design risks producing computing professionals who underestimate the knowledge and skill needed to design and develop accessible solutions². At the same time, most faculty beyond HCI or web design are insufficiently equipped to include accessibility topics^{4,6}.

Graphs + Sidewalk accessibility

Learning objectives

Topics: Graphs, Dijkstra's shortest path algorithm, and sidewalk accessibility

Data structures content: This assignment focuses on the implementation of Dijkstra's single-source shortest path (SSSP) algorithm using graphs. As students work on this programming assignment, they will learn by implementing about several graph concepts, such as directed graphs, weighted graphs, neighbors, path, and graph breadth first traversal.

Accessibility content: This assignment introduces students to the topic of accessibility of sidewalks for people with disabilities. Factors that may make sidewalks inaccessible to wheelchair users or blind people are the lack of curb ramps, existing obstacles, e.g., a tree branch, and the texture of the sidewalk, such as slippery surfaces or cracks. Sidewalk accessibility requirements are specified by the [ADA](#) and cover details such as the width and the slope of the sidewalk.

Assignment overview

The goal of this assignment is to develop a program that finds the most accessible path between two locations. The program should accept a csv file and source and destination nodes as input. The csv file holds graph data that are represented by a node label and the weight of edges connecting this node to other nodes in the graph. The weight of an edge represents its accessibility score. The program should analyze the csv file and display the shortest path from the source node to the destination node and its weight.

Students were given skeleton code to guide them through the implementation of Dijkstra SSSP algorithm. Some implementation decisions were made for the students, such as using a minimum heap to hold the weight values of the graph nodes. The implementation of the SSSP algorithm was broken down into several methods for students to write their code, such as computing the shortest path from source node to each reachable node, and creating the list of nodes that represents the shortest path between the source and destination nodes.

To engage students with real-world sidewalk accessibility data, we used the [Project Sidewalk's API](#) to build the csv files used in this assignment. Project Sidewalk is an open-source web-based [tool](#) for collecting street-level accessibility data using crowdsourcing (volunteers and paid workers)³. To further engage the students with the accessibility learning objectives, students were asked to query the online API provided by the Project Sidewalk and create new csv files with proper data formatting for their own testing. This exercise helped students to learn about data querying and data wrangling.

TRY IT!



**PROJECT
SIDEWALK**

<http://projectsidewalk.org>



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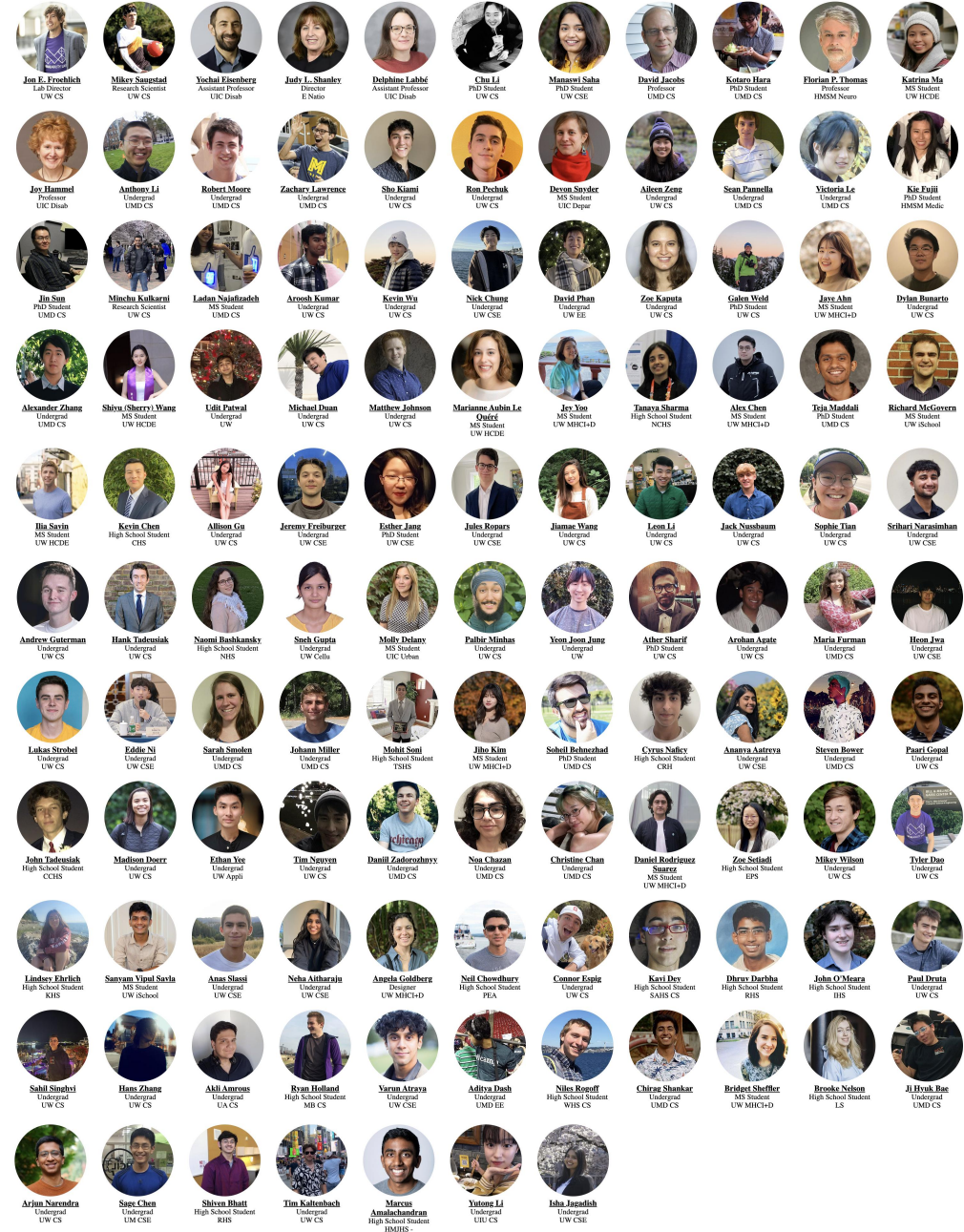


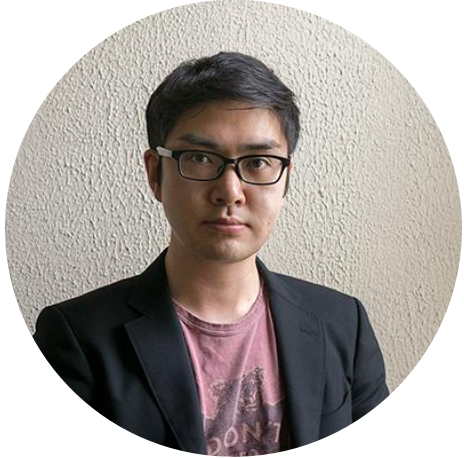
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PROJECT SIDEWALK WAS BUILT BY STUDENTS, FACULTY, AND OUR COMMUNITY PARTNERS





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2012-2016



Manaswi Saha
UW CSE PhD'22
2016-2022



Mikey Saugstad
Research Engineer
2017-present



Yochai Eisenberg
UIC Professor
Disability & Public Health
2017-present

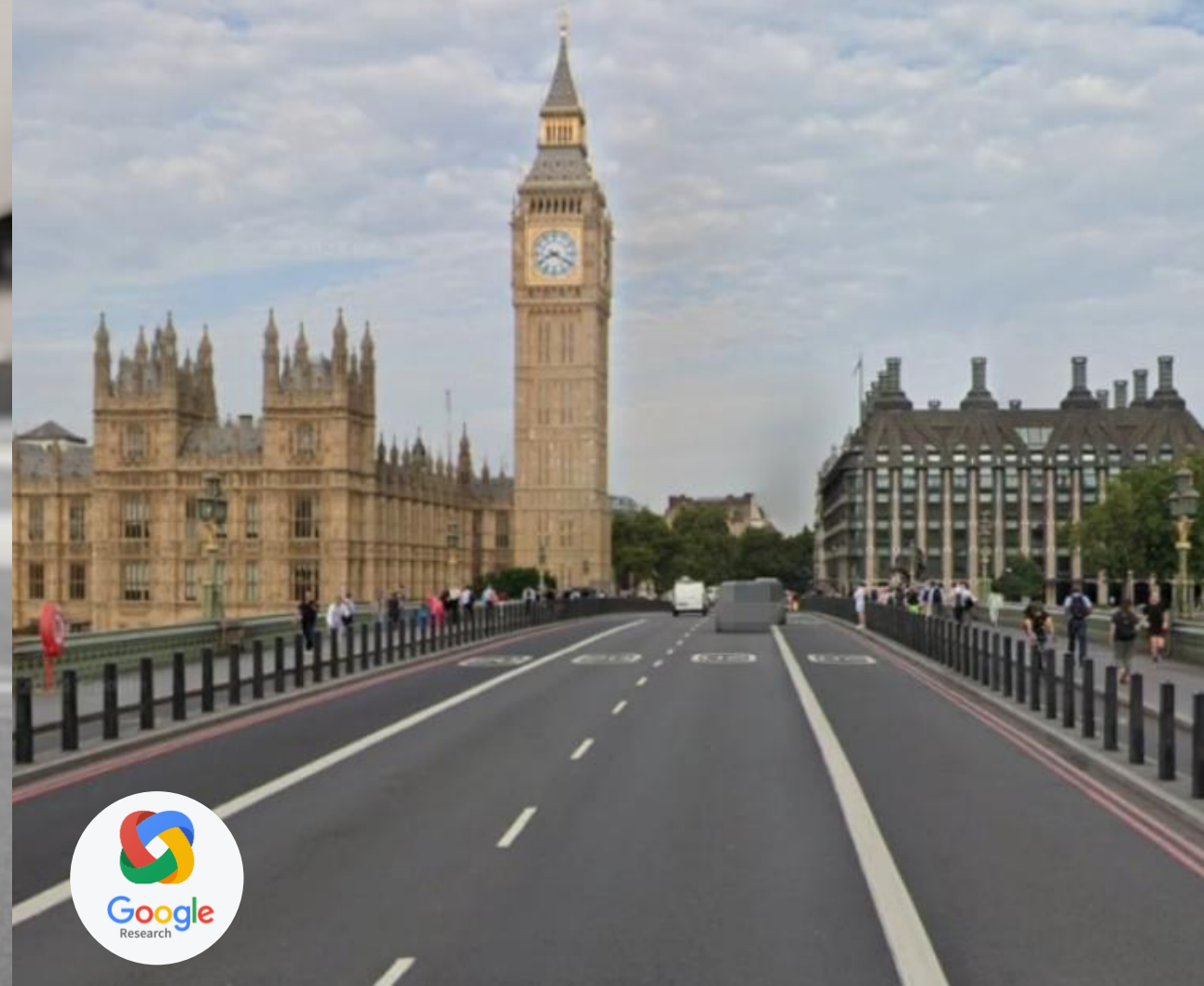


Chu Li
UW CSE PhD
2022-present

PROJECT SIDEWALK



STREETREADERAI



STREETREADERAI








How can we...
make interactive
streetscape tools
accessible to all?



StreetReaderAI

Making Street View Accessible via Context-Aware, Multimodal AI

				
JON E. FROEHLICH Google Research	ALEX FIANNACA Google DeepMind	NIMER JABER Google	VICTOR TSARAN Google	SHAUN KANE Google Research

You're standing in **Gyeongbokgung Palace**, facing northwest with a clear view of a majestic two-tiered palace building adorned with intricate, colorful patterns...



