Scalable Techniques to Study the **Equitable** Distribution and Condition of US Sidewalks

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INDEPENDENCE, QUALITY OF LIFE, PHYSICAL ACTIVITY

Thapar *et al.*, 2004 ; Nuernberger, 2008

Source: https://americanhistory.si.edu/


NO CURB RAMPS
CHANEL
ONE WAY
DIESEL


PHYSICAL OBSTACLES


FedEx
INCOMPLETE SIDEWALKS


SURFACE PROBLEMS


PHYSICAL OBSTACLES
NO CURB RAMP
SURFACE DEGRADATION

THE PROBLEM IS NOT JUST A LACK OF ACCESSIBLE SIDEWALKS

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 cities.

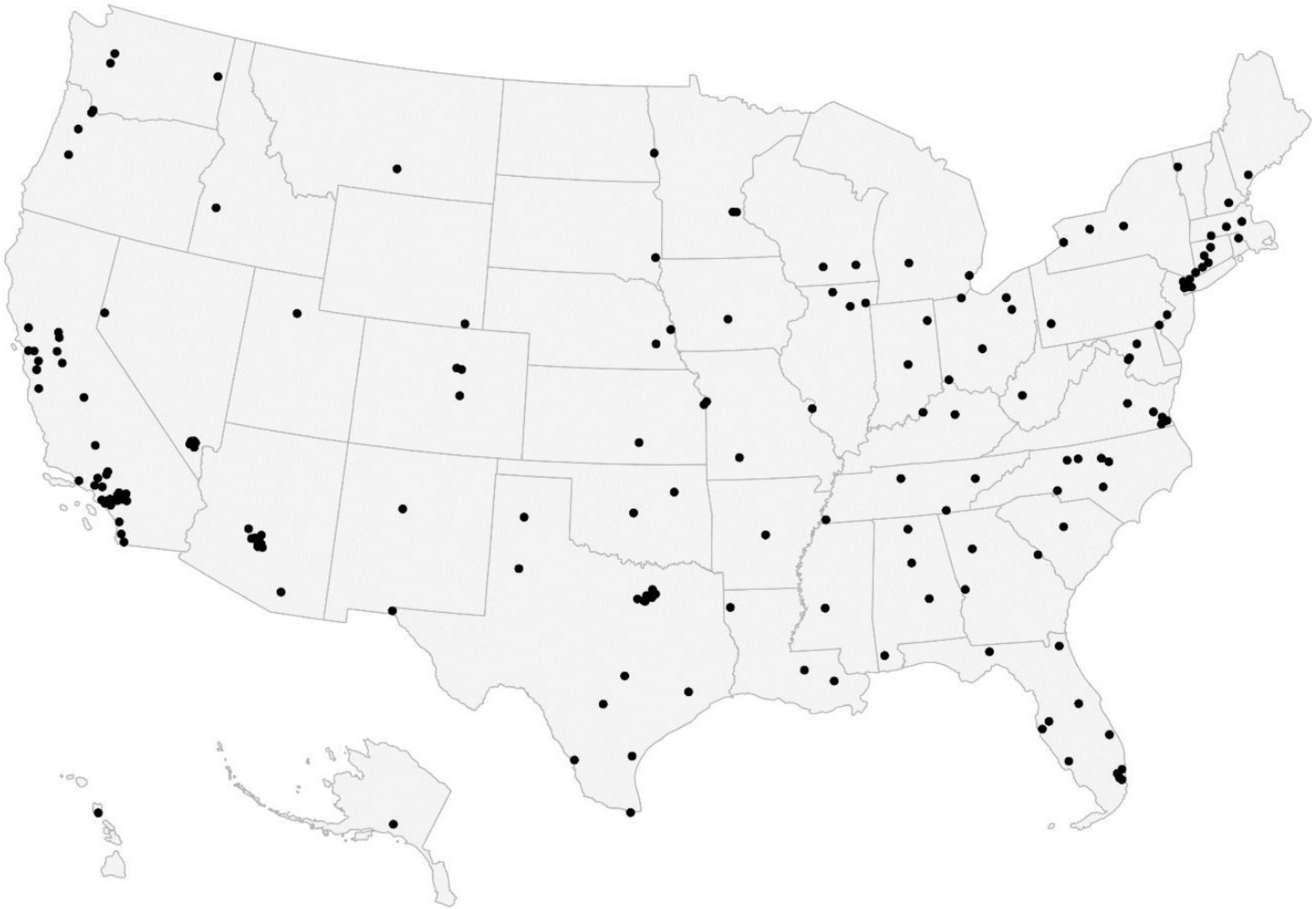
National Council on Disability, 2007
The impact of the Americans with Disabilities Act: Assessing the progress toward achieving the goals of the ADA

BACKGROUND

STUDY OF OPEN DATA ON SIDEWALKS

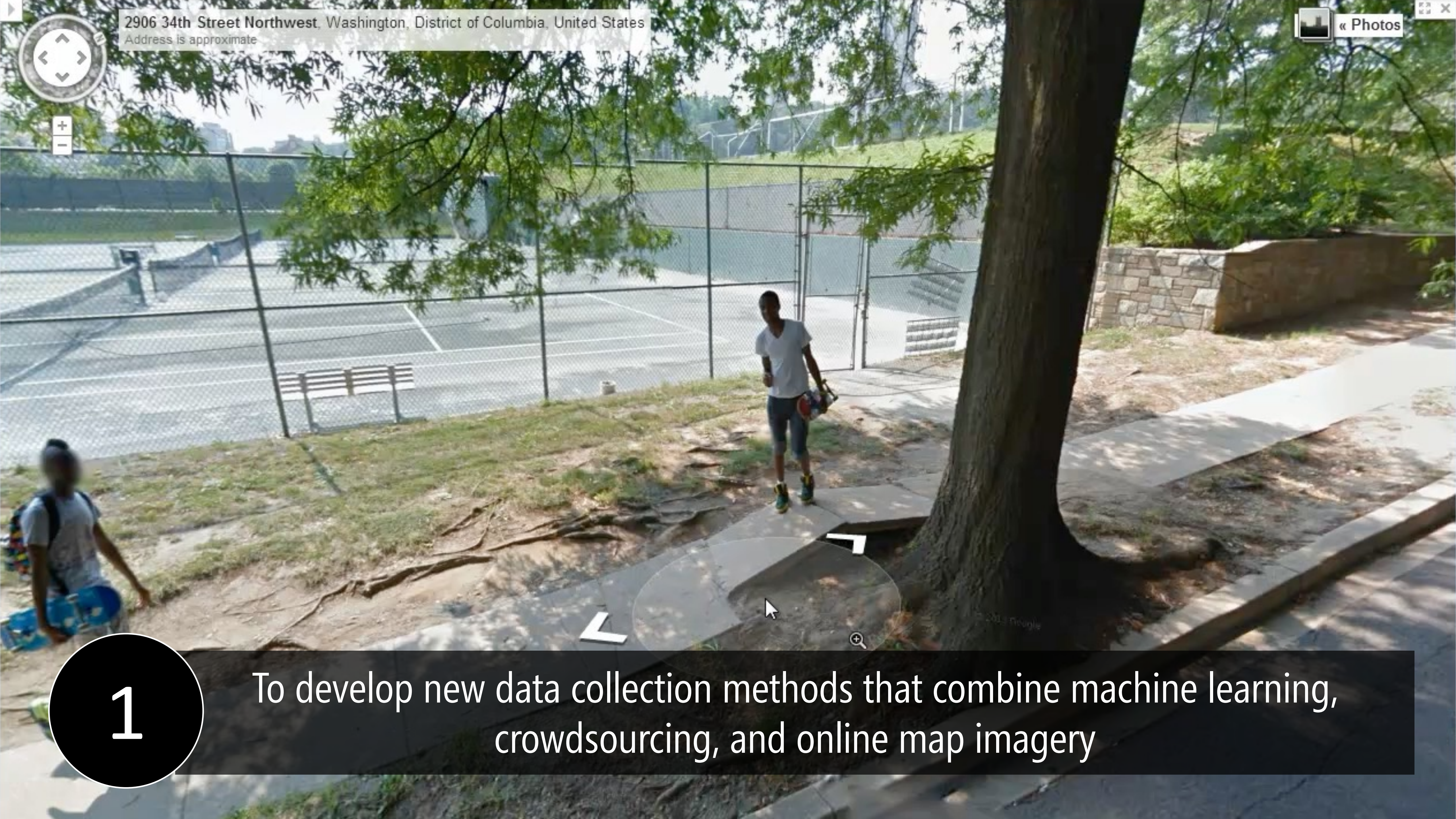
178 US CITIES

54% OPEN STREET DATA
20% SIDEWALKS
10% CURB RAMPS
<5% BASIC ACCESSIBILITY INFO



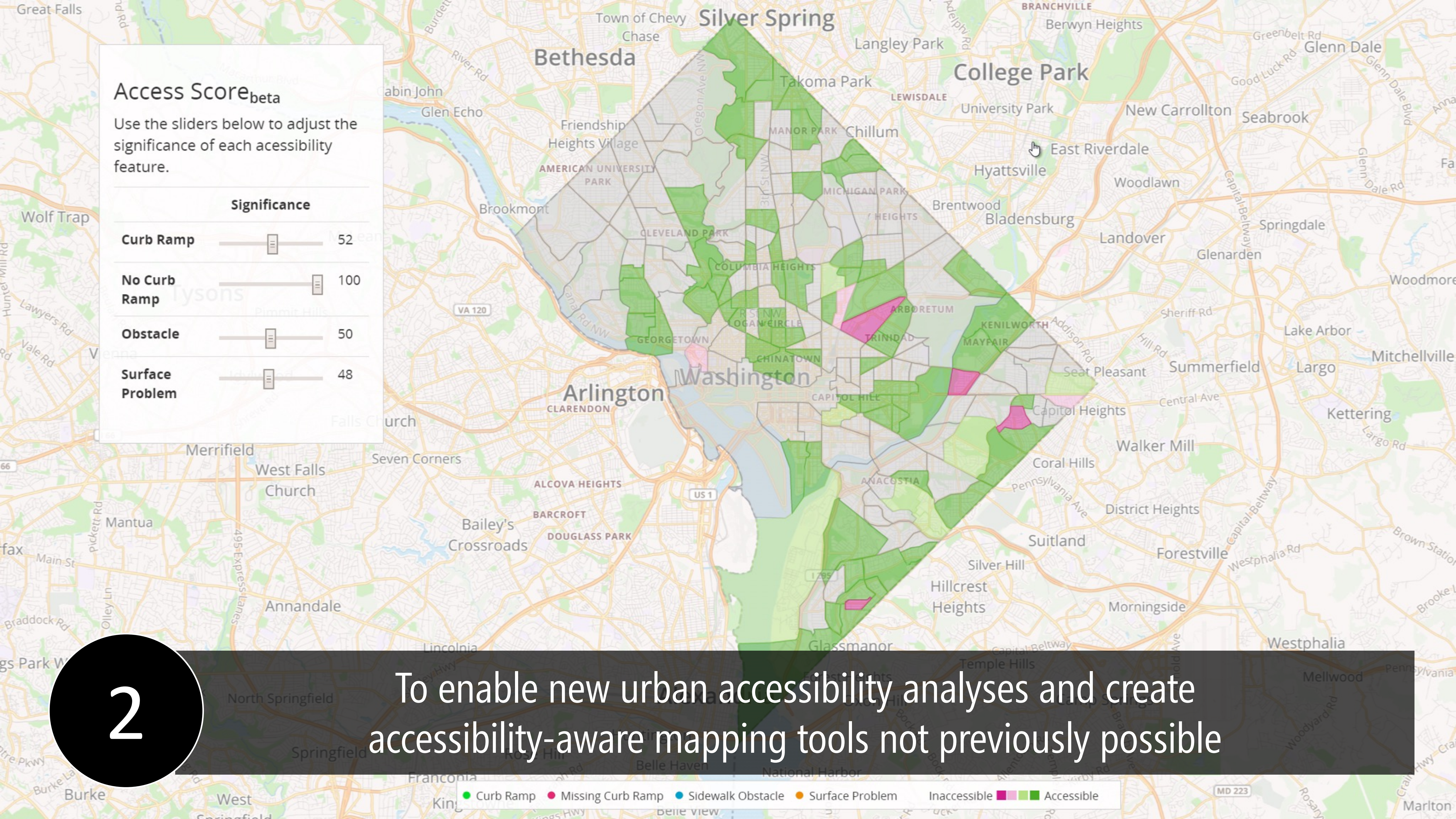
Source: Shiloh Deitz. 2020. *Free Movement: Enhancing Open Data to Facilitate Independent Travel for Persons with Disabilities.*

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



1

To develop new data collection methods that combine machine learning, crowdsourcing, and online map imagery

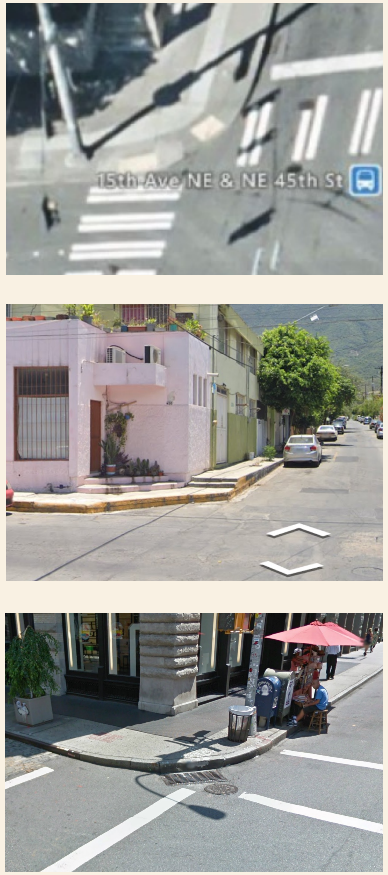

Access Score beta
Use the sliders below to adjust the significance of each acessibility feature.
Significance
Curb Ramp 52
No Curb Ramp 100
Obstacle 50
Surface Problem 48
Curb Ramp
Missing Curb Ramp
Sidewalk Obstacle
Surface Problem
Inaccessible
Accessible
2
To enable new urban accessibility analyses and create accessibility-aware mapping tools not previously possible

TRY IT!

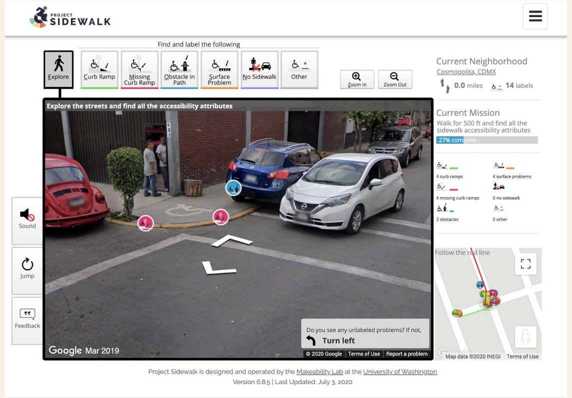
PROJECT SIDEWALK

http://projectsidewalk.org

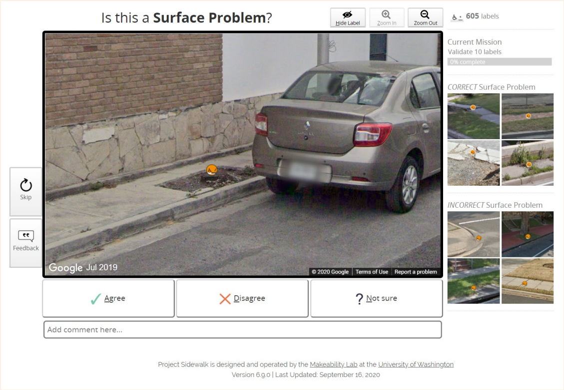
ONLINE MAP IMAGERY



REMOTE CROWDSOURCING INTERFACES



Labeling missions



Validation missions

HUMAN LABELS

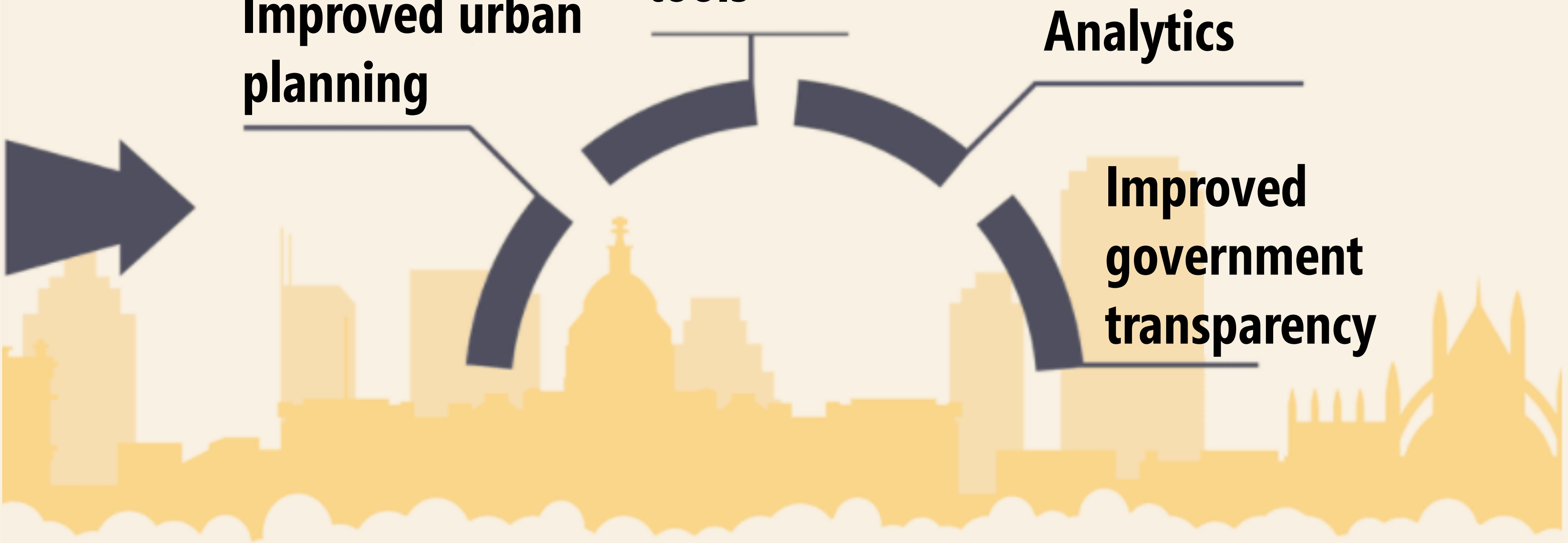
MACHINE LEARNING

PROJECT SIDEWALK

HTTP://PROJECTSIDEWALK.IO

OUTCOMES

MACHINE LEARNING



Tohme: Detecting Curb Ramps in Google Street View Using Crowdsourcing, Computer Vision, and Machine Learning

Kotaro Hara[1,2], Jin Sun, Robert Moore[1,2], David Jacobs, Jon E. Froehlich[1,2]
[1]Makeability Lab | [2]Human Computer Interaction Lab (HCIL)
Computer Science Department, University of Maryland, College Park
{kotaro, jinsun, dwj, jonf}@cs.umd.edu; rmoore15@umd.edu

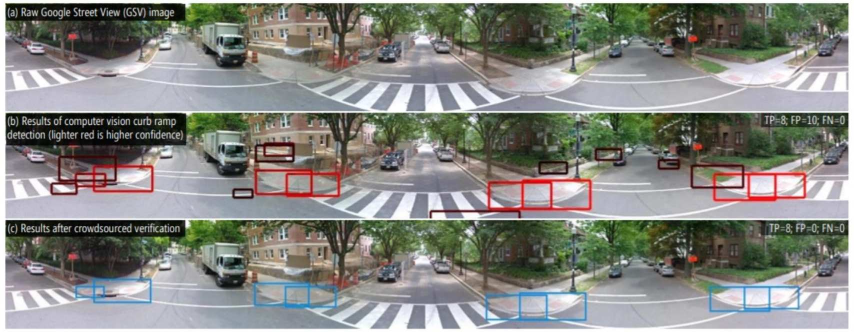


Figure 1: In this paper, we present *Tohme*, a scalable system for semi-automatically finding curb ramps in Google Streetview (GSV) panoramic imagery using computer vision, machine learning, and crowdsourcing. The images above show an actual result from our evaluation.

ABSTRACT

Building on recent prior work that combines Google Street View (GSV) and crowdsourcing to remotely collect information on physical world accessibility, we present the first "smart" system, *Tohme*, that combines machine learning, computer vision (CV), and custom crowd interfaces to find curb ramps remotely in GSV scenes. Tohme consists of two workflows, a human labeling pipeline and a CV pipeline with human verification, which are scheduled dynamically based on predicted performance. Using 1,086 GSV scenes (street intersections) from four North American cities and data from 403 crowd workers, we show that Tohme performs similarly in detecting curb ramps compared to a manual labeling approach alone (F-measure: 84% *vs.* 86% baseline) but at a 13% reduction in time cost. Our work contributes the first CV-based curb ramp detection system, a custom machine-learning based workflow controller, a validation of GSV as a viable curb ramp data source, and a detailed examination of why curb ramp detection is a hard problem along with steps forward.

UIST '14, October 05 - 08 2014, Honolulu, HI, USA
Copyright 2014 ACM 978-1-4503-3069-5/14/10$15.00.
http://dx.doi.org/10.1145/2642918.2647403

Author Keywords

Crowdsourcing accessibility, computer vision, Google Street View, Amazon Mechanical Turk

INTRODUCTION

Recent work has examined how to leverage massive online map datasets such as Google Street View (GSV) along with crowdsourcing to collect information about the accessibility of the built environment [22–26]. Early results have been promising; for example, using a manually curated set of static GSV images, Hara *et al.* [24] found that minimally trained crowd workers in Amazon Mechanical Turk (turkers) could find four types of street-level accessibility problems with 81% accuracy. However, the sole reliance on *human* labor limits scalability.

In this paper, we present Tohme[1], a scalable system for remotely collecting geo-located curb ramp data using a combination of crowdsourcing, Computer Vision (CV), machine learning, and online map data. Tohme lowers the overall human time cost of finding accessibility problems in GSV while maintaining result quality (Figure 1). As the first work in this area, we limit ourselves to sidewalk curb ramps (sometimes called "curb cuts"), which we selected because of their visual salience, geospatial properties (*e.g.*, often located on corners), and significance to accessibility.

[1] Tohme is a Japanese word that roughly translates to "remote eye."

Deep Learning for Automatically Detecting Sidewalk Accessibility Problems Using Streetscape Imagery

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[2]Department of Computer Science, University of Maryland, College Park, USA
{gweld, infrared, aileenz, kheimerl, jonf}@cs.washington.edu, antli@umd.edu

ABSTRACT

Recent work has applied machine learning methods to automatically find and/or 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.,* geography). 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 and, 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. Artificial Intelligence: 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 [47], quality of life [38], and overall physical activity [17]. While mapping tools like Google and Apple Maps have begun offering pedestrian-focused features, they do not incorporate sidewalk routes or information on sidewalk accessibility [23], which limits their utility and disproportionately affects people with disabilities. A key challenge is data: 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 inspections by city transit departments or community volunteers. However, these audits are expensive, labor intensive, and infrequent. [1] Moreover, the resulting data is in disparate formats, is not typically open (*i.e.,* published online), and is not intended for end-user tools [23, 50]. To expand who can collect sidewalk data and to improve data granularity and freshness, researchers have introduced smartphone-based tools [15, 46, 52] as well as instrumented wheelchairs [35, 39, 51, 57], both of which capture sidewalk information *in situ* as it's experienced. However, these tools have been limited by low adoption, small geographic coverage, and high user burden (*e.g.,* requiring users to take out their phones, load an app, take a picture, annotate it, and upload it) [20, 23].

