

Application of Crowdsourced Data in Pavement Maintenance and Management

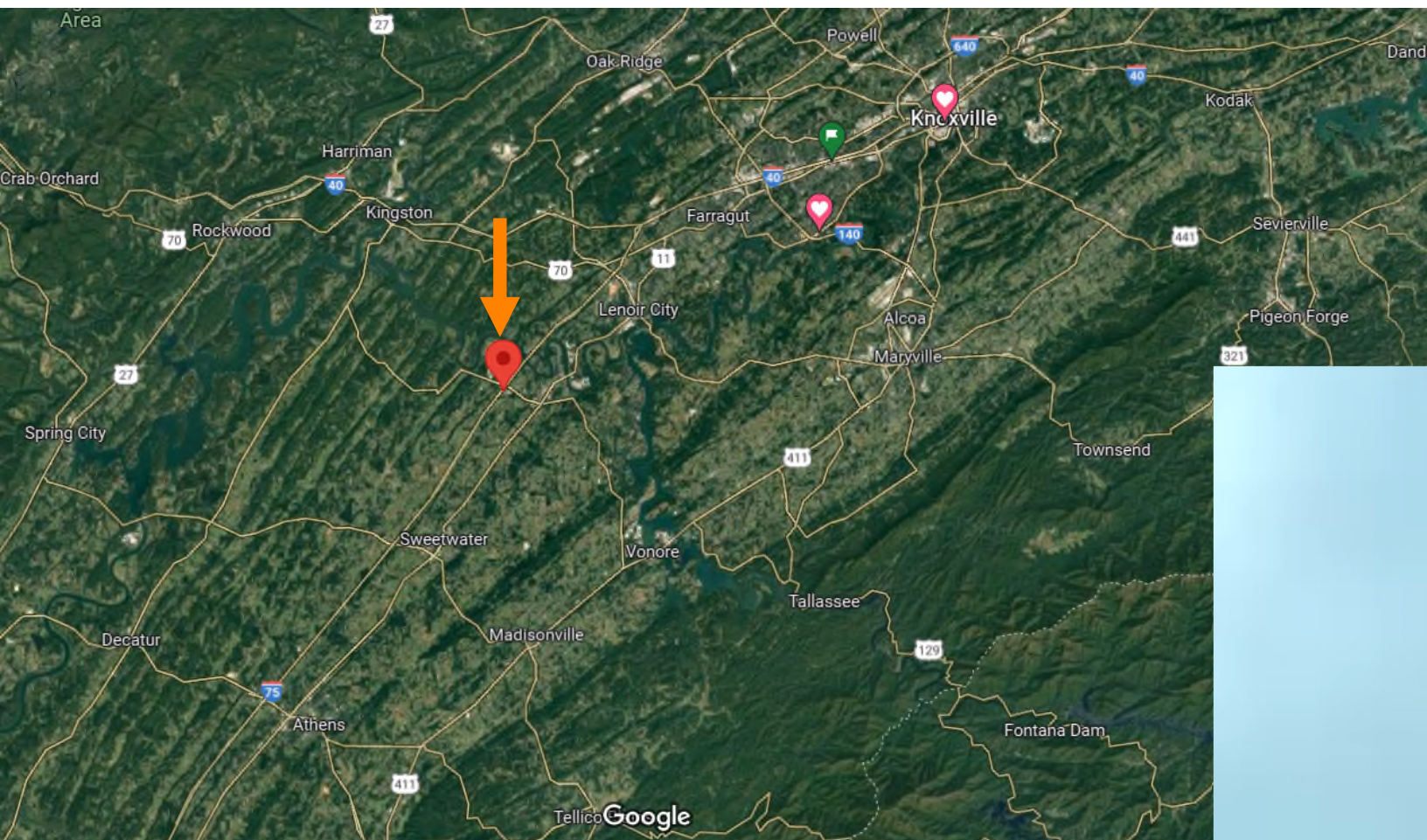


THE UNIVERSITY OF
TENNESSEE
KNOXVILLE



Presenter: Yangsong Gu
Advisor: Dr. Lee D. Han

7/28/2022

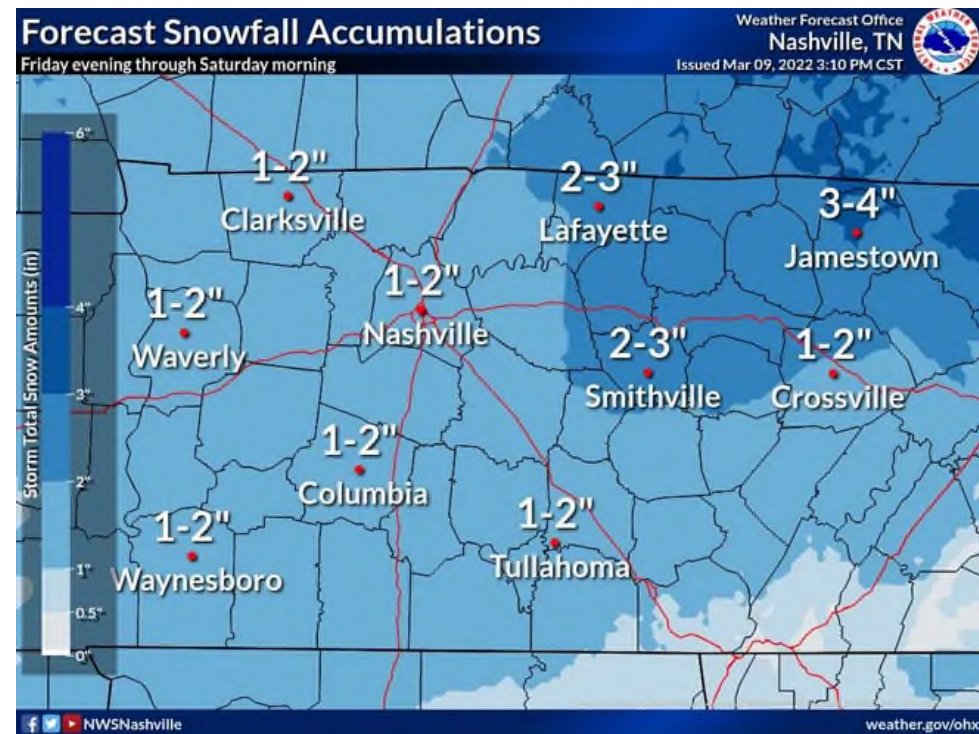


April 16

I-75 Mile Marker 70 – 72, Southbound

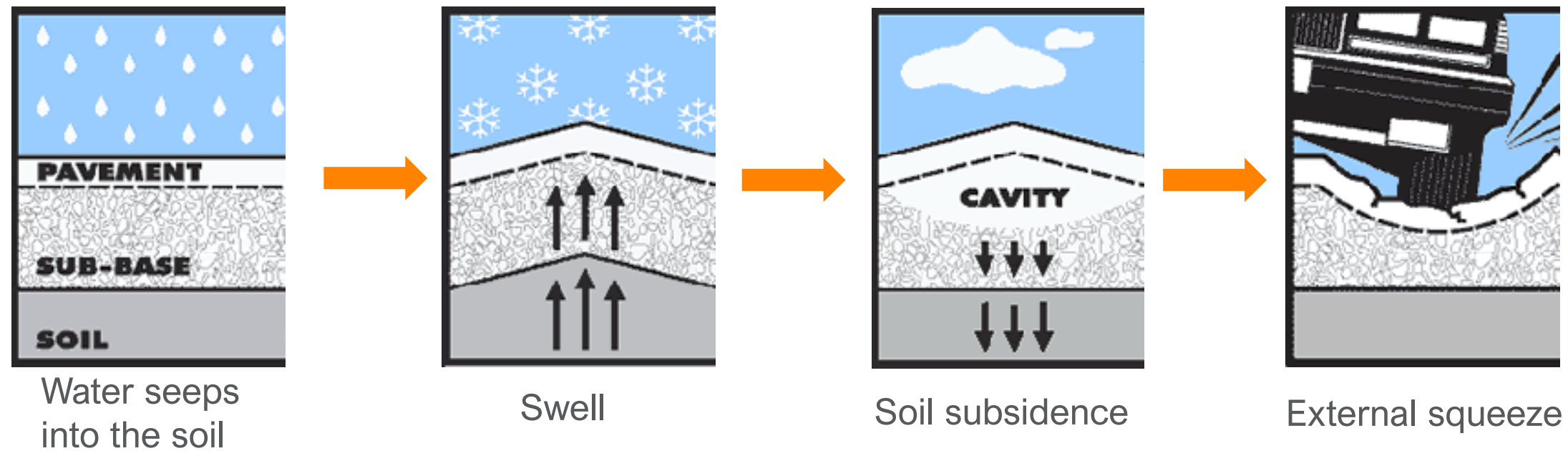
Black spots are
potholes or cracks





a. Snowfall

b. Ice Storm