Google Street View

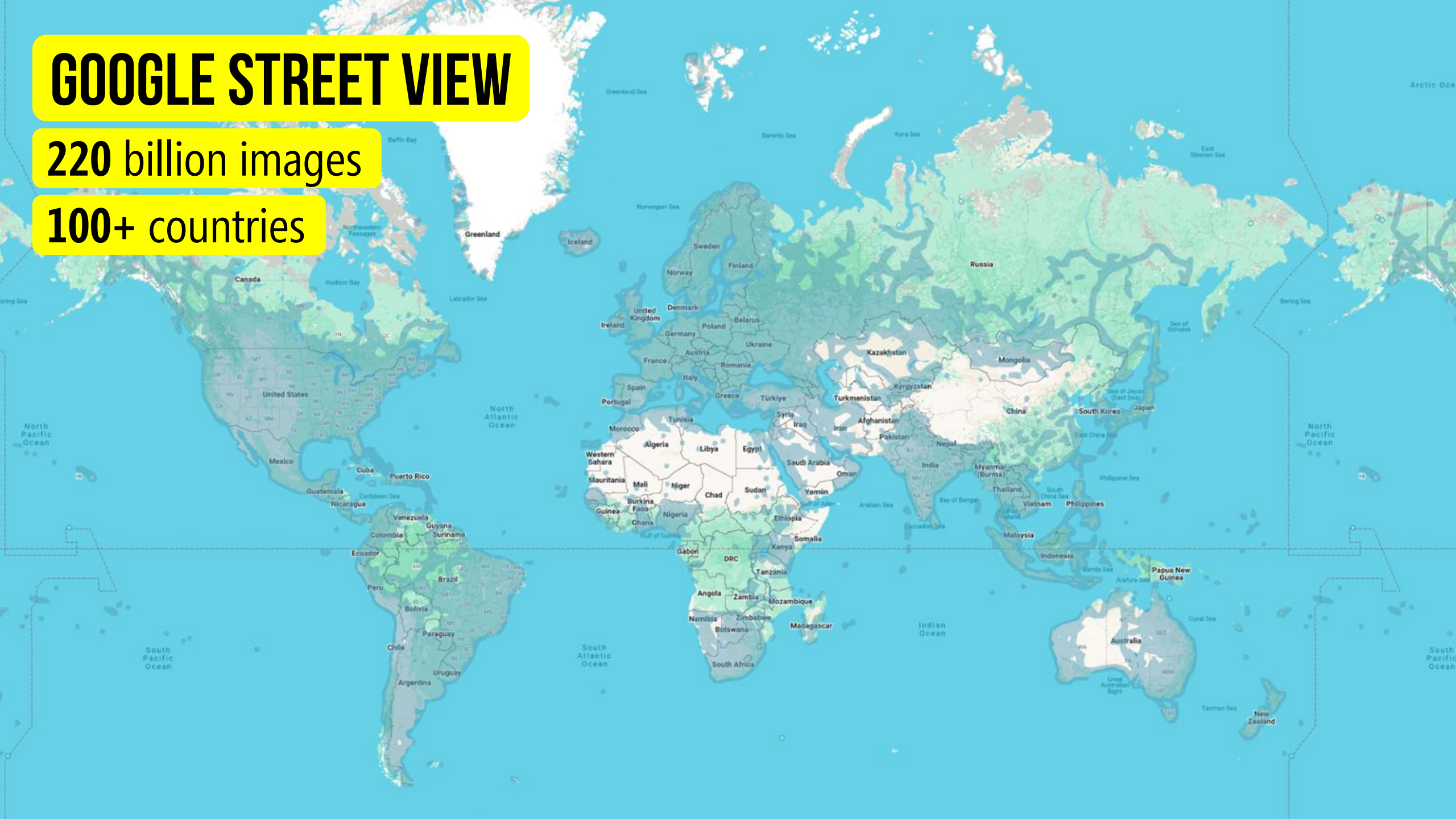
TRANSFORMED HOW PEOPLE **LEARN** ABOUT THE **WORLD**



GOOGLE STREET VIEW

220 billion images

100+ countries



Fundamentally **Inaccessible**

← 2411 7th Ave
New York

Google Street View

Aug 2024 See more dates

GOOGLE STREET VIEW

Current Screen Reader Experience



Times Square

Madame Tussauds New York

LITTLE

× Street View, application

7th Ave

Google

← 2411 7th Ave
New York

Google Street View

Aug 2024 See more dates

VIBRANT ADS

STREETLIGHT

TOWERING BUILDINGS

STREET SIGNS

STORE FRONTS

CONSTRUCTION

BOLLARDS

SIDEWALK

WIDE STREET

× Street View, application

Times Square

Madame Tussauds New York

LITTLE

HOW CAN WE MAKE **STREETSCAPE** **TOOLS ACCESSIBLE** TO BLIND USERS?



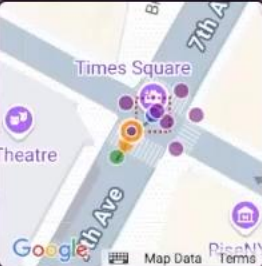
Let's try this again but with **StreetReaderAI**

Search for a location to go to...

Nearby Virtual Tours



Ask a question about this location...



AI Description
The image shows a street scene in Times Square, New York City, with a wide avenue stretching into the distance, lined with tall buildings covered in bright billboards and advertisements. In front of you is a crosswalk with white stripes, and a delivery truck is driving away from you in the center of the road. To the right is a sidewalk with metal bollards. At the corner to the right is a sign that reads "W 45 St, One Way".

StreetReaderAI is not just a context-aware description tool for streetscape images

StreetReaderAI is an accessible, immersive, and interactive street view map experience

Search for a location to go to...



Nearby

Virtual Tours

Generate Description

what's the nearest bus stop?

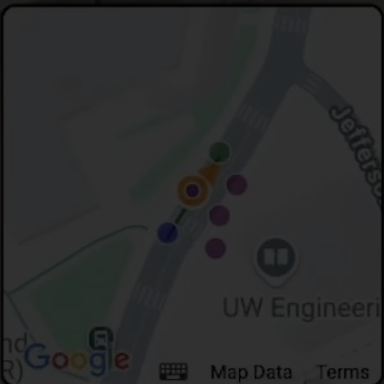
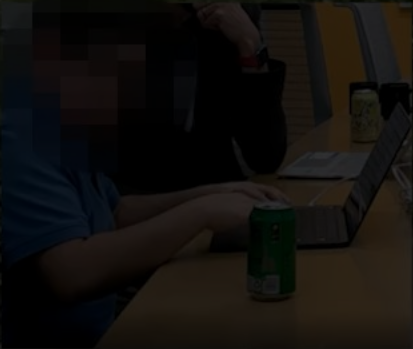
The nearest bus stop is just to your right, across the street. It's a bit further down the block, but it's the only one visible in your current view.

Listening...

End Conversation

EXAMPLE

Where's the bus stop?



Search for a location to go to...



Nearby

Virtual Tours



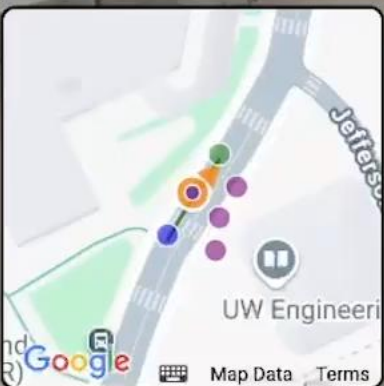
Generate Description

what's the nearest bus stop?

The nearest bus stop is just to your right, across the street. It's a bit further down the block, but it's the only one visible in your current view.

Listening...

End Conversation



Where's the bus stop?



Search for a location to go to...



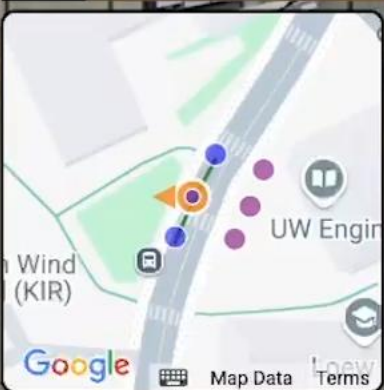
Nearby

Virtual Tours

Fluidly interacting in street view

Engaging in context-aware chat

Learning critical geo-info latent in images



Generate Description

only one visible in your current view.

Where's the bus stop?

The bus stop is behind you. It's on the other side of the street.

Okay.

Great. Let me know if you have any other questions.

turn me to towards the bus station

Done

what's ahead of me.

The bus stop is directly ahead of you. There are benches and a covered area.

are there any shelters in this stop?

Yes, the bus stop has a covered shelter with benches.

Ask a question about this location...



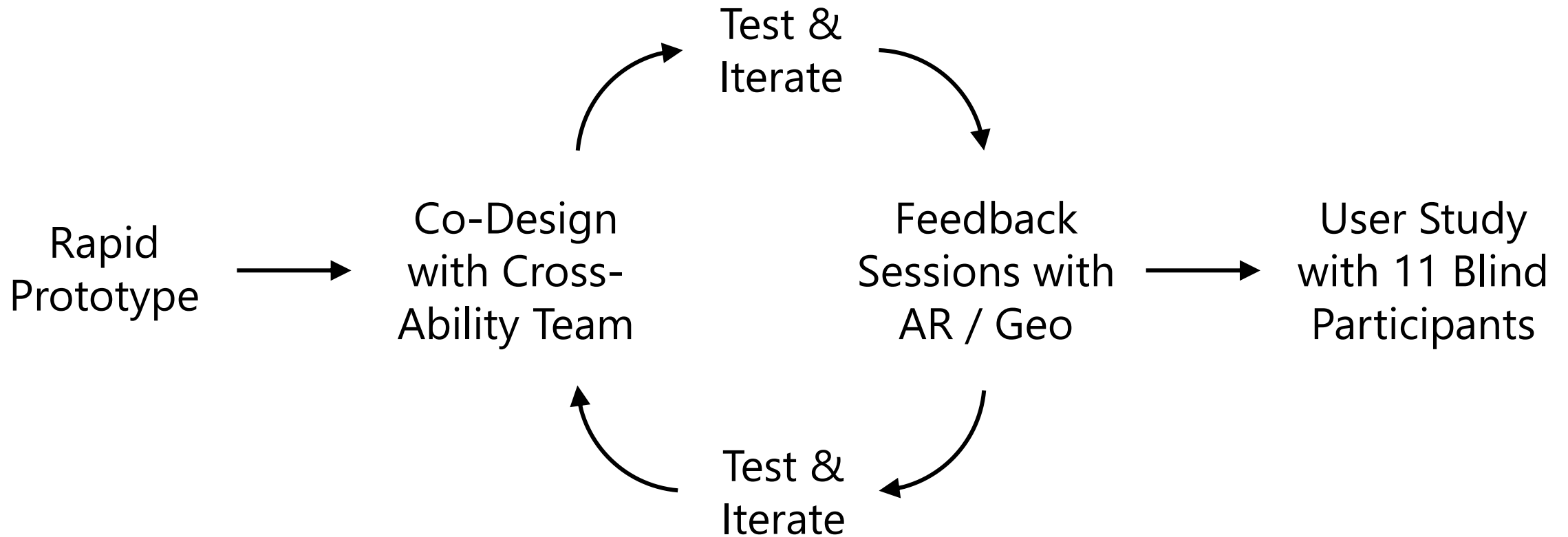
End Conversation

Oh, covered. Beautiful. So no rain.

A dark, low-key photograph of the Eiffel Tower in Paris, France, centered in the background. The tower is illuminated against a dark sky. In the foreground, there are silhouettes of trees and a grassy area with some people walking. The overall mood is mysterious and iconic.

DESIGNING STREETREADERAI

ITERATIVE DESIGN PROCESS

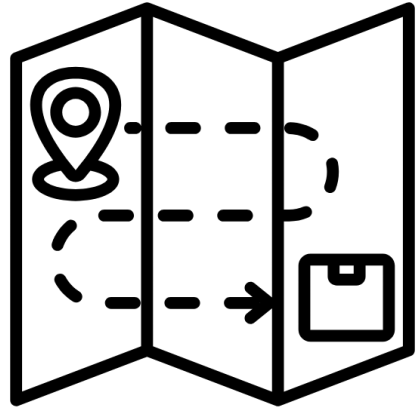


FOUR CORE USER TASKS



POI Investigations

What does a place look like?



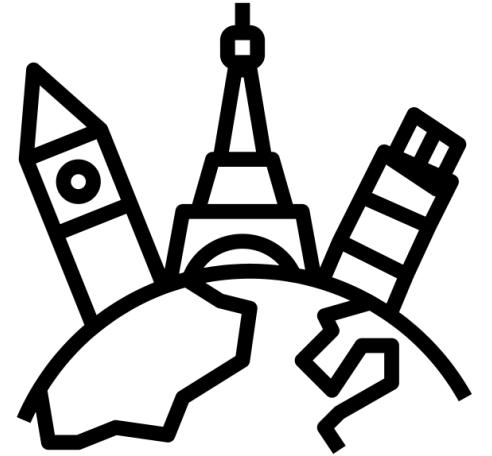
Route Planning

What does my route look like?



Open-Ended Exploring

I just want to explore...



Virtual Tourism

I've always wanted to visit...

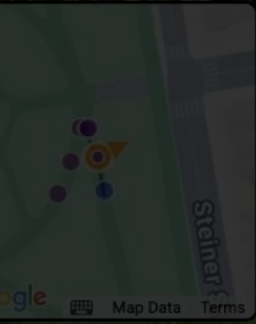
Search for a location to go to...

Virtual Tours

Generate Description

- Ask a question about this location...
- Are there curb cuts at the intersection in front of me?
- How many lanes of traffic are there on Hayes Street?
- Are there any tactile markings to indicate the crosswalk?

SYSTEM OVERVIEW



Now Facing Northeast.

Search for a location to go to...



Nearby

Virtual Tours

LOCATION SEARCH

AI DESCRIBER

Generate Description

AI CHAT

Ask a question about this location...

Are there curb cuts at the intersection in front of me?

How many lanes of traffic are there on Hayes Street?

Are there any tactile markings to indicate the crosswalk?

MINI-MAP

STATUS MESSAGES

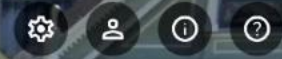
Now Facing
Northeast.

Search for a location to go to...



Nearby

Virtual Tours



AI DESCRIBER

Generate Description

Combines **GIS data** +
image analysis

Ask a question about this location...



Are there curb cuts at the intersection in front of me?

