



# Interaction Dynamics for Crowdsourced Obstacle Data

Matt Rice (presenter)  
Kevin Curtin, Manzhu Yu

# Dr. Matt Rice

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- ▶ **Program Director**, MS Geographic and Cartographic Sciences
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# Personnel

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- ▶ Dr. Matt Rice ([GMU](#))
- ▶ Dr. Kevin Curtin ([Alabama](#))
- ▶ Dr. Manzhu Yu ([Penn State](#))

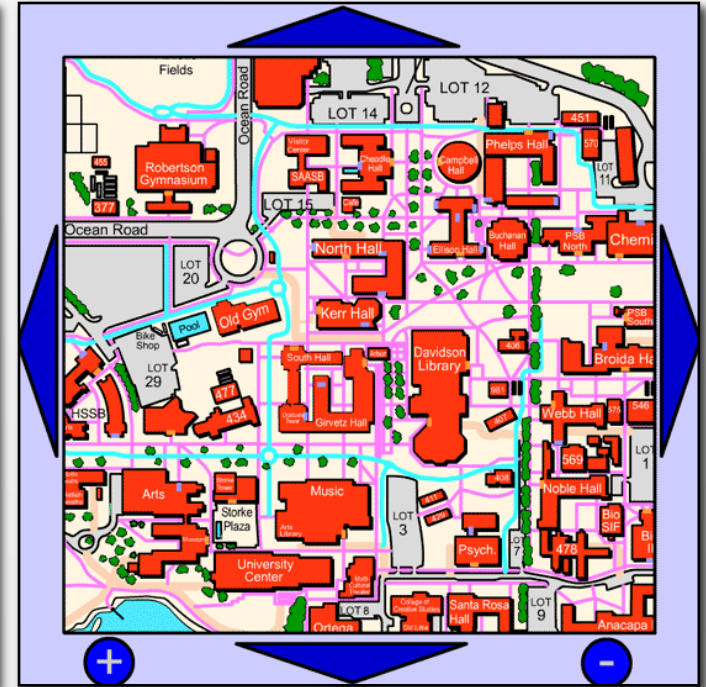
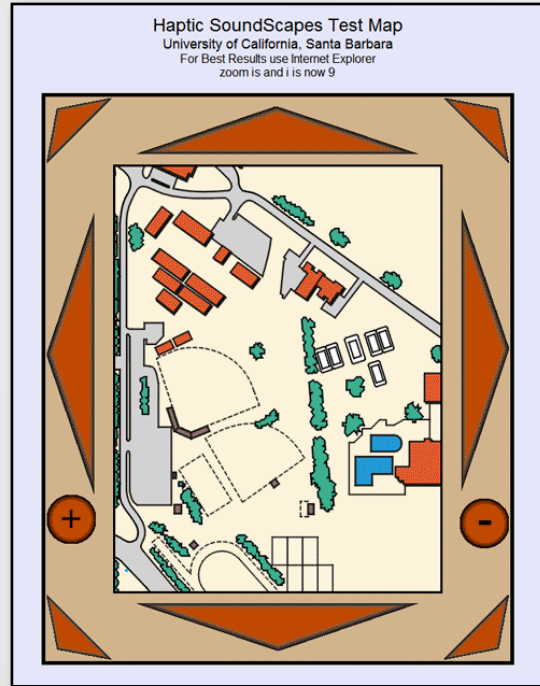


- ▶ **Collaborators:** Dr. Dieter Pfoser (GMU), Dr. Sven Fuhrmann (GMU), Mr. Douglas Caldwell (USACE-ERDC/GRL), Dr. Han Qin

**Student assistants:** Toby Williams, Rebecca Rice, Rodney Vese, Eric Ong, Kelsea Ciarocca, Megan Rice, Chris Seitz

**Funding:** USACE/ERDC, BAA #AA-10-4733, Contract #W9132V-11-P-0011

# Motivations



- ▶ Barriers: Print and Movement
- ▶ Wayfinding and Accessibility
- ▶ Non-visual mapping interfaces
- ▶ Rice et al. (2005), Golledge et al. (2005, 2006)

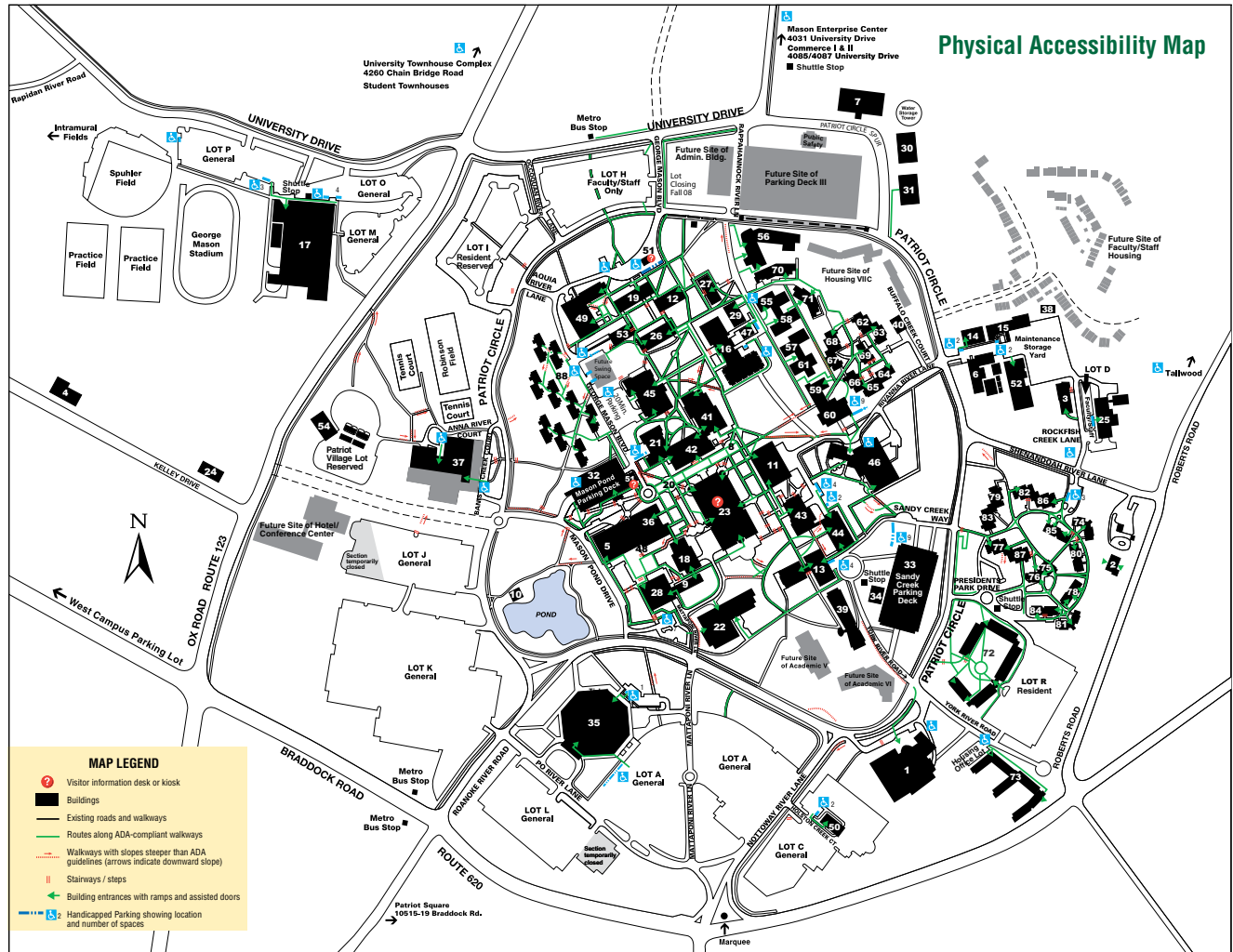


# Non-accessible accessibility

## Physical Accessibility Map

**GEORGE MASON UNIVERSITY**  
**FAIRFAX CAMPUS**  
 4400 University Drive  
 Fairfax, VA 22030  
 703-993-1000

- |   |                                   |
|---|-----------------------------------|
| 1 Aquatic and Fitness Center                      | 62 Amherst                        |
| 2 Buchanan House                                  | 63 Brunswick                      |
| 3 Carow Hall                                      | 64 Carroll                        |
| 4 Cary House                                      | 65 Dickenson                      |
| 5 Center for the Arts/Concert Hall                | 66 Essex                          |
| 6 Central Heating/Cooling Plant                   | 67 Franklin                       |
| 7 Child Development Center                        | 68 Grayson Hall                   |
| 8 Clock   | 69 Hanover Hall                   |
| 9 College Hall                                    | 70 Commonwealth                   |
| 10 Cross Cottage                                  | 71 Dominion                       |
| 11 David King Hall                                | 72 Liberty Square                 |
| 12 East Building                                  | 73 Promise Heights/Housing Office |
| 13 Enterprise Hall                                | 74 Adams                          |
| 14 Facilities Administration                      | 75 Eisenhower                     |
| 15 Facilities Management, Customer Service Center | 76 Eisenhower Extension           |
| 16 Fennick Library                                | 77 Harrison                       |
| 17 Field House and Module                         | 78 Jackson                        |
| 18 Fine Arts Building                             | 79 Jefferson                      |
| 19 Finley Building                                | 80 Kennedy                        |
| 20 George Mason Statue                            | 81 Lincoln                        |
| 21 Harris Theater                                 | 82 Madison                        |
| 22 Innovation Hall                                | 83 Monroe                         |
| 23 Johnson Center                                 | 84 Roosevelt                      |
| 24 Kelley II                                      | 85 Truman                         |
| 25 Krasnow Institute                              | 86 Washington                     |
| 26 Krug Hall                                      | 87 Witson                         |
| 27 Lecture Hall                                   | 88 Student Apartments             |
| 28 Mason Hall                                     |                                   |
| 29 North Chesapeake Module                        |                                   |
| 30 Northeast Module                               |                                   |
| 31 Northeast Module II                            |                                   |
| 32 Parking Deck, Mason Pond                       |                                   |
| 33 Parking Deck, Sandy Creek                      |                                   |
| 34 Parking Services                               |                                   |
| 35 Patriot Center                                 |                                   |
| 36 Performing Arts Building                       |                                   |
| 37 PE Building                                    |                                   |
| 38 Recycling Center                               |                                   |
| 39 Research I                                     |                                   |
| 40 Rivanna Module                                 |                                   |
| 41 Robinson Hall A                                |                                   |
| 42 Robinson Hall B                                |                                   |
| 43 Science and Tech I                             |                                   |
| 44 Science and Tech II                            |                                   |
| 45 Student Union I                                |                                   |
| 46 Student Union II                               |                                   |
| 47 South Chesapeake Module                        |                                   |
| 48 TheaterSpace/Black Box                         |                                   |
| 49 Thompson Hall                                  |                                   |
| 50 University Police                              |                                   |
| 51 Visitor Information                            |                                   |
| 52 Warehouse                                      |                                   |
| 53 West Building                                  |                                   |
| 54 West PE Module                                 |                                   |
| <b>Residential Chesapeake</b>                     |                                   |
| 55 Blue Ridge                                     |                                   |
| 56 Northern Neck                                  |                                   |
| 57 Piedmont                                       |                                   |
| 58 Shenandoah                                     |                                   |
| 59 Skyline Fitness Center                         |                                   |
| 60 Southside Dining                               |                                   |
| 61 Tidewater                                      |                                   |