To partially address these scalability issues, researchers have begun developing automated methods for sidewalk assessment using machine learning and online imagery (*e.g.,* satellite photos [10, 8], panoramic streetscape imagery [31, 32, 59]). While still early, these complementary approaches promise to dramatically decrease manual labor and cost. However, they have been limited by two interrelated issues: small training sets and the choice in machine learning model—both of which negatively impact performance. In this paper, we attempt to address both of these issues.

We present the first examination of deep learning methods to automatically assess sidewalk accessibility in terms of *curb ramps*, *missing curb ramps*, *surface problems*, and *sidewalk obstructions* from widely available streetscape imagery. Our work is enabled by the recently released Project Sidewalk open dataset, which contains a corpus of 300,000+ image-based sidewalk accessibility labels collected via remote crowdsourcing in Google Street View (GSV) [55] (Figure 1). Specifically, we investigate two application tasks using GSV panoramas: automatically *validating* crowdsourced labels and automatically *labeling* sidewalk accessibility issues.

Our research questions include:

- **R1:** How well does our machine learning approach perform across our two tasks (validation and labeling)?
- **R2:** What is the impact of additional, non-image related training features on performance?
- **R3:** How does classification accuracy change as a function of training data amount?
- **R4:** How well does our model generalize across cities?

To address these questions, we trained two sets of deep convolutional neural networks using ResNet-18 [33]—one set for

[1] As one example, the Seattle Department of Transportation completed their first ever sidewalk assessment in 2016, which took 14 interns nearly a year to complete. [1]

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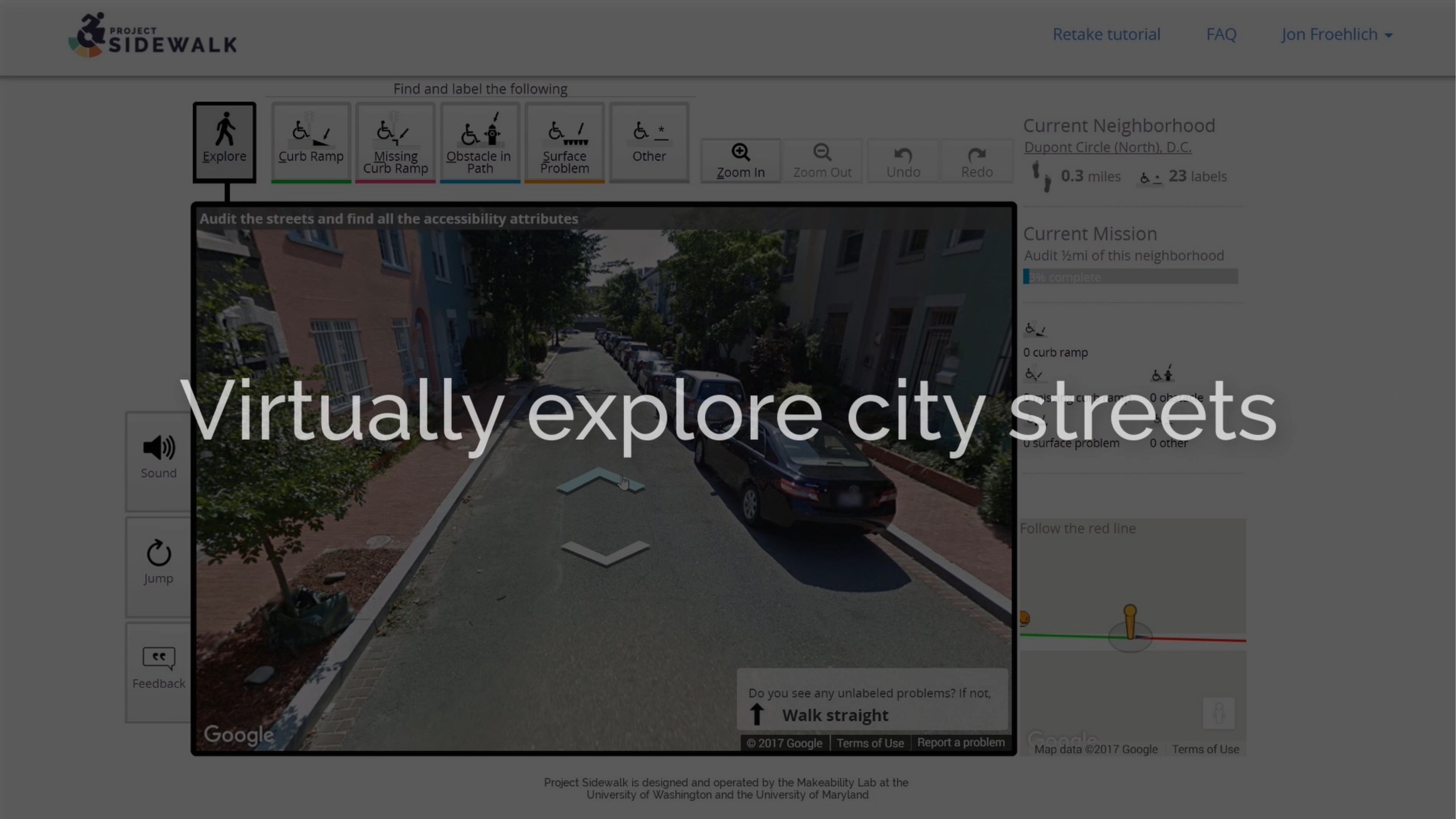
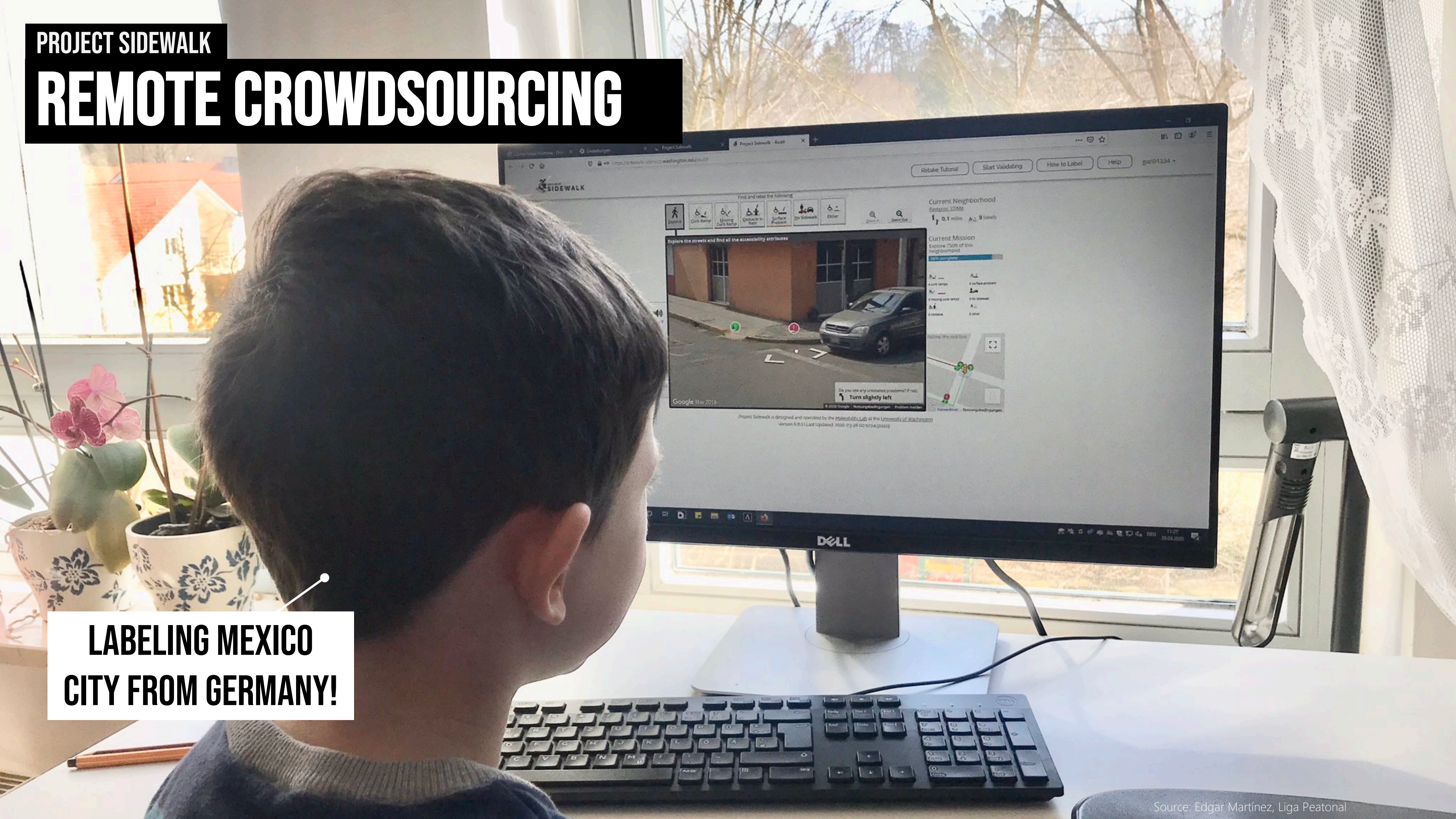
DOI: 10.1145/3308561.3353798



PROJECT SIDEWALK
Retake tutorial
FAQ
Jon Froehlich
Find and label the following
Explore
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
Other
Zoom In
Zoom Out
Undo
Redo
Current Neighborhood
Dupont Circle (North), D.C.
0.3 miles
23 labels
Current Mission
Audit ½mi of this neighborhood
0 curb ramp
0 surface problem
0 other
Follow the red line
Audit the streets and find all the accessibility attributes
Virtually explore city streets
Sound
Jump
Feedback
Do you see any unlabeled problems? If not,
Walk straight
Google
© 2017 Google
Terms of Use
Report a problem
Map data ©2017 Google
Terms of Use
Project Sidewalk is designed and operated by the Makeability Lab at the University of Washington and the University of Maryland

PROJECT SIDEWALK

REMOTE CROWDSOURCING

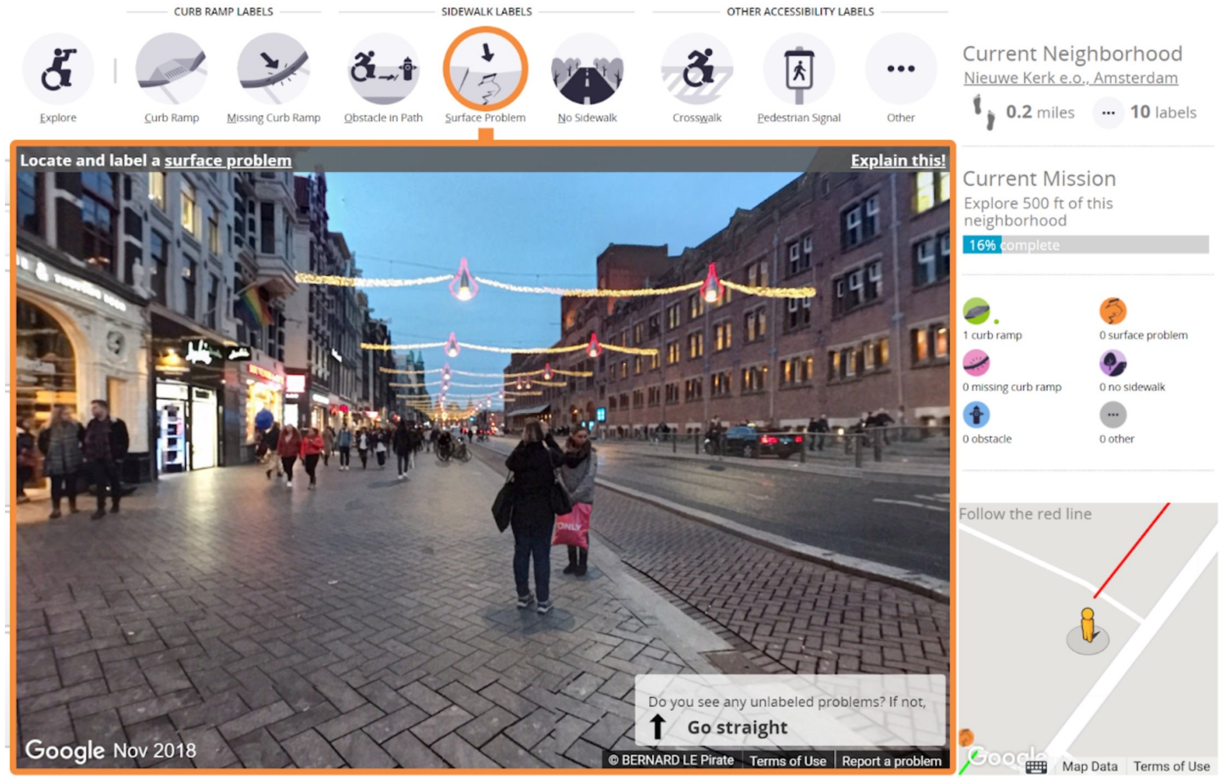


LABELING MEXICO CITY FROM GERMANY!