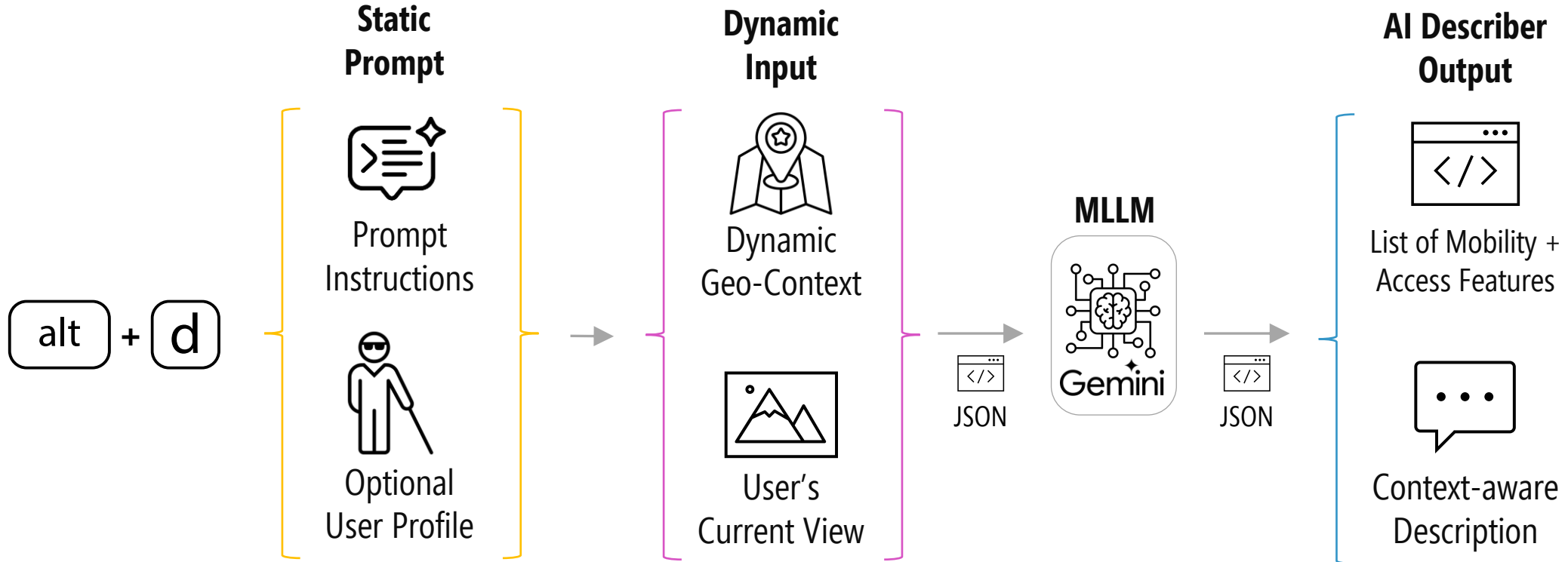
How many lanes of traffic are there on Hayes Street?

Are there any tactile markings to indicate the crosswalk?



Google Map Data Terms

AI DESCRIBER



AI DESCRIBER: STATIC PROMPT

alt + d

Static Prompt



Prompt Instructions

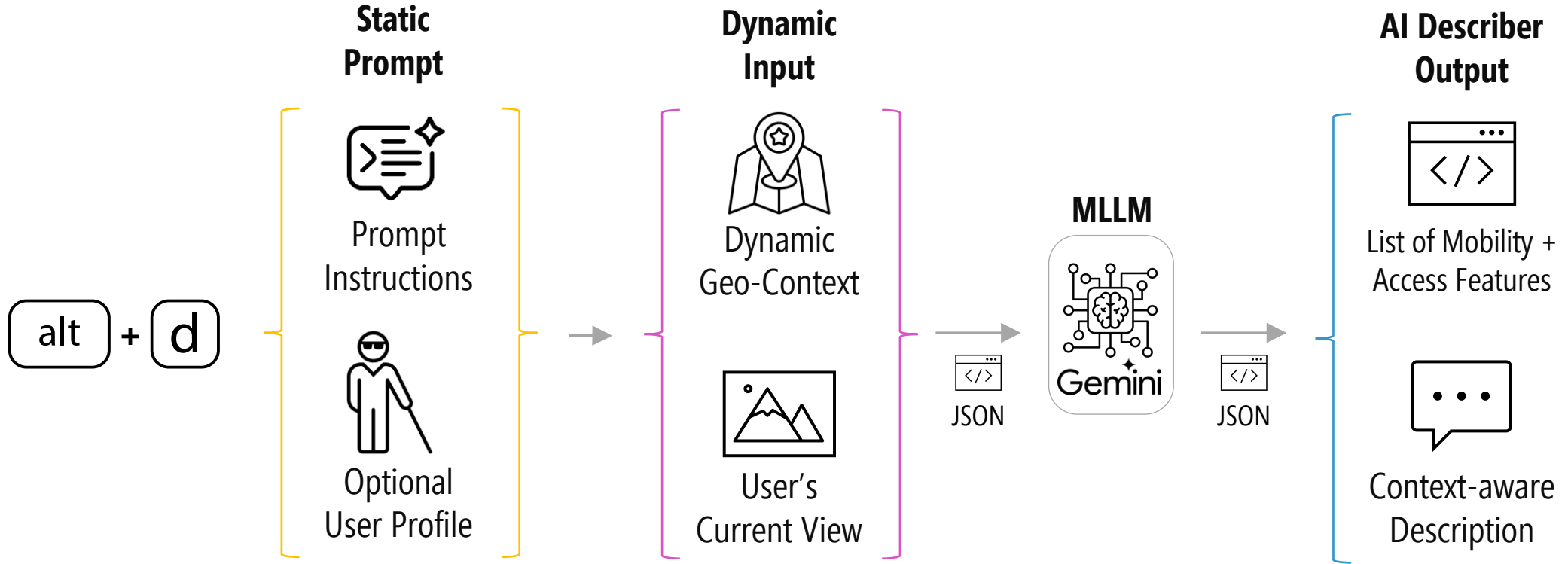
"You are an **expert in describing visual scenes for people who are blind** or have low vision. You will be assisting users who are navigating Google Street View using a screen reader..."



Optional User Profile

"I use a **cane** & a **service dog** for navigation. I prefer to walk and take public transportation."

AI DESCRIBER



AI DESCRIBER: DYNAMIC INPUT

Dynamic Prompt



Prompt Instructions



Optional Profile

Dynamic Input

USER LOCATION



<lat, lng>



Heading



Road Address



City, State, Country

VIEW METADATA



Date



Photographer



Pitch

NEARBY PLACES

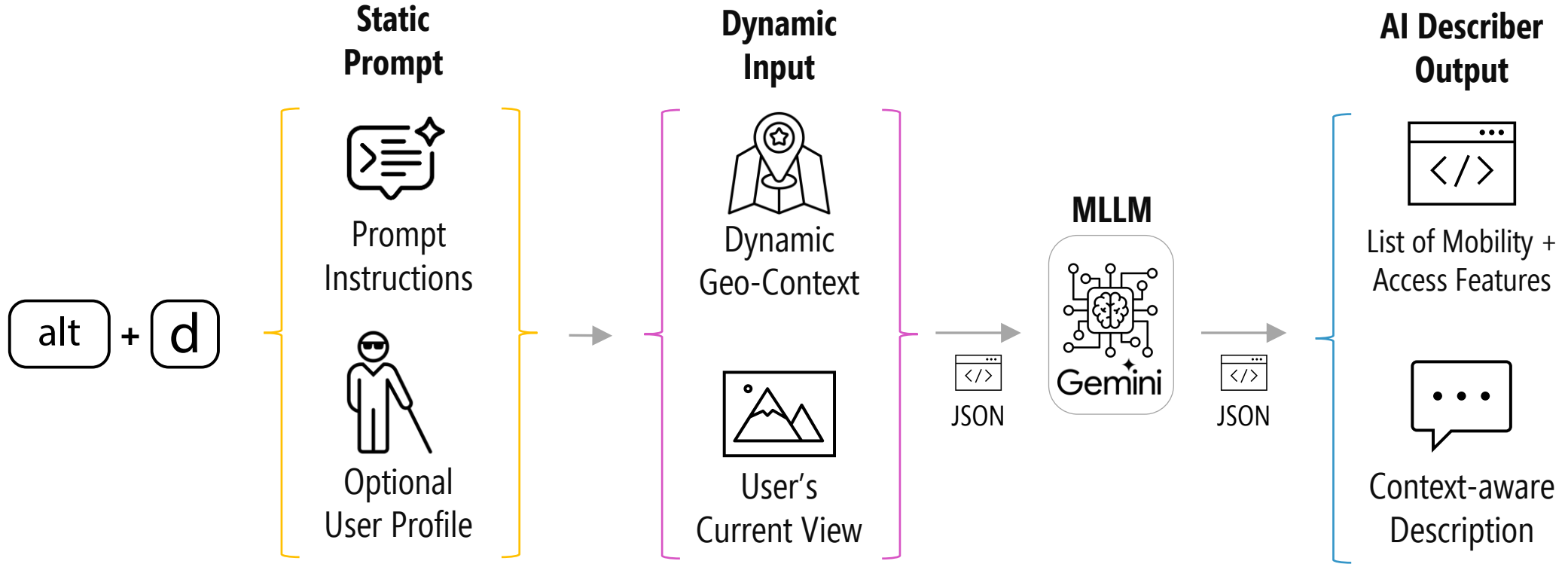


- Place Name
- Place Name
- Place Name
- Place Type
- Editorial Summary
- Place Address
- <lat, lng>
- Relative distance
- Relative heading

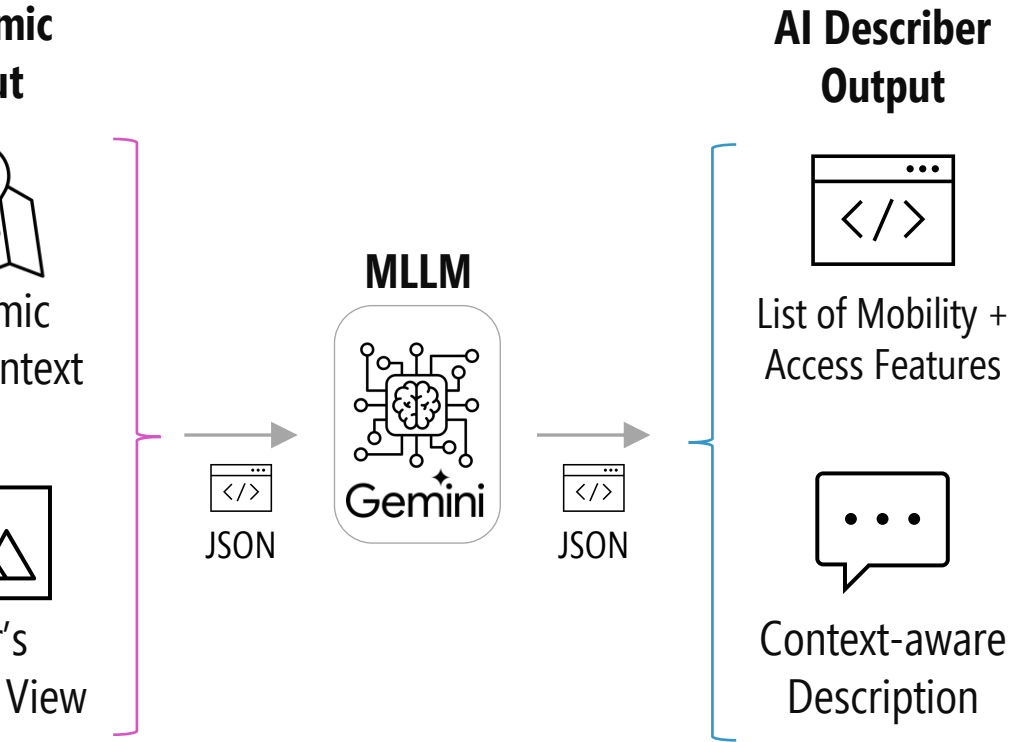
CURRENT USER VIEW



AI DESCRIBER



AI DESCRIBER: OUTPUT



```
{  
  mobilityFeatures: [There is a crosswalk in front of you,  
    down the hill", "The crosswalk has painted white  
    stripes", "There is a stop sign", ...],  
  obstacles: ["There are cars parked on the street", "You  
    need to walk down a hill"],  
  safetySummary: "Use caution when crossing...",  
}
```

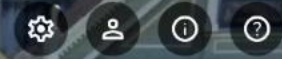
"The image shows a **view from Alamo Square in San Francisco** with the user facing **northeast**. In front of the user, **across a street with crosswalks**, is a row of Victorian houses, known as the **Painted Ladies**. To the right, **about 35 meters away**, is the Painted Ladies Observatory."

Search for a location to go to...



Nearby

Virtual Tours



Hayes St &, Steiner St, San Francisco, CA 94117, USA

Summary Mobility Obstacles Safety

The image shows a view from Alamo Square in San Francisco, with the user facing northeast. In front of the user, across a street with crosswalks, is a row of Victorian houses, known as the Painted Ladies. To the right, about 35 meters away, is The Painted Ladies Observatory.

Loaded from cache

Regenerate

AI CHAT

Ask a question about this location...