**MAP LEGEND**

- Visitor information desk or kiosk
- Buildings
- Existing roads and walkways
- Routes along ADA-compliant walkways
- Walkways with slopes steeper than ADA guidelines (arrows indicate downward slope)
- Stairways / steps
- Building entrances with ramps and assisted doors
- Handicapped Parking showing location and number of spaces



# Navigation Obstacles





# Navigation Obstacles

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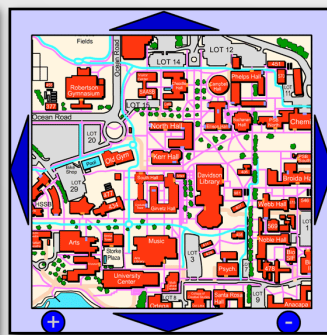
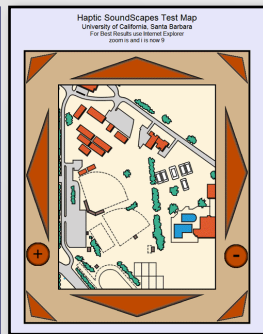
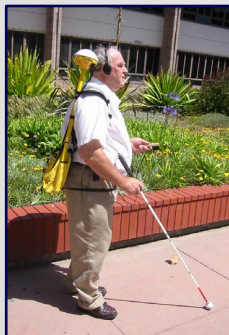
# Navigation Obstacles





# Summary

- ▶ **Accessibility** facilitates equity, participation, access to public space, transit, employment
- ▶ **Geoaccessibility** uses maps, geospatial information, and GIS to understand obstacles and enhance access
- ▶ **Key:** high-quality, high-resolution geospatial data and real-time updates
- ▶ **Challenges:** Modes of communication, infrastructure, interaction dynamics



# **GEOCROWDSOURCED DATA COLLECTION**

# Obstacle Reporting Systems

**Welcome!**

We are creating a tool to report obstacles on campus, and support the navigation for our community with disabilities... and we need your help!

For more information about the research click [here](#)

**Filter by status**

- Reports
- Obstacles
- Under Review
- Confirmed
- Official Reports
- Closed

**Report new obstacle**

Please, complete all the information in the following tabs.

To learn how to complete the form go to ["How it works"](#) in our website

**KEY:**

- Click for more information
- This information is required

User ID:

[More Information...](#)

- Time & Location
- Obstacle Details
- Upload Image

**generate the polygon template** **drawing polygon** **Map** **Satellite**

The map displays a campus area with numerous red circular icons containing a white 'X', representing reported obstacles. A yellow polygon is drawn around a central area of the campus, likely representing a 'polygon template' for reporting. The interface includes a sidebar with navigation and filtering options, and a top navigation bar with map controls.

# GMU Geocrowdsourcing Testbed: Obstacle Report

**Report ID:** *report\_000424*

**Report date:** *8/14/2015 16:51*

**Obstacle type:** *sidewalk obstruction,construction detour*

**Obstacle impact:**

**Image:** [image\(1\):](#)



**Duration:** *Long (> 7 days)*

**Urgency:** *Medium*

**Location Comment:** *Near the corner of Patriot Circle and George Mason Blvd, south of Merten Hall*

**Obstacle Comment:** *Construction barrels & sign board for detour and road closures*

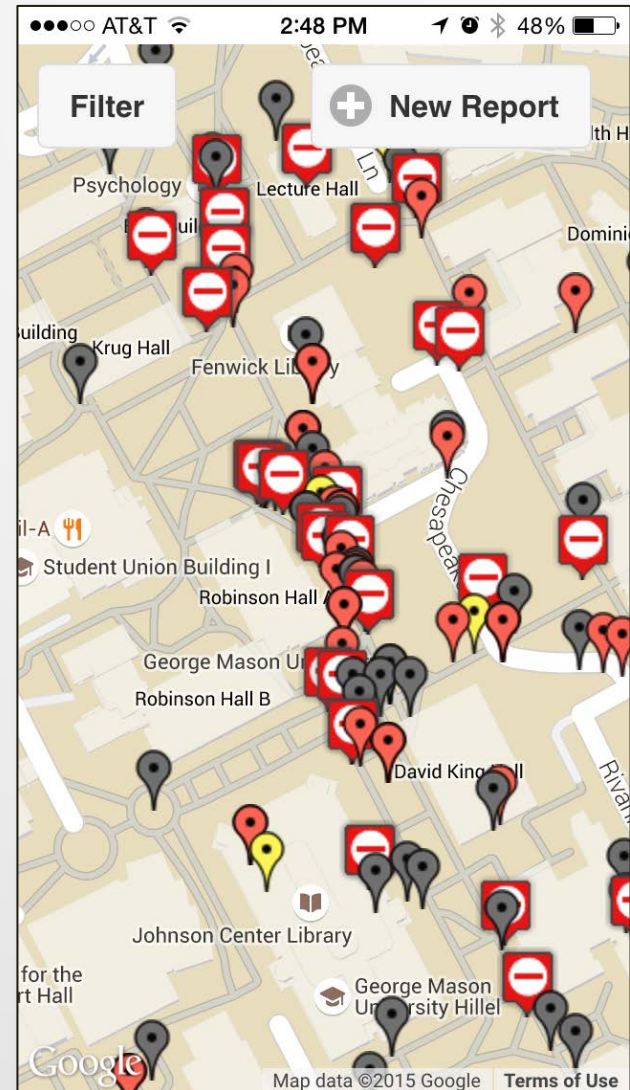
**Status:** *submitted/in process/under review*





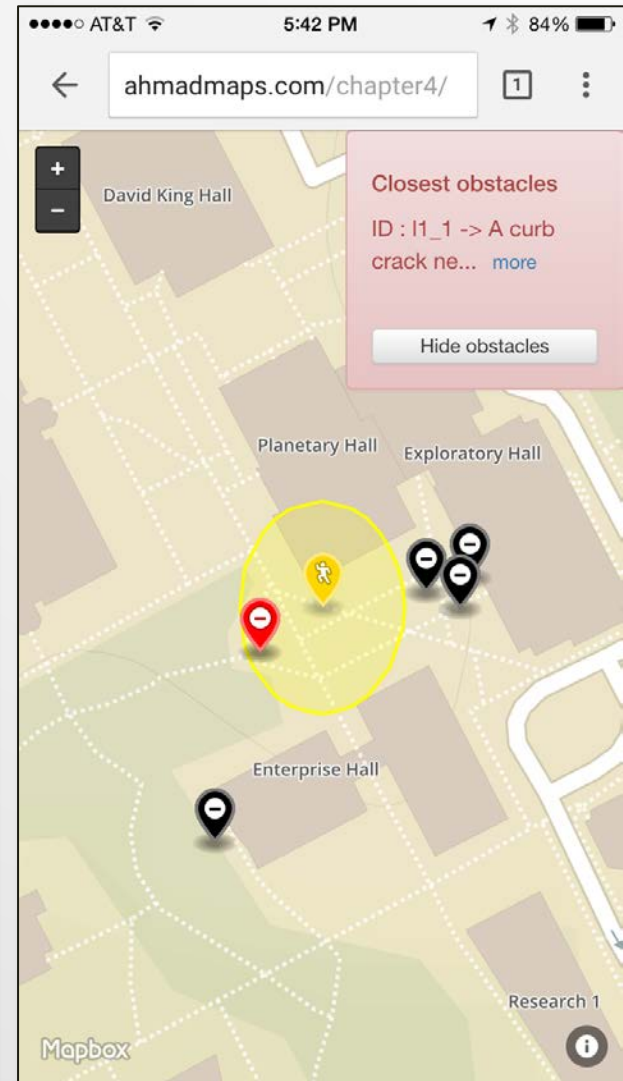
# Mobile Web Application (v.1)

- ▶ Web application
- ▶ Google Maps, Sencha Touch
- ▶ Purpose: data collection



# Mobile Web Application

- ▶ V.2
- ▶ Turf, Mapbox
- ▶ Primary: Obstacle interaction with movement
- ▶ Latency issues



# Native Mobile Application (v.1, iPad)

The screenshot displays a mobile application interface for a native mobile application (v.1, iPad). The main view is a map of George Mason University, showing streets like Patriot Cir, Rivanna River Ln, and Staffordshire Ln. A large blue shaded area is overlaid on the map, indicating a specific region of interest. Several green location pins are scattered across the map, and a red pin is located within the blue shaded area. A small inset image shows a photograph of a road with orange traffic cones and a fence.

At the top of the screen, the status bar shows "AT&T LTE", the time "11:51 AM", and a battery level of "96%".

On the right side, there is a navigation panel with two tabs: "Explore" (selected) and "Routing". Below the tabs is a search bar containing the text "fairfax". A "Get Route" button is positioned below the search bar.

The panel lists three obstacles:

- obstacle\_38**: There is a big area surrounded by a orange 227m -39.46°
- obstacle\_34**: Construction fencing, barricades, and deep hole for 298m -38.26°
- obstacle\_29**: The hand railing that should be mounted to hold for 29m -35.23°

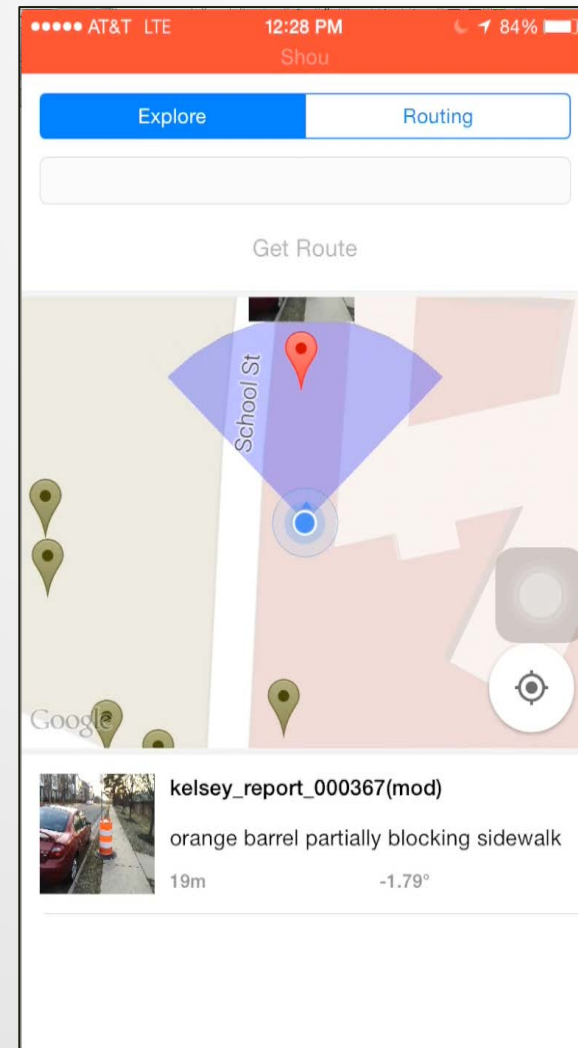
Below the list, there is a photograph of orange traffic cones and a fence. The "Name" field is labeled "obstacle\_38" and the "Description" field contains the text: "There is a big area surrounded by a orange small fence, and cones in the nearby area, which block the entire".

At the bottom left, the Google logo is visible. At the bottom right, there is a compass icon and a copyright notice: "©2015 Google - Map data ©2015 Google".