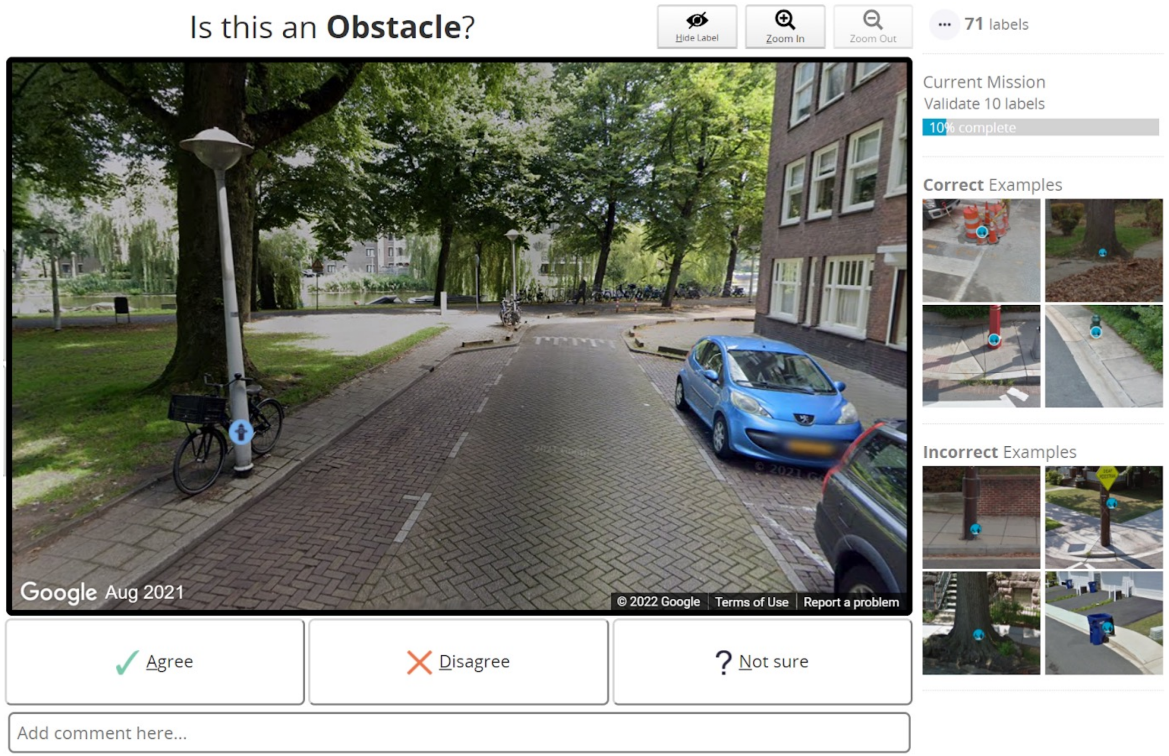
Source: Edgar Martínez, Liga Peatonal

PROJECT SIDEWALK

TWO DATA COLLECTION MISSIONS

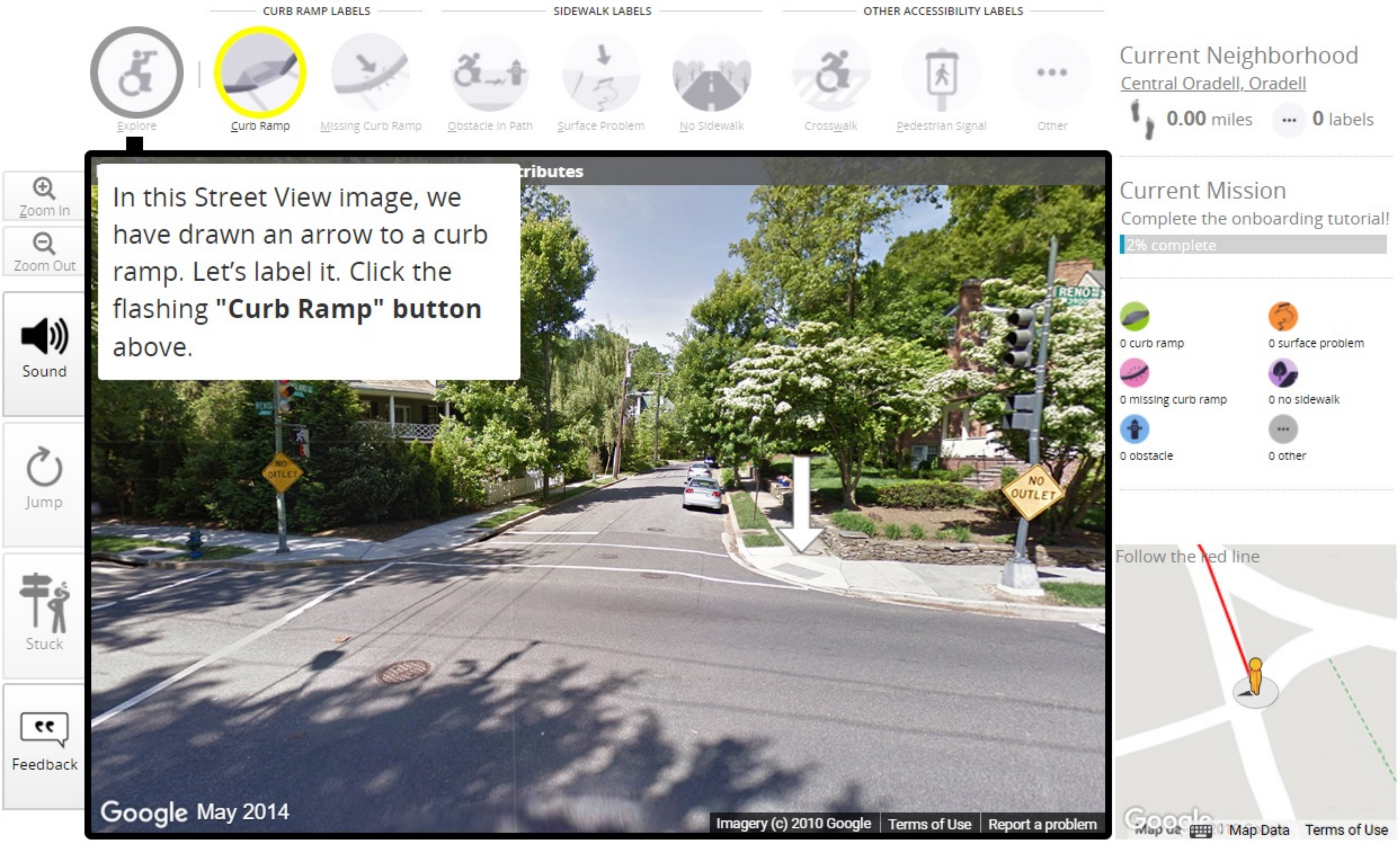


1 FIND, LABEL, & ASSESS SIDEWALKS

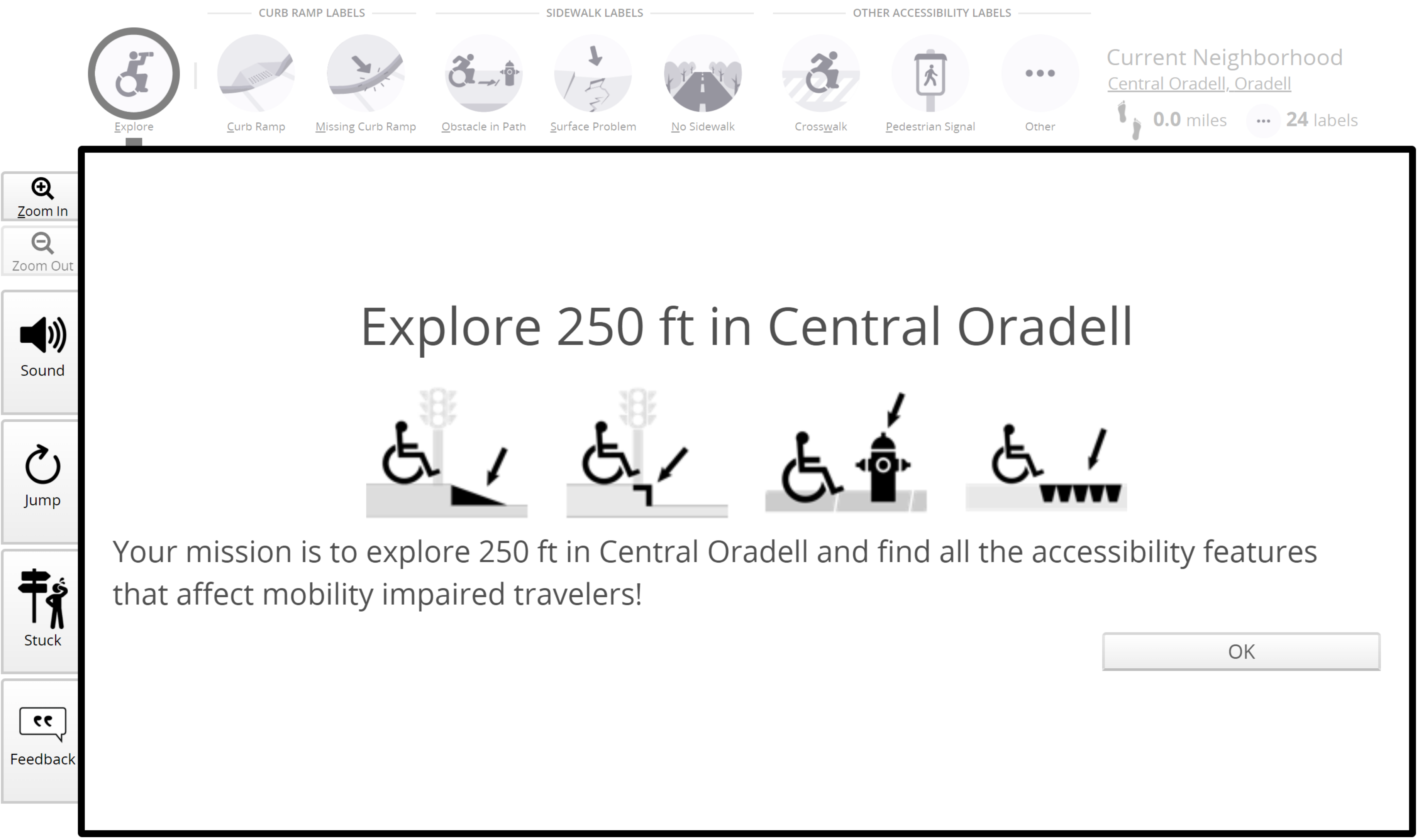


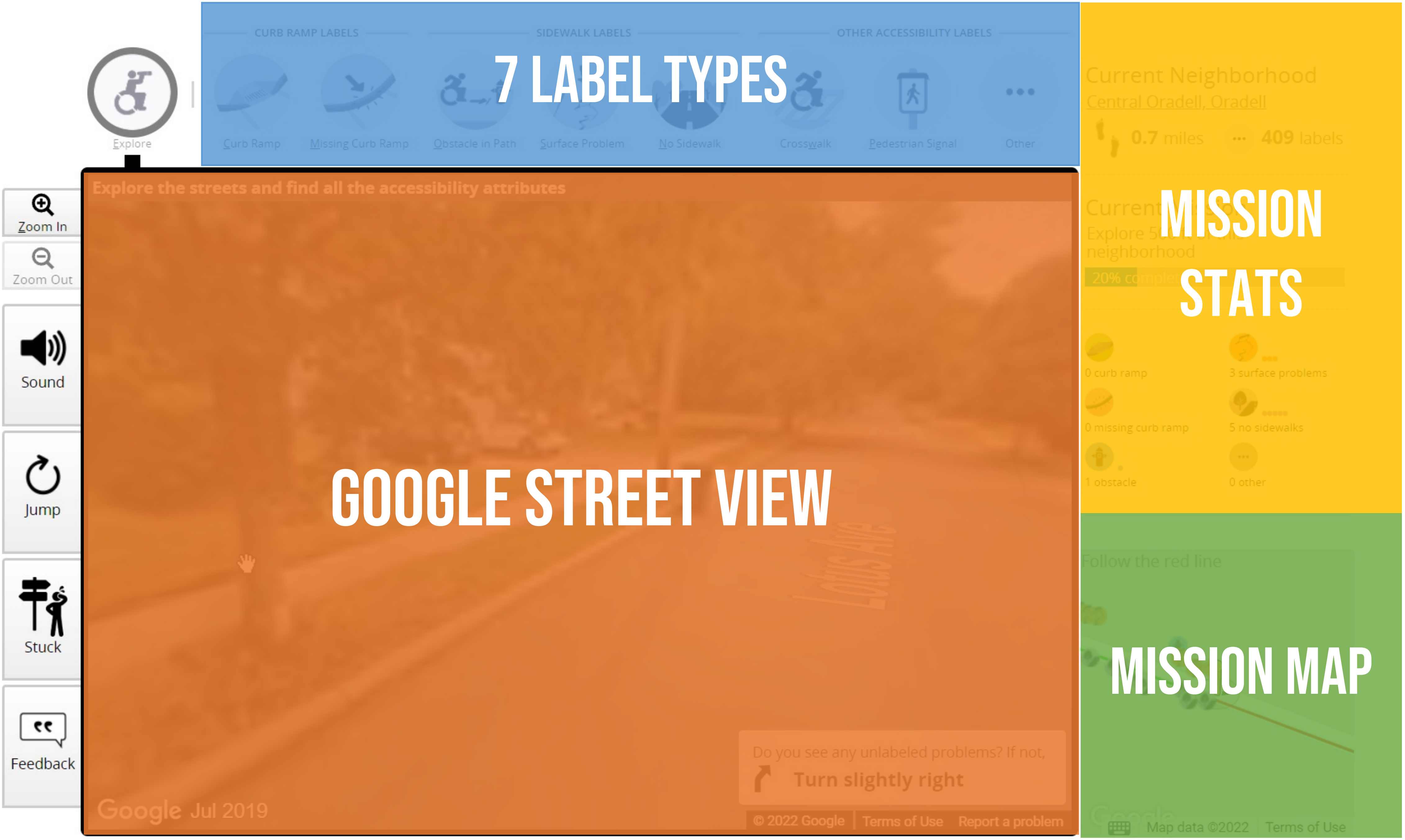
2 VALIDATING & CORRECTING LABELS

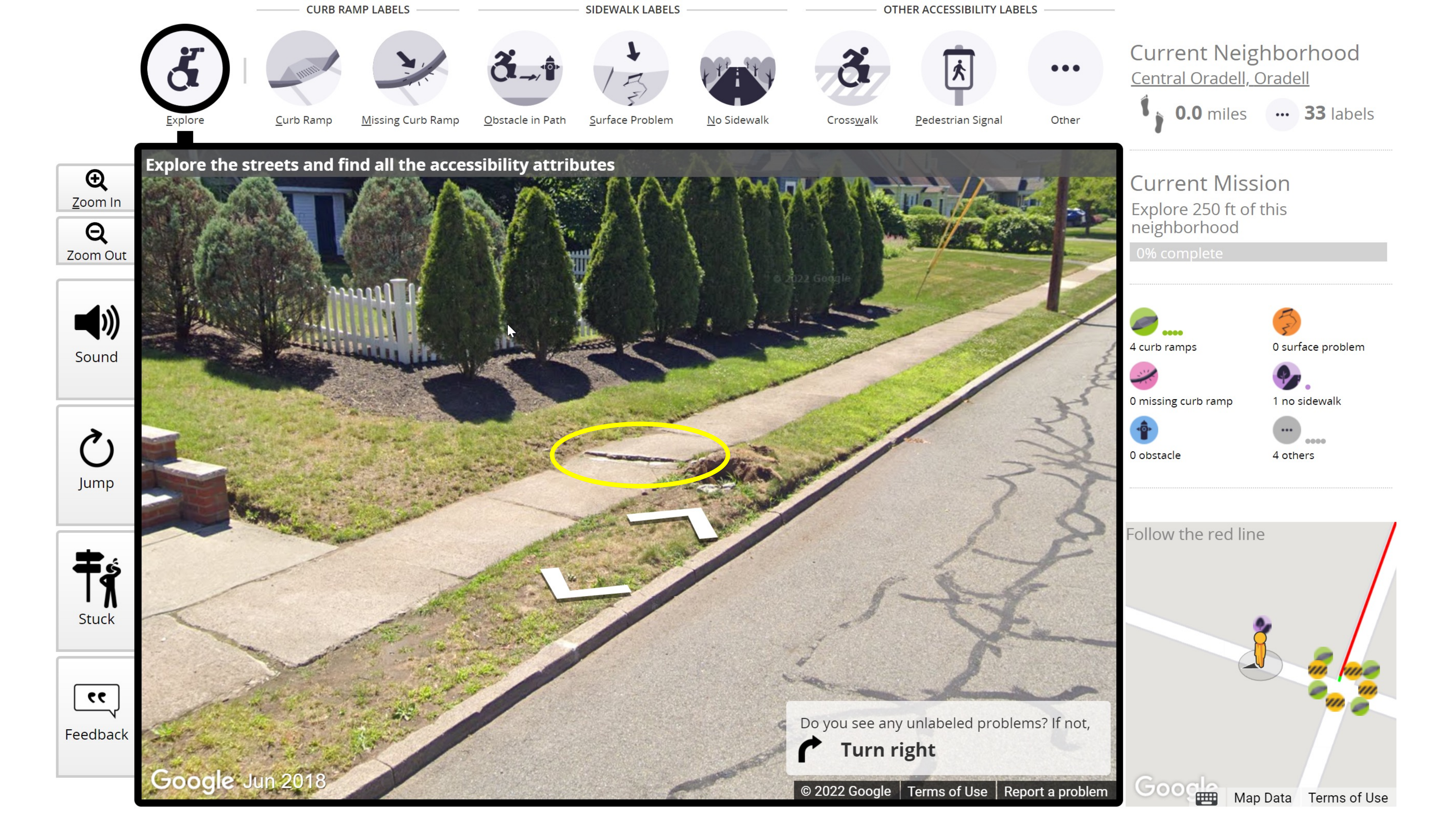
FIRST MISSION: INTERACTIVE TUTORIAL



EXPLORATION MISSION




7 LABEL TYPES
MISSION STATS
GOOGLE STREET VIEW
MISSION MAP
CURB RAMP LABELS
SIDEWALK LABELS
OTHER ACCESSIBILITY LABELS
Explore
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
No Sidewalk
Crosswalk
Pedestrian Signal
Other
Zoom In
Zoom Out
Sound
Jump
Stuck
Feedback
Explore the streets and find all the accessibility attributes
Current Neighborhood
Central Oradell, Oradell
0.7 miles
409 labels
0 curb ramp
3 surface problems
0 missing curb ramp
5 no sidewalks
1 obstacle
0 other
Follow the red line
Do you see any unlabeled problems? If not,
Turn slightly right
Google Jul 2019
© 2022 Google
Terms of Use
Report a problem
Map data ©2022
Terms of Use


CURB RAMP LABELS
SIDEWALK LABELS
OTHER ACCESSIBILITY LABELS
Explore
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
No Sidewalk
Crosswalk
Pedestrian Signal
Other
Current Neighborhood
Central Oradell, Oradell
0.0 miles
33 labels
Zoom In
Zoom Out
Sound
Jump
Stuck
Feedback
Explore the streets and find all the accessibility attributes
Current Mission
Explore 250 ft of this neighborhood
0% complete
4 curb ramps
0 surface problem
0 missing curb ramp
1 no sidewalk
0 obstacle
4 others
Follow the red line
Do you see any unlabeled problems? If not,
Turn right
Google Jun 2018
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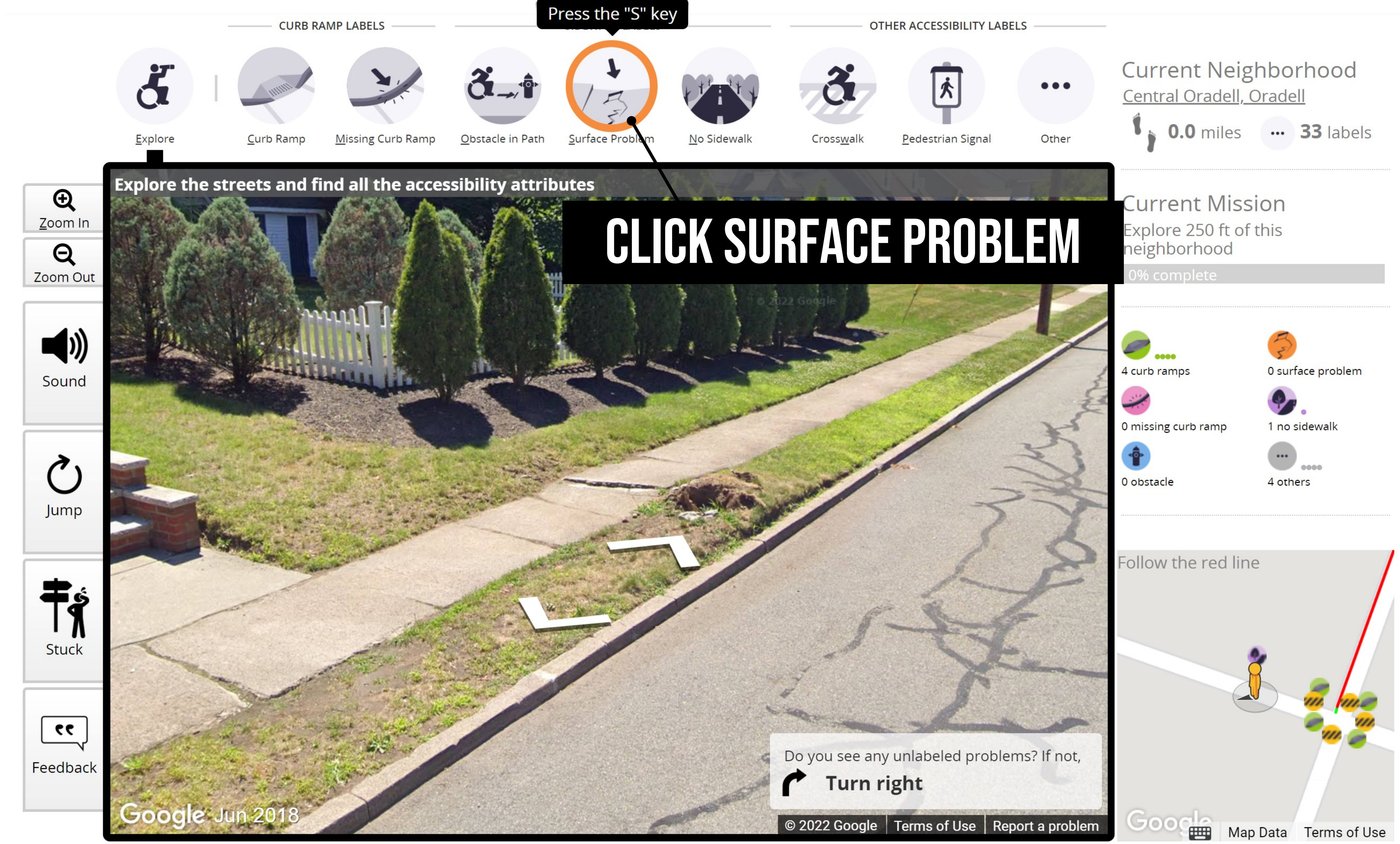
Report a problem
Google
Map Data
Terms of Use


Press the "S" key
CURB RAMP LABELS
OTHER ACCESSIBILITY LABELS
Explore
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
No Sidewalk
Crosswalk
Pedestrian Signal
Other
Current Neighborhood
Central Oradell, Oradell
0.0 miles
33 labels
Explore the streets and find all the accessibility attributes
CLICK SURFACE PROBLEM
Current Mission
Explore 250 ft of this neighborhood
0% complete
Zoom In
Zoom Out
Sound
Jump
Stuck
Feedback
4 curb ramps
0 surface problem
0 missing curb ramp
1 no sidewalk
0 obstacle
4 others
Follow the red line
Do you see any unlabeled problems? If not,
Turn right
Google Jun 2018
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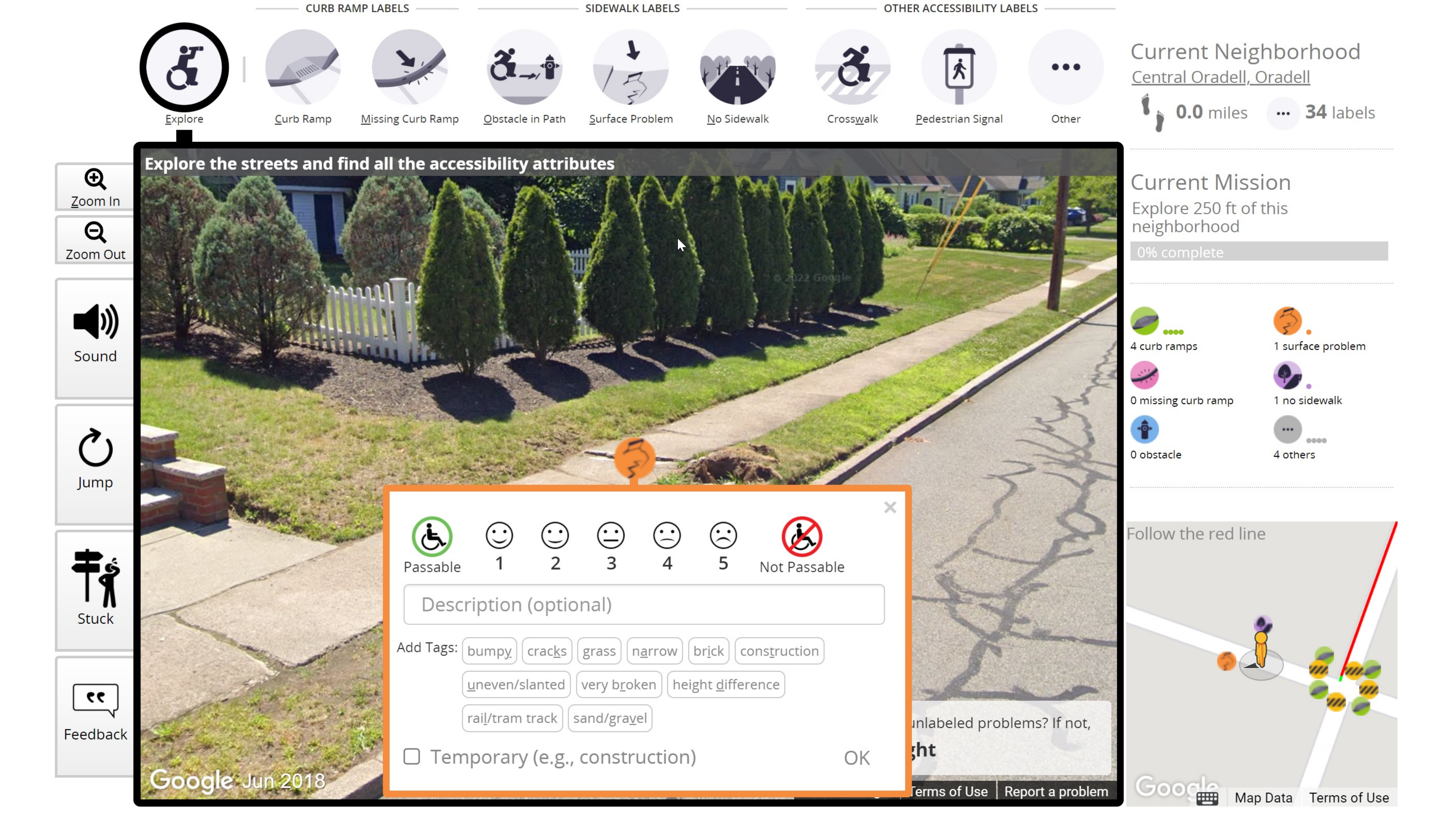
Report a problem
Map Data
Terms of Use


CURB RAMP LABELS
SIDEWALK LABELS
OTHER ACCESSIBILITY LABELS
Explore
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
No Sidewalk
Crosswalk
Pedestrian Signal
Other
Current Neighborhood
Central Oradell, Oradell
0.0 miles
34 labels
Zoom In
Zoom Out
Sound
Jump
Stuck
Feedback
Explore the streets and find all the accessibility attributes
© 2022 Google
Current Mission
Explore 250 ft of this neighborhood
0% complete
4 curb ramps
1 surface problem
0 missing curb ramp
1 no sidewalk
0 obstacle
4 others
Passable
1
2
3
4
5
Not Passable
Description (optional)
Add Tags:
bumpy
cracks
grass
narrow
brick
construction
uneven/slanted
very broken
height difference
rail/tram track
sand/gravel
Temporary (e.g., construction)
OK
unlabeled problems? If not,
ght
Follow the red line
Google Jun 2018
Terms of Use
Report a problem
Google
Map Data
Terms of Use


CURB RAMP LABELS
SIDEWALK LABELS
OTHER ACCESSIBILITY LABELS
Explore
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
No Sidewalk
Crosswalk
Pedestrian Signal
Other
Current Neighborhood
Central Oradell, Oradell
0.0 miles
34 labels
Current Mission
Explore 250 ft of this neighborhood
0% complete
4 curb ramps
1 surface problem
0 missing curb ramp
1 no sidewalk
0 obstacle
4 others
Follow the red line
Zoom In
Zoom Out
Sound
Jump
Stuck
Feedback
Explore the streets and find all the accessibility attributes
Passable
1
2
3
4
5
Not Passable
Description (optional)
Add Tags:
bumpy
cracks
grass
narrow
brick
construction
uneven/slanted
very broken
height difference
rail/tram track
sand/gravel
Temporary (e.g., construction)
OK
RATE SEVERITY
COMMENTS
TAGS
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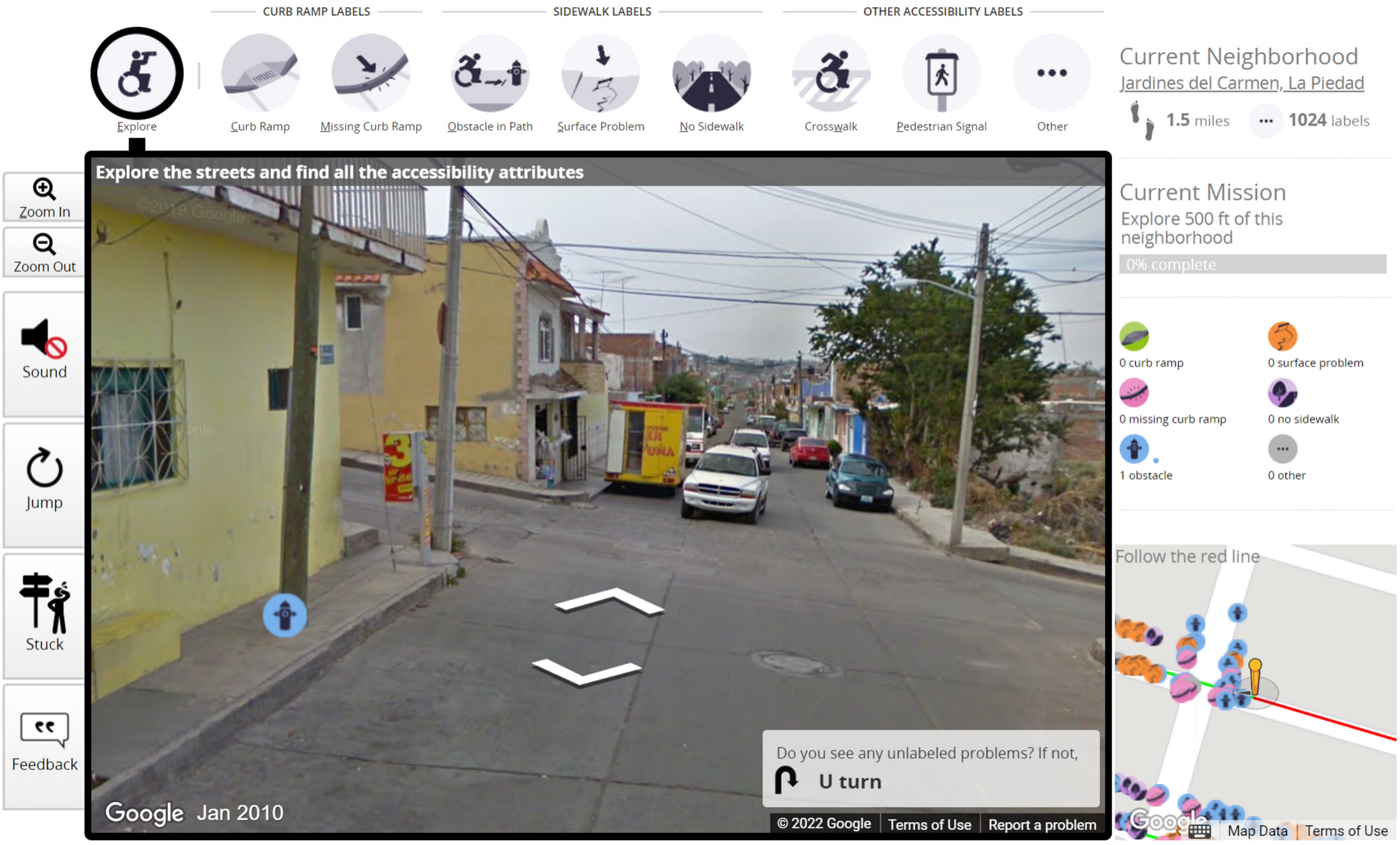
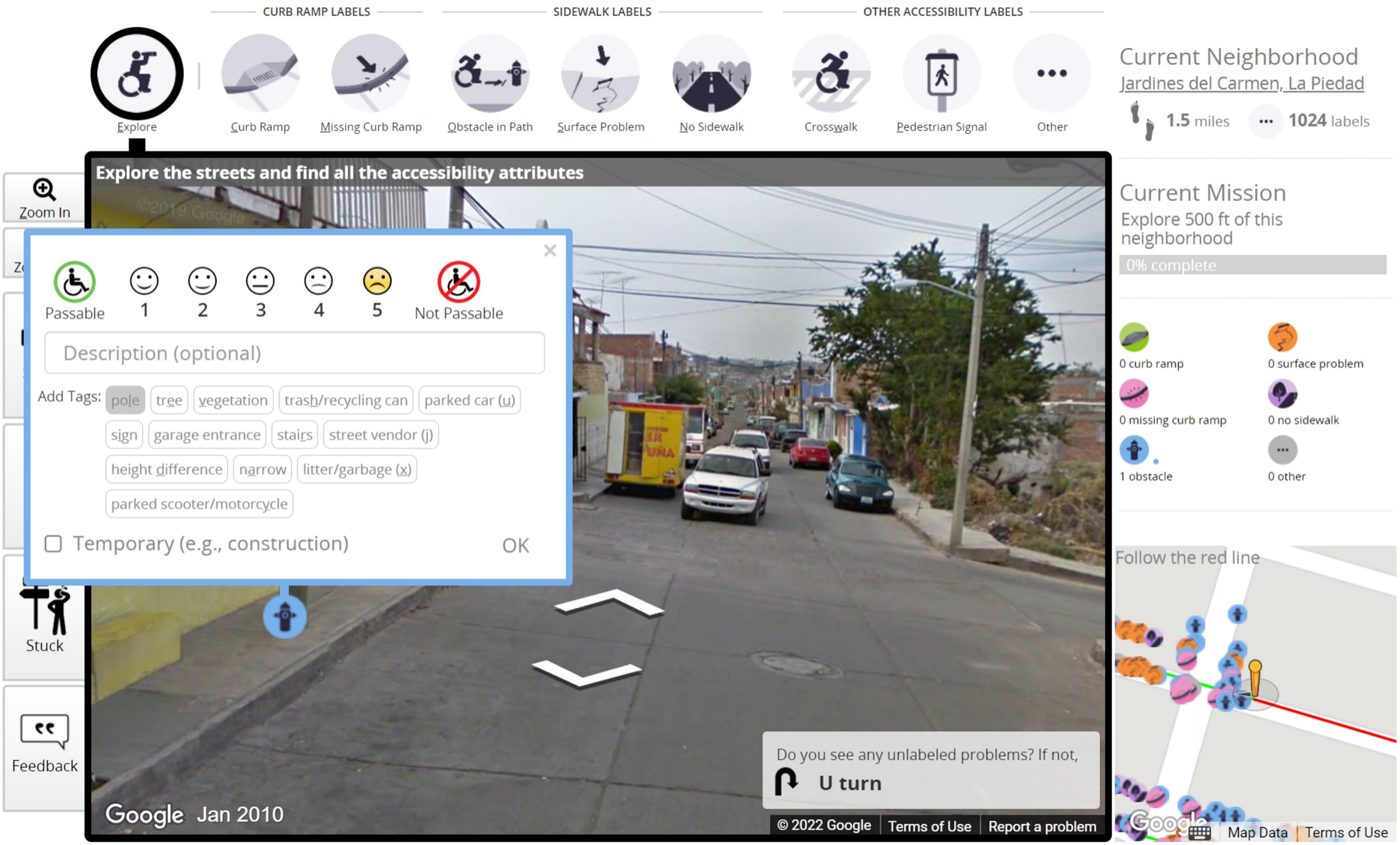
Report a problem
Map Data
Terms of Use