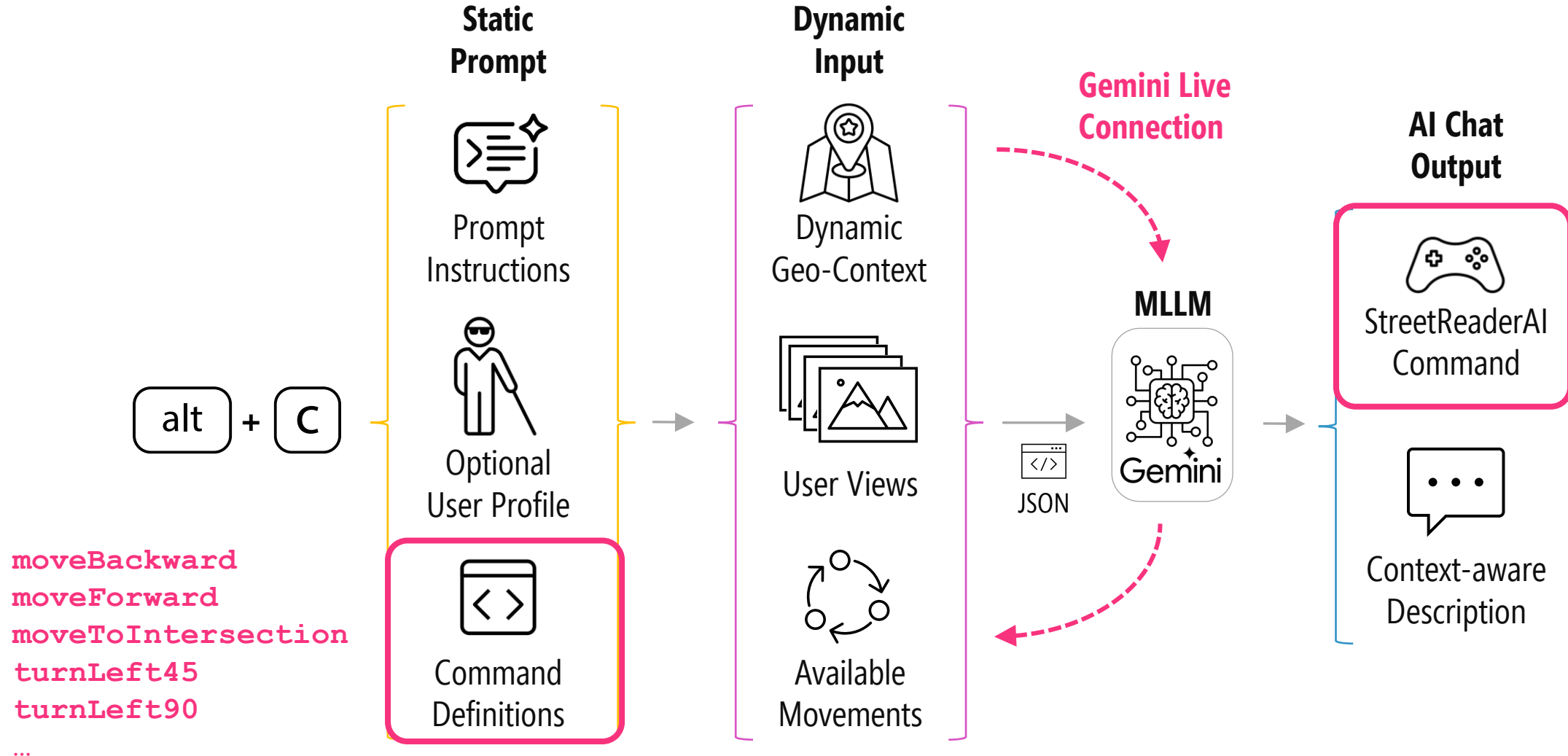


End Conversation



Google Map Data Terms

AI CHAT: LIVE BIDIRECTIONAL UPDATES



USER STUDY

LAB-BASED USER STUDY



11 Blind Participants

All cane users
Mixed familiarity with AI



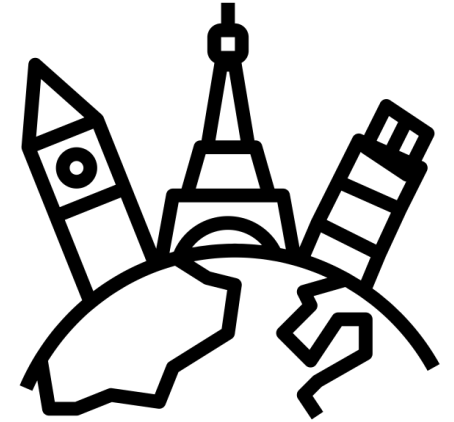
POI Investigations

What does a place look like?



Open-Ended Exploring

I just want to explore...



Virtual Tourism

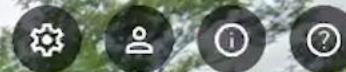
I've always wanted to visit...

Search for a location to go to...



Nearby

Virtual Tours



Generate Description

Yes, there are a few obstacles including some tables and chairs on the sidewalk as well as a sandwich board sign on the right. There is also a vehicle parked on the street. Be careful when walking in this area.

Are there any curb ramps in the image?

Yes, there is a curb ramp visible in the image in front of you. It appears to be on the other side of the street.

Are there any crosswalks in this area?

Yes, there is a crosswalk in front of you. It appears to be a standard painted crosswalk.

Are there any accessible pedestrian signals around this area?

Based on the image, I do not see any accessible pedestrian signals. There are standard traffic signals at the intersection but I cannot confirm if they have an audio component.

Ask a question about this location...



End Conversation



So [it's like] if you just physically moved your body...

LAB-BASED USER STUDY



11 Blind Participants

All cane users
Mixed familiarity with AI



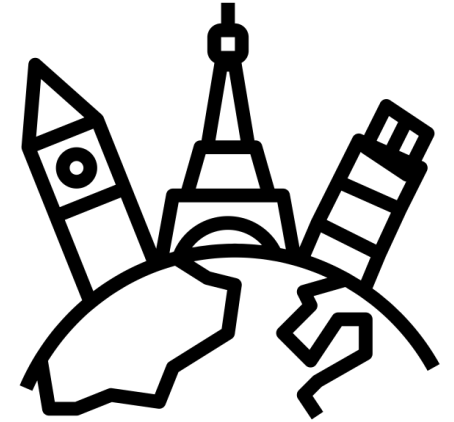
POI Investigations

What does a place look like?



Open-Ended Exploring

I just want to explore...



Virtual Tourism

I've always wanted to visit...

TASK 1: POI INVESTIGATIONS



11 Blind Participants

All cane users
Mixed familiarity with AI



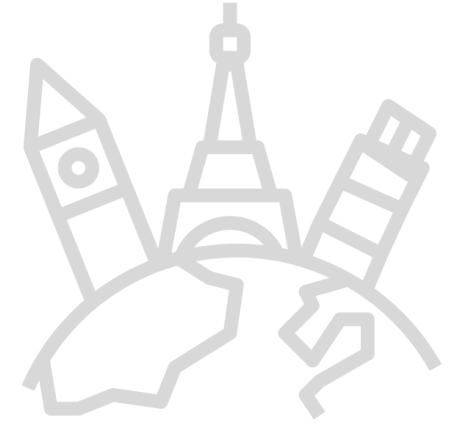
POI Investigations

What does a place look like?



Open-Ended Exploring

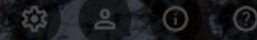
I just want to explore...



Virtual Tourism

I've always wanted to visit...

Search for a location to go to...



Nearby

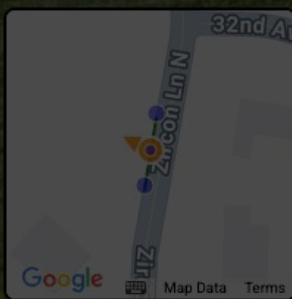
Virtual Tours

Ask a question about this location...



"You plan to take your **two young nieces** to an **unfamiliar playground**. Your goal is to **learn about** the playground **before going**"

TASK 1: PLAYGROUND SCENARIO



Search for a location to go to...



Nearby

Virtual Tours

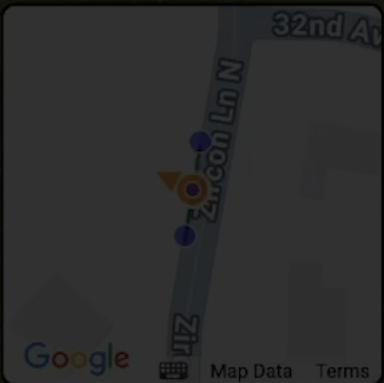
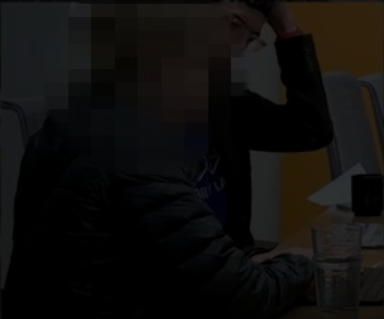
Generate Description

Use AI to generate a description about this location...



Observe the **diversity** and type of **questions** asked, and the system's response

PLAYGROUND EXAMPLES



2.0x

Search for a location to go to...



Nearby

Virtual Tours

Generate Description

Ask a question about this location...



Google

2.0x

TASK 1: POI INVESTIGATIONS



11 Blind Participants

All cane users
Mixed familiarity with AI



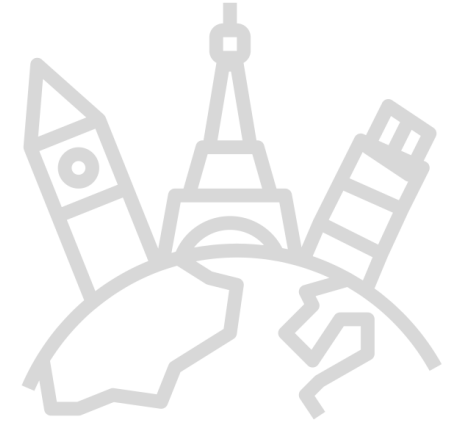
POI Investigations

What does a place look like?



Open-Ended Exploring

I just want to explore...



Virtual Tourism

I've always wanted to visit...

TASK 2: OPEN-ENDED EXPLORING



11 Blind Participants

All cane users
Mixed familiarity with AI



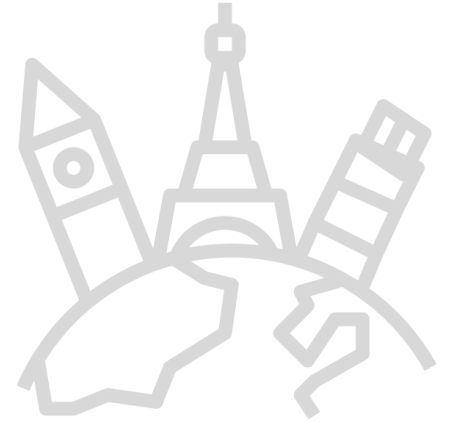
POI Investigations

What does a place look like?



Open-Ended Exploring

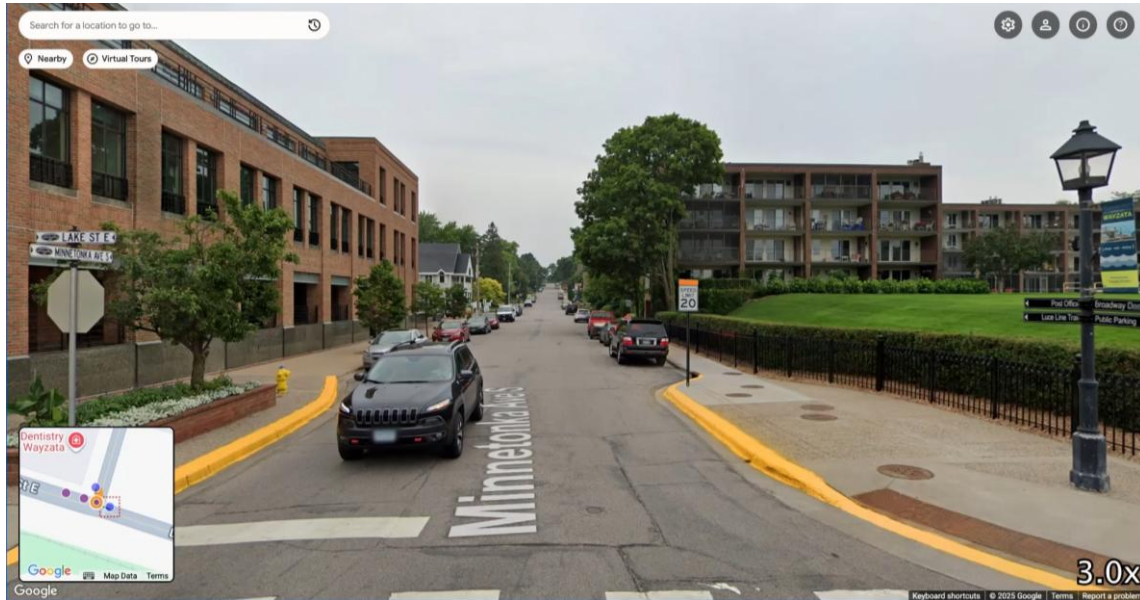
I just want to explore...



Virtual Tourism

I've always wanted to visit...

TWO EXPLORATION SCENARIOS



Explore Route to Ice Cream Shop

Walk east to explore the route

110 meters: ~4 heading changes, 12 steps

TWO EXPLORATION SCENARIOS



Explore Route to Ice Cream Shop

Walk east to explore the route

110 meters: ~4 heading changes, 12 steps



Explore Route to Japanese Restaurant

Walk north then west to explore the route

75 meters: ~7 heading changes, 5 steps

USER STUDY RESULTS

OVERALL REACTIONS

Usefulness

6.4/7

Median=7/7 (SD=0.9)

Use in Future?