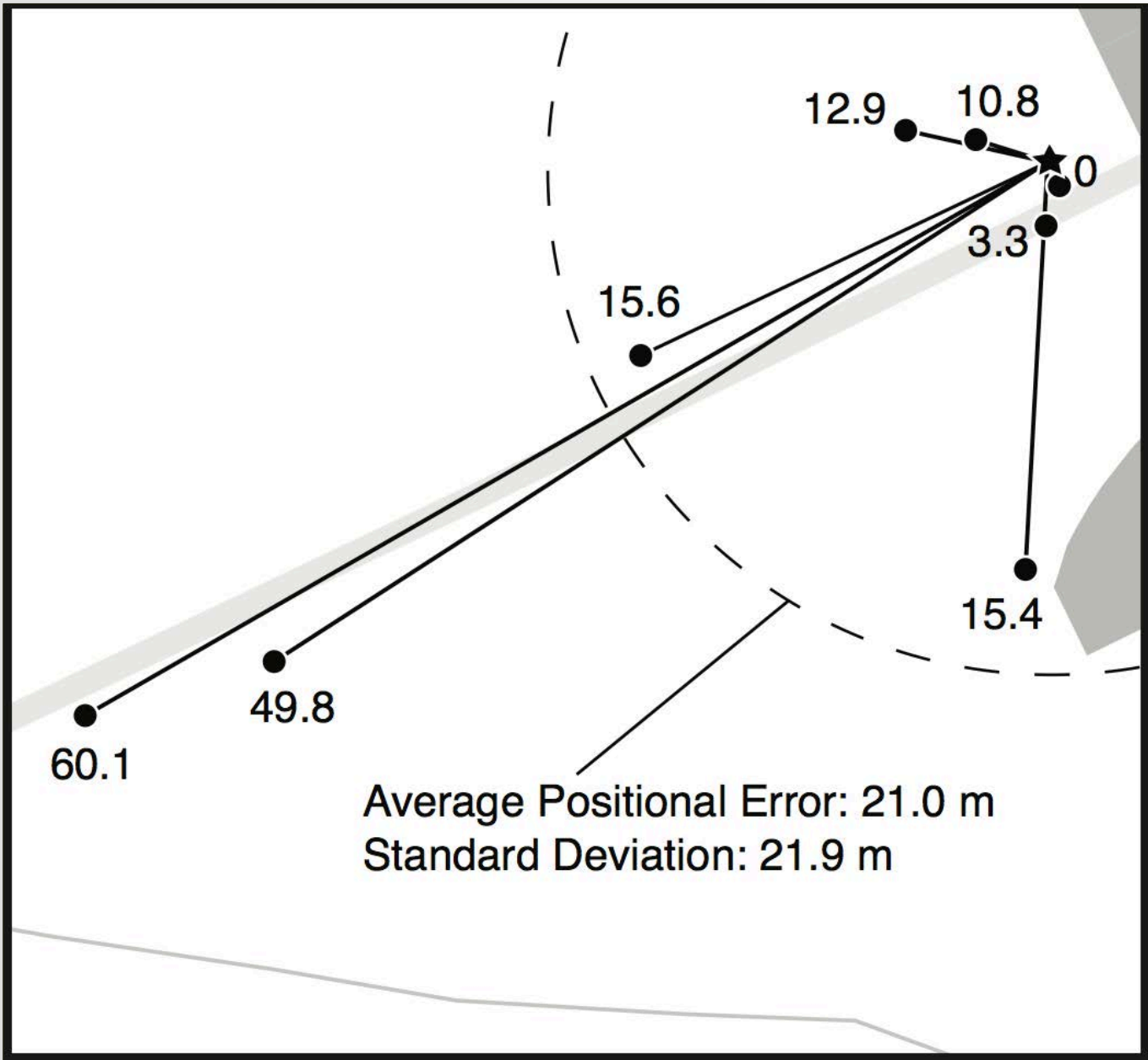


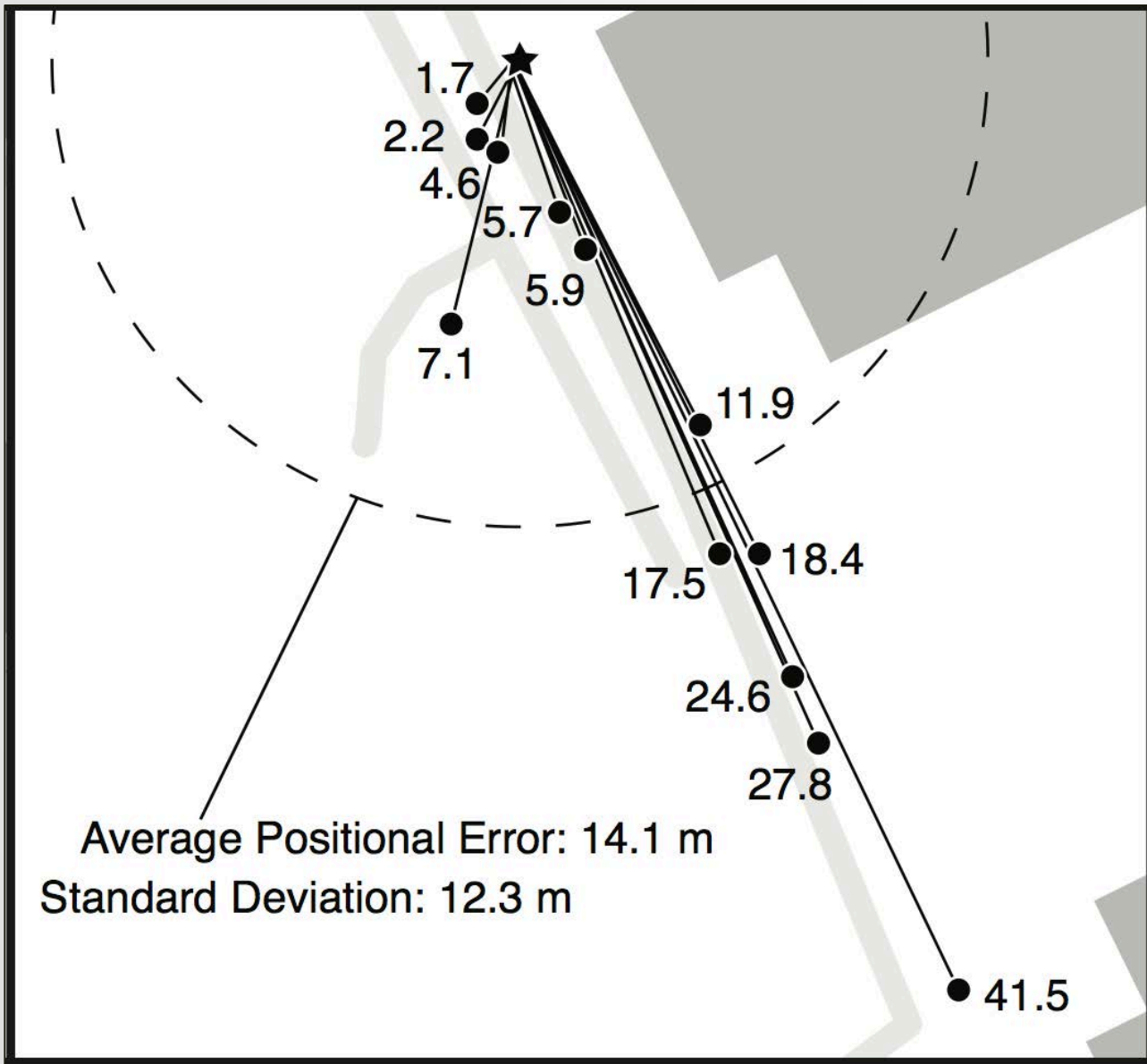
# Native Mobile Application

- ▶ Swift for iOS
- ▶ Responsive
- ▶ Modes: Explore/Routing
- ▶ Chimes/cues
- ▶ 100 ft. interaction buffer
- ▶ Stable trajectory/compass









# QUALITY ASSESSMENT

# Quality Assessment of Geocrowdsourced Data

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Elements of Spatial Data quality (Guptill and Morrison 1995, Veregin 1999)

Positional  
Accuracy

Attribute  
Accuracy

Completeness

Logical  
Consistency

Semantic  
Accuracy

Temporal  
Accuracy

Lineage

Usage

## Quality Assessment Studies:

- ▶ National Map Accuracy Standards, NSSDA, GIS
- ▶ Haklay (2010), [Girres and Touya \(2010\)](#): Horizontal Positional Accuracy of OSM data is +/-6 meters [“Haklay Distance”]
- ▶ Goodchild & Li (2012) [Quality Assessment methods for VGI](#)
- ▶ Camponovo & Freundsuh (2014): Accuracy of attributes, categorization
- ▶ Good review: [Senaratne et al. \(2018\)](#)



# Quality Assessment of Geocrowdsourced Data

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Elements of spatial data quality (Guptill and Morrison 1995, Veregin 1999)

Positional Accuracy

Attribute Accuracy

Completeness

Logical Consistency

Semantic Accuracy

Temporal Accuracy

Lineage

Usage

**Goodchild and Li (2012)** Three methods of assessing VGI data quality:

## Social Approach

Project researchers field check and moderate crowdsourced data

## Crowdsourced Approach

Based on Linus' Law; if enough people contribute, errors will be corrected (Haklay et al. 2010)

## Geographic Approach

Crowdsourced data is compared to official data and known geographic phenomena

**Our approach:** Social moderation → hybrid crowdsourcing

# Obstacle Report Attributes

Report Attribute	Format	Categories	Required
Date & Time of Observation	Selected from calendar, or typed to fit MM/DD/YYYY HH:MM format		Y
Location (X,Y)	Click-drag of locator icon (web), or GPS-coordinates from device (mobile)		Y
Location (text)	Text box		N
Obstacle Type	Selection menu	sidewalk obstruction, construction detour, entrance/exit problem, poor surface condition, crowd/event, other	Y
Obstacle Description	Text box		N
Duration	Drop-down menu	Short (<1 day), Medium (1-7 days), Long (>7 days)	Y
Urgency	Drop-down menu	Low, Medium, High	Y
Image	Image upload		N

# Quality Assessment Variables

Quality Assessment Variables	Score	Rank	Weight (%)
QA: Moderator Quality Score	1-5	1	20
QA: Location (X,Y)	0-1	2	17
QA: Image Quality	0,1,2,3	3	15
QA: Urgency	0,1,2	4	12
QA: Obstacle type	0,1,2	5	11
QA: Duration	0,1,2	6	10
QA: Temporal Consistency	0,1	7	6
QA: Location text	0,1	8	5
QA: Completeness	0-100% scaled to 0-1	9	4
			100

## Index Image



## Positional Error Summary

**Average Positional Error: 6.60 m**  
**Standard Deviation: 0.89 m**

## Obstacle Image Detail



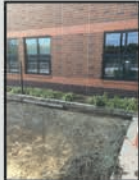
Date: October 19 2016 18:23:35  
Device\_Mod: iPhone 5  
Lens\_Model: iPhone 5 back camera 4.12mm f/2.4  
latitude: 38.829208  
longitude: -77.305503  
Image\_Dire: 57.574675



Date: October 19 2016 18:25:43  
Device\_Mod: iPhone 7  
Lens\_Model: iPhone 7 back camera 3.99mm f/1.8  
latitude: 38.829181  
longitude: -77.30545  
Image\_Dire: 86.075812