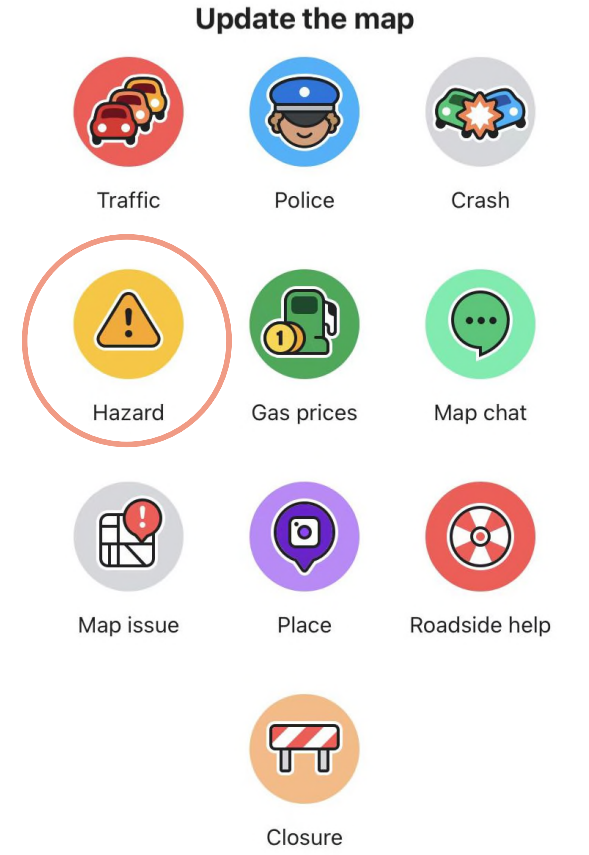
c. Birth of a Pothole

1. Image source: <https://www.tennessean.com/story/news/local/2022/03/11/parts-middle-tn-expected-see-up-6-inches-snow/7000266001/>
2. <https://www.tn.gov/tema/news/2022/3/3/gov--lee-requests-federal-relief-for-february-ice-storm.html>
3. <https://www.tn.gov/tdot/maintenance/potholes.html>

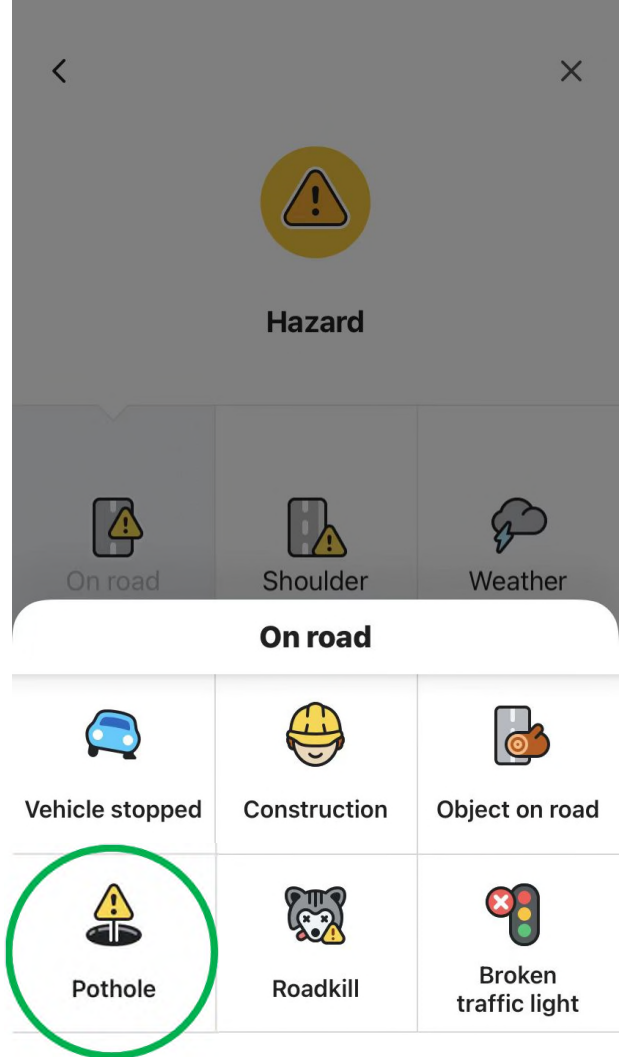
Topic 1

Identify Potholes from Crowdsourced Reports

Moving eyes are more intelligent than moving scanners



Reports are public. Your Waze username will appear with your report.



Introduction & Background

Pavement distress

- **Distress type:** Patching/Potholes, Fatigue crack, Rut Depth
- **Data collection:** Laser scanner, accelerometers, image processing, citizen report
- **Limitation:** labor-intensive, costly, lagging