6.6/7

Median=7/7 (SD=0.8)

*"Most navigation systems can get you to the last 5-10 feet but this **helps get you to the door and even describes it**"*

-P10

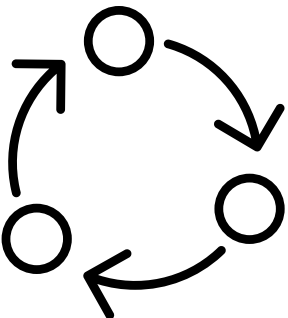
*"This is just **so exciting**—having a conversation about the street [with AI]... this is really amazing"*

Screen Reader User

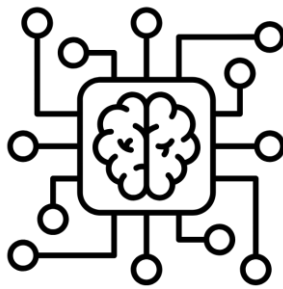
StreetReaderAI

Collaborator

KEY PROBLEMS



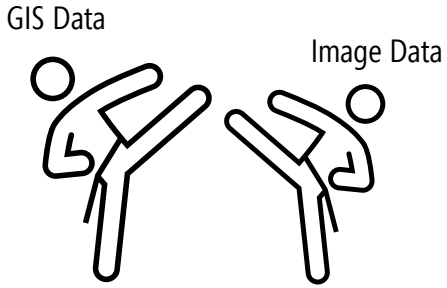
Orientation



Truth?



System Limits



Conflicting Info

USER STUDY RESULTS

AI SYSTEM USES (N=1,053)

AI DESCRIBER

12.9%

136 Instances

vs.

AI CHAT

87.1%

917 Instances

Strong tendency
towards AI Chat



AI SYSTEM USES (N=1,053)

AI DESCRIBER

12.9%

136 Instances

vs.

AI CHAT

87.1%

917 Instances

Strong tendency
towards AI Chat

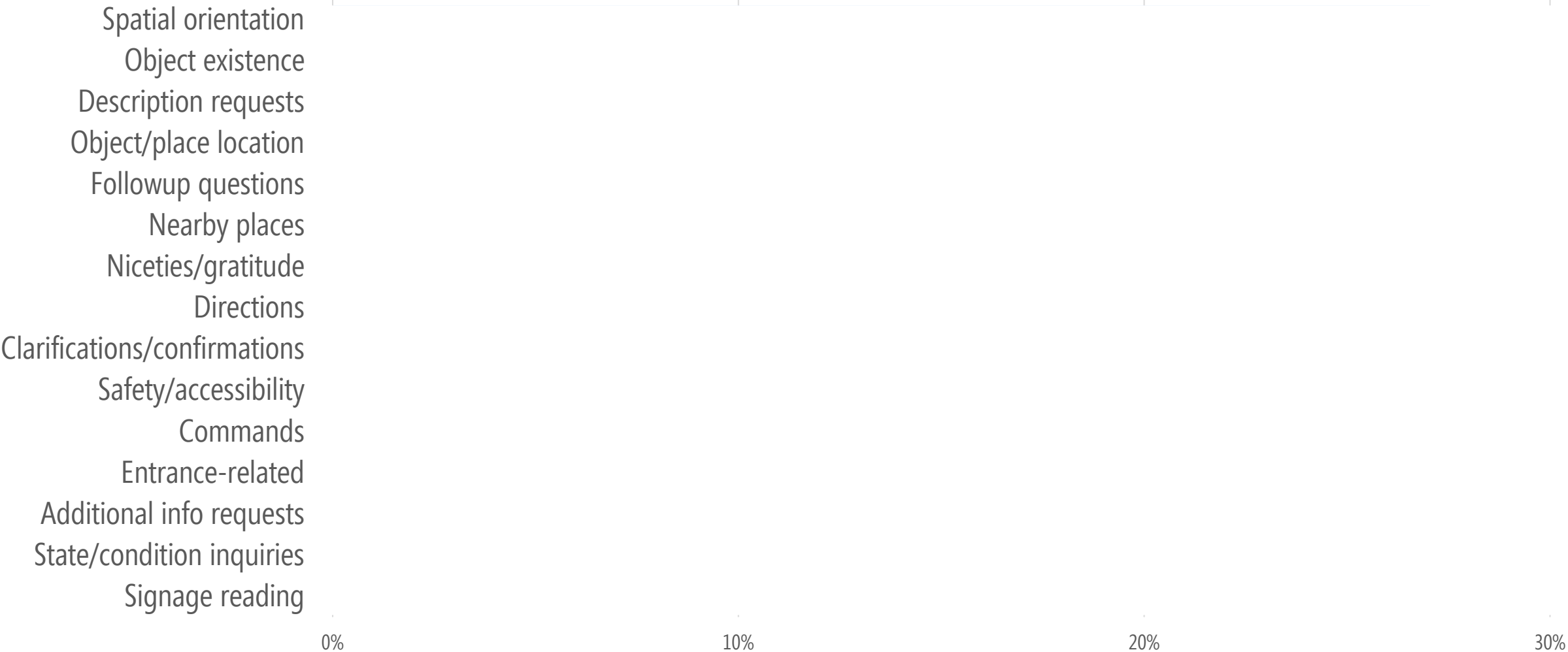


*"The more you **ask**,
the more you **learn**"*

**What questions do blind people
ask a street view system?**

USER STUDY RESULTS

QUESTION TYPES (N=917)

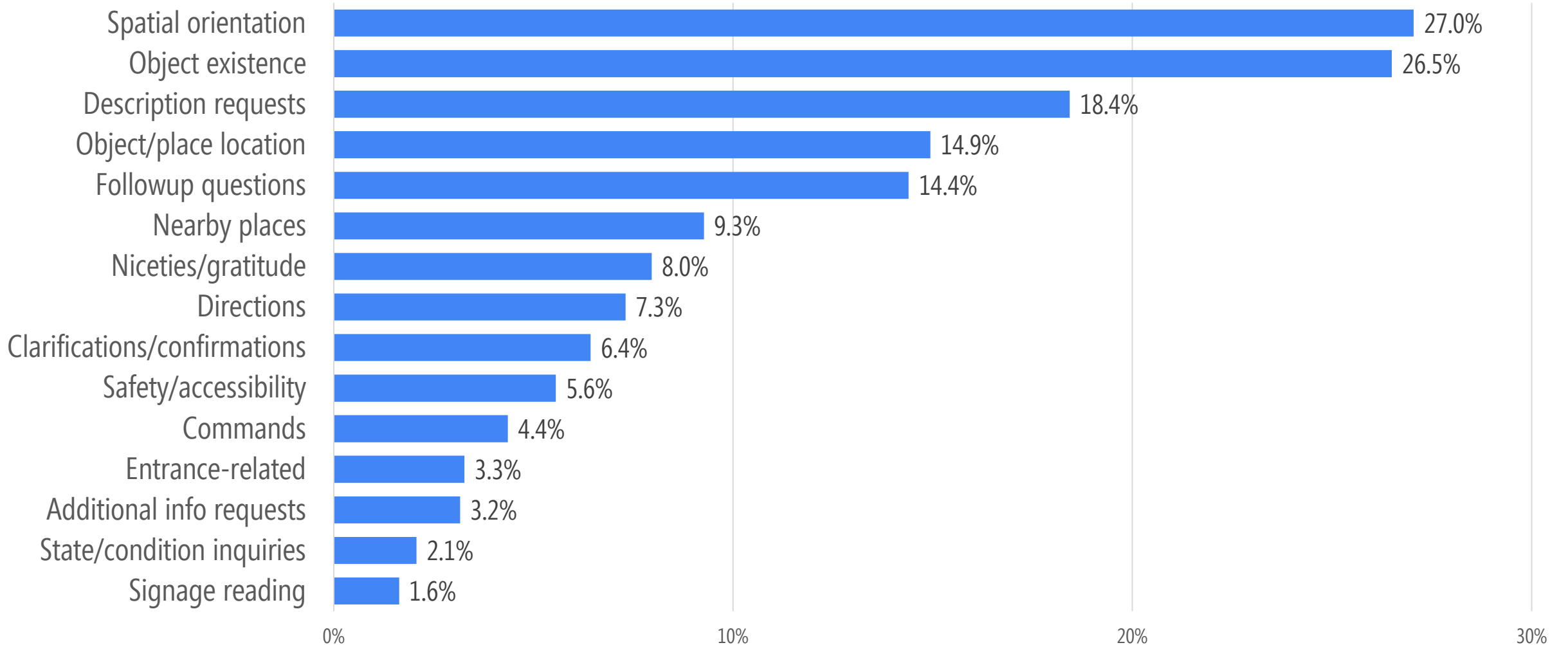


*Each question could be tagged with up to 3 categories

Percentage of AI Chat Interactions

USER STUDY RESULTS

QUESTION TYPES (N=917)

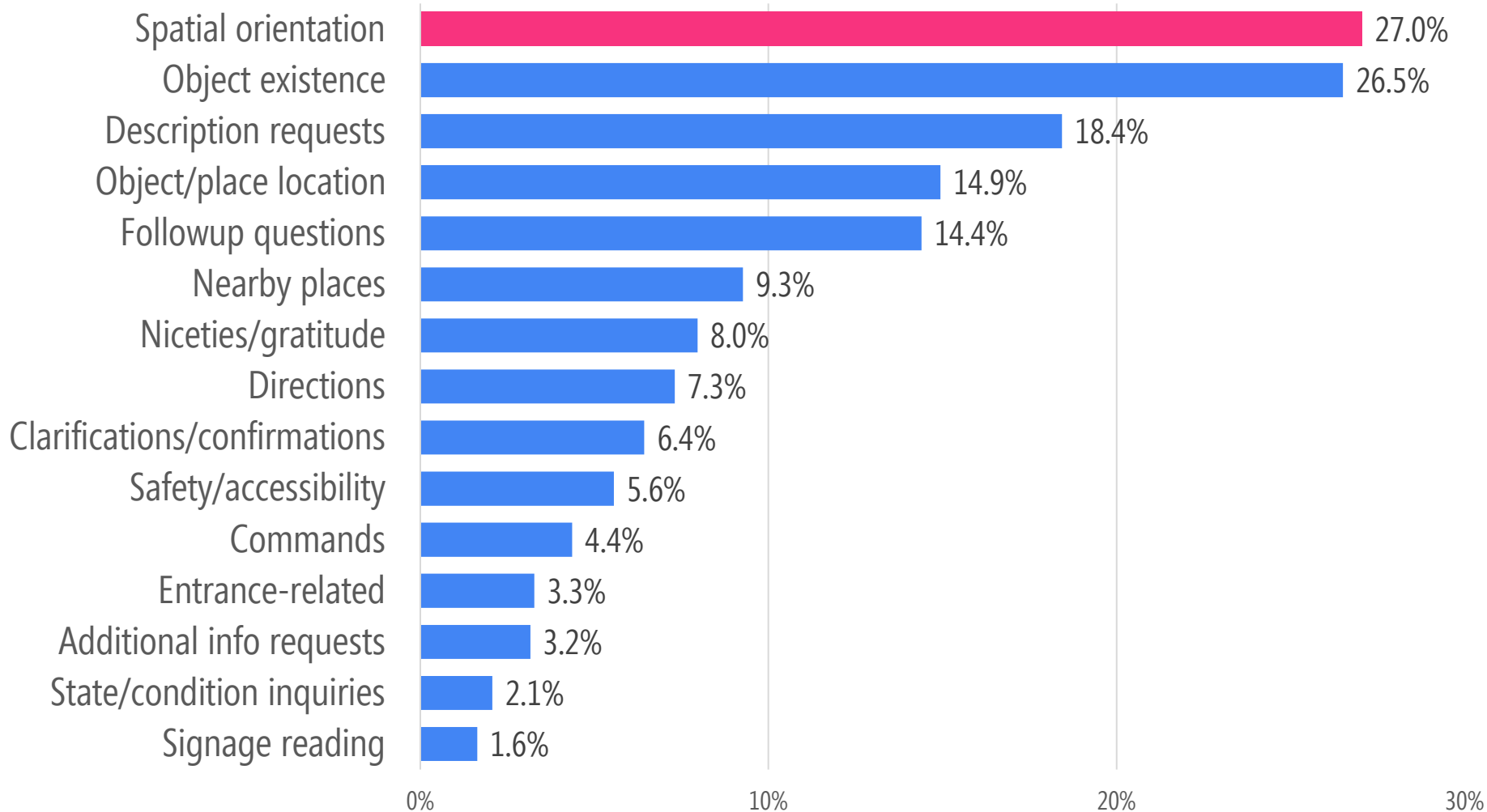


*Each question could be tagged with up to 3 categories

Percentage of AI Chat Interactions

USER STUDY RESULTS

QUESTION TYPES (N=917)



“How far is the bus stop to where I’m standing?”

“Which side is the bus stop sign on?”