Date: October 29 2016 11:52:37  
Device\_Mod: iPhone 6 Plus  
Lens\_Model: iPhone 6 Plus back camera 4.15mm f/2.2  
latitude: 38.829119  
longitude: -77.305467  
Image\_Dire: 97.353086



Date: October 29 2016 11:52:56  
Device\_Mod: iPhone 6 Plus  
Lens\_Model: iPhone 6 Plus back camera 4.15mm f/2.2  
latitude: 38.829117  
longitude: -77.305442  
Image\_Dire: 176.126638





# Evolving quality assessment elements

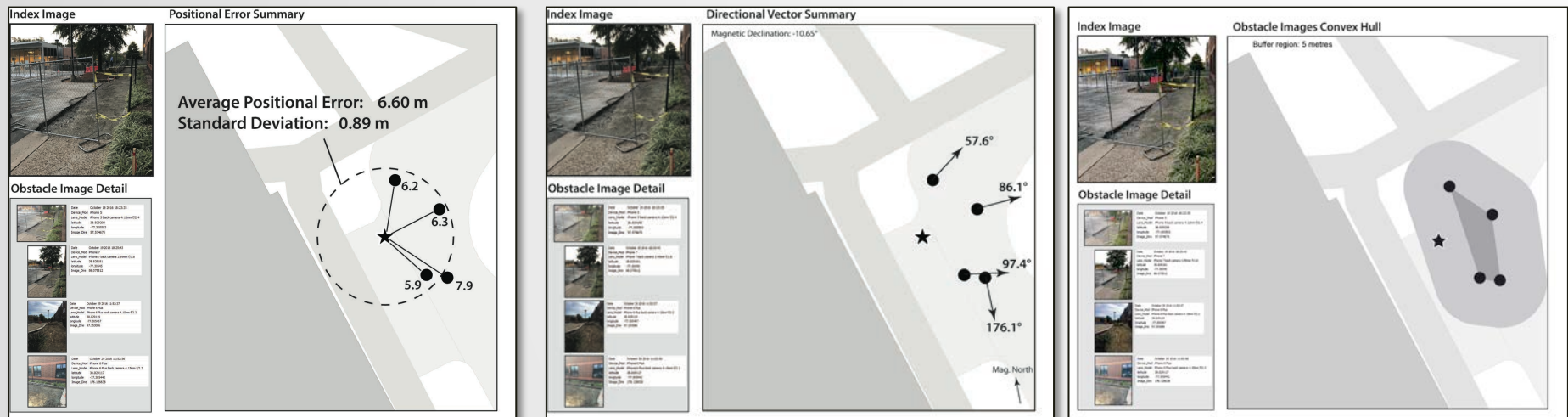


Table 2. Quality assessment elements in the evolving GMU-GcT

	Desktop/mobile	Image share
QA: Location (X, Y)	Metric	Derived
QA: Location text	Binary	Binary-complex
QA: Temporal consistency	Binary	Derived
QA: Obstacle type	Categorical	Not applicable
QA: Duration	Categorical	Not applicable
QA: Urgency	Categorical	Not applicable
QA: Image quality	Ordinal	Ordinal
QA: Completeness	Metric	Not applicable
QA: Moderator quality score	Ordinal	Not applicable

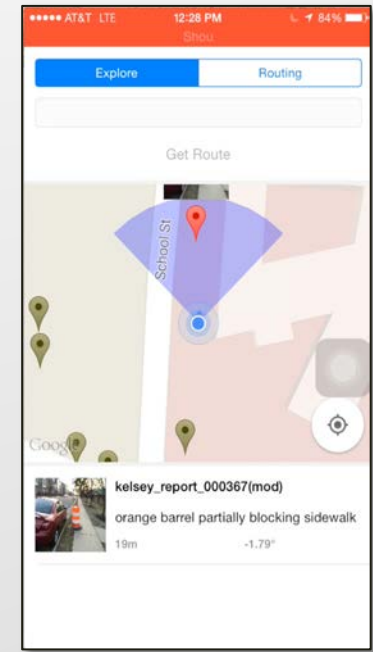
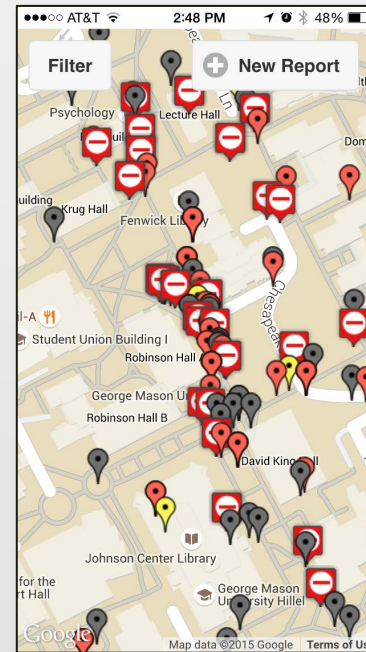
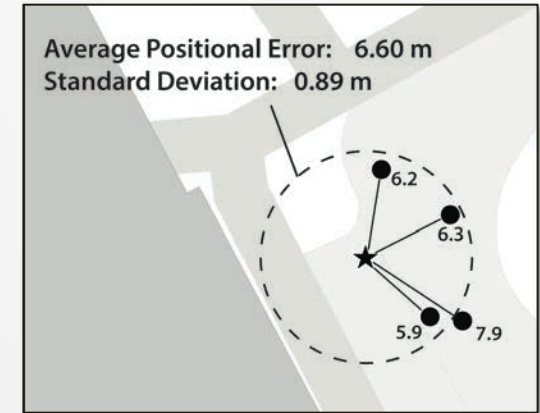


# EXPERIMENTATION WITH AN IMAGE-BASED GEOCROWDSOURCING SYSTEM

# How many contributors does it take?

## Haklay et al (2013) “How Many Volunteers...”

- ▶ Experimentation (2018, with T. Williams)
- ▶ 19-21 contributors
- ▶ Mobile phone-based app
- ▶ 13 features of various sizes





IV FOURTH ESTATE

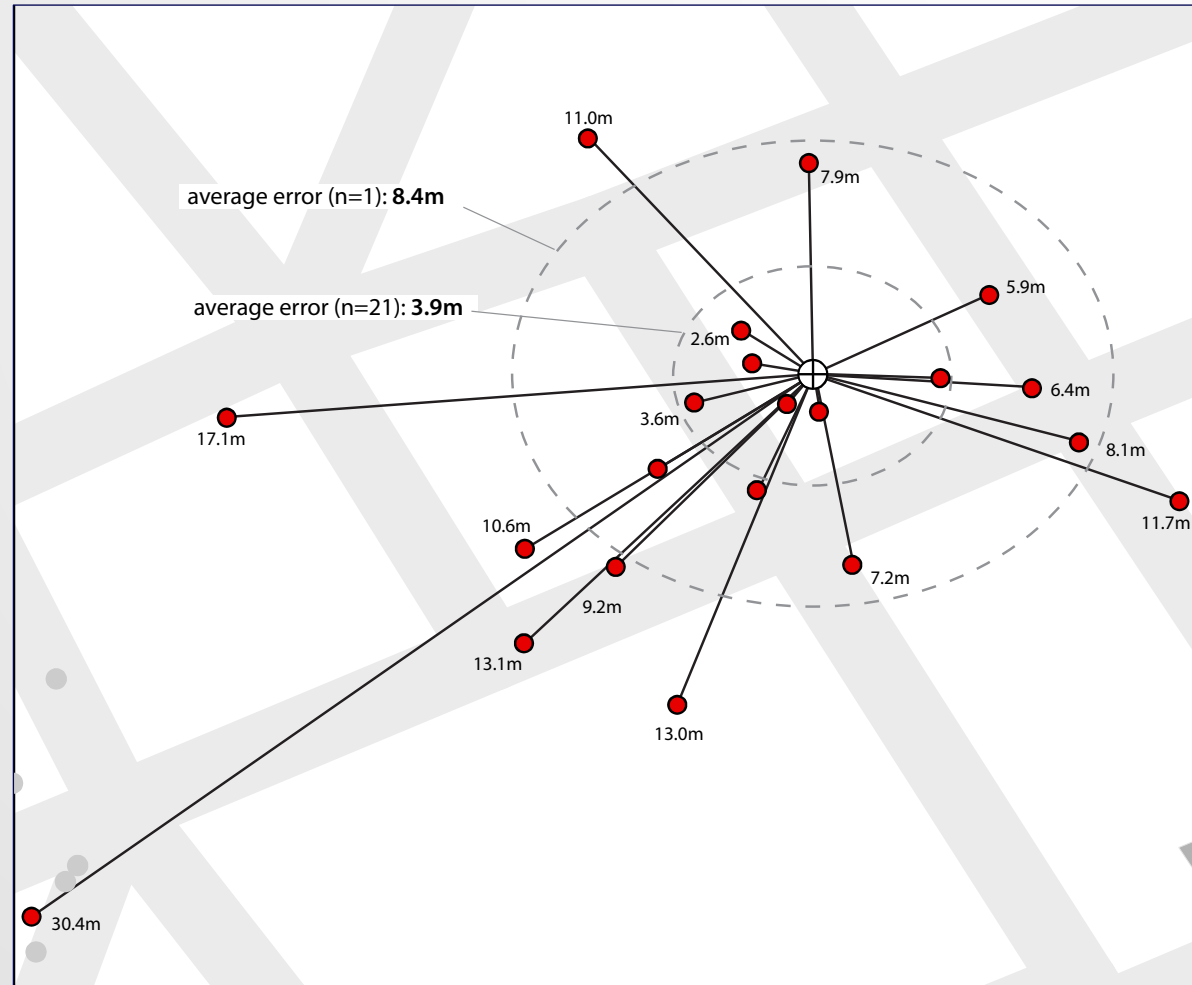
gotcha TO ADVERTISE HERE  
CALL 310.657.6269