Collected from networkwide app users

Crowdsourced data

- Wide coverage of road network
- Low-cost
- Real-time

Introduction & Background



Update the map



Traffic



Police



Crash



Hazard



Gas prices



Map chat



Map issue



Place

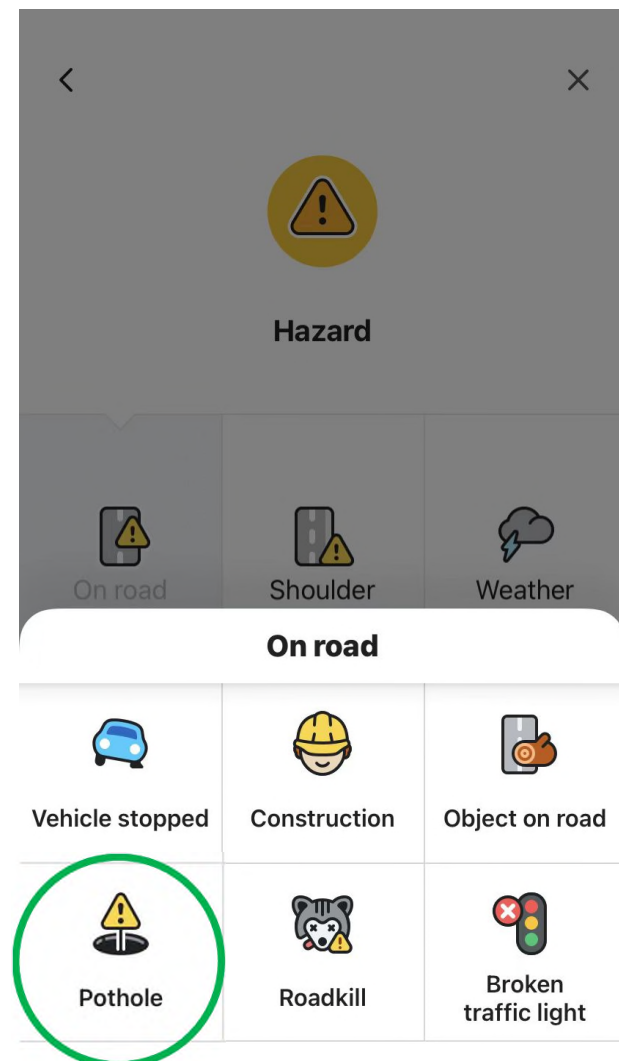


Roadside help



Closure

Reports are public. Your Waze username will appear with your report.