“What’s to the left of this building”

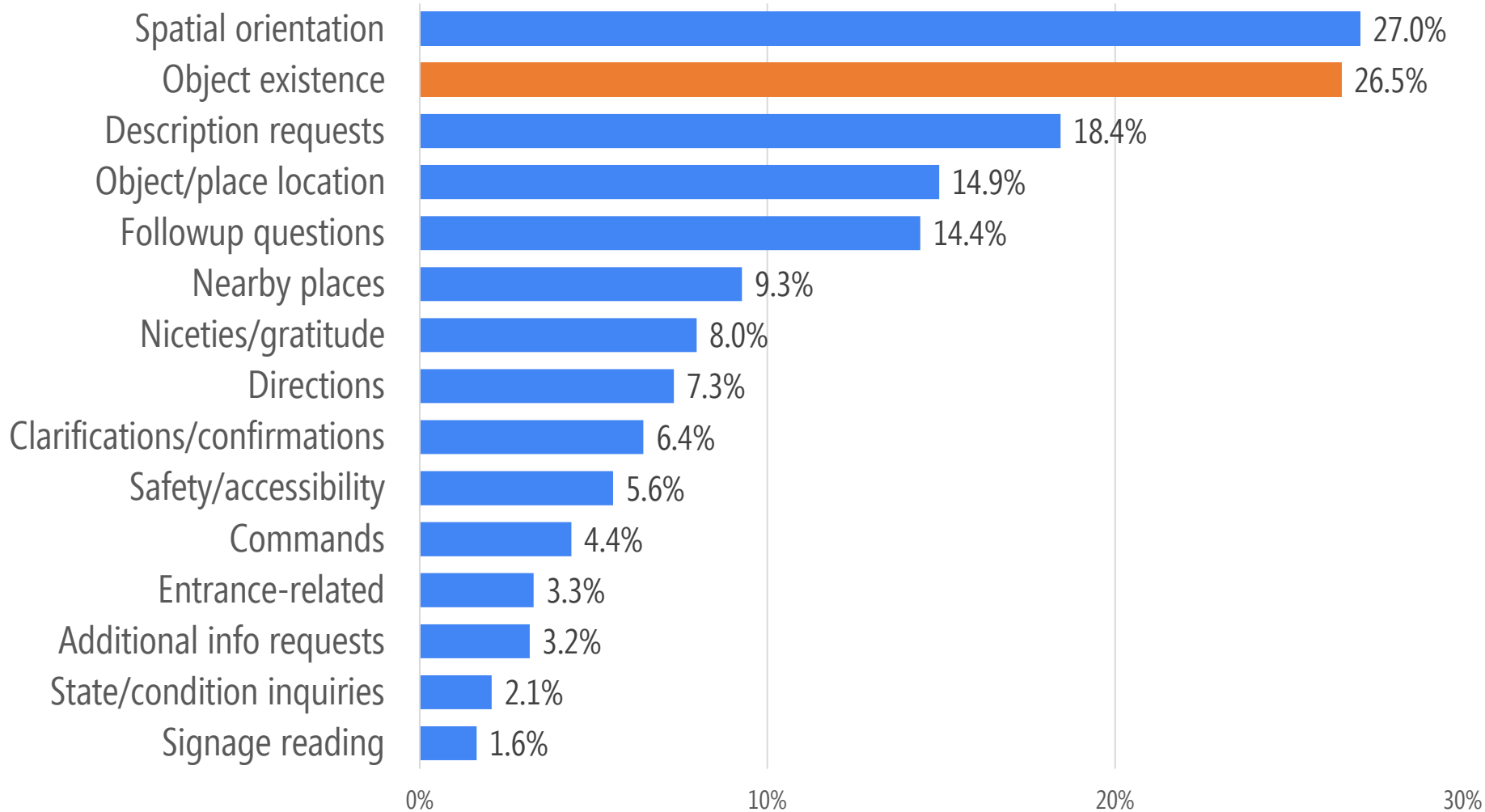
...

*Each question could be tagged with up to 3 categories

Percentage of AI Chat Interactions

USER STUDY RESULTS

QUESTION TYPES (N=917)



"Is there a bench?"

"Are there soccer fields?"

"Is there a crosswalk?"

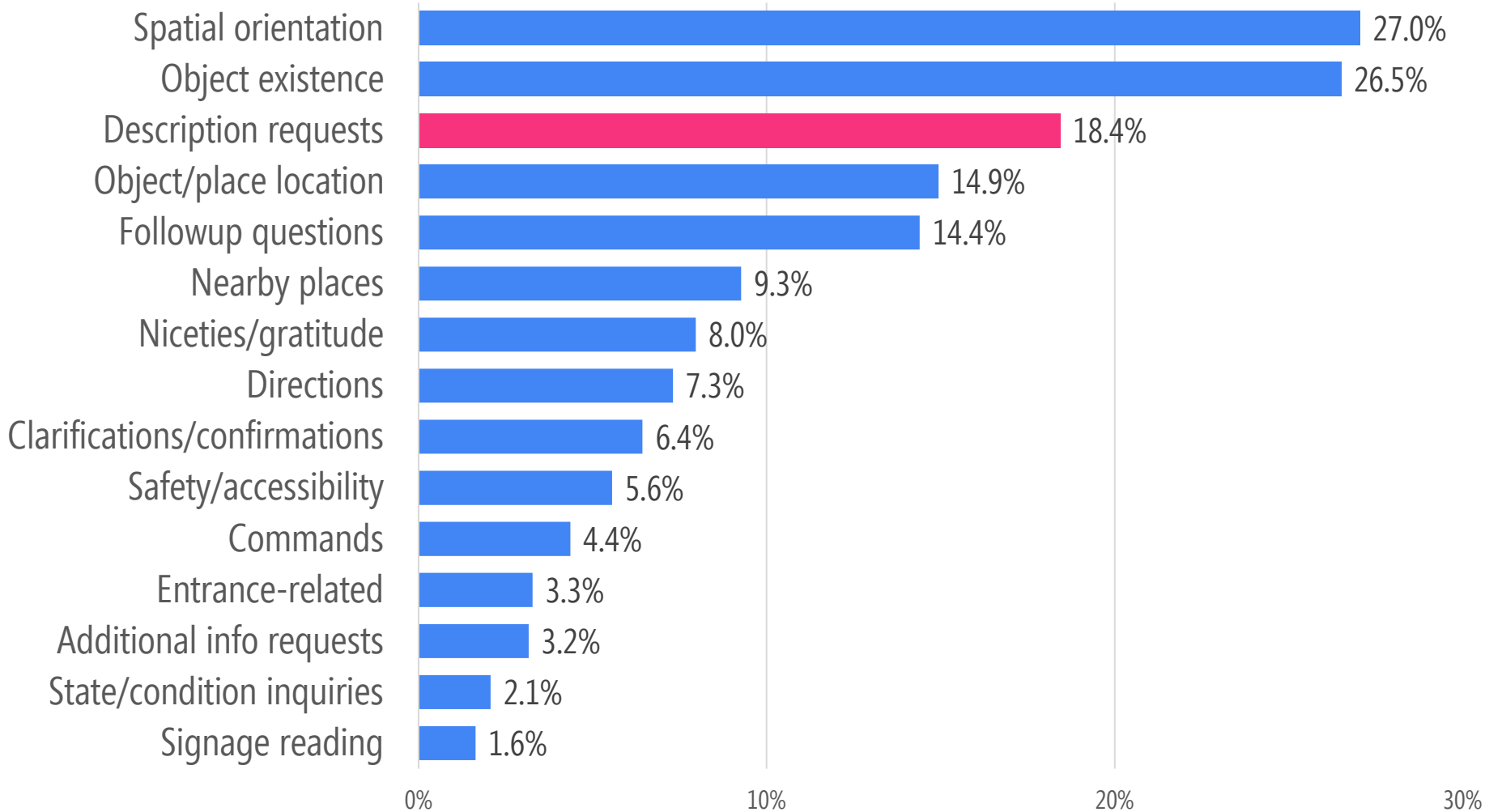
...

*Each question could be tagged with up to 3 categories

Percentage of AI Chat Interactions

USER STUDY RESULTS

QUESTION TYPES (N=917)



"What's in front of me?"

"What do you see?"

...

Percentage of AI Chat Interactions

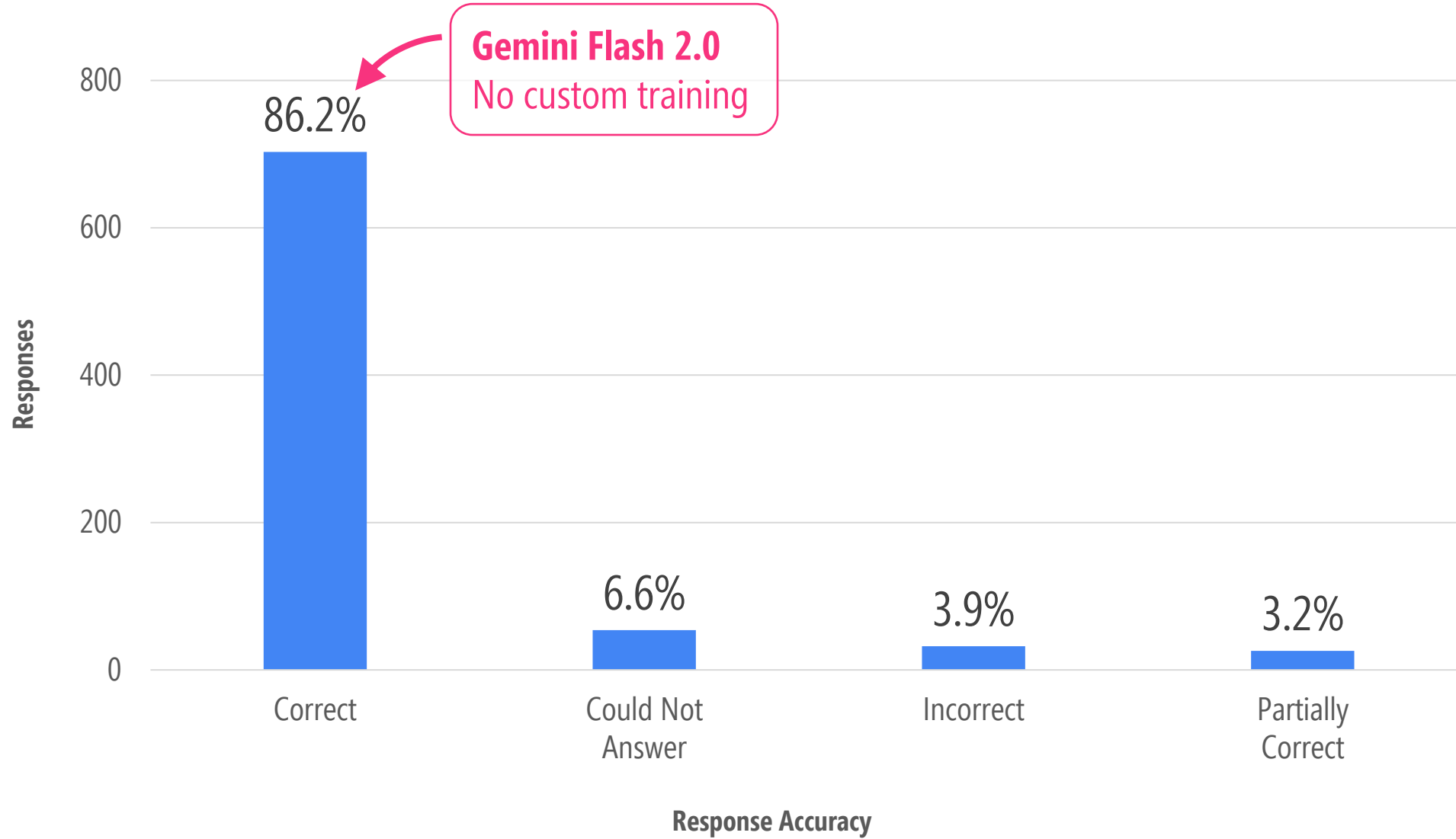
*Each question could be tagged with up to 3 categories