# IMPACT MENTAL HEALTH THROUGH YOUR EDUCATION

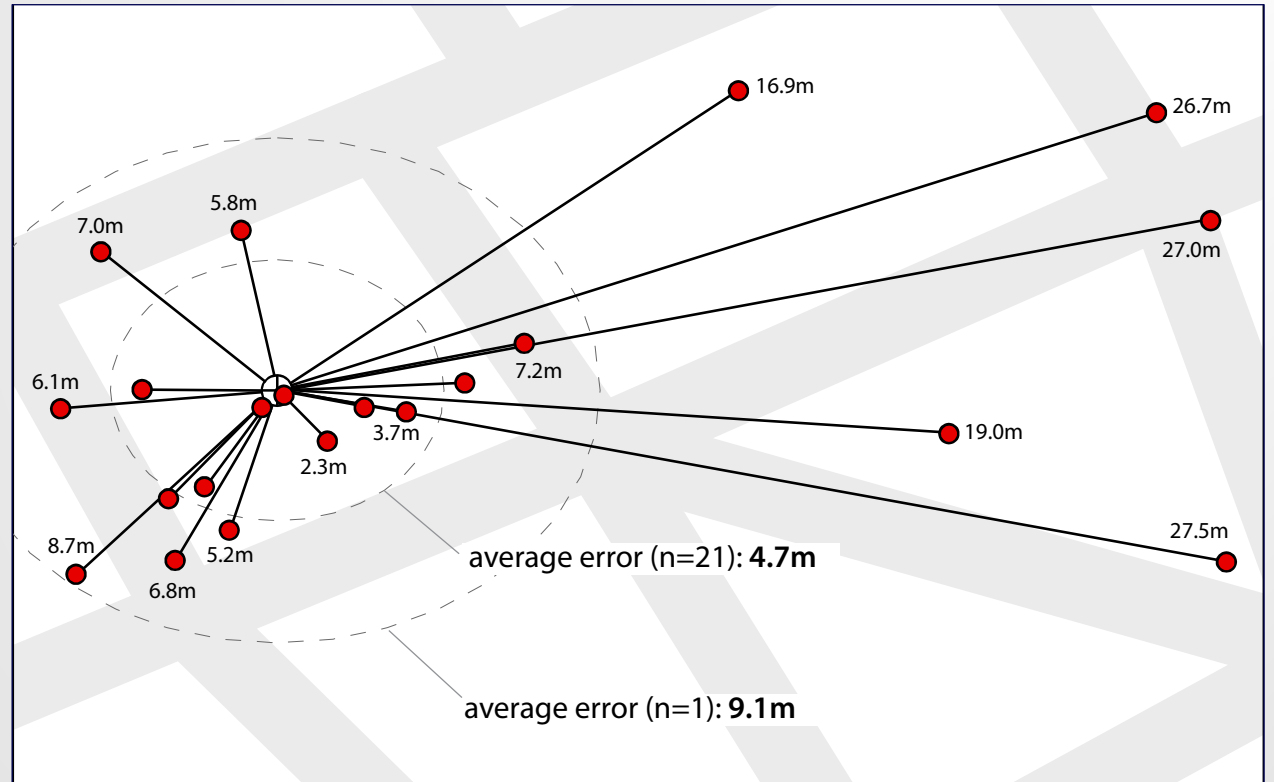
Earn an advanced degree in Counseling or Clinical Psychology right here in downtown Washington D.C. and help provide high-quality mental health services for those who need it most.

# Collective Object Positioning

- ▶ 21 contributors
- ▶ Calculation of every subset
- ▶  $n=1, 21!/1!*20!$
- ▶  $n=2, 21!/2!*19!$
- ▶ ...
- ▶  $n=21,$
- ▶  $n=1, 8.4\text{m}$
- ▶  $n=21, 3.9\text{m}$



- ▶  $n=1, 9.1\text{m}$
- ▶  $n=21, 4.7\text{m}$

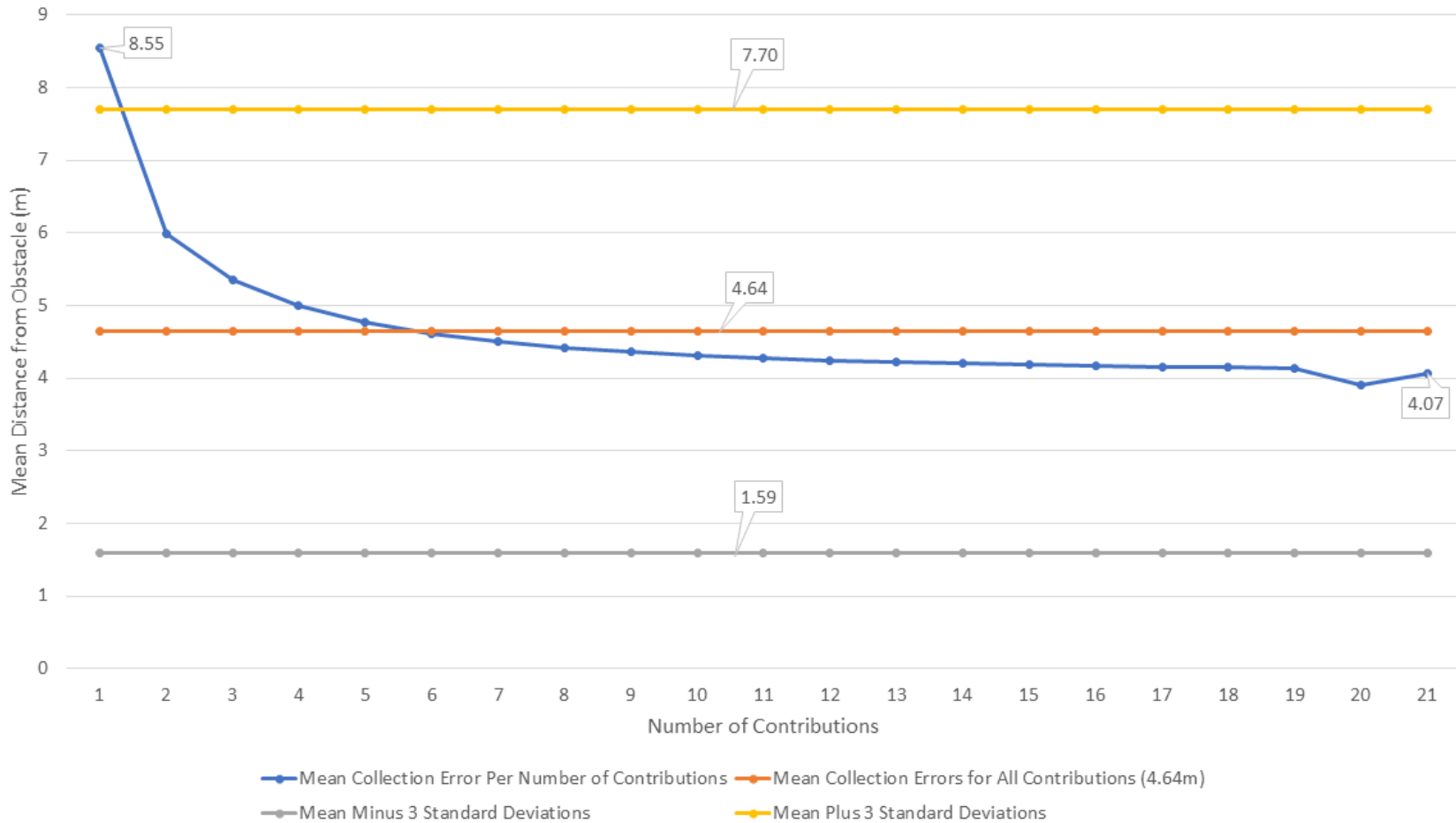






# Collective Positioning

Increased Accuracy with Increased Contributions



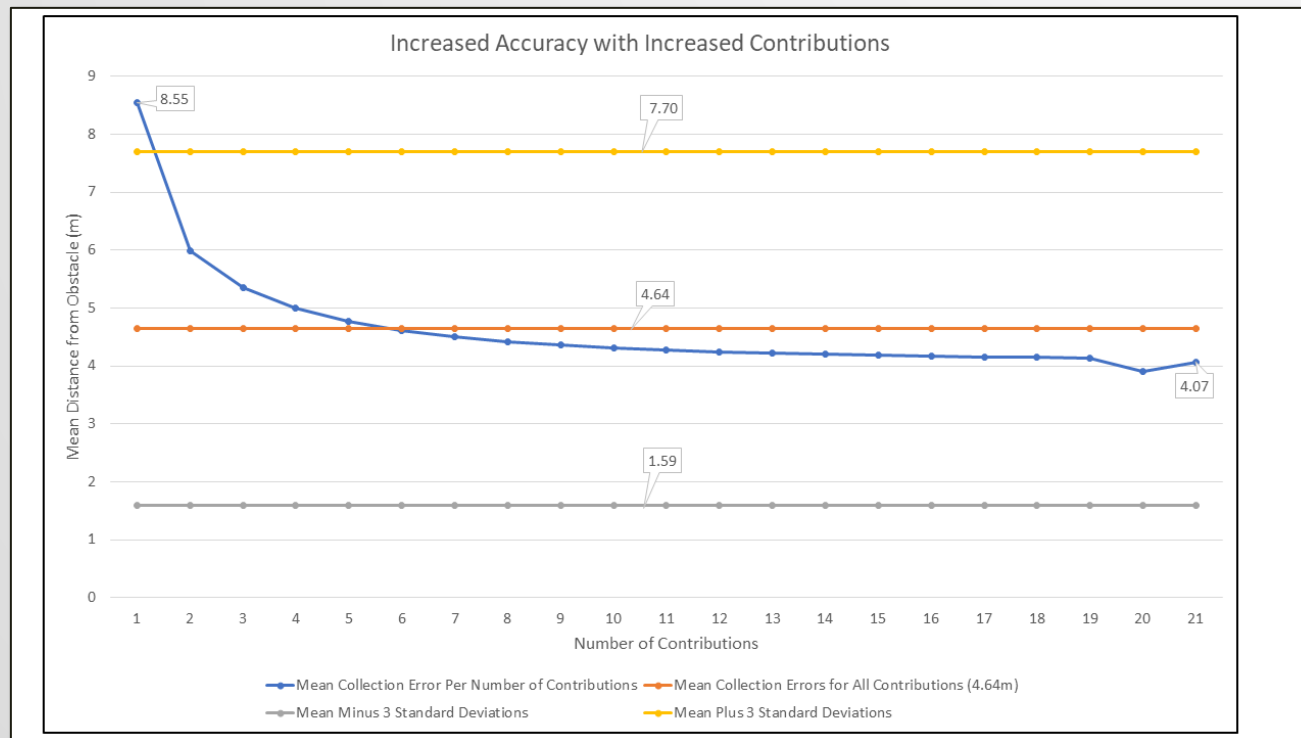
# Lessons Learned

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- ▶ **Quality assessment** of collective data is essential
- ▶ **3 ways to do it:** social moderation, geocrowdsourcing, rules-based approaches (Goodchild & Li 2012)
- ▶ **Social moderation** (moderator field check, fix errors) can work well for small areas, but is expensive
- ▶ **Categorization is difficult**, even for trained data contributors
  - **Problems:** semantic, ontological, perceptual
- ▶ There is a need for a simpler system with automation
- ▶ Our current approach: **image-based, collective positioning**

# Lessons Learned

- ▶ Our current approach: image-based, collective positioning
- ▶ 4-5 independent contributors achieved  $< 6.0\text{m}$  of positional accuracy