CURB RAMP LABELS
SIDEWALK LABELS
OTHER ACCESSIBILITY LABELS
Explore
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
No Sidewalk
Crosswalk
Pedestrian Signal
Other
Current Neighborhood
Jardines del Carmen, La Piedad
1.5 miles
1024 labels
Zoom In
Zoom Out
Sound
Jump
Stuck
Feedback
Explore the streets and find all the accessibility attributes
Current Mission
Explore 500 ft of this neighborhood
0% complete
0 curb ramp
0 surface problem
0 missing curb ramp
0 no sidewalk
1 obstacle
0 other
Follow the red line
Do you see any unlabeled problems? If not,
U turn
Google
Jan 2010
© 2022 Google
Terms of Use
Report a problem
Map Data
Terms of Use



CURB RAMP LABELS
SIDEWALK LABELS
OTHER ACCESSIBILITY LABELS
Explore
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
No Sidewalk
Crosswalk
Pedestrian Signal
Other
Current Neighborhood
Jardines del Carmen, La Piedad
1.5 miles
1024 labels
Zoom In
Explore the streets and find all the accessibility attributes
Passable
1
2
3
4
5
Not Passable
Description (optional)
Add Tags:
pole
tree
vegetation
trash/recycling can
parked car (u)
sign
garage entrance
stairs
street vendor (j)
height difference
narrow
litter/garbage (x)
parked scooter/motorcycle
Temporary (e.g., construction)
OK
Stuck
Feedback
Current Mission
Explore 500 ft of this neighborhood
0% complete
0 curb ramp
0 surface problem
0 missing curb ramp
0 no sidewalk
1 obstacle
0 other
Follow the red line
Do you see any unlabeled problems? If not,
U turn
Google
Jan 2010
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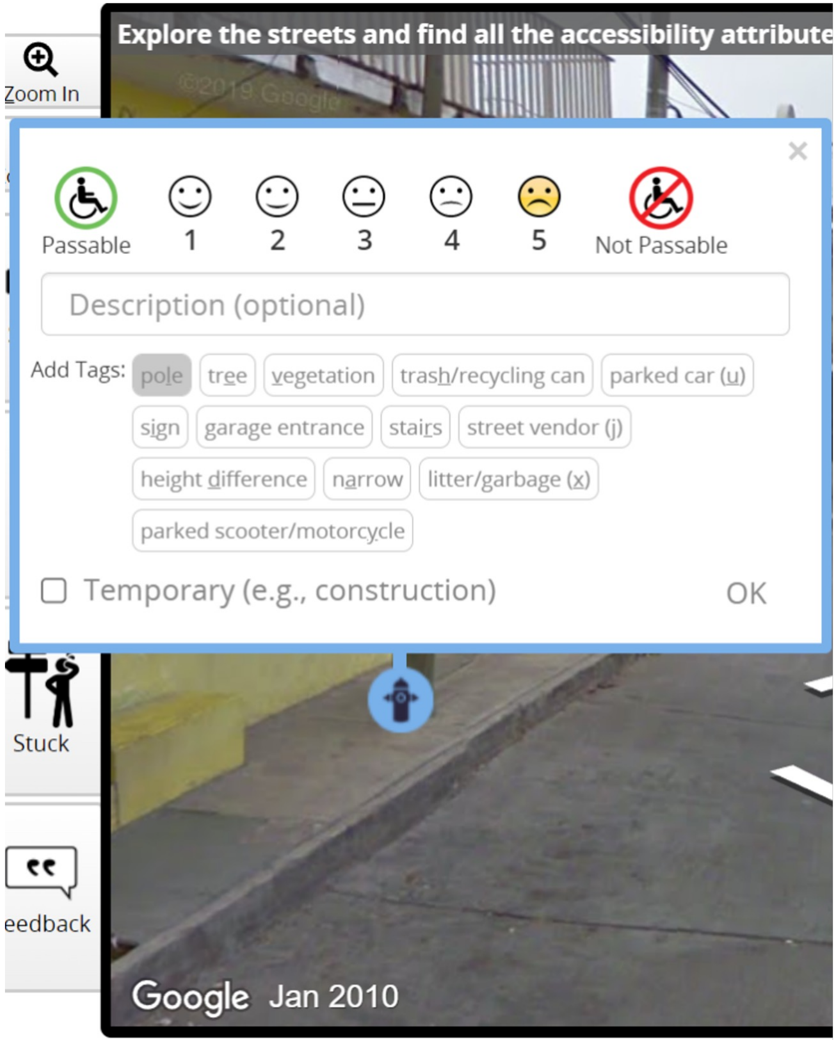
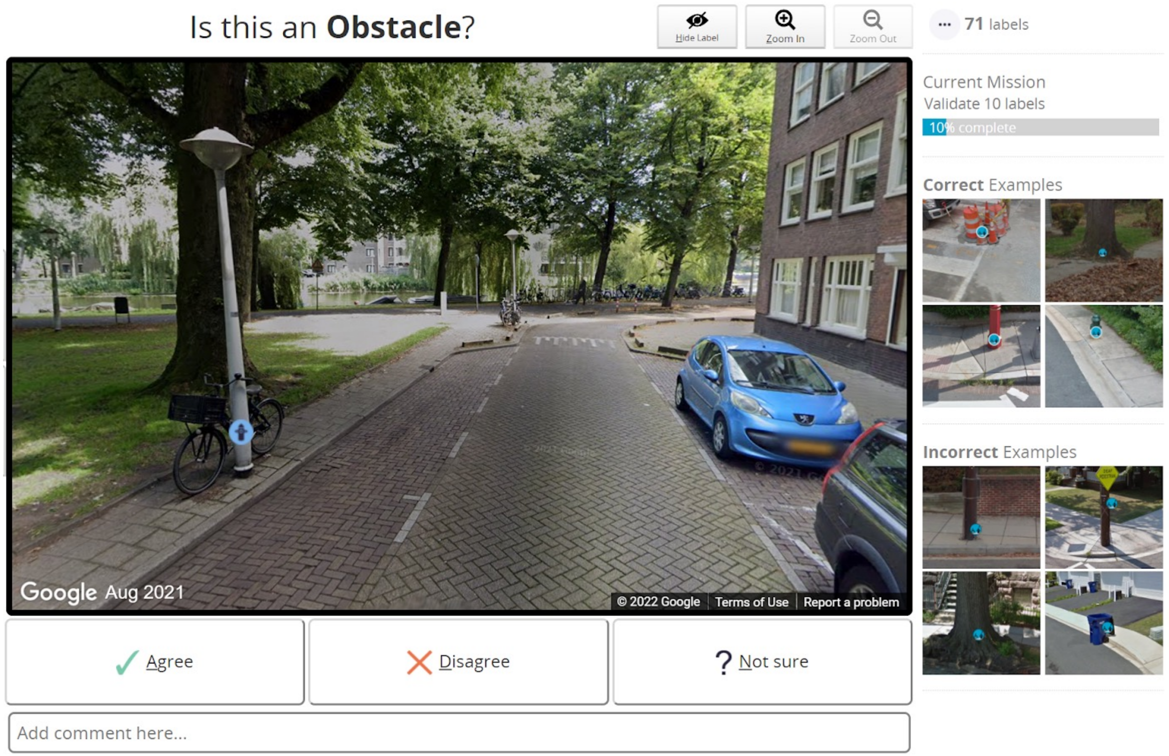
Report a problem
Map Data
Terms of Use

EXAMPLE OBSTACLE TAGS



PROJECT SIDEWALK

TWO DATA COLLECTION MISSIONS



1 FIND, LABEL, & ASSESS SIDEWALKS

2 VALIDATING & CORRECTING LABELS

Is this a **Missing Curb Ramp**?

Hide Label | Zoom In | Zoom Out

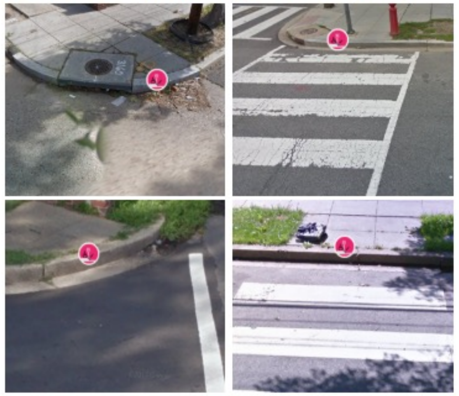
1113 labels

✓ Agree | ✕ Disagree | ? Not sure

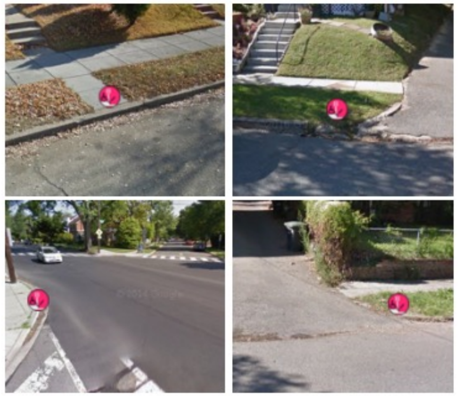
Add comment here...

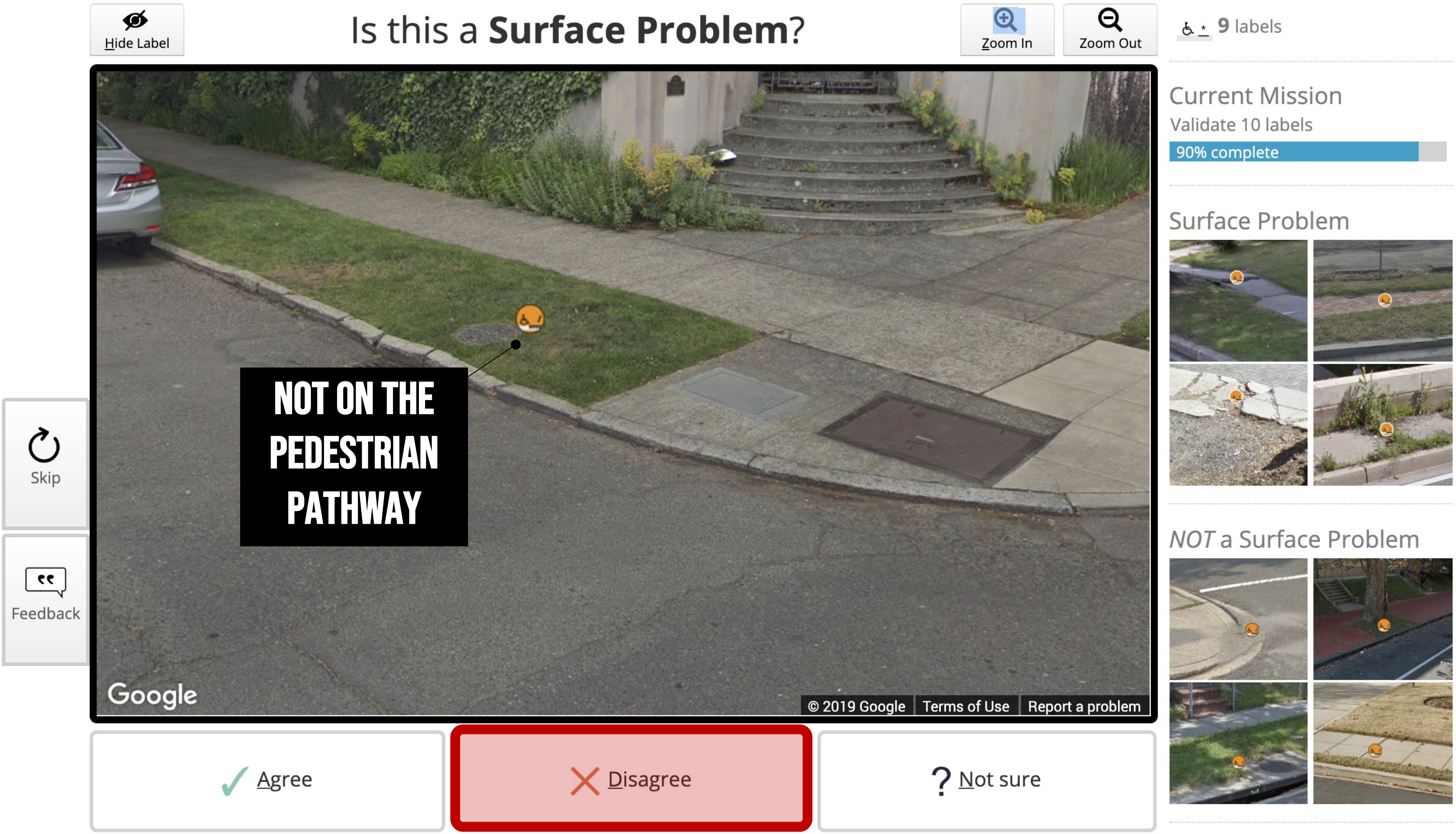
Current Mission
Validate 10 labels
50% complete

CORRECT Missing Curb Ramp

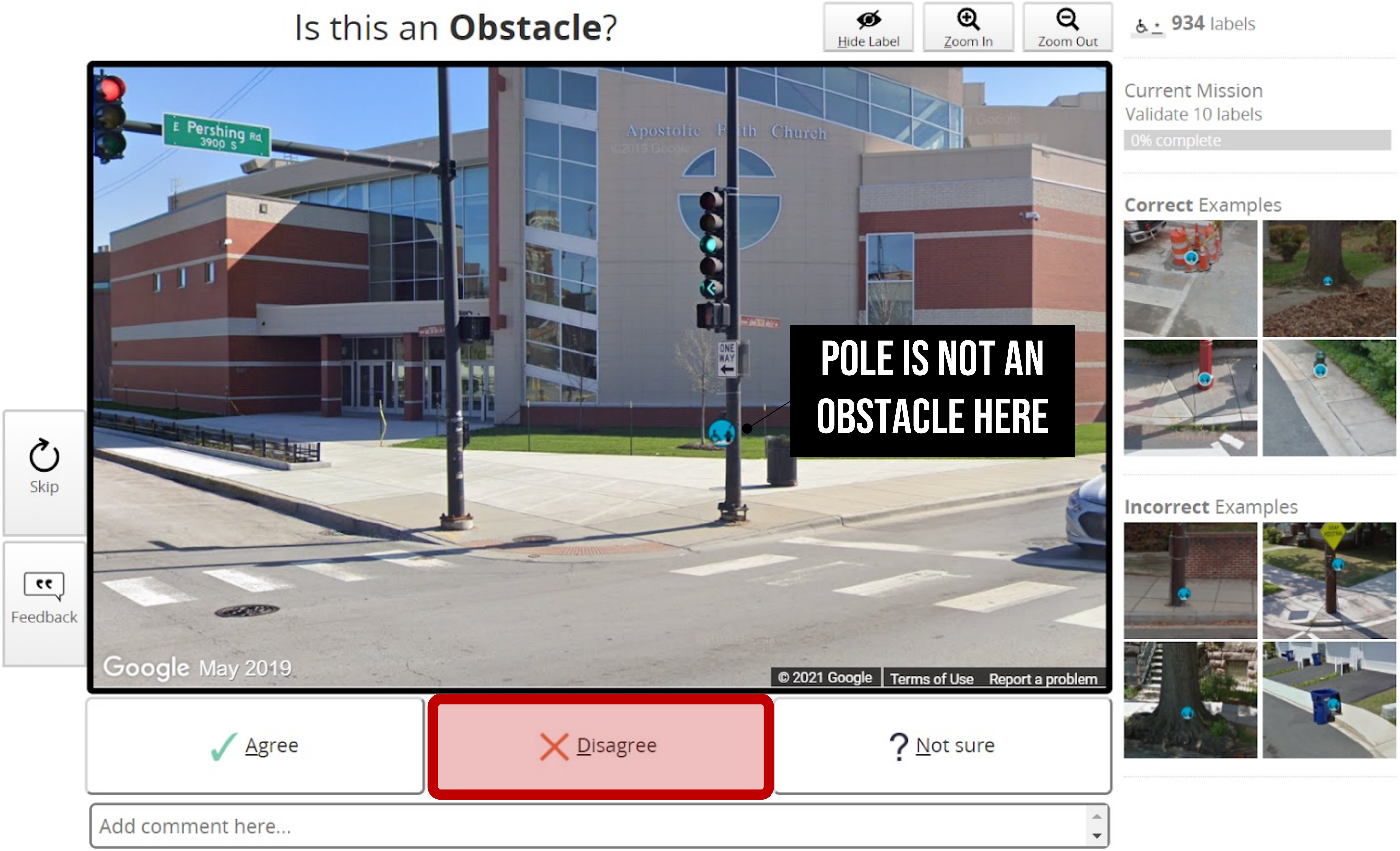


INCORRECT Missing Curb Ramp




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
NOT ON THE PEDESTRIAN PATHWAY
Skip
Feedback
Google
© 2019 Google
Terms of Use
Report a problem
Agree
Disagree
Not sure


Is this a Surface Problem?
Hide Label
Zoom In
Zoom Out
3337 labels
Current Mission
Validate 10 labels
0% complete
Correct Examples
Incorrect Examples
Skip
Feedback
Google Apr 2019
© 2021 Google
Terms of Use
Report a problem
Agree
Disagree
Not sure
Add comment here...



Is this an Obstacle?
Hide Label
Zoom In
Zoom Out
934 labels
Current Mission
Validate 10 labels
0% complete
Correct Examples
Incorrect Examples
E Pershing Rd
3900 S
Apostolic Faith Church
ONE WAY
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...

Image source: montgomeryplanning.org

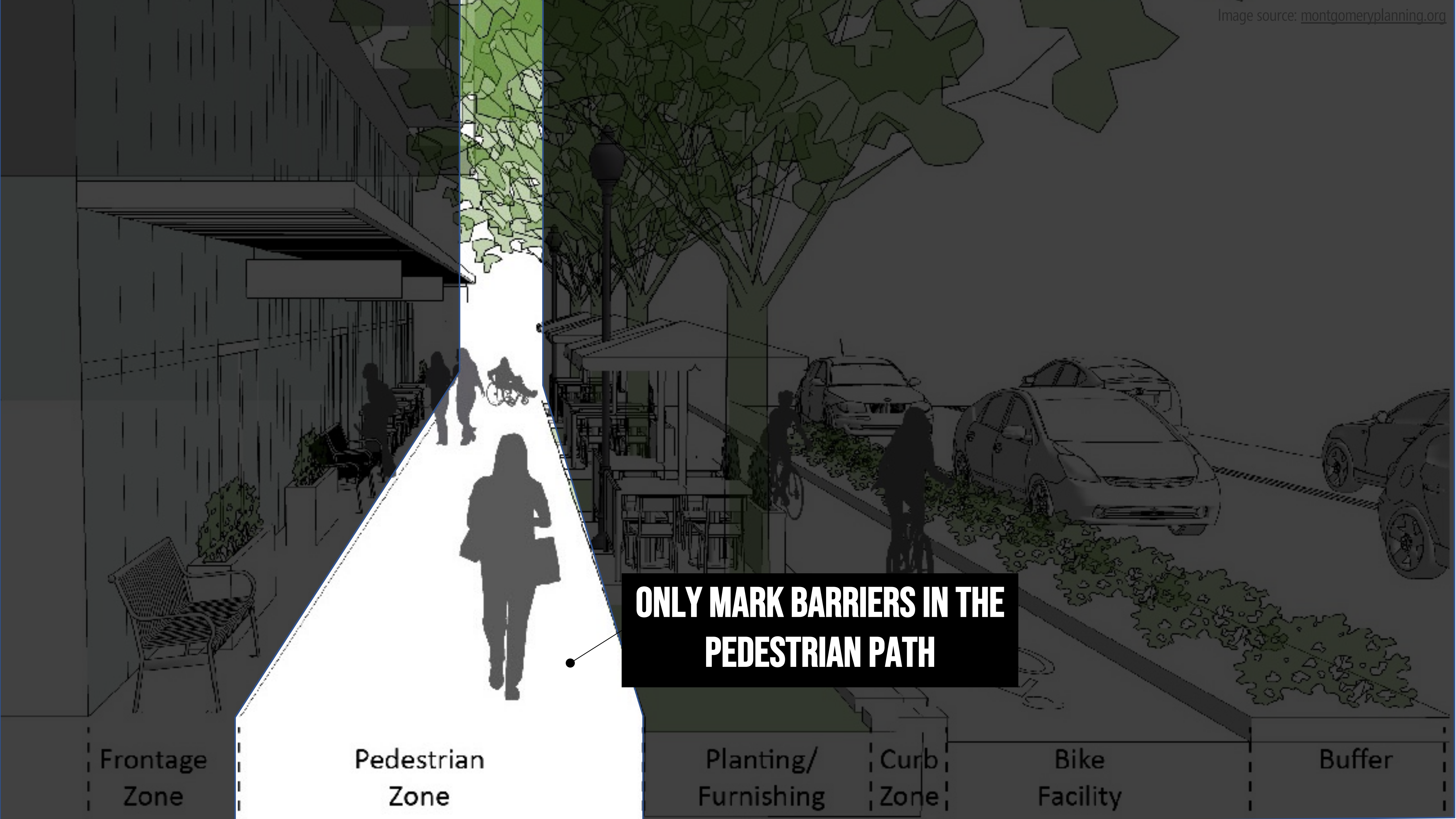


Image source: montgomeryplanning.org
ONLY MARK BARRIERS IN THE PEDESTRIAN PATH
Frontage Zone
Pedestrian Zone
Planting/ Furnishing
Curb Zone
Bike Facility
Buffer

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

Club Campestre · ROMA · © Mapbox © OpenStreetMap **Improve this map**

Your missions	Distance	Labels	Validations	Accuracy
140	2.03 mi	568	1249	90.7%

Achievements

Missions

Congratulations, you've earned all mission badges!