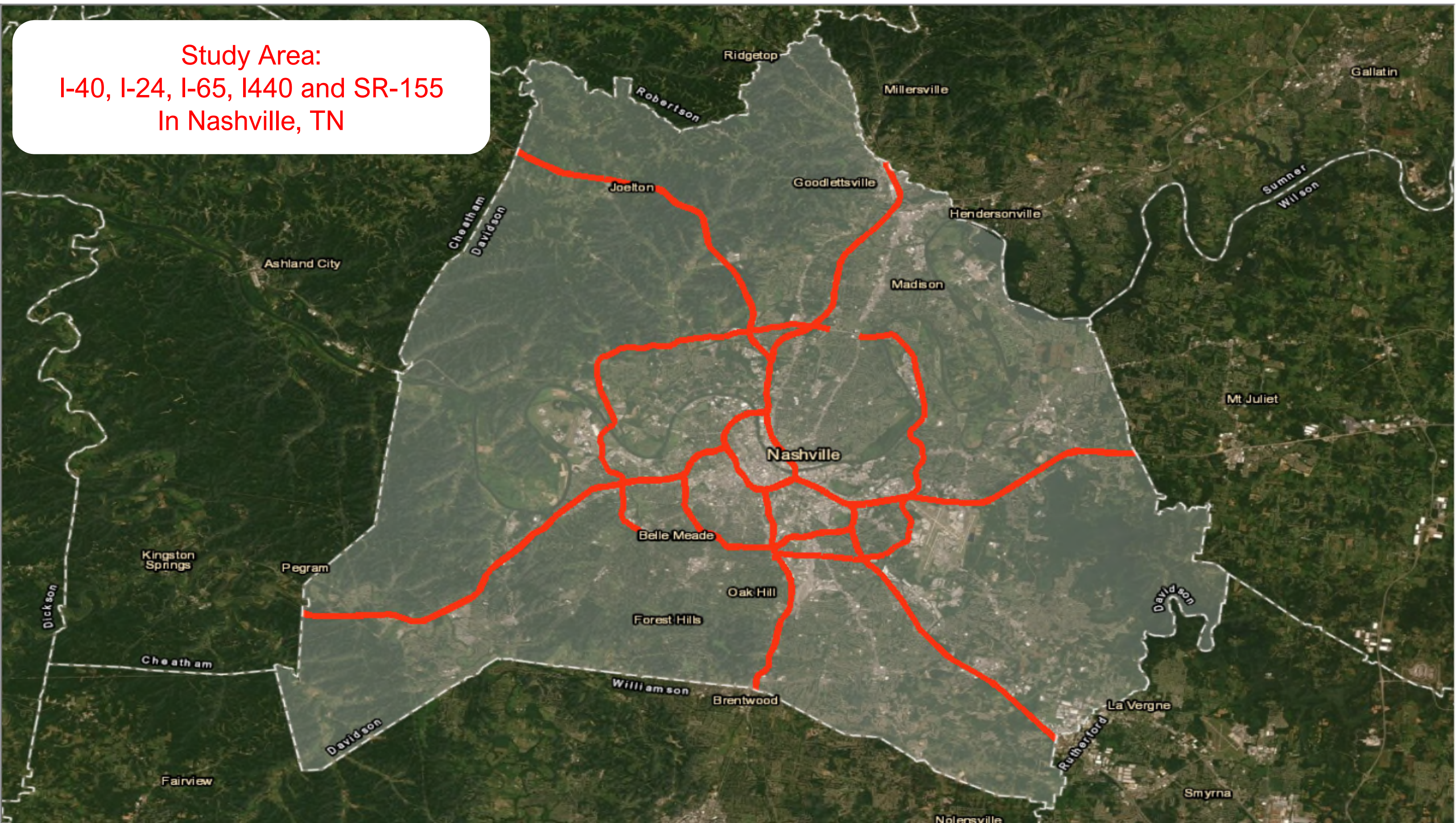
Challenges

- Redundant reports
- False reports

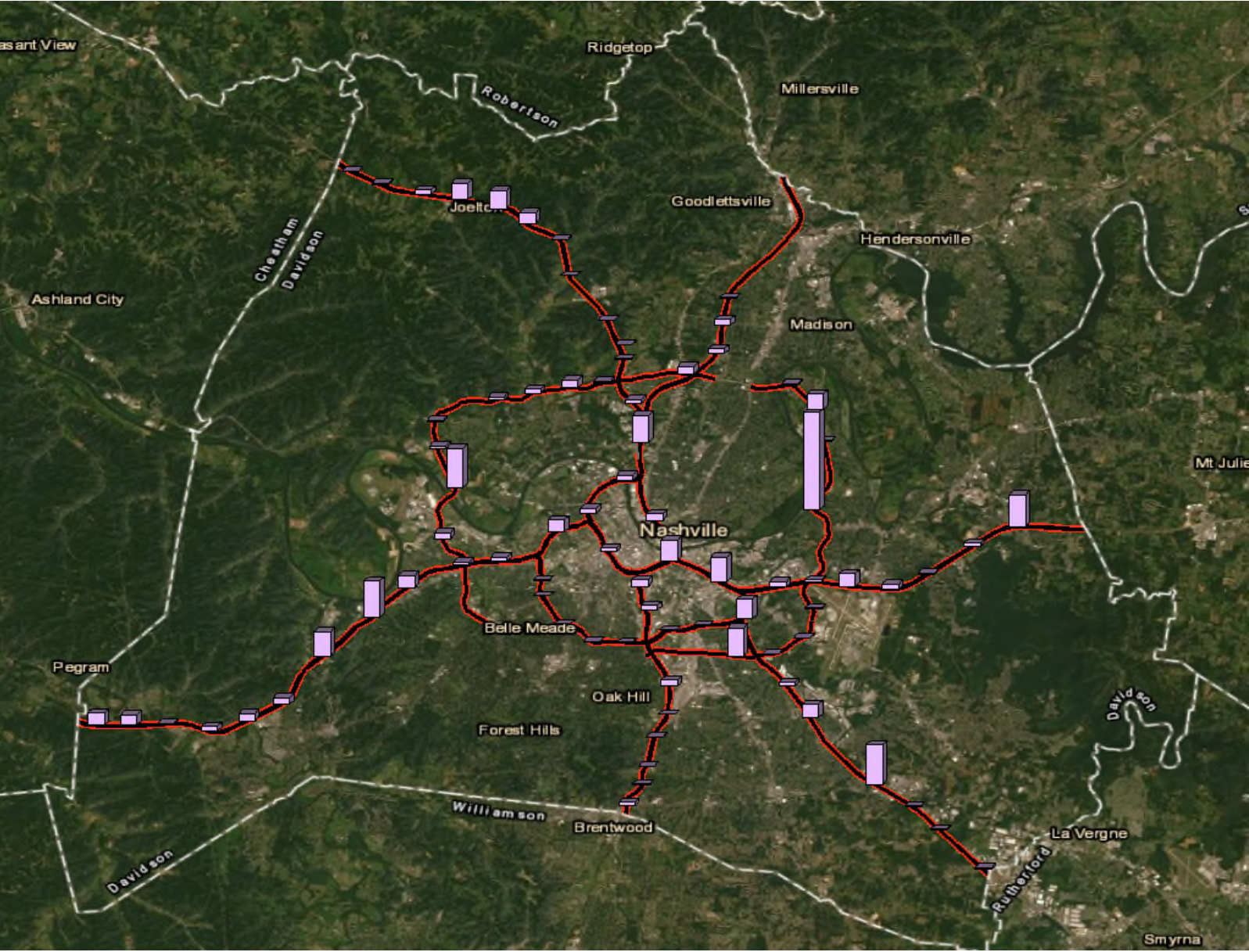
countermeasures