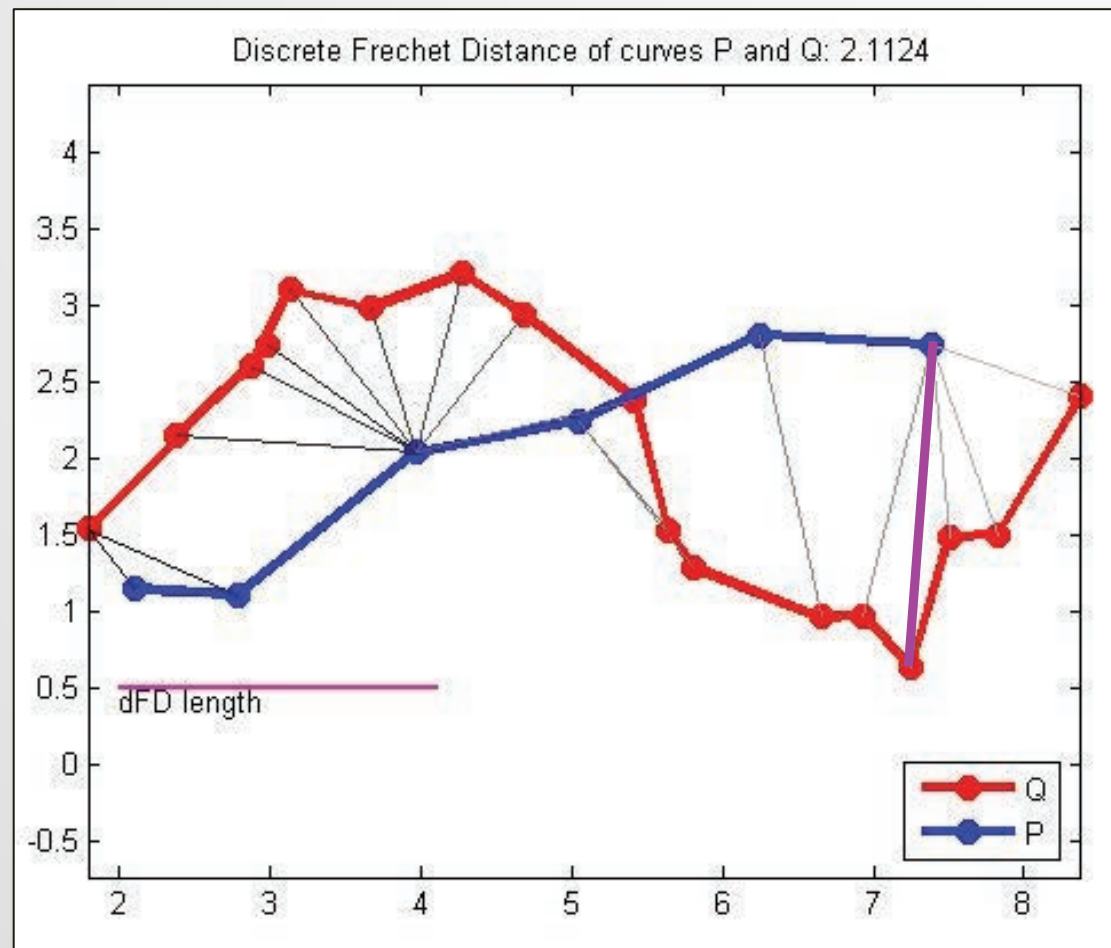


# MOBILE GPS ACCURACY, AND DYNAMIC OBSTACLE ALERTS

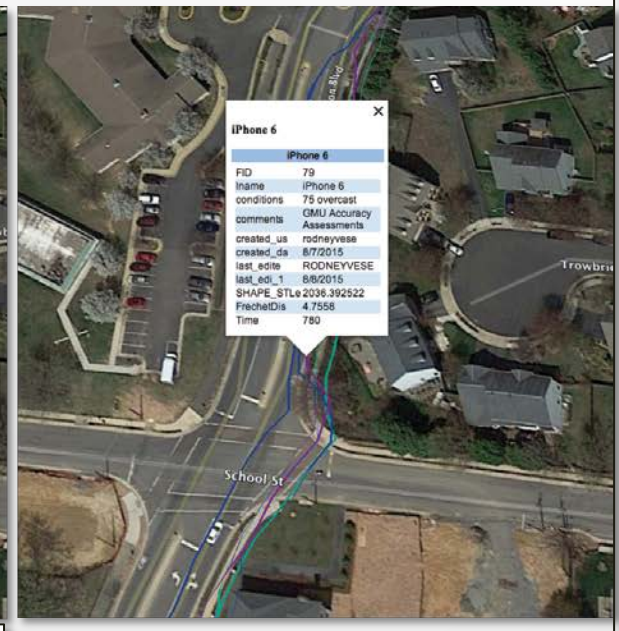
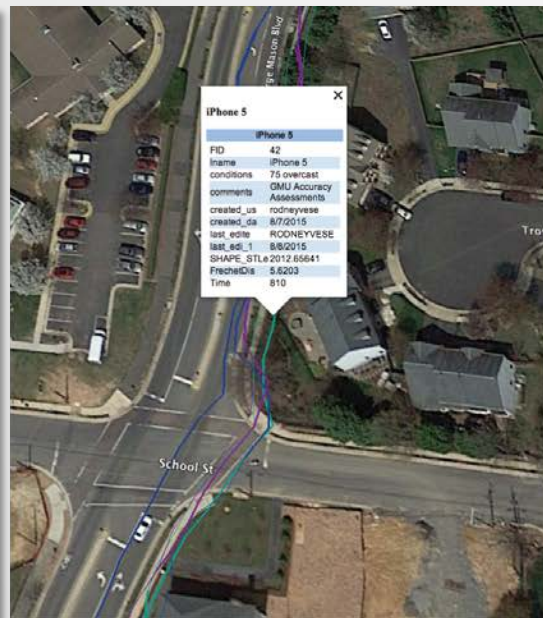


# Fréchet Distance

- ▶ Old measure (1906)
- ▶ Fréchet Distance for curves P and Q, from Brakatsoulos et al. (2005)



# Mobile Device GPS Study

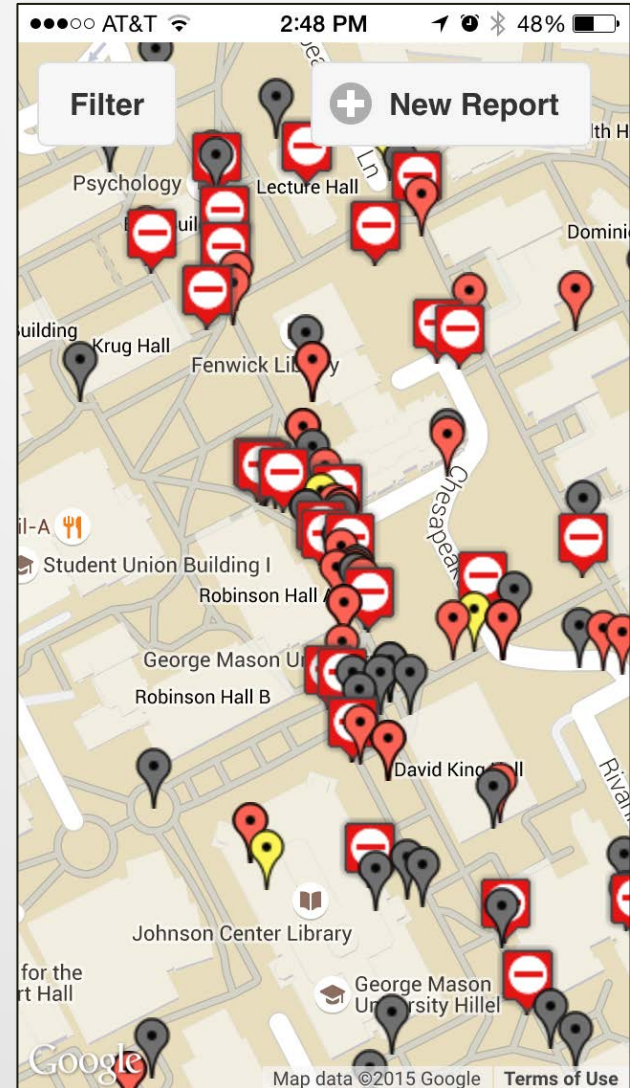


## Average Frchet Distances

		Track	Total
<b>iPhone 6</b>	Track 1	5.89	<b>5.92</b>
	Track 2	5.11	
	Track 3	7.94	
<b>iPhone 5</b>	Track 1	5.26	<b>6.72</b>
	Track 2	6.68	
	Track 3	10.44	
<b>iPhone4</b>	Track 1	8.71	<b>10.51</b>
	Track 2	11.32	
	Track 3	13.15	

# Mobile Web Application (v.1)

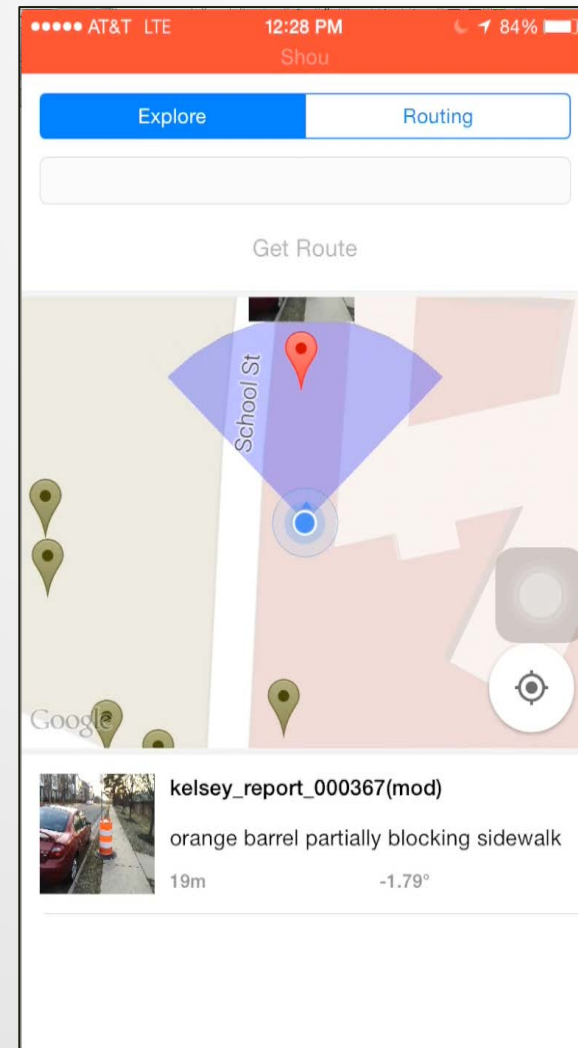
- ▶ Web application
- ▶ Google Maps, Sencha Touch
- ▶ Purpose: data collection