AI model accuracy **is critical**

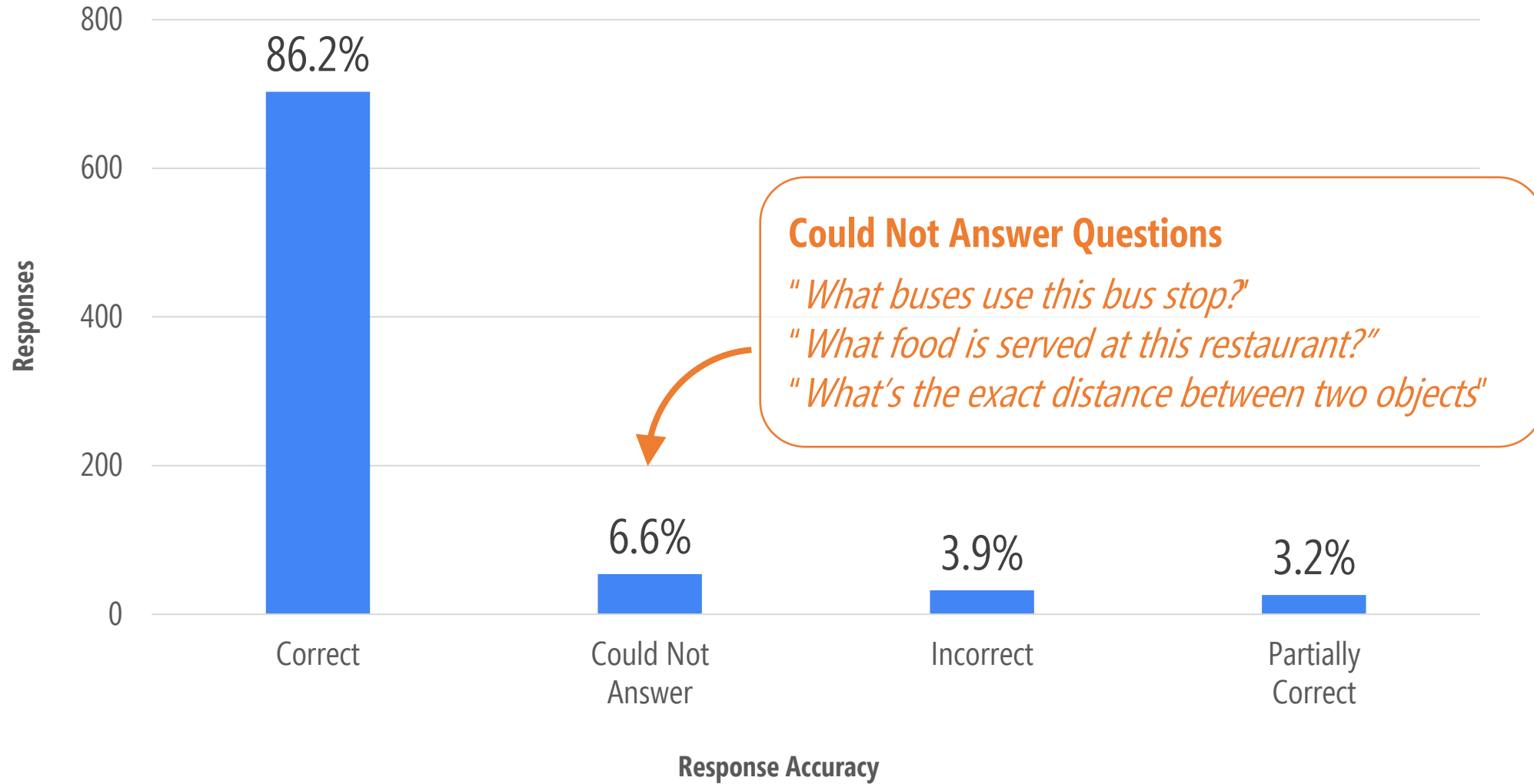
QUESTION RESPONSE ACCURACY (N=816)



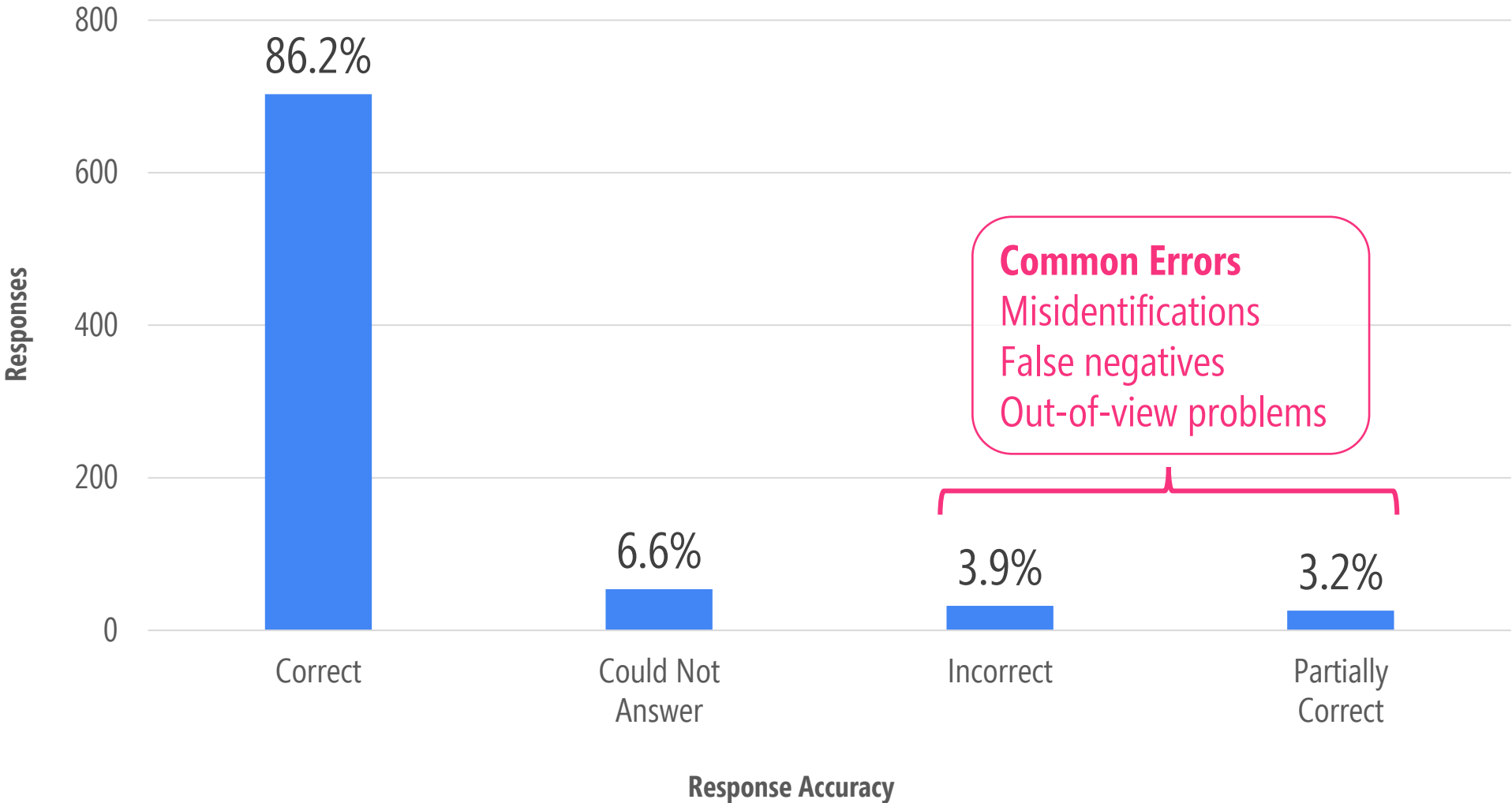
QUESTION RESPONSE ACCURACY (N=816)



QUESTION RESPONSE ACCURACY (N=816)



QUESTION RESPONSE ACCURACY (N=816)



Search for a location to go to...



Nearby

Virtual Tours



Generate Description

the street.

Okay.

Great. Let me know if you have any other questions.

turn me to towards the bus station

Done

what's ahead of me.

The bus stop is directly ahead of you. There are benches and a covered area.

are there any shelters in this stop?

Yes, the bus stop has a covered shelter with benches.

is there an APS system nearby?

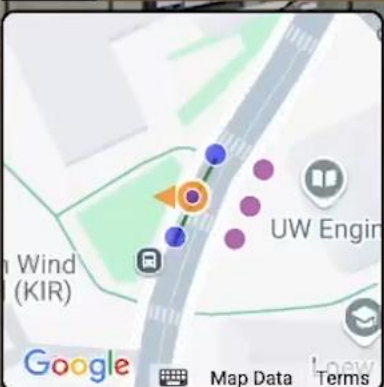
I'm sorry, but I don't have the ability to detect APS systems.

Listening...

End Conversation

✗ INCORRECT

Correct answer: no pedestrian signals



Are there any pedestrian signals nearby?

In some cases, system behaved
inconsistently and **unpredictably**

Search for a location to go to...



Nearby

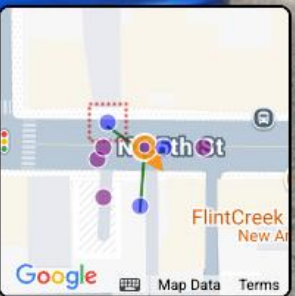
Virtual Tours



Ask a question about this location...



OLD BIKE RACK



Search for a location to go to...

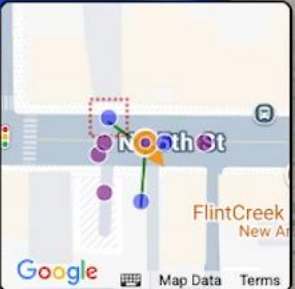
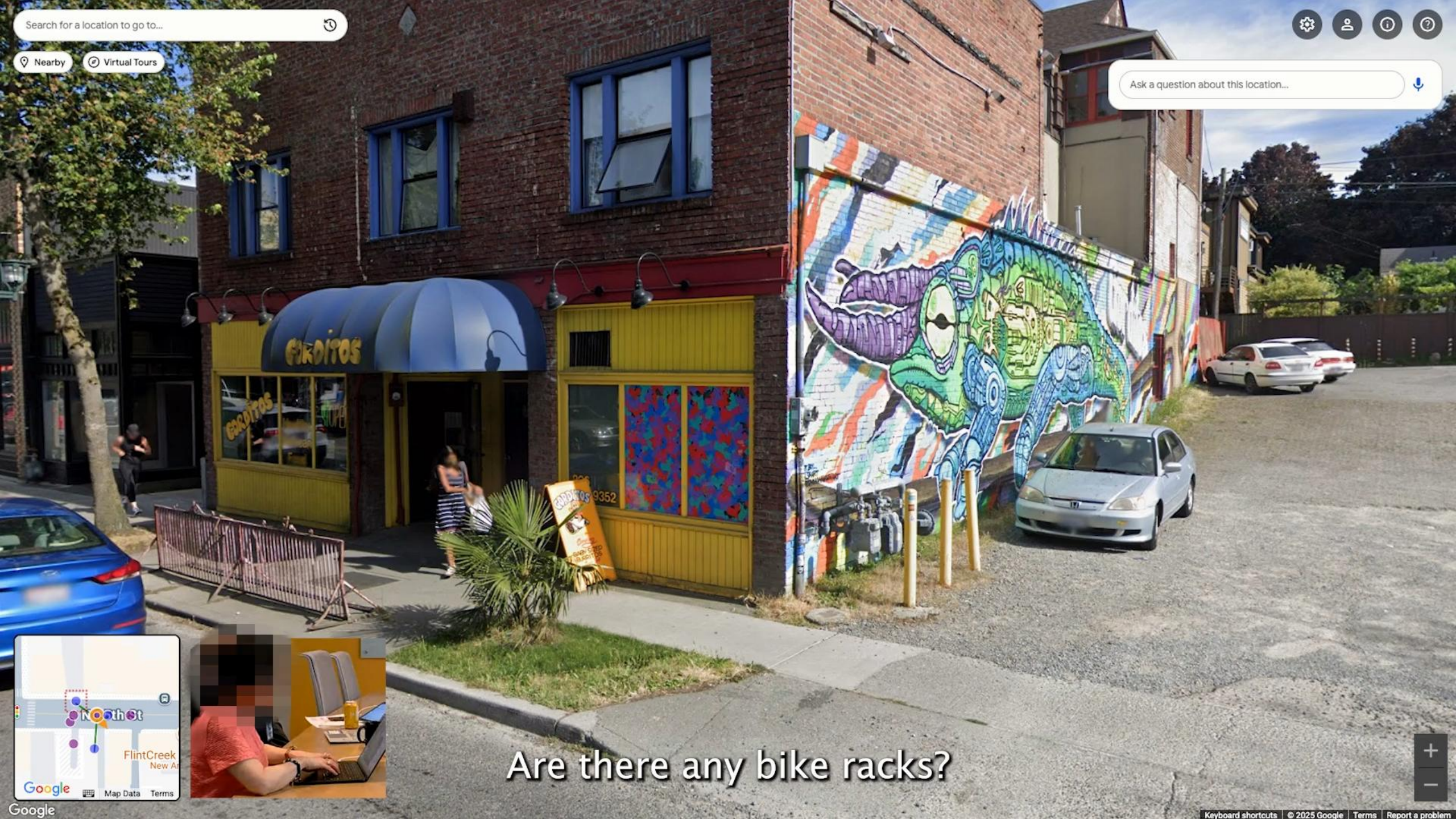


Nearby

Virtual Tours



Ask a question about this location...



Are there any bike racks?



But StreetReaderAI also gets it **right**

Search for a location to go to...