5 · 10 · 20 · 50 · 100

Distance

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

500 ft · 0.25 mi · 0.5 mi · 1 mi · 5 mi

Labels

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

50 · 250 · 500 · 1k · 5k

Validations

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

100 · 250 · 500 · 1k · 5k

Project Sidewalk - Leaderboard | Project Sidewalk - jonfroehlich

sidewalk-spgg.cs.washington.edu/leaderboard

PROJECT SIDEWALK

Start Exploring | Start Validating | How to Label | Data | jonfroehlich

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!

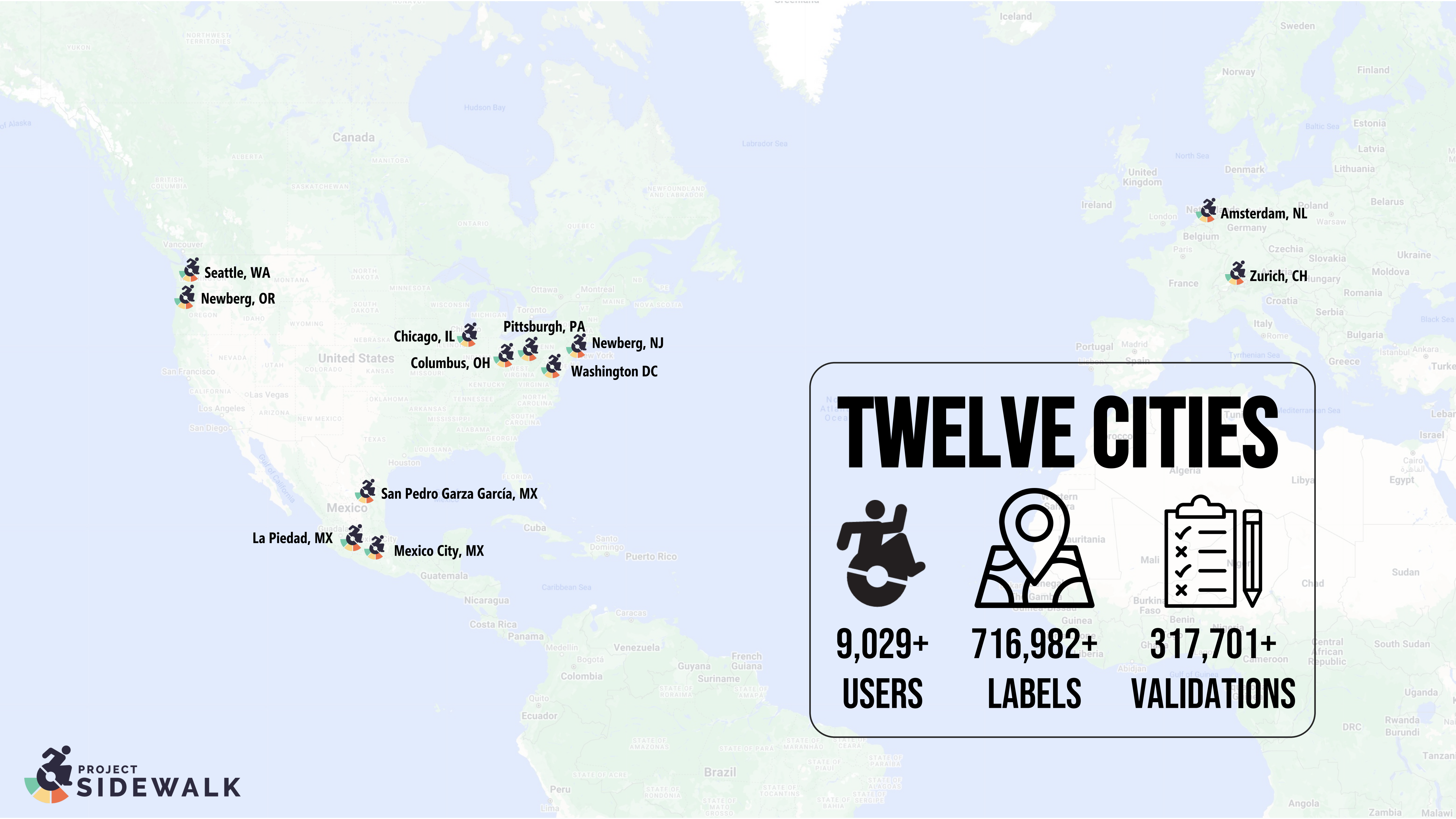
PROJECT SIDEWALK
About Us
Terms of Use
Help
Labeling Guide

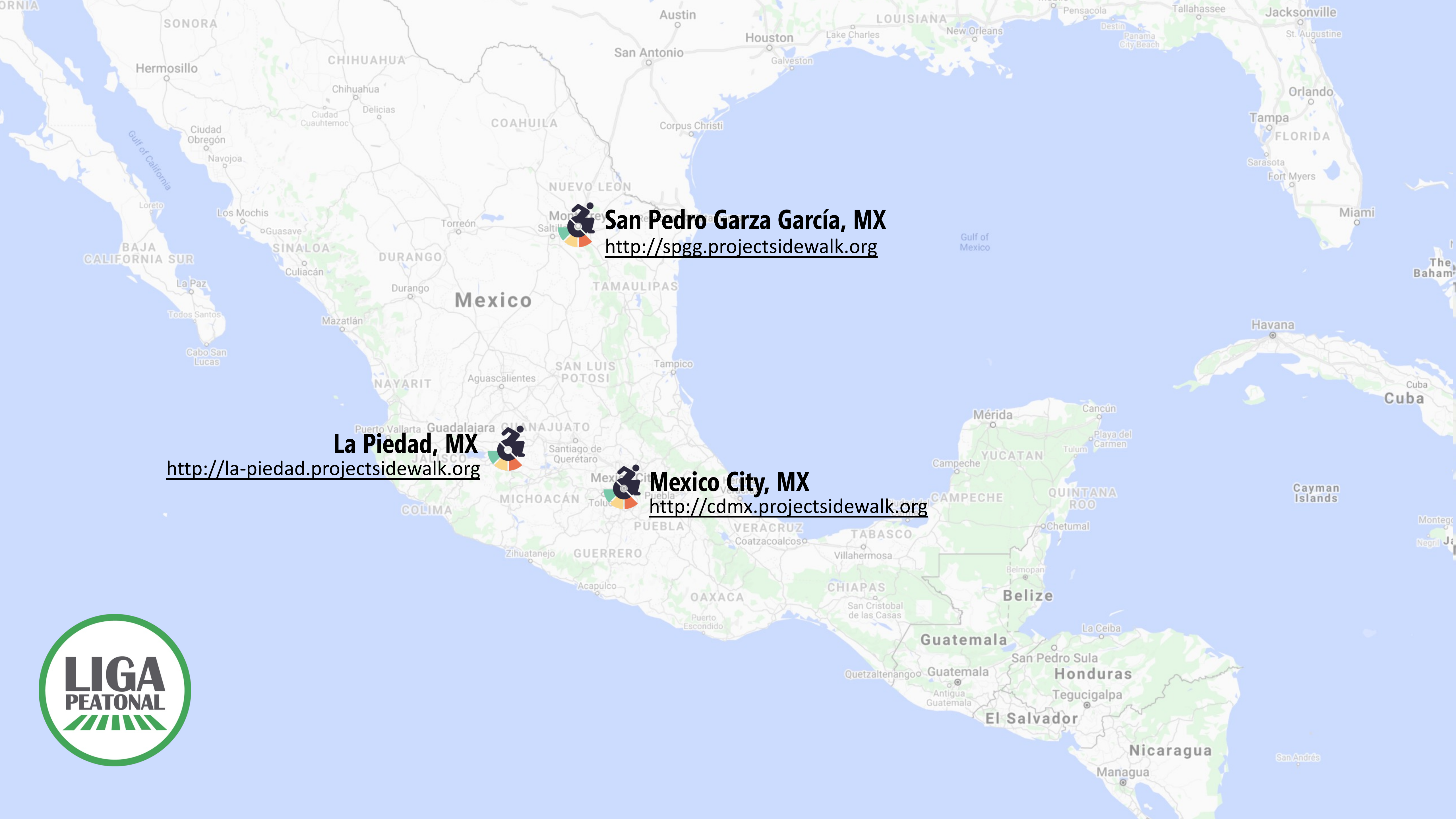
DEVELOPER
Sidewalk API

CONNECT
Github
Twitter
Email Us
Facebook

TEN CITIES
IN NORTH AMERICA

PROJECT SIDEWALK


Seattle, WA
Newberg, OR
Chicago, IL
Pittsburgh, PA
Columbus, OH
Newberg, NJ
Washington DC
San Pedro Garza García, MX
La Piedad, MX
Mexico City, MX
Amsterdam, NL
Zurich, CH
TWELVE CITIES
9,029+
USERS
716,982+
LABELS
317,701+
VALIDATIONS
PROJECT
SIDEWALK


San Pedro Garza García, MX
http://spgg.projectsidewalk.org
La Piedad, MX
http://la-piedad.projectsidewalk.org
Mexico City, MX
http://cdmx.projectsidewalk.org
LIGA
PEATONAL

PROJECT SIDEWALK

Comienza a explorar | Comienza a validar | Cómo etiquetar | Datos ▾ | Iniciar sesión

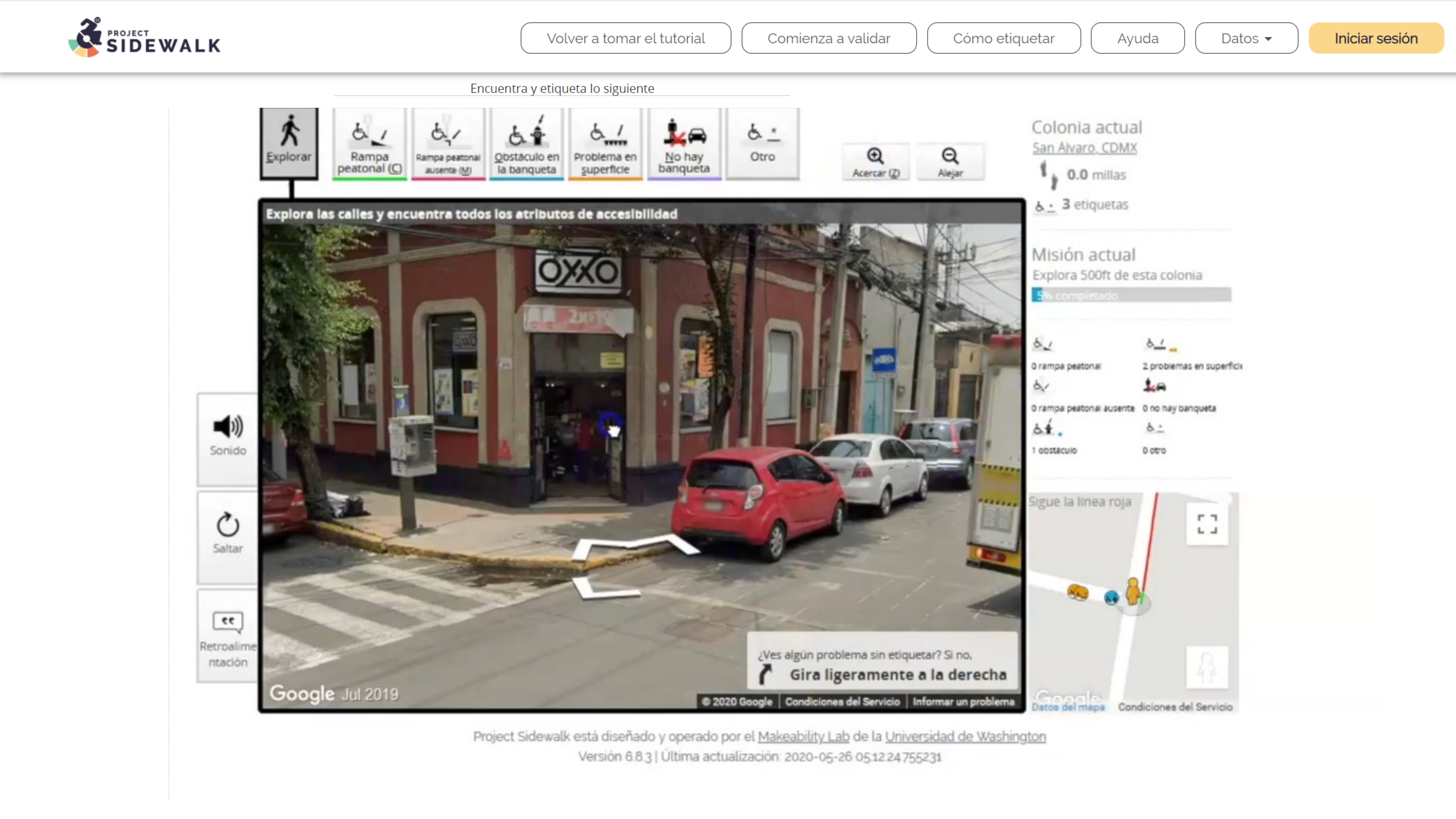
Creemos un camino para todas las personas

Comienza a explorar SPGG

También estamos en: Seattle, WA Columbus, OH Mexico City, MX Newberg, OR

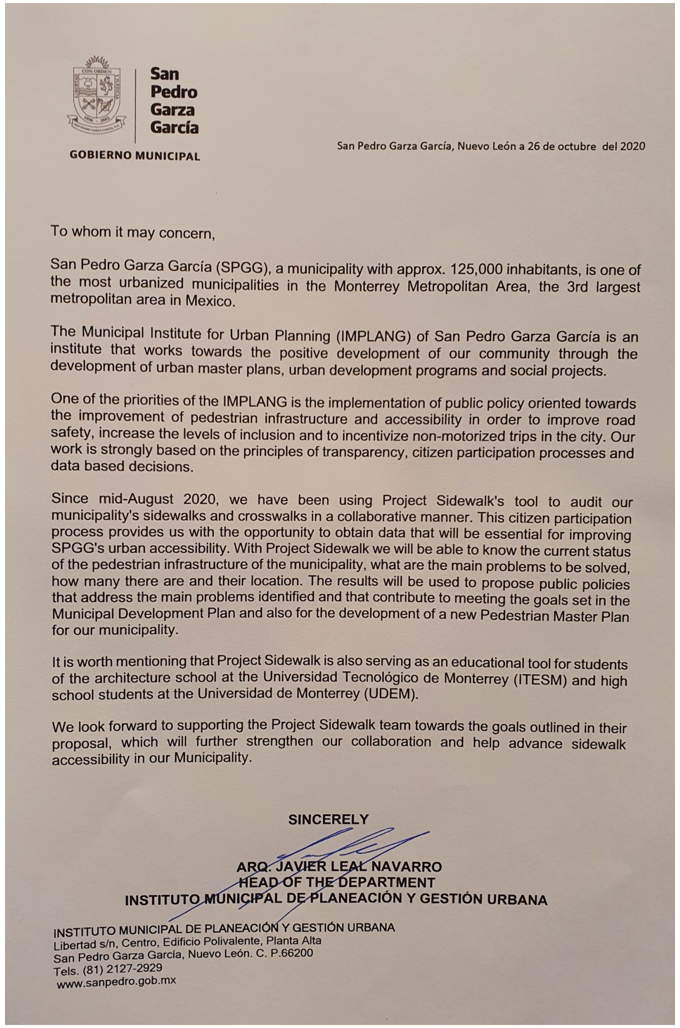
Cómo puedes ayudar

Explora virtualmente las calles de la ciudad para


PROJECT SIDEWALK
Volver a tomar el tutorial
Comienza a validar
Cómo etiquetar
Ayuda
Datos
Iniciar sesión
Encuentra y etiqueta lo siguiente
Explorar
Rampa peatonal (C)
Rampa peatonal ausente (M)
Obstáculo en la banqueta
Problema en superficie
No hay banqueta
Otro
Acercar (Z)
Alejar
Colonia actual
San Alvaro, CDMX
0.0 millas
3 etiquetas
Misión actual
Explora 500ft de esta colonia
0 rampa peatonal
2 problemas en superficie
0 rampa peatonal ausente
0 no hay banqueta
1 obstáculo
0 otro
Sigue la línea roja
Explora las calles y encuentra todos los atributos de accesibilidad
OXXO
Sonido
Saltar
Retroalimentación
¿Ves algún problema sin etiquetar? Si no,
Gira ligeramente a la derecha
Google Jul 2019
© 2020 Google
Condiciones del Servicio
Informar un problema
Datos del mapa
Condiciones del Servicio
Project Sidewalk está diseñado y operado por el Makeability Lab de la Universidad de Washington
Versión 6.8.3 | Última actualización: 2020-05-26 05:12:24.755231

PROJECT SIDEWALK MEXICO

SAN PEDRO, MX


San Pedro Garza García

GOBIERNO MUNICIPAL

San Pedro Garza García, Nuevo León a 26 de octubre del 2020

To whom it may concern,

San Pedro Garza García (SPGG), a municipality with approx. 125,000 inhabitants, is one of the most urbanized municipalities in the Monterrey Metropolitan Area, the 3rd largest metropolitan area in Mexico.

The Municipal Institute for Urban Planning (IMPLANG) of San Pedro Garza García is an institute that works towards the positive development of our community through the development of urban master plans, urban development programs and social projects.

One of the priorities of the IMPLANG is the implementation of public policy oriented towards the improvement of pedestrian infrastructure and accessibility in order to improve road safety, increase the levels of inclusion and to incentivize non-motorized trips in the city. Our work is strongly based on the principles of transparency, citizen participation processes and data based decisions.

Since mid-August 2020, we have been using Project Sidewalk's tool to audit our municipality's sidewalks and crosswalks in a collaborative manner. This citizen participation process provides us with the opportunity to obtain data that will be essential for improving SPGG's urban accessibility. With Project Sidewalk we will be able to know the current status of the pedestrian infrastructure of the municipality, what are the main problems to be solved, how many there are and their location. The results will be used to propose public policies that address the main problems identified and that contribute to meeting the goals set in the Municipal Development Plan and also for the development of a new Pedestrian Master Plan for our municipality.

It is worth mentioning that Project Sidewalk is also serving as an educational tool for students of the architecture school at the Universidad Tecnológico de Monterrey (ITESM) and high school students at the Universidad de Monterrey (UDEM).

We look forward to supporting the Project Sidewalk team towards the goals outlined in their proposal, which will further strengthen our collaboration and help advance sidewalk accessibility in our Municipality.

SINCERELY

ARQ. JAVIER LEAL NAVARRO
HEAD OF THE DEPARTMENT
INSTITUTO MUNICIPAL DE PLANEACIÓN Y GESTIÓN URBANA

INSTITUTO MUNICIPAL DE PLANEACIÓN Y GESTIÓN URBANA
Libertad s/n, Centro, Edificio Polivalente, Planta Alta
San Pedro Garza García, Nuevo León. C. P.66200
Tels. (81) 2127-2929
www.sanpedro.gob.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

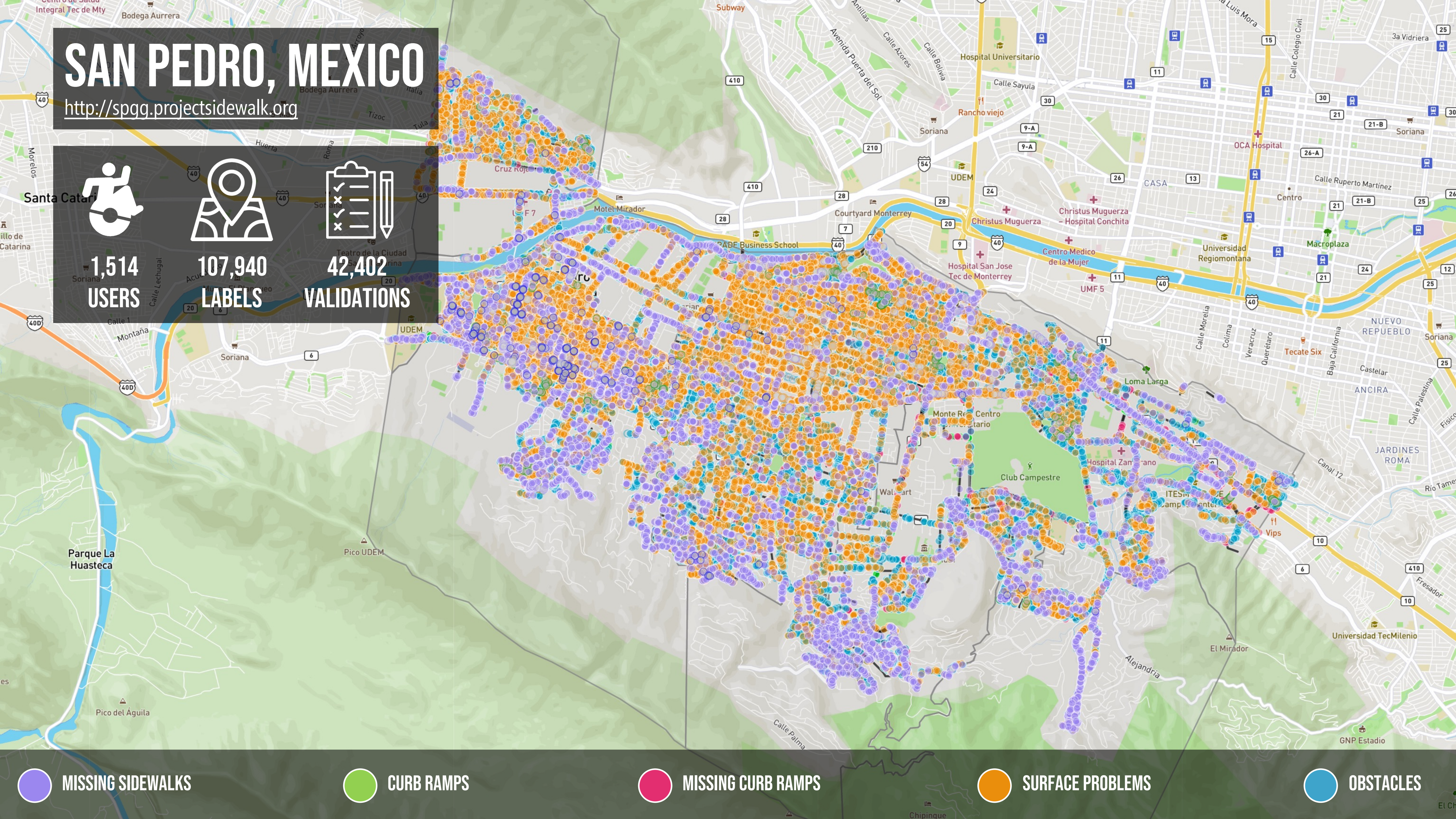
SAN PEDRO, MEXICO

http://spgg.projectsidewalk.org

1,514 USERS

107,940 LABELS

42,402 VALIDATIONS



CURB RAMPS

SEVERITY RATING 5

http://sidewalkgallery.io/


Narrow + obstacle


Not enough landing space


Points into traffic


Narrow


No friction/tactile strip


Not level with street


Steep + obstacle


Steep


Poor design


NEW CURB RAMP IS NOT ACCESSIBLE.
CAN ONLY BE ENTERED FROM ONE DIRECTION
Find and label the following
Explore
Curb Ramp
Missing Curb Ramp
Obstacle in Path
Surface Problem
No Sidewalk
Other
Zoom In
Zoom Out
Current Neighborhood
Cosmopolita, CDMX
0.3 miles
69 labels
Current Mission
Explore 750 ft of this
0 missing curb ramp
0 no sidewalk
1 obstacle
0 other
Explore the streets and find all the accessibility attributes
Sound
Jump
Feedback
Passable
1
2
3
4
5
Not Passable
Can only be entered from one direction. Has a stee
Add Tags:
narrow
points into traffic
missing friction strip
steep
not enough landing space
Temporary (e.g., construction)
OK
Do you see any unlabeled problems? If not,
Turn slightly left
Follow the red line
Google
© 2020 Google
Terms of Use
Report a problem
Map data ©2020 INEGI
Terms of Use