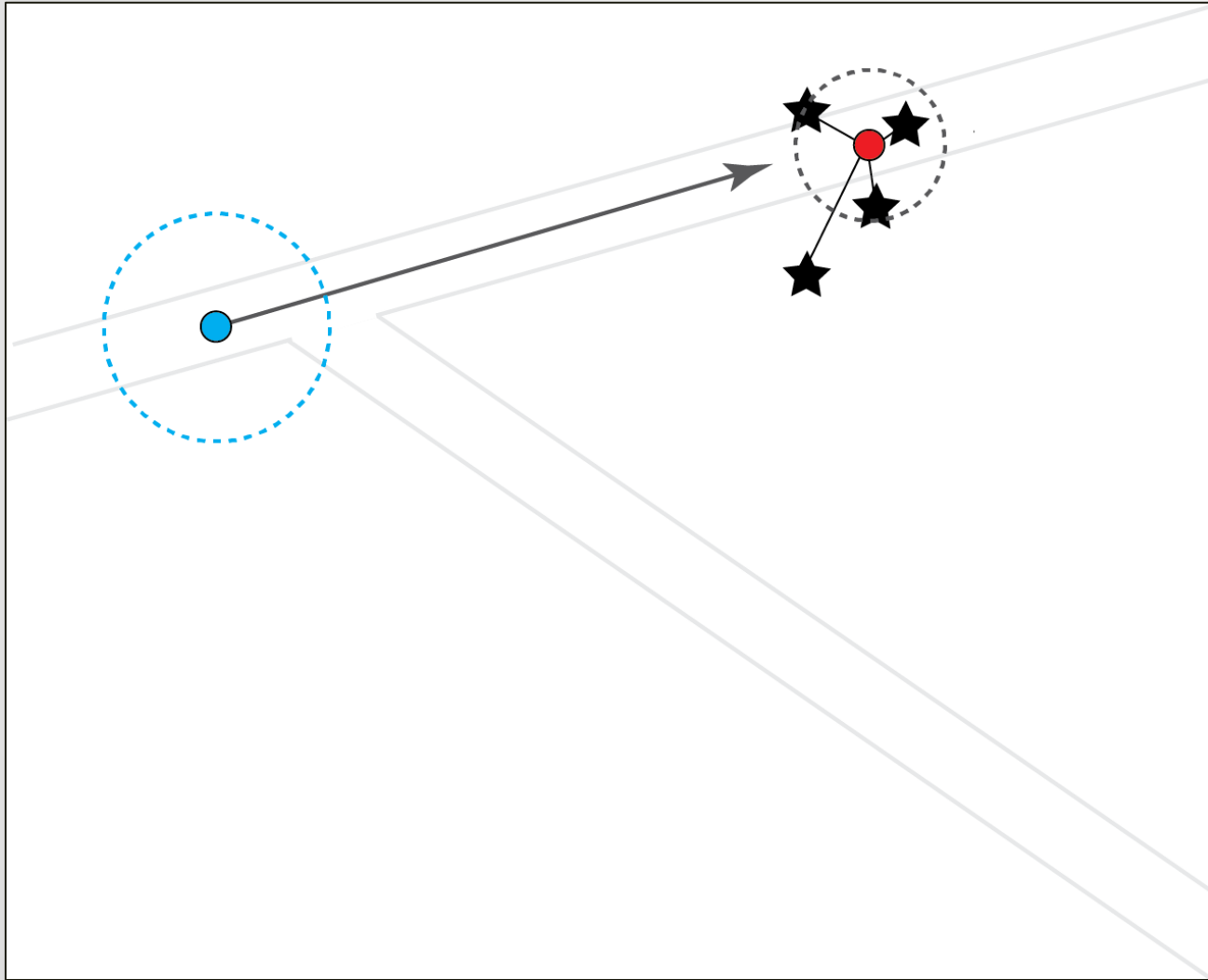
# Native Mobile Application (v.2)

- ▶ Swift for iOS
- ▶ Responsive
- ▶ Modes: Explore/Routing
- ▶ Chimes/cues
- ▶ 100 ft. interaction buffer
- ▶ Stable trajectory/compass



# User uncertainty, obstacle uncertainty

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# Obstacle 11

Platform:  
Web App

Interaction  
Walking Speed

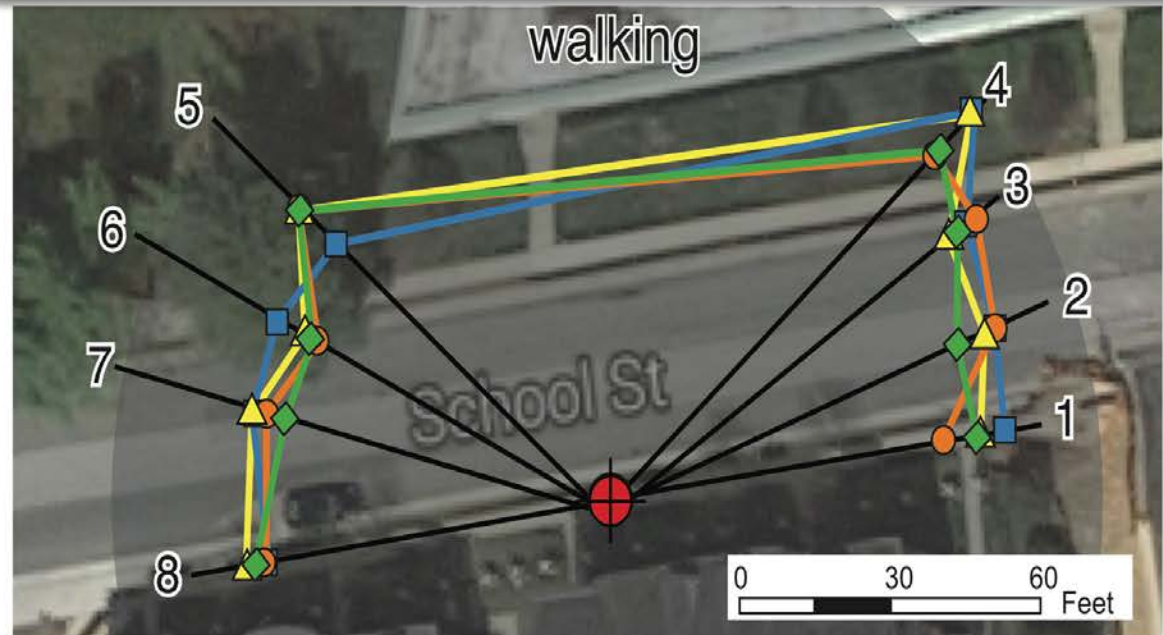


## Obstacle Details

**Type:** Sidewalk Obstruction  
Construction Detour

**Location:** On School St. on the sidewalk  
across from the Commonwealth Care Center

**Description:** Sidewalk excavation.  
Closed Sidewalk.



	▲ iPhone 5	● iPhone 6	■ iPhone 6+	◆ iPad 2
Average Distance (ft):	79.1	76.4	79.3	76.6
Standard Deviation (ft):	8.4	8.4	8.9	7.7

## Obstacle 11

Platform:  
Web App

Interaction  
Biking Speed

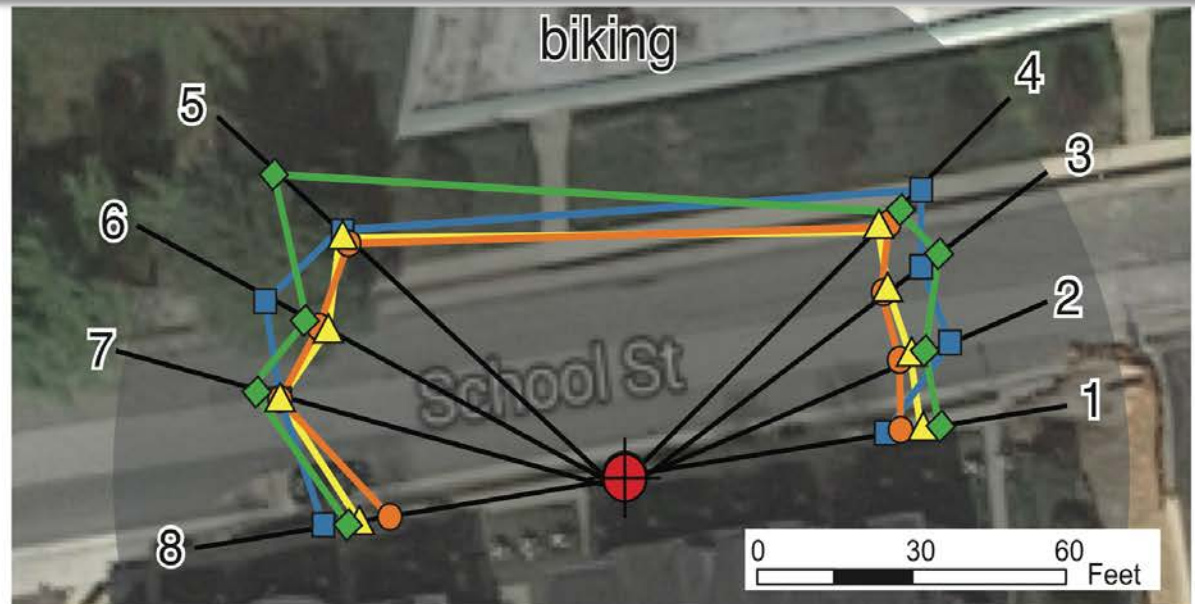


## Obstacle Details

**Type:** Sidewalk Obstruction  
Construction Detour

**Location:** On School St. on the sidewalk  
across from the Commonwealth Care Center

**Description:** Sidewalk excavation.  
Closed Sidewalk.



	▲ iPhone 5	● iPhone 6	■ iPhone 6+	◆ iPad 2
Average Distance (ft):	63.1	61.8	67.8	69.4
Standard Deviation (ft):	5.5	7.5	7.7	10.2



# Obstacle 11

Platform:  
Mobile App

Interaction  
Walking Speed

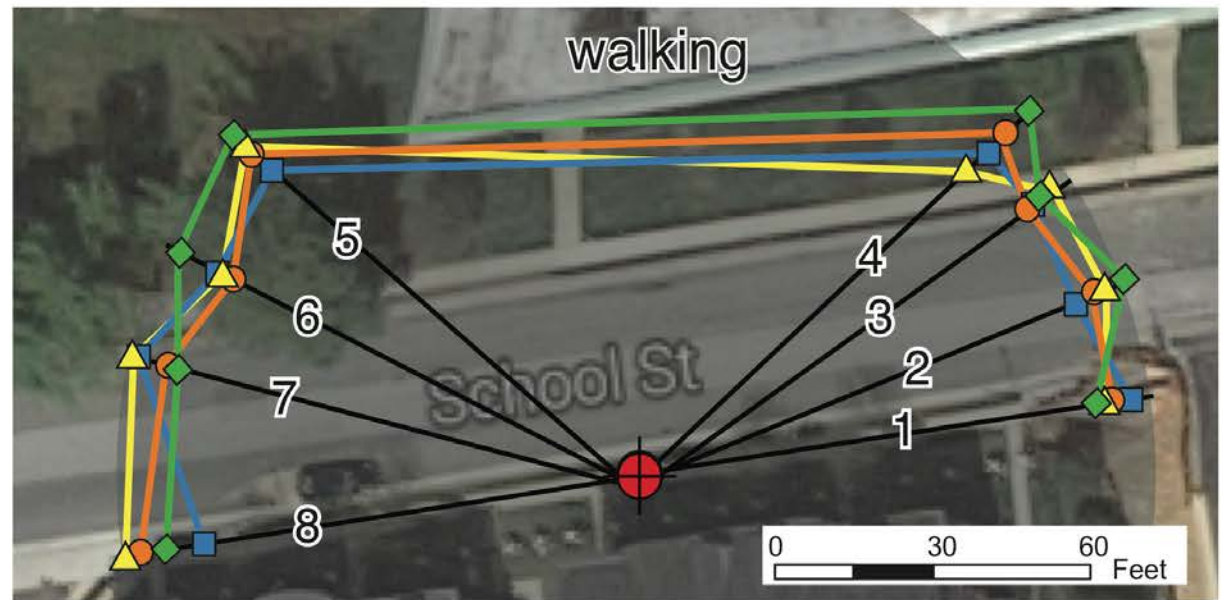


## Obstacle Details

**Type:** Sidewalk Obstruction  
Construction Detour

**Location:** On School St. on the sidewalk  
across from the Commonwealth Care Center

**Description:** Sidewalk excavation.  
Closed Sidewalk.



	▲ iPhone 5	● iPhone 6	■ iPhone 6+	◆ iPad 2
Average Distance (ft):	93.6	92.6	91.6	95.3
Standard Deviation (ft):	7.3	7.2	7.1	7.4