- Thresholds-based match
- Clustering

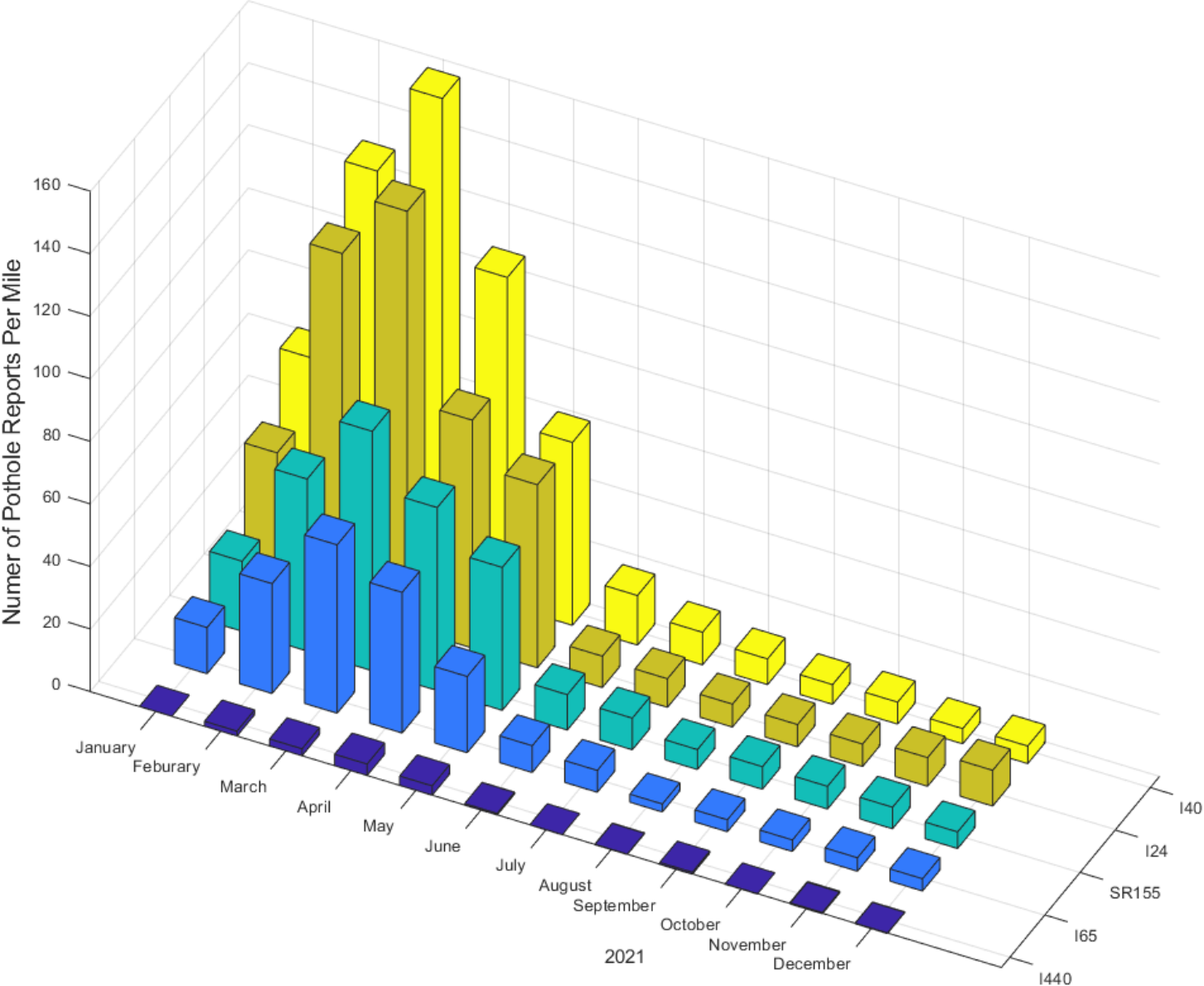
Study Area:
I-40, I-24, I-65, I440 and SR-155
In Nashville, TN