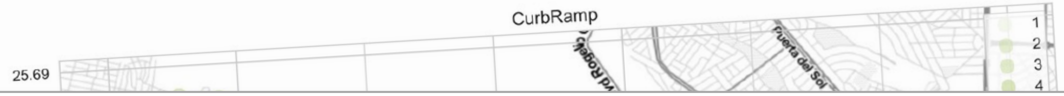

Seattle, WA
Mexico City, MX
Anchorage
Gulf of Alaska
BRITISH COLUMBIA
Hudson Bay
OREGON
CALIFORNIA
Las Vegas
Los Angeles
San Diego
ARIZONA
NEW MEXICO
OKLAHOMA
TEXAS
ARKANSAS
TENNESSEE
MISSISSIPPI
ALABAMA
NORTH CAROLINA
SOUTH CAROLINA
North Atlantic Ocean
Mexico
Gulf of California
Honolulu
Lahaina
HAWAII
Hilo
Dakar
Senegal
The Gambia
Ecuador
STATE OF AMAZONAS
STATE OF PARA
STATE OF MARANHAO
STATE OF CEARA
STATE OF PARAIBA

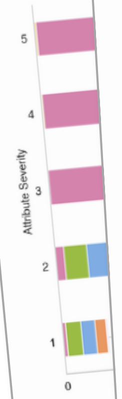
URBAN ANALYTICS

AVERAGE SEVERITY RATINGS

	Curb Ramp	Missing Ramp	Missing Sidewalk	Sidewalk Obstacle	Surface Problem
Seattle, WA	1.5 (0.7)	3.8 (1.0)	4 (0.8)	3.2 (1.1)	2.9 (0.9)
Columbus, OH	1.4 (0.7)	3.8 (1.2)	4.1 (1.1)	2.2 (1.4)	2.1 (1.0)
Newberg, OR	1.5 (0.7)	3.9 (1.0)	3.9 (0.9)	3.1 (1.1)	2.7 (1.0)
Mexico City, MX	**2.8 (1.4)**	**4.7 (0.6)**	**4.6 (0.8)**	**4.1 (1.0)**	**3.6 (1.2)**
San Pedro, MX	**2.8 (1.4)**	4.4 (0.9)	4.5 (0.9)	4 (0.9)	**3.6 (1.1)**

Cell format: Avg Severity (Stdev). Scale: 1 (best) to 5 (worst)

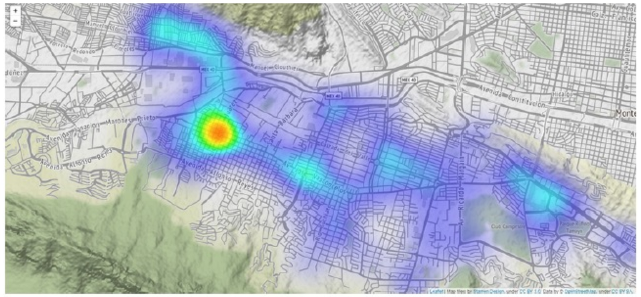




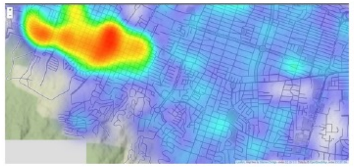
HEATMAPS

SAN PEDRO GARZA GARCÍA

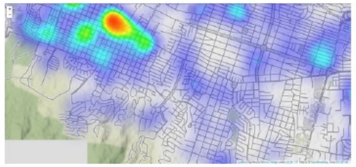
ACCIDENTS
(PEDESTRIANS)



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.



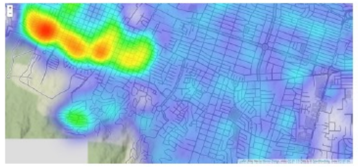
Missing Curb Ramp (3+)



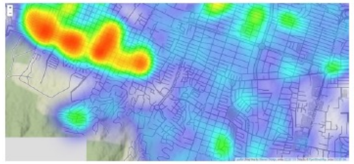
Curb Ramp (3+)

No sidewalk (3+)

Other (3+)



Obstacle in Path (3+)



Surface Problem (3+)

POR UN MEJOR FUTURO URBANO

ENFOQUE ACTIVISTA

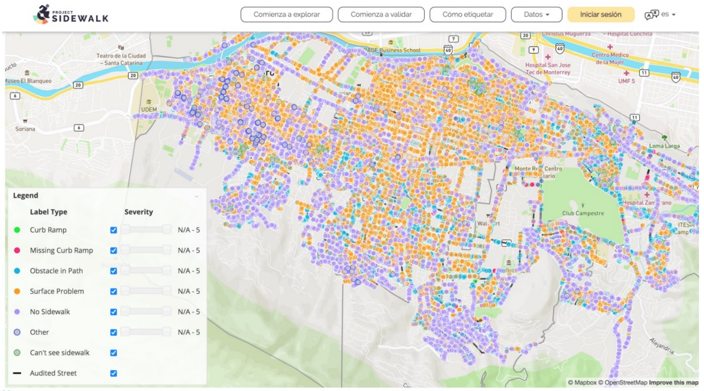
E

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



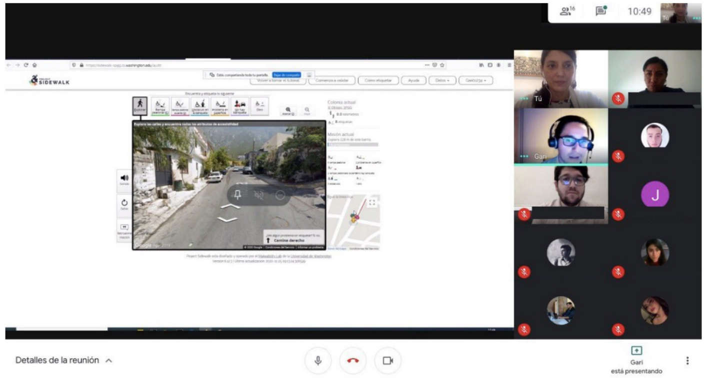
>>
Fotografía 2. Mapa de etiquetas en Project Sidewalk

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 105 117 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.



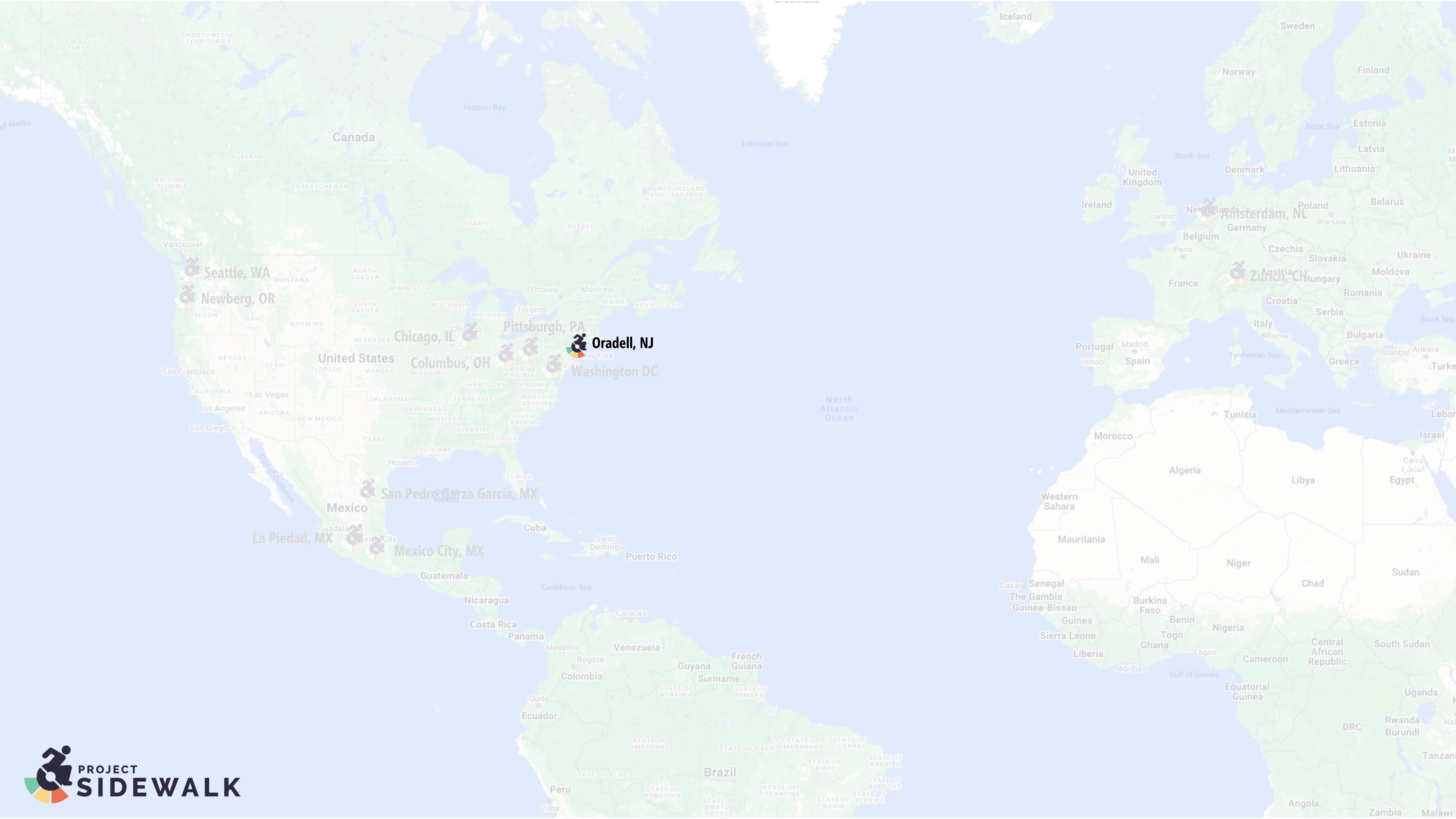
>>
Fotografía 4. Mapatón San Pedro Garza García

Fuente: Liga Peatonal (2020).

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 introducía 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 en sitio 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 destaquen 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 sí lo hacen los muros ciegos, la falta de luminarias, los recovecos o terrenos baldíos.


Seattle, WA
Newberg, OR
Chicago, IL
Pittsburgh, PA
Columbus, OH
Oradell, NJ
Washington DC
San Pedro Garza García, MX
La Piedad, MX
Mexico City, MX
Amsterdam, NL
Zurich, CH
PROJECT
SIDEWALK

ORADELL DEPLOYMENT

PARTNERSHIP OF THREE ORGANIZATIONS

Oradell Girl Scouts

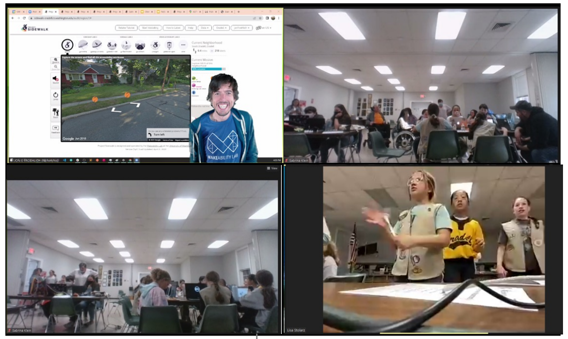
National Multiple Sclerosis Society
Bergen Multiple Sclerosis Community Council

Hackensack Meridian
School of Medicine

Initial Presentation to Oradell City Council
Mar 2022

First Mapathon (Hybrid)
Apr 2022

Second Mapathon (Hybrid)
Aug 2022



Girl Scout Data Analysis
Oct 2022

Planned Presentation to City Council
Jan 2023

ORADELL DEPLOYMENT

COLLECTED DATA

Users	Miles Audited	Labels	Validations	Accuracy
81	**48.6 miles**	**11,135**	**14,919**	**93.1%**
	~35% of streets have been audited more than once			As calculated by user validations of labels

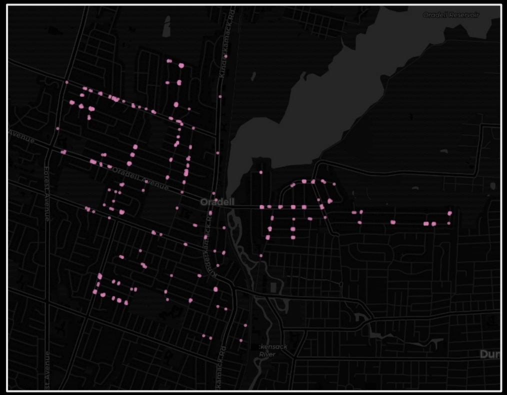
ORADELL DEPLOYMENT

SIDEWALK DATA

ORADELL DEPLOYMENT

TRELLIS PLOTS OF SIDEWALK DATA

Curb Ramps
733 labels



Missing Curb Ramps
381 labels

Obstacles
161 labels

Surface Problems
1,542 labels

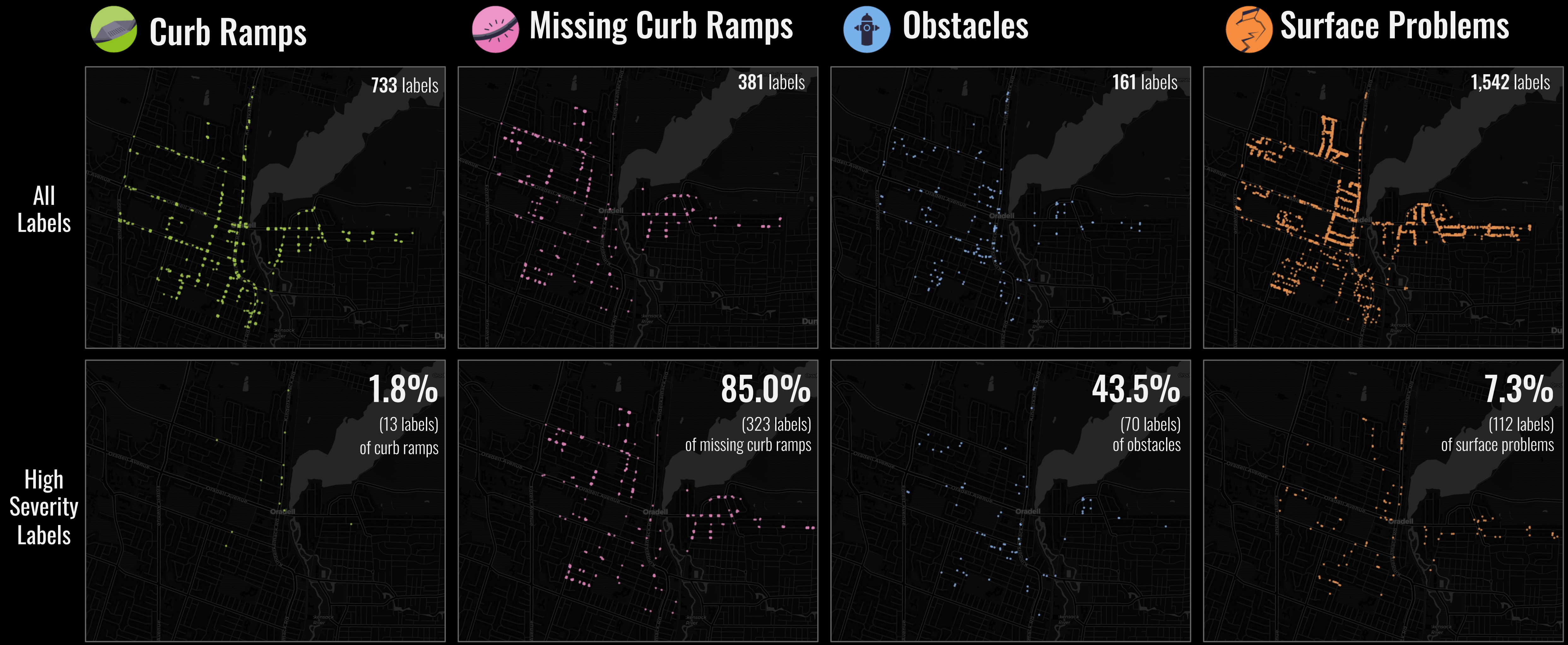
Missing Sidewalks
2,456 labels

Surface Problems
1,542 labels

Missing Sidewalks
2,456 labels

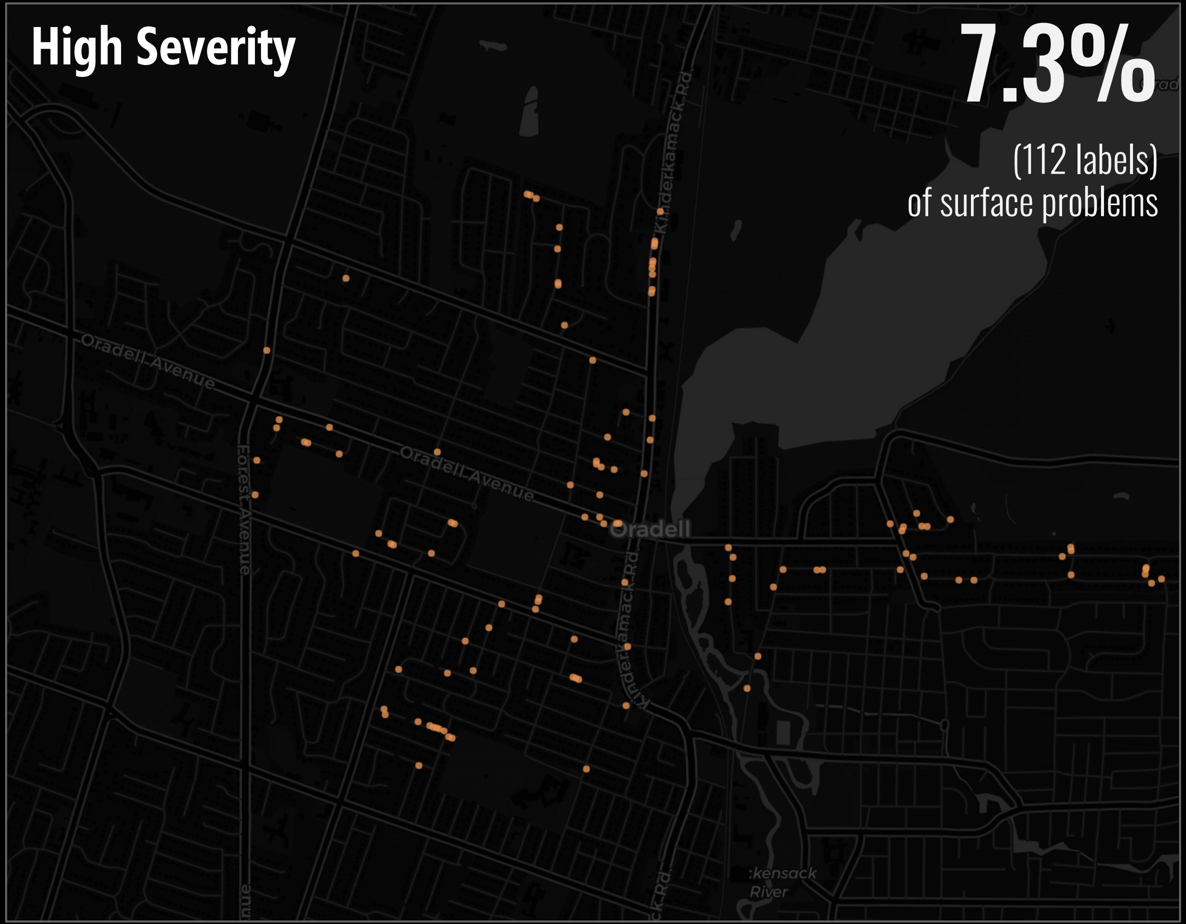
ORADELL DEPLOYMENT

HIGH SEVERITY (≥ 4)



ORADELL DEPLOYMENT

SURFACE PROBLEMS



ORADELL DEPLOYMENT

HIGH SEVERITY (≥ 4) SURFACE PROBLEMS

ORADELL DEPLOYMENT

TAG ANALYSIS

Surface Problem Tags	Count	% of Surface Tags	Avg Severity (SD)
height difference	**1455**	**29.0%**	**1.96 (0.99)**
cracks	**1256**	**25.0%**	**1.71 (0.79)**
uneven/slanted	**1031**	**21.0%**	**2.34 (1.02)**
grass	547	11.0%	1.46 (0.63)
very broken	235	5.0%	2.44 (1.04)
bumpy	177	4.0%	2.25 (0.92)
n/a	90	2.0%	2.00 (1.02)
narrow sidewalk	88	2.0%	2.59 (0.93)
brick/cobblestone	74	1.0%	1.95 (0.72)
sand/gravel	47	1.0%	2.26 (0.94)
construction	2	0.0%	4.00 (n/a)
street has no sidewalks	1	0.0%	3.00 (n/a)

Surface Problem

×

Labeled: May 6, 2022, 5:14 PM

Image Date: Mar 2022

Severity

Tags

height difference | uneven/slanted

Temporary

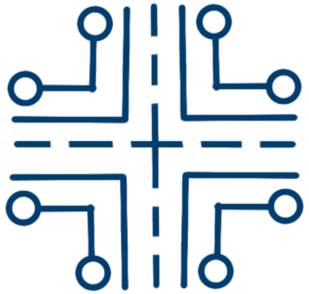
No

Description

No description

What can we do with **Project Sidewalk data?**

MOTIVATION



WHERE

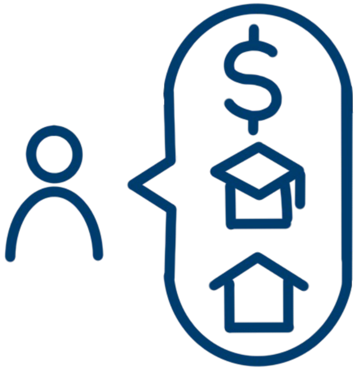
sidewalks are

HOW

they are connected

WHAT

their conditions are



RELATIONSHIP

to socio-economic factors

How can we use crowdsourced sidewalk assessment data to examine **sidewalk condition patterns** in a city?

And how do sidewalk quality patterns map to
socioeconomic factors like wealth, race, density and education?