# Obstacle 11

Platform:  
Mobile App

Interaction  
Biking Speed

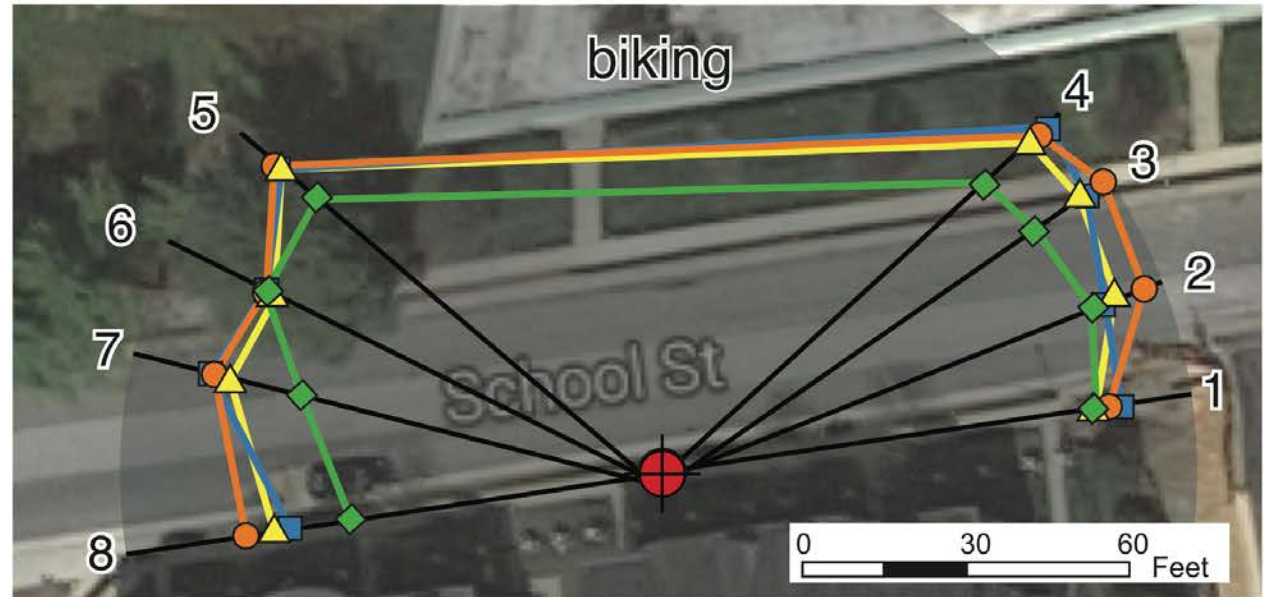


## Obstacle Details

Type: Sidewalk Obstruction  
Construction Detour

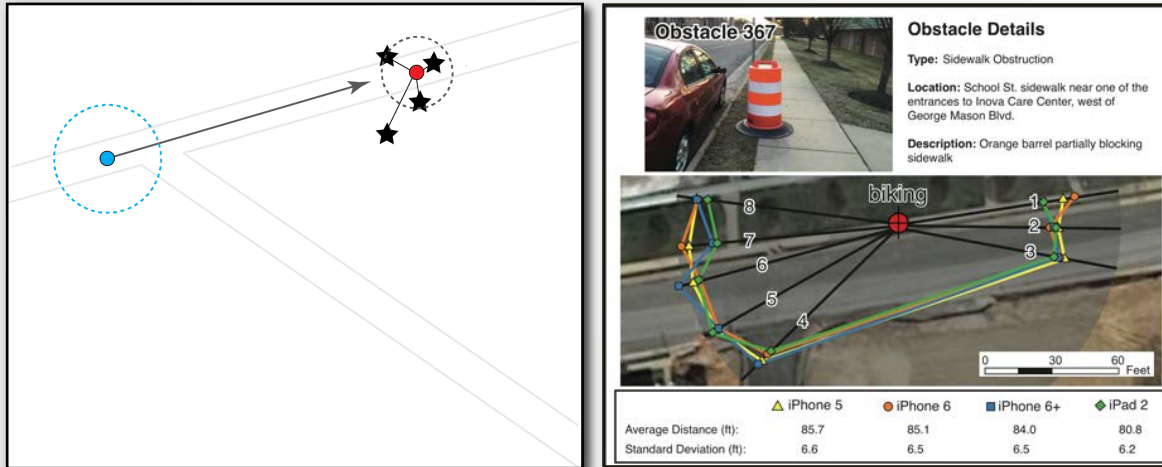
Location: On School St. on the sidewalk  
across from the Commonwealth Care Center

Description: Sidewalk excavation.  
Closed Sidewalk.



	▲ iPhone 5	● iPhone 6	■ iPhone 6+	◆ iPad 2
Average Distance (ft):	85.4	88.3	86.6	78.5
Standard Deviation (ft):	7.2	7.4	5.8	6.1

# Accuracy and Uncertainty, Interaction



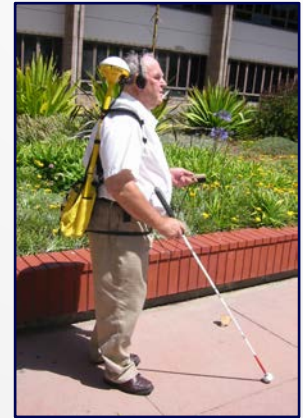
Distances in ft (meters)	Obstacle 11		Obstacle 367	
	WebApp	MobileApp	WebApp	MobileApp
<b>Walking</b>	77.9 (23.7)	93.3 (28.4)	69.3 (21.1)	97.9 (29.8)
<b>Biking</b>	65.5 (20.0)	84.7 (25.5)	52.9 (16.1)	83.9 (25.6)

Table 2. Alert distances summarized by mode of travel and by application type

# Summary

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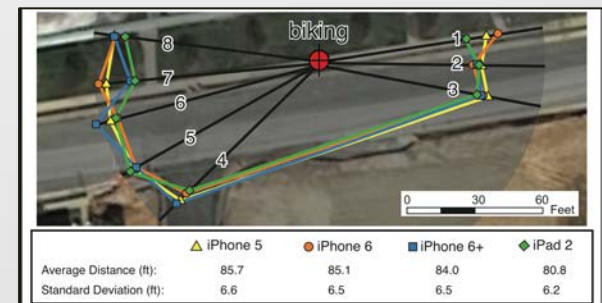
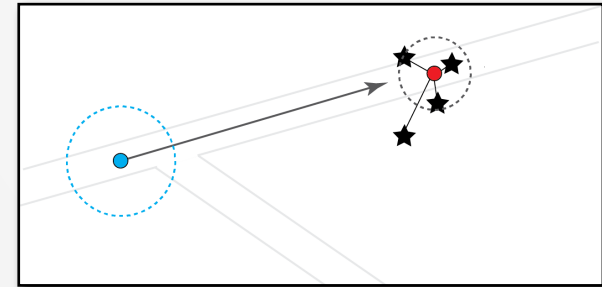
- ▶ **Two barriers** for persons with vision/mobility impairment: print and movement
- ▶ **Physical accessibility** can be facilitated with information from maps, GIS, spatial modeling, and geocrowdsourcing
- ▶ A major factor in the usefulness and quality of this information is **temporal relevancy**.
- ▶ **Geocrowdsourcing** is a key to quickly gathering relevant data.





# Summary

- ▶ **Quality assessment (QA)** methods, borrowed and modified from GIS, have been used successfully in many projects
- ▶ **Recent QA approaches** are based on image data and time/location elements from mobile apps
- ▶ **Interaction dynamics**, based on QA and GPS uncertainty, have been explored to better understand the use of the collected data.
- ▶ Native mobile apps can provide **proximity-sensitive warnings** for crowdsourced obstacles



# Technical Reports

2012: <https://apps.dtic.mil/sti/pdfs/ADA576607.pdf>

2013: <https://apps.dtic.mil/sti/pdfs/ADA588474.pdf>

2014: <https://apps.dtic.mil/sti/pdfs/ADA615952.pdf>

2015: <https://apps.dtic.mil/dtic/tr/fulltext/u2/1001943.pdf>

November 2012

## Crowdsourced Geospatial Data

A report on the emerging phenomena of crowdsourced and user-generated geospatial data

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Annual Report, BAA #AA10-4733, Contract #W9132V-11-P-0011  
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Under Work Unit 633734T0800

Monitored by  
U.S. Army Topographic Engineering Center  
7701 Telegraph Road, Alexandria, VA 22315-3864

September 2013

## Crowdsourcing to Support Navigation for the Disabled

A report on the motivations, design, creation, and assessment of a testbed environment for accessibility

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Under Work Unit 33143

Monitored by U.S. Army Topographic Engineering Center  
7701 Telegraph Road, Alexandria, VA 22315-3864

September 2014

## Quality Assessment and Accessibility Applications of Crowdsourced Geospatial Data

A report on the development and extension of the George Mason University Geocrowdsourcing Testbed

Matthew T. Rice, Fabiana I. Paez, Rebecca M. Rice, Eric W. Ong, Han Qin, Christopher R. Seitz, Jessica V. Fayne, Kevin M. Curtin, Sven Fuhrmann, Dieter Pfoser, and Richard M. Medina  
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Annual Report, BAA #AA10-4733, Contract #W9132V-11-P-0011  
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Prepared for Geospatial Research Laboratory  
U.S. Army Engineer Research and Development Center  
U.S. Army Corps of Engineers

Under Data Level Enterprise Tools

Monitored by Geospatial Research Laboratory  
7701 Telegraph Road, Alexandria, VA 22315-3864

September 2015

## Social Moderation and Dynamic Elements in Crowdsourced Geospatial Data

A report on quality assessment, dynamic extensions, and mobile device engagement in the George Mason University Geocrowdsourcing Testbed

Matthew T. Rice, Kevin M. Curtin, Dieter Pfoser, Rebecca M. Rice, Sven Fuhrmann, Han Qin, Rodney D. Vese Jr., Eric W. Ong, Jessica V. Fayne, Fabiana I. Paez, Christopher R. Seitz  
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# Theses & Dissertations

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1. Jeff Heuwinkel (2020) [“A Geographical Analysis of Optimal Queue Locations for Autonomous Vehicles”](#)
2. Toby Williams (2018) [“Mobile Positioning Dynamics in an Image-based Hybrid Geocrowdsourcing System”](#)
3. Han Qin (2017) [“Modeling Accessibility Through Geocrowdsourcing”](#)
4. Ahmad Aburizaiza (2017) [“A Geospatial Footprint Library for Validating Volunteered Geographic Information”](#)
5. Rebecca Rice (2015) [Validating VGI Quality in Local Crowdsourced Accessibility Mapping Applications”](#)
6. Robin Rodgers, (2015) [“A Statistical Comparison of Sidewalk Slopes Derived from Multi-resolution Digital Elevation Models in Support of Accessibility”](#)
7. Patricia Pease, (2014) [“The Influence of Training on Position and Attribute Accuracy in Volunteered Geographic Information”](#)
8. Fabiana Paez, (2014) [“Recruitment, Training, and Social Dynamics in Geocrowdsourcing for Accessibility”](#)

# Journal & Conference Publications

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- ▶ Heuwinkel, J. R., Rice, M. T., Yu, M., Curtin, K. M., & Jacobson, R. D. (2019, January). Mobility routing optimization for physical accessibility and thermoregulation. In *Proceedings of the ICA* (Vol. 2). <https://doi.org/10.5194/ica-proc-2-42-2019>
- ▶ Qin, H., Curtin, K.M. & Rice, M.T. Pedestrian network repair with spatial optimization models and geocrowdsourced data. *GeoJournal* **83**, 347–364 (2018). <https://doi.org/10.1007/s10708-017-9775-x>
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