Pothole Reports



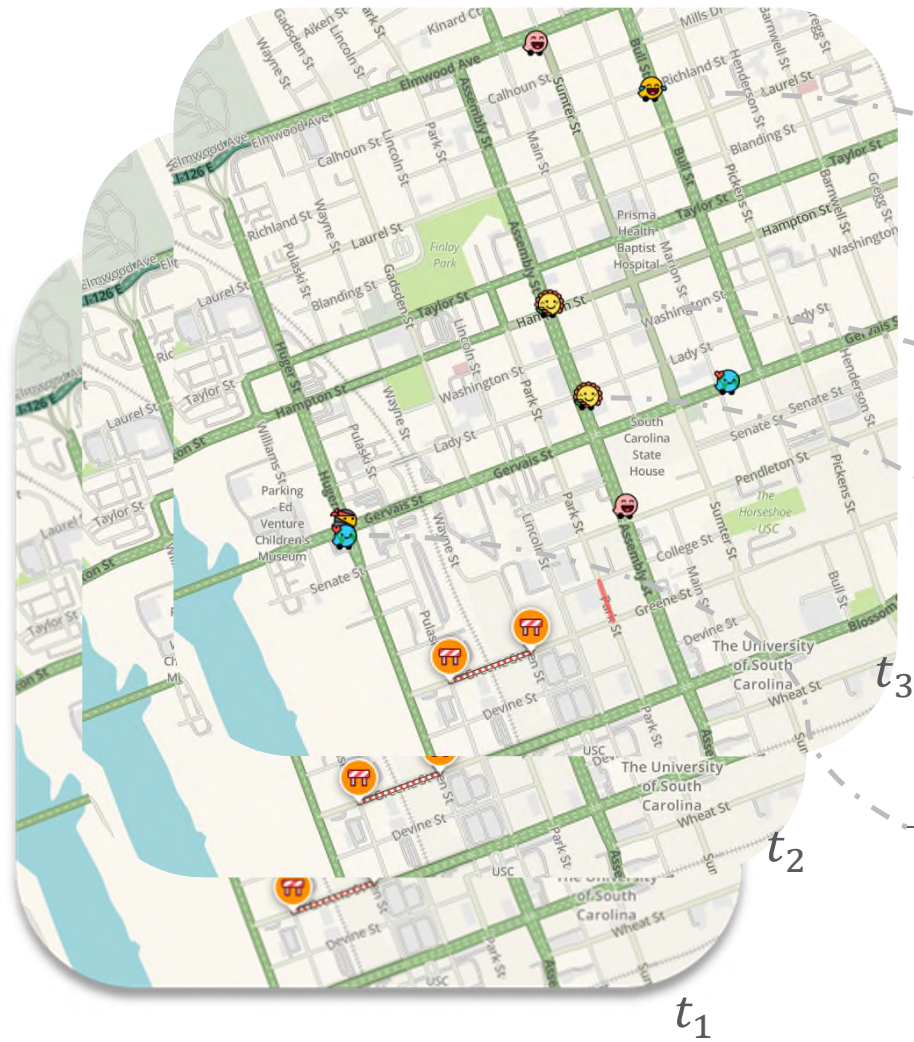
a. Spatial Distribution



b. Temporal Frequency

Topic 1. Pothole Detection

Method



Spatial-temporal DBSCAN (density-based clustering)