TRADITIONAL ACCESSIBILITY AUDITS

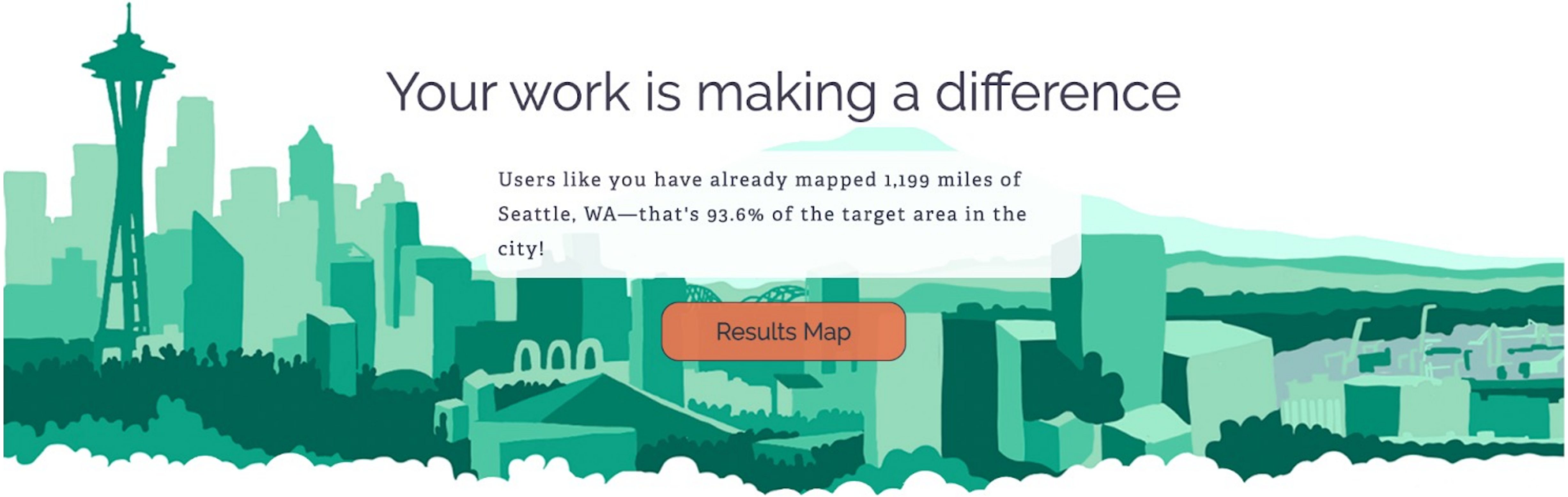
SIDEWALK DATA COLLECTION

Walkability Audit
Wake County, North Carolina

Walkability Audit
Wake County, North Carolina

Safe Routes to School Walkability Audit
Rock Hill, South Carolina

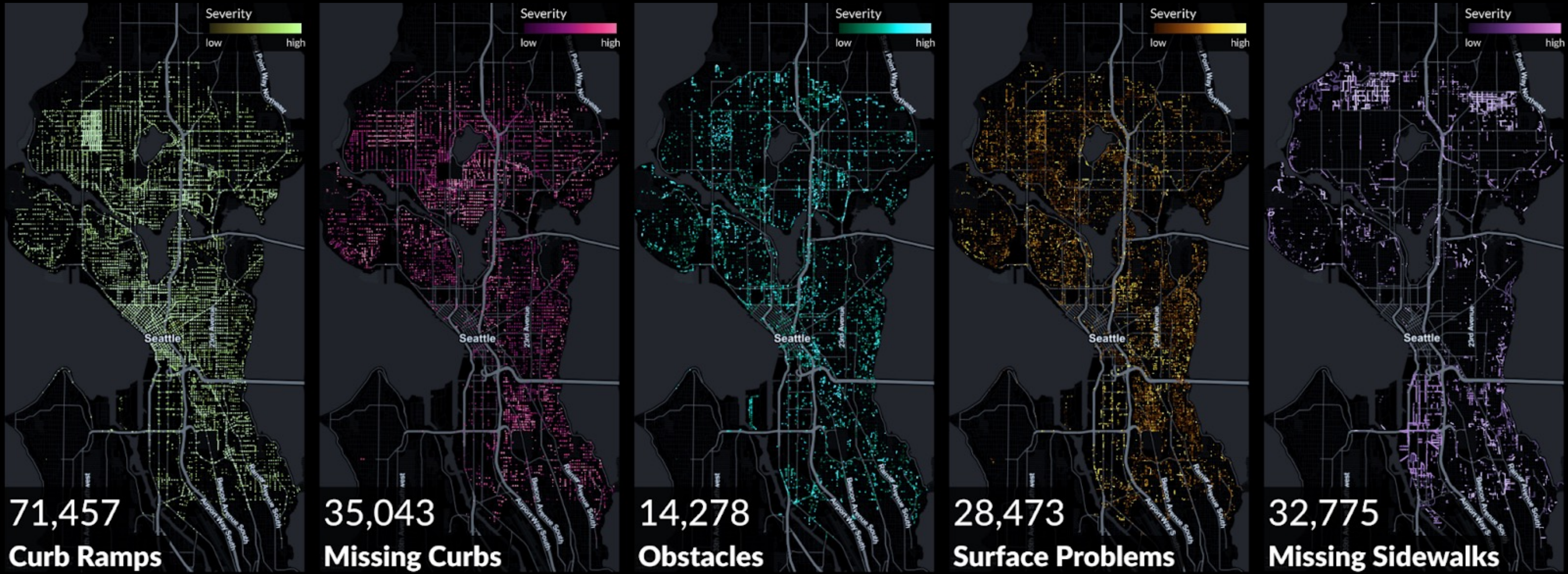
SIDEWALK DATA COLLECTION



93.6%	1,198.9	209,351	187,220
target area mapped	miles covered	labels	validations

SIDEWALK DATA COLLECTION

PROJECT SIDEWALK IN SEATTLE



ACCESS SCORE MODEL

LABEL TYPES

Curb Ramps

Missing Curb Ramps

Obstacles

Surface Problem

Missing Sidewalk

ACCESS SCORE MODEL

SEVERITY RATING

Severity 1

Severity 2

Severity 3

Severity 4

Severity 5

ACCESS SCORE MODEL

Significance Vector

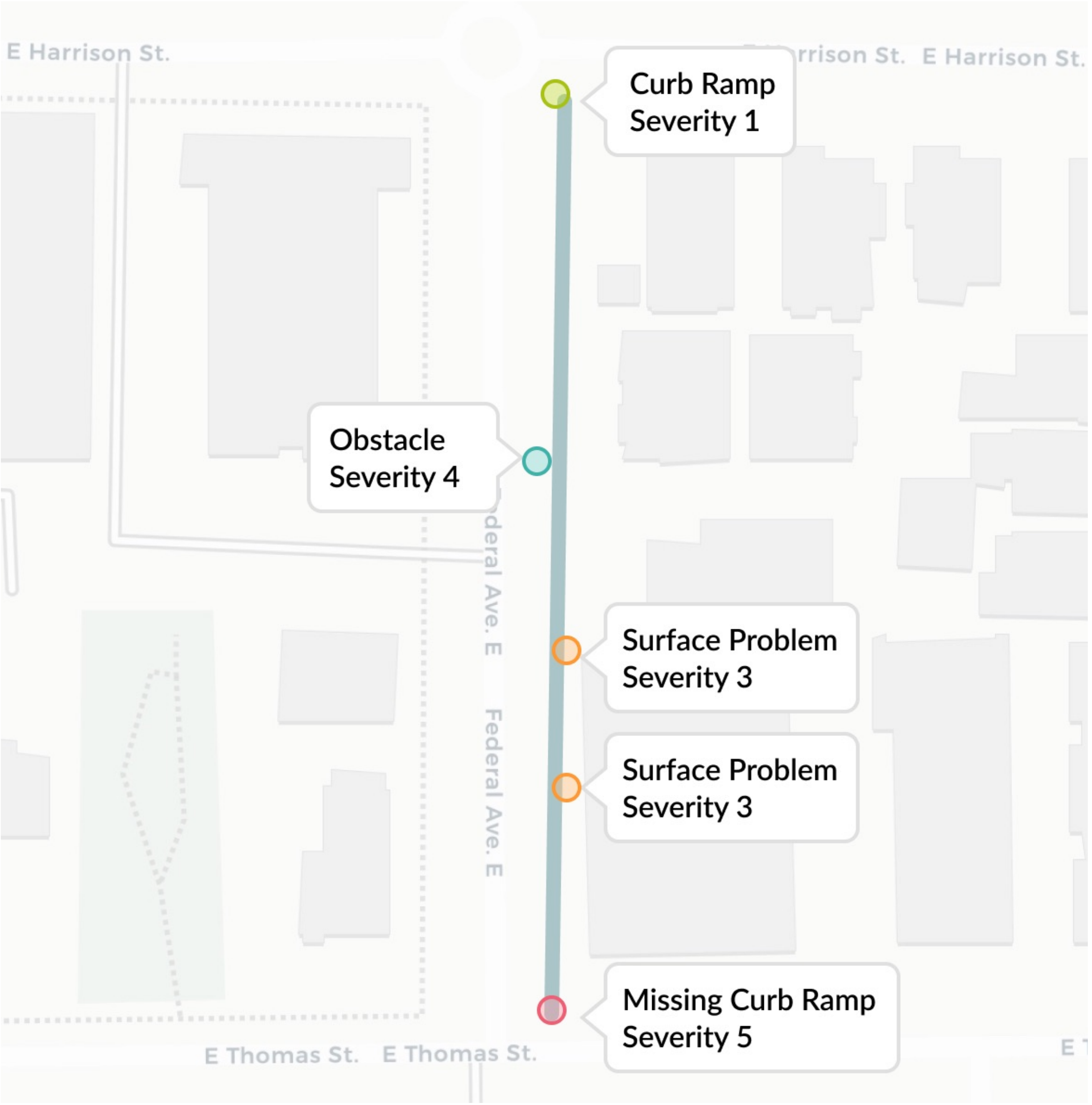
xa = (1.0, -1.0, -0.6, -0.8)

Accessibility Feature Vector

ws = (1, 1, 2, 1)