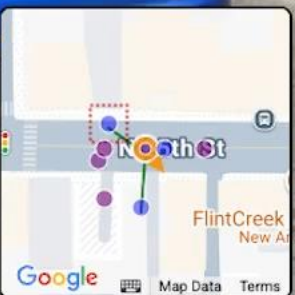
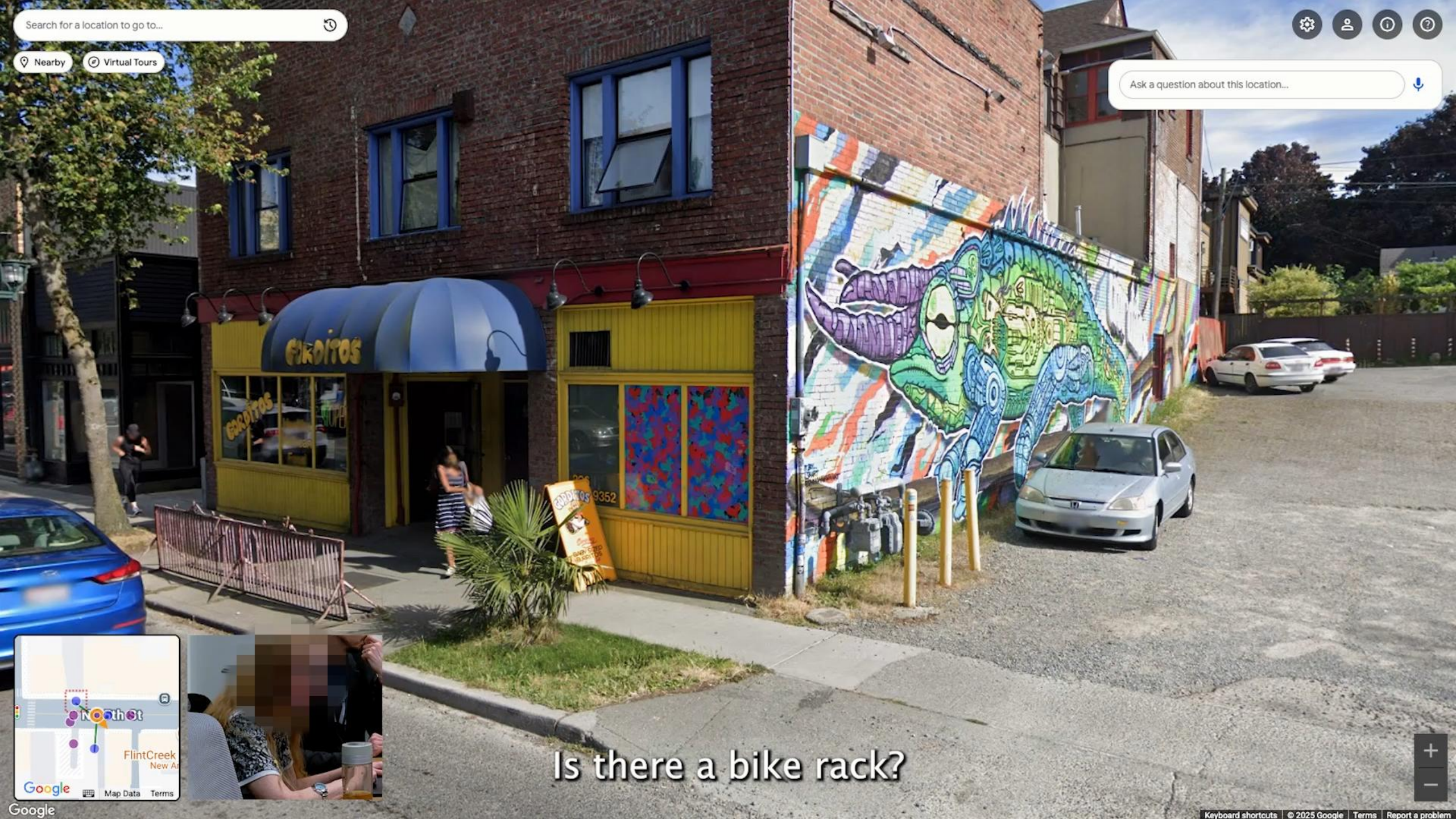


Nearby

Virtual Tours



Ask a question about this location...



Is there a bike rack?



User asks a question **before**
the target is visible in image

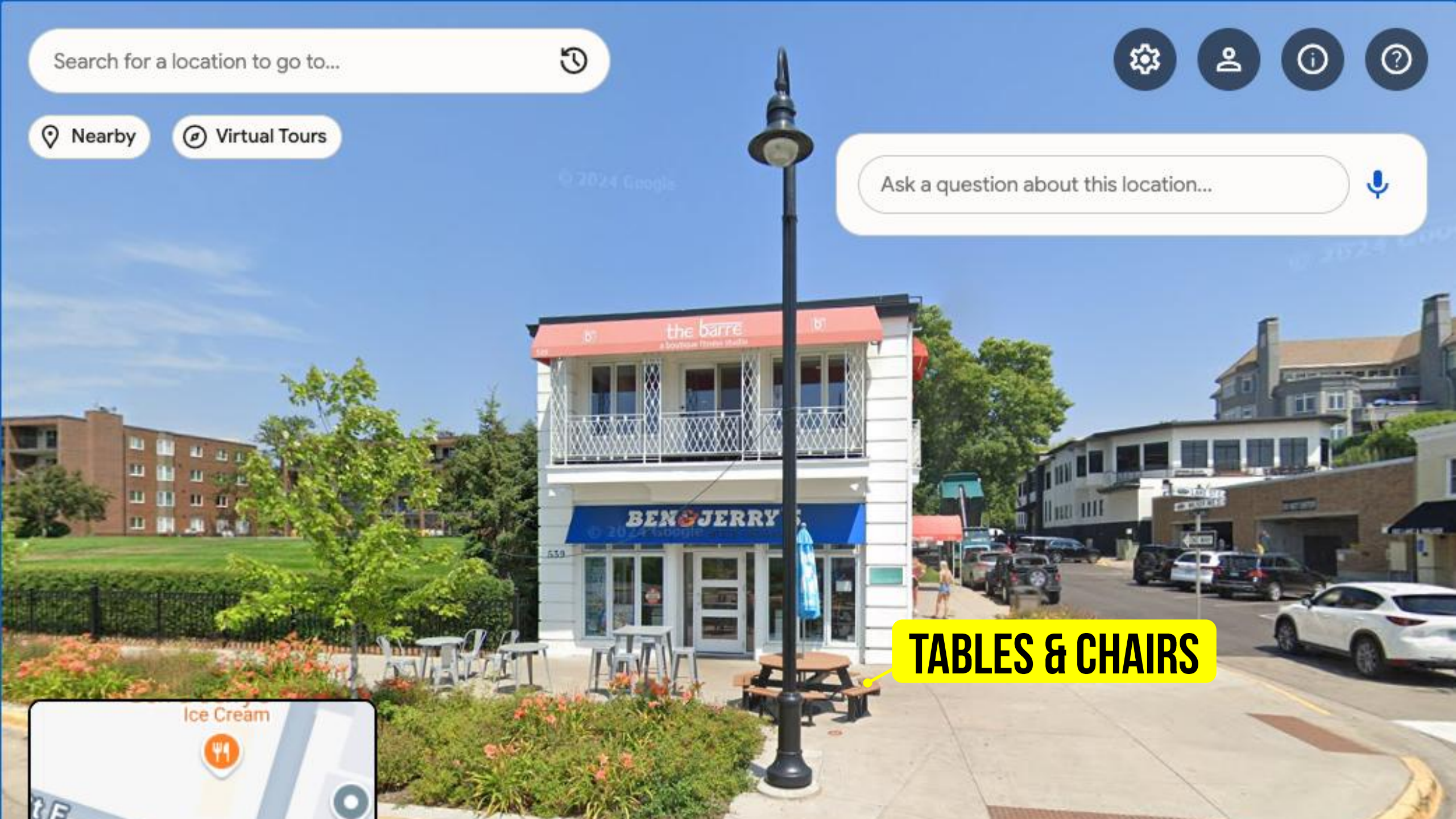
Search for a location to go to...



Nearby

Virtual Tours

Ask a question about this location...



TABLES & CHAIRS

Ice Cream



Search for a location to go to...



Nearby

Virtual Tours



Generate Description

Turn East.

Okay

move forward 100 m

Okay, I have moved you forward.

Verizon move forward

Okay, I have moved you forward.

forward to Ben & Jerry's

Okay, I have moved you forward. Ben & Jerry's is to your left.

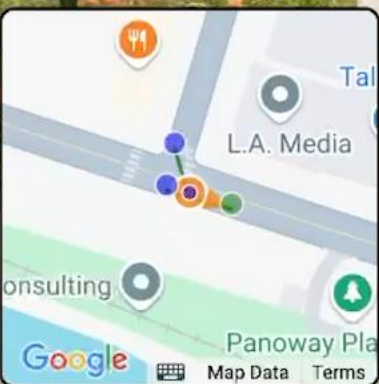
Listening...

End Conversation

✗ INCORRECT

Correct answer: there are tables & chairs

Solution: AI needs better viewpoint



County Road

Okay. I have moved you forward.

2.0x

Search for a location to go to...



Nearby

Virtual Tours

Generate Description

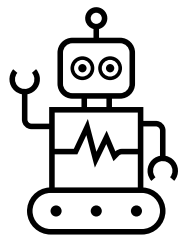
Listening...

End Conversation

✓ **Outdoor Seating**
Target now in view, AI gets it right



Is there an outdoor seating outside the Ben Jerry's store?



“Does the cafe entrance look accessible? Where is the door?” Towards Geospatial AI Agents for Visual Inquiries

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Yang Zhang³ Alex Fiannaca⁴ Philip Nelson² Shaun Kane²

¹University of Washington ²Google Research ³UCLA ⁴Google DeepMind

jonf@cs.uw.edu

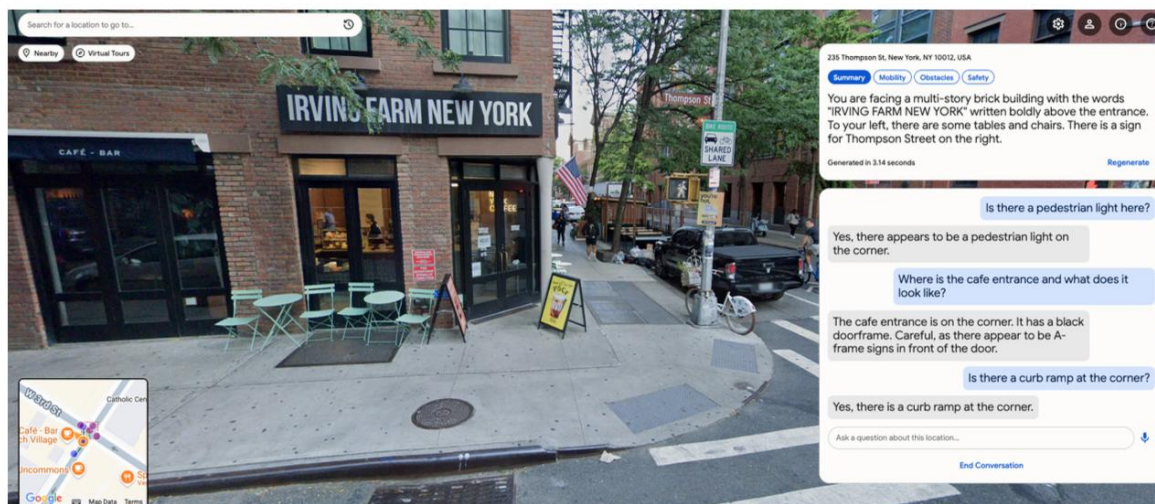


Figure 1. We introduce our vision for *Geo-Visual Agents*—multimodal AI agents capable of understanding and responding to nuanced visual-spatial inquiries about the world by analyzing large-scale repositories of geospatial images combined with traditional GIS data sources. For example, *StreetViewAI* [14] (above) makes street view accessible to blind users by combining geographic context, user information, and dynamic street view images into an MLLM, accessed via an AI chat interface and accessible screen reader controls.

Abstract

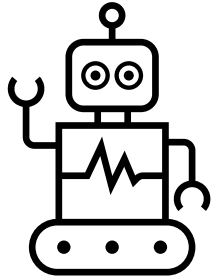
Interactive digital maps have revolutionized how people travel and learn about the world; however, they rely on pre-existing structured data in GIS databases (e.g., road networks, POI indices), limiting their ability to address geovisual questions related to what the world looks like. We introduce our vision for Geo-Visual Agents—multimodal AI agents capable of understanding and responding to nu-

1. Introduction

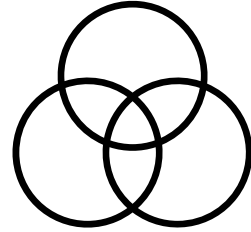
Over the last two decades, precise location sensing, pervasive internet connectivity, and interactive digital maps have transformed human mobility from travel planning to *in situ* navigation.. Despite these advances, current mapping systems are confined to pre-existing structured geospatial data, leaving a vast repository of visual information—latent within street-level, aerial, and user-contributed imagery—

Proposes a
more **agentic**
approach

FUTURE
FUTURE WORK



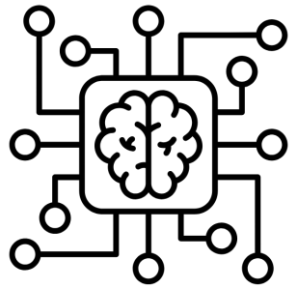
Agentic AI



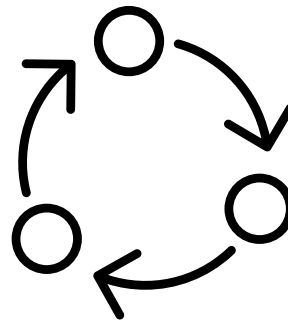
**Multimodal
Data Sources**



Data Provenance



**Model
Transparency**



**Improved SV
Immersion**



**Handoff to In-Situ
Experience**



CLOSING QUOTE

Having the freedom to get lost.



Having the freedom to get lost.

A person in a wheelchair is shown from the side, crossing a city street. The person is wearing a dark jacket and pants. The background shows a blurred cityscape with tall buildings. The image is part of a split-screen composition.

PRECIPICE OF A **FUNDAMENTAL SHIFT
IN ACCESSIBLE MOBILITY**



Join us. Together, **let's transform access** to the world!



ACKNOWLEDGEMENTS

FUNDING SOURCES



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FOUNDATION



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Accessible Technology and Experiences

UNIVERSITY *of* WASHINGTON





HUMAN-AI FOR PHYSICAL WORLD ACCESSIBILITY

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UMN Cray Colloquium

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