Parameters

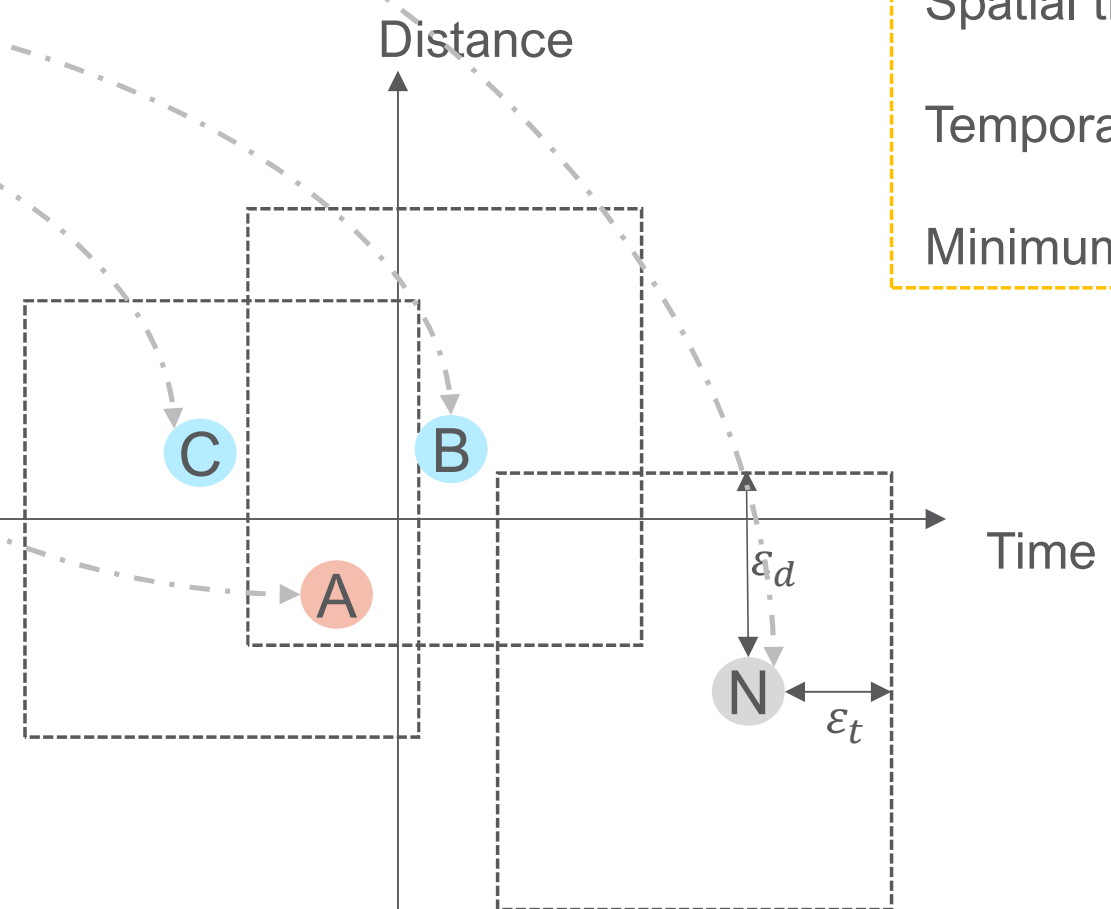
Spatial threshold ϵ_d

Temporal threshold ϵ_t

Minimum number of points

Point type

- True reports
 - Non-core point (blue circle)
 - Core point (red circle)
- False reports
 - Noise point (grey circle)



Topic 1. Pothole Detection

2

Results

E.g., I-40 W

Single Spot and Pothole Zone

Sooner

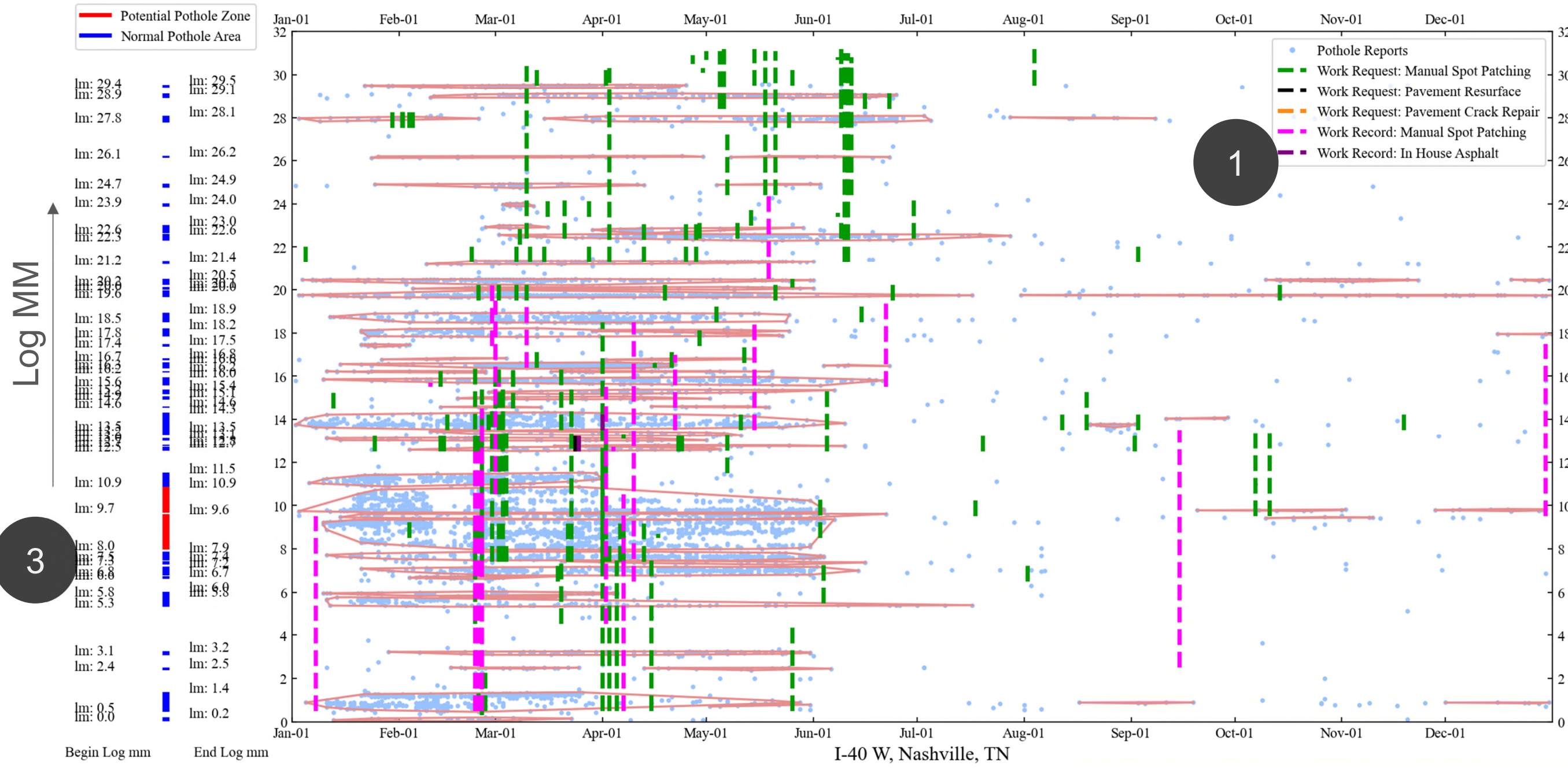
Accurate

Complement

Inspection

3

Identified Pothole Activity