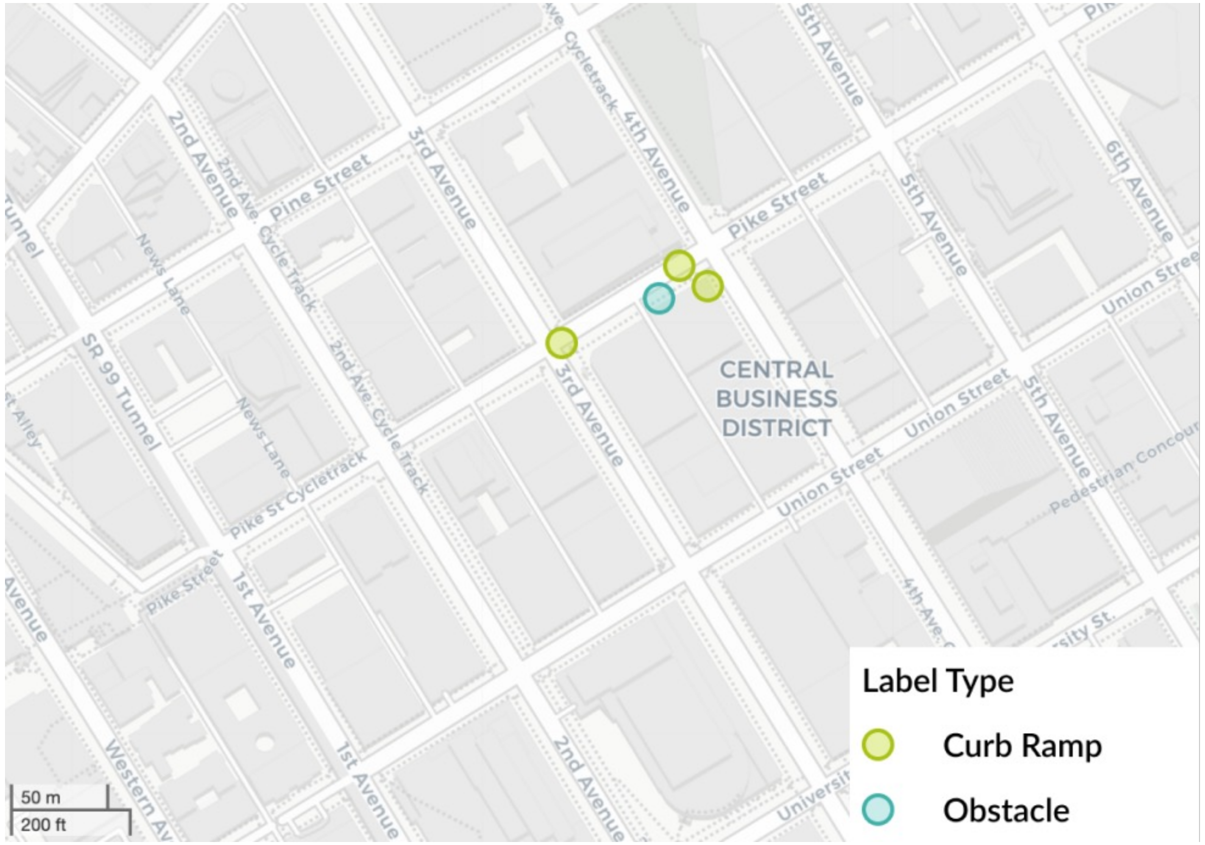
AccessScore: Sidewalk Segment

$$AS_{sidewalk} = \frac{1}{1 + e^{-(ws \cdot xa)}} = 0.12$$



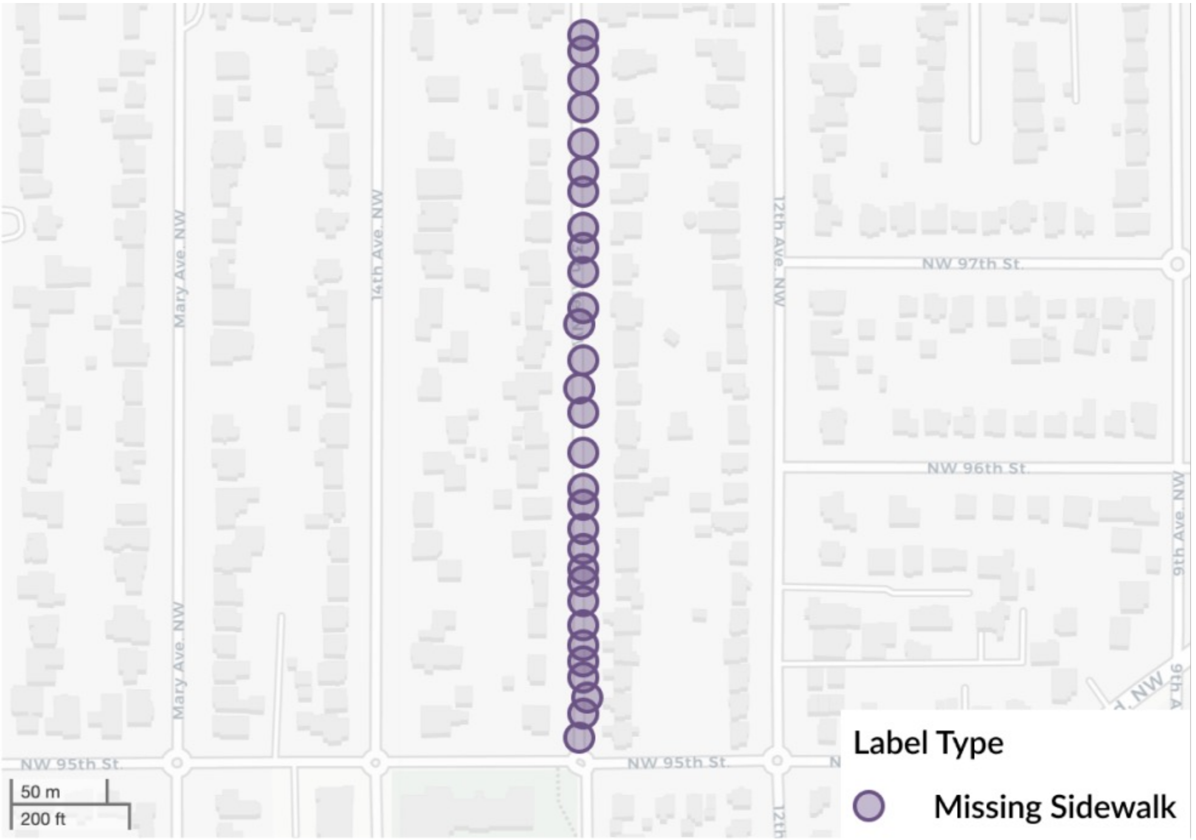
METHOD

HIGH ACCESS SCORE STREET



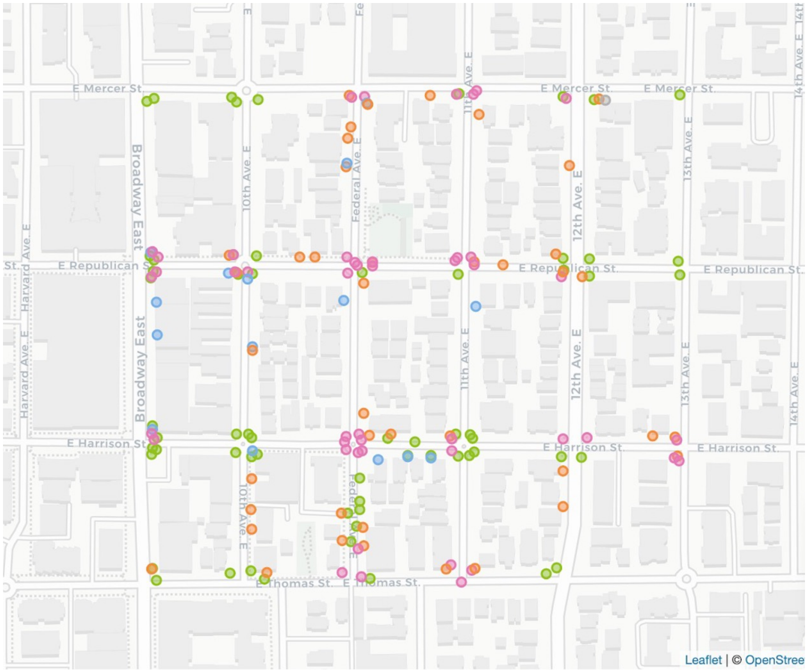
METHOD

LOW ACCESS SCORE STREET

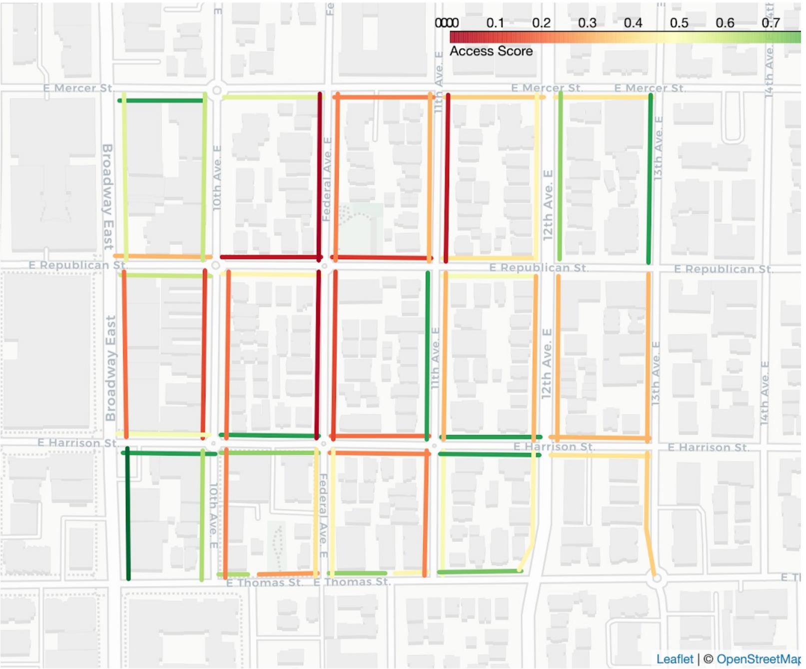


METHOD

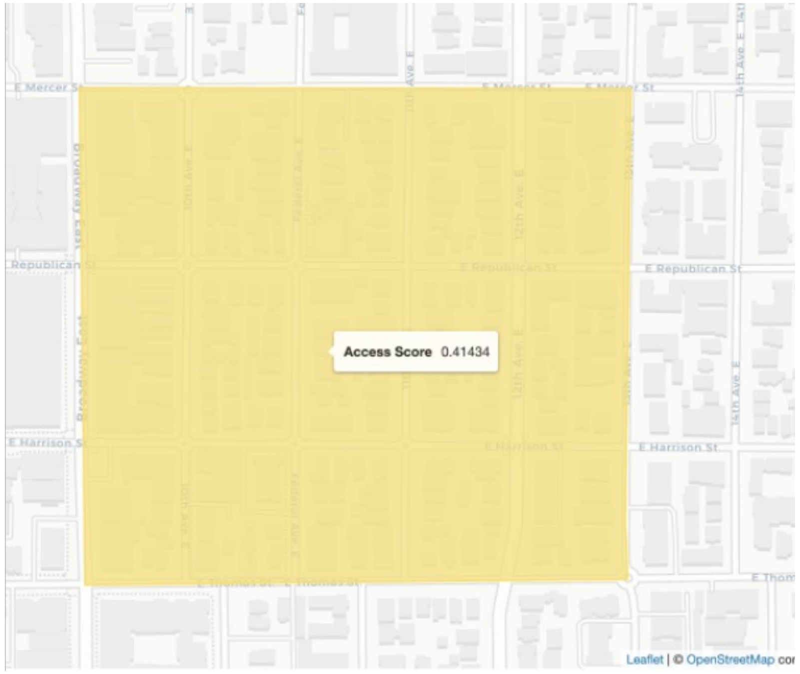
ACCESS SCORE



Labels



Sidewalk Access Score

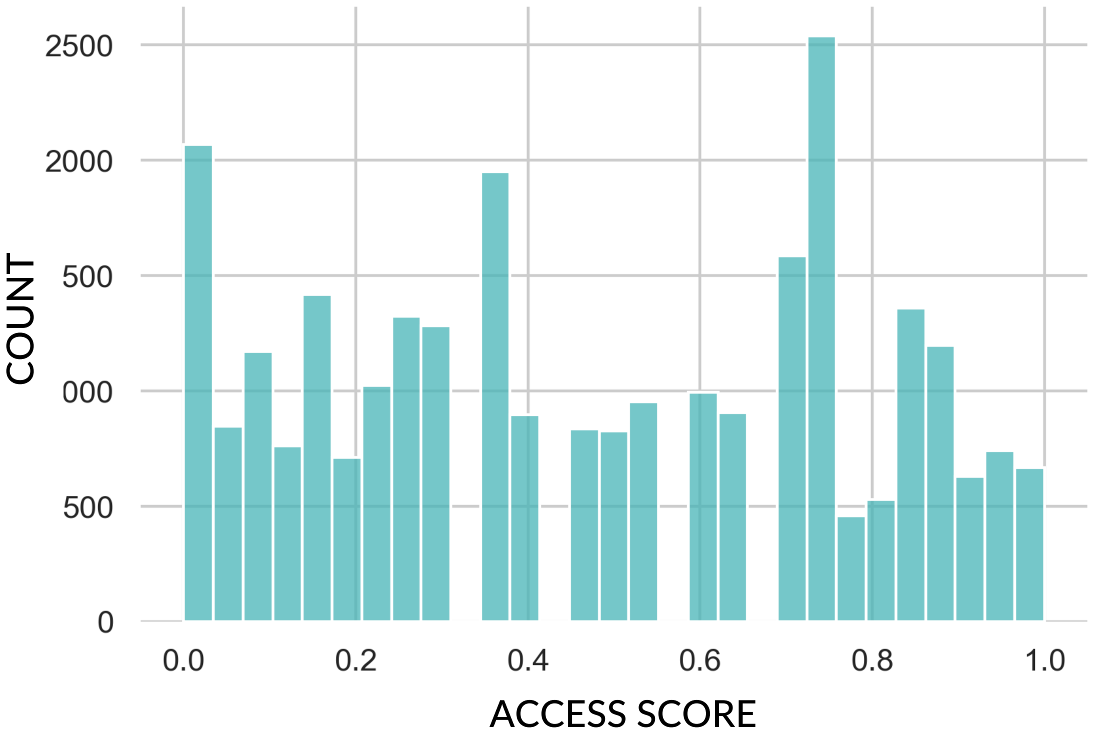


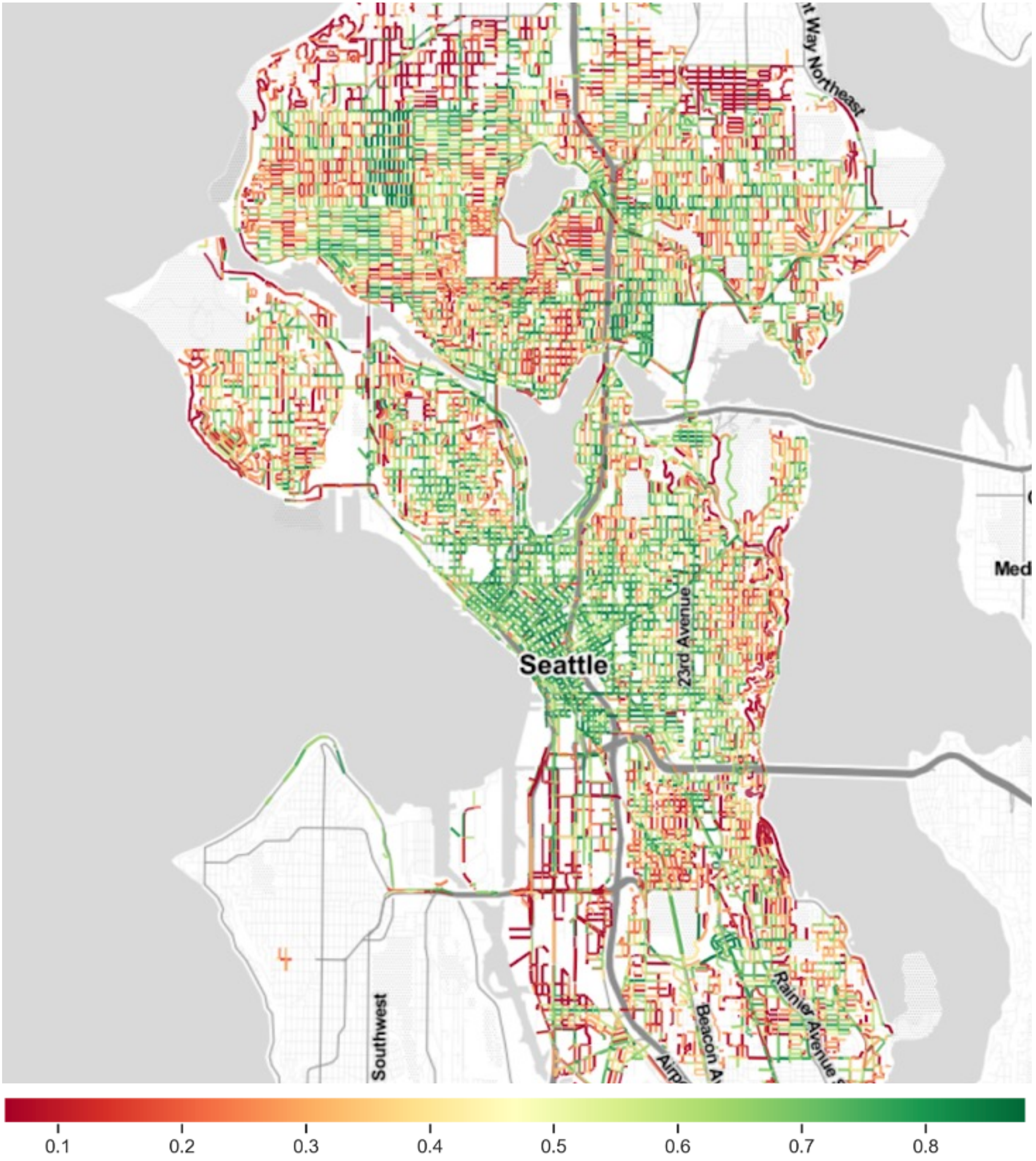
Neighborhood Access Score

LIMITATIONS OF CROWDSOURCING

FINDINGS

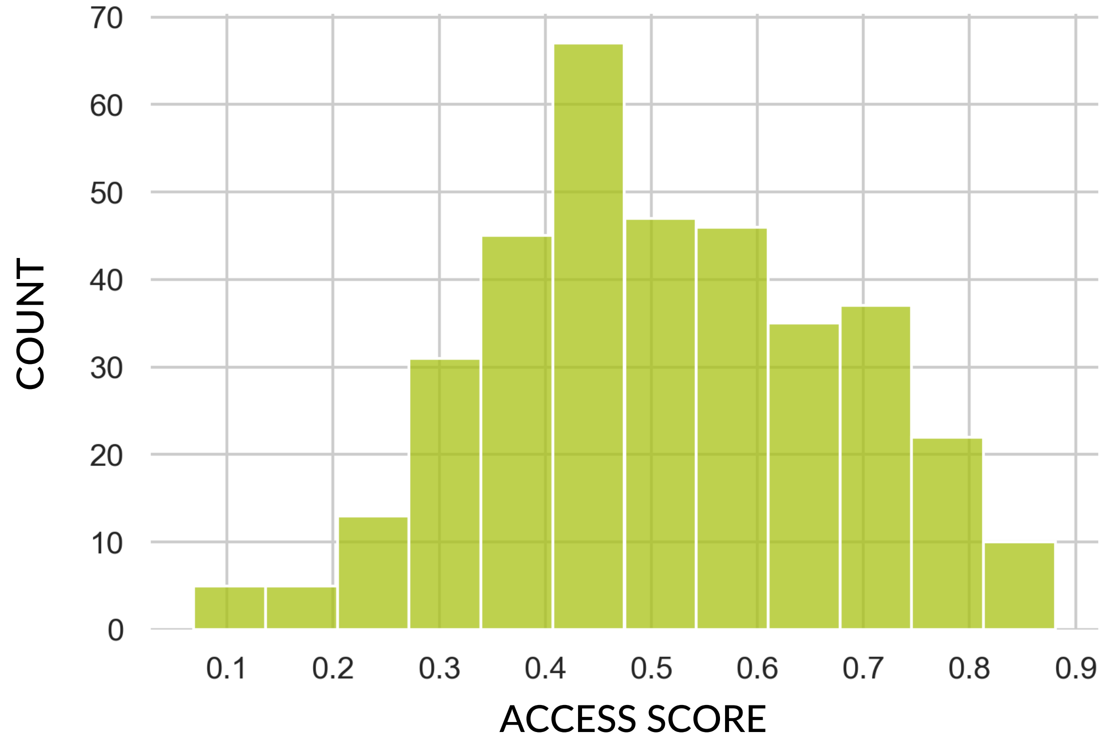
SPATIAL DISTRIBUTION PER SIDEWALK SEGMENT

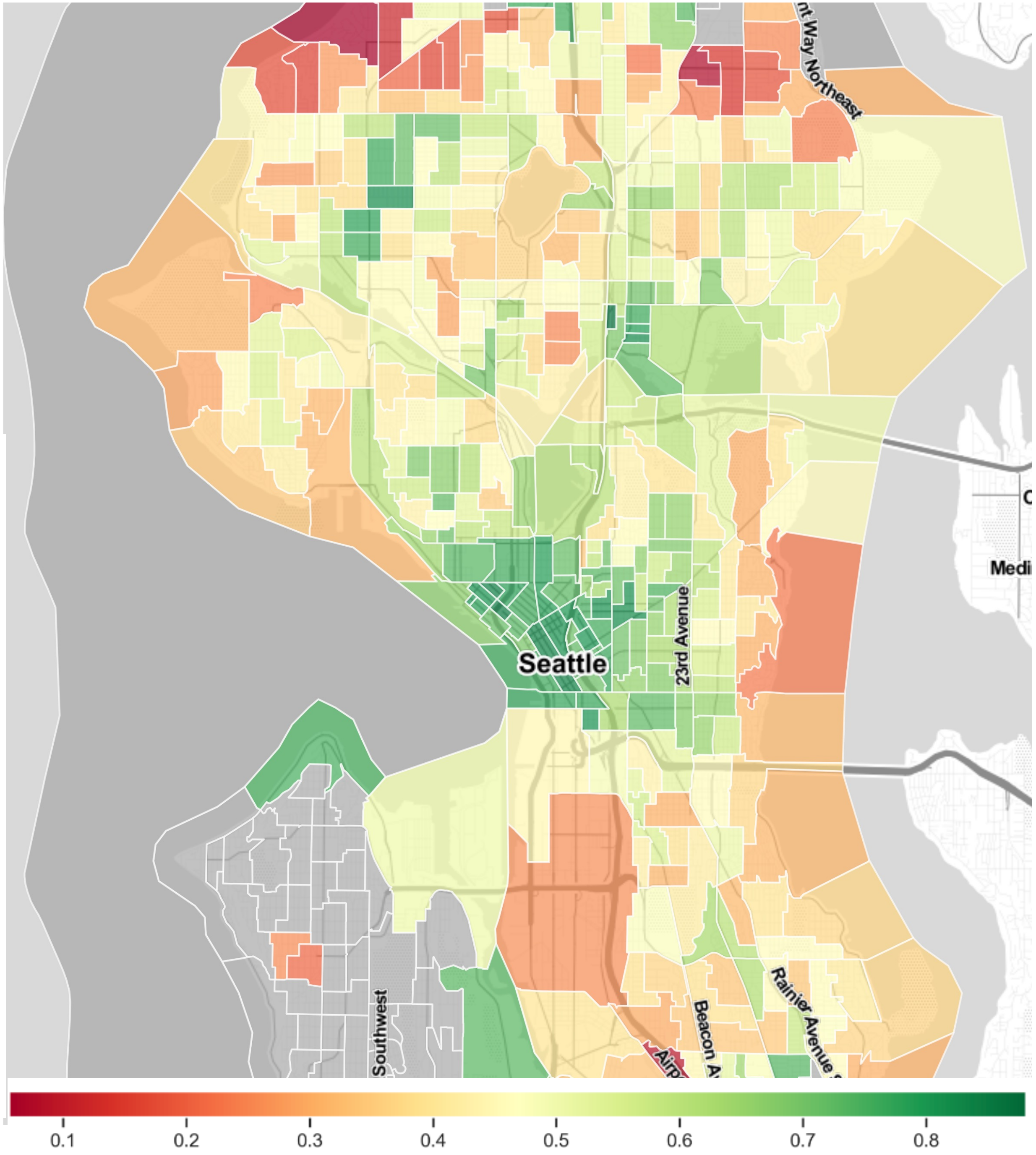


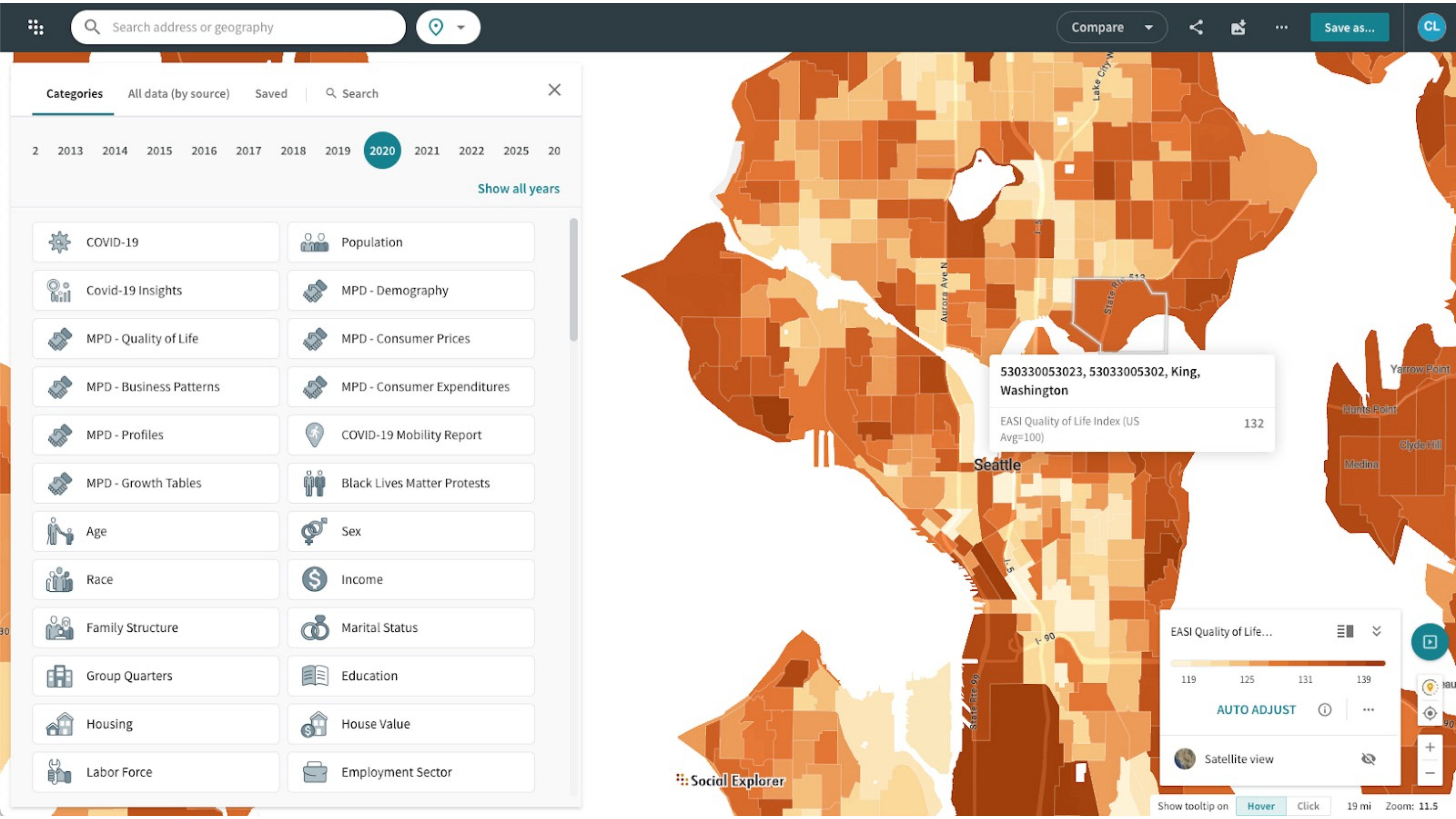


FINDINGS

SPATIAL DISTRIBUTION PER NEIGHBORHOOD







Search address or geography
Compare
Save as...
CL
Categories
All data (by source)
Saved
Search
2
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2025
20
Show all years
COVID-19
Population
Covid-19 Insights
MPD - Demography
MPD - Quality of Life
MPD - Consumer Prices
MPD - Business Patterns
MPD - Consumer Expenditures
MPD - Profiles
COVID-19 Mobility Report
MPD - Growth Tables
Black Lives Matter Protests
Age
Sex
Race
Income
Family Structure
Marital Status
Group Quarters
Education
Housing
House Value
Labor Force
Employment Sector
530330053023, 53033005302, King, Washington
EASI Quality of Life Index (US Avg=100)
132
Seattle
Yarrow Point
Hunts Point
Clyde Hill
Medina
EASI Quality of Life...
119
125
131
139
AUTO ADJUST
Satellite view
Social Explorer
Show tooltip on
Hover
Click
19 mi
Zoom: 11.5

FINDINGS

SOCIO-ECONOMIC CORRELATIONS

- Population
- Race & Citizenship
- Education
- Income
- Housing
- Modes of travel

Property	rho	Property	rho	Property	rho
Population Density (Per Sq. Mile)	0.52	Car, Truck, or Van%	-0.50	Average Gross Rent	-0.13
White Alone%	-0.23	Drove Alone%	-0.49	Owner Occupied%	-0.57
Black or African American Alone%	0.12	Carpooled%	-0.24	Renter Occupied%	0.57
American Indian & Alaska Native Alone%	0.16	Public Transportation%	0.23	1, Detached%	-0.60
Asian Alone%	0.23	Motorcycle%	-0.07	1, Attached%	-0.04
Pacific Islander Alone%	0.07	Bicycle%	-0.07	2%	-0.07
Some Other Race Alone%	0.14	Walked%	0.50	3 or 4%	0.03
Two or More Race%	-0.01	Other Means%	0.04	5 to 9%	0.07
Racial Diversity	-0.23	Less than 10 Minutes%	0.13	10 to 19%	0.20
Citizenship - Native%	-0.08	10 to 19 Minutes%	0.21	20 to 49%	0.43
Foreign Born - Naturalized%	-0.17	20 to 29 Minutes%	0.07	50 or More%	0.51
Foreign Born - Not a Citizen%	0.23	30 to 39 Minutes%	-0.14	Housing Units Built 2014 or Later%	0.35
Family Households%	-0.49	40 to 59 Minutes%	-0.20	Housing Units Built 2010 to 2013%	0.27
Average Household Size	-0.42	60 to 89 Minutes%	-0.13	Housing Units Built 2000 to 2009%	0.28
Less than High School%	0.12	Median Household Income	-0.31	Housing Units Built 1990 to 1999%	0.22
High School Graduate%	0.00	Average Household Income	-0.32	Housing Units Built 1980 to 1989%	0.07
Some College%	0.04	Median Family Income	-0.15	Housing Units Built 1970 to 1979%	-0.02
Bachelors Degree%	-0.02	Average Family Income	-0.13	Housing Units Built 1960 to 1969%	-0.10
Masters Degree%	-0.01	Per Capita Income	-0.06	Housing Units Built 1950 to 1959%	-0.33
Professional School Degree%	-0.09	Median Housing Value	-0.21	Housing Units Built 1940 to 1949%	-0.42
Doctorate Degree%	-0.13	Median Gross Rent	-0.13	Housing Units Built 1939 or Earlier%	-0.12
Unemployed%	0.07	Median Gross Rent as a % of Income	0.16		

FINDINGS

SOCIO-ECONOMIC CORRELATIONS

Lower sidewalk quality neighborhoods:

- More affluent
- Predominantly white
- Lower housing and population density
- Driving is the primary mode of transportation

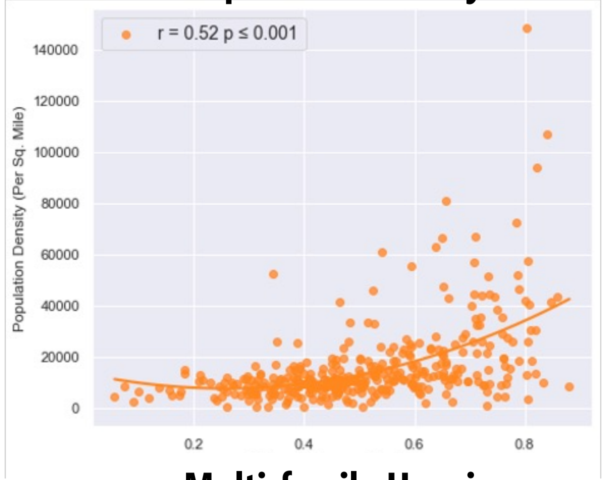
FINDINGS

SOCIO-ECONOMIC CORRELATIONS

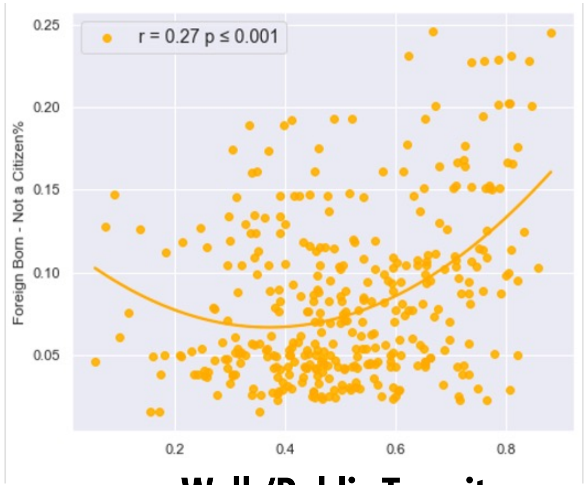
Higher sidewalk quality neighborhoods:

- Higher population and housing density
- Higher racially diversity
- Higher proportion of immigrants
- Commute primarily by walking or public transportation

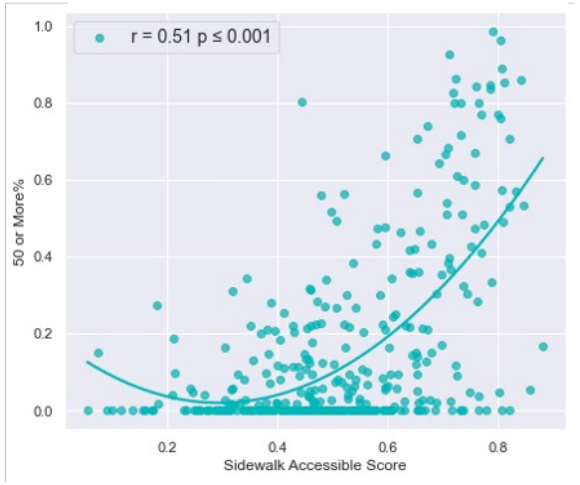
Population Density



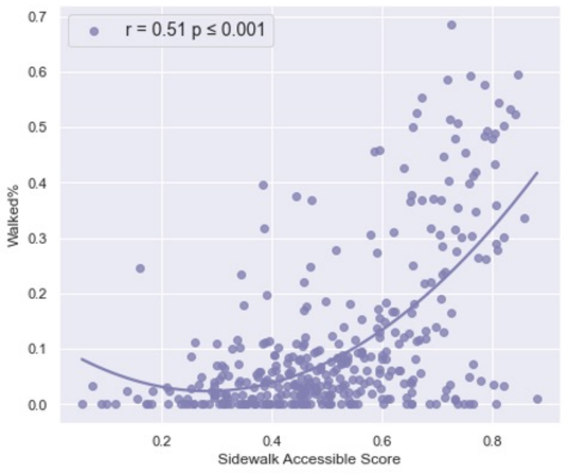
Non-citizens



Multi-family Housing



Walk/Public Transit



FUTURE WORK

- Large-scale, cross-regional studies on sidewalk equity
- Improve the accessibility of existing infrastructure
- Influence urban design guidelines and policies

CALLING FOR PARTNERS!

Together let's transform sidewalk accessibility in WA state!

sidewalk@cs.uw.edu

CALLING FOR PARTNERS!

Together let's transform sidewalk accessibility in WA state!

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- Government initiatives
- Local communities
- Universities

- Prioritize sidewalk renovation
- Facilitate ADA transitions
- Inform urban planning policies

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Oradell Girl Scouts

Hackensack Meridian School of Medicine

World Enabled

LIGA PEATONAL

El Colegio de Michoacán

Open Columbus

Universidad de Monterrey
Homo hominis in ministerio perficitur

City of Amsterdam

Universidad Autónoma de Sinaloa

San Pedro Garza García
Gobierno Municipal

amsterdam intelligence

City of Newberg

UIC University of Illinois Chicago

Tecnológico de Monterrey

National Multiple Sclerosis Society
Bergen Multiple Sclerosis Community Council

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Google

IBM

PACIFIC NW TRANSPORTATION CONSORTIUM
PACTRANS
REGION 10

CREATE
Center for Research and Education on Accessible Technology and Experiences
UNIVERSITY of WASHINGTON

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... Following

Project Sidewalk

@projsidewalk Follows you

Our mission: map the world's sidewalks and their accessibility using remote crowdsourcing, artificial intelligence, and online satellite & streetscape imagery

Seattle, WA projectsidewalk.org Joined June 2016

PROJECT SIDEWALK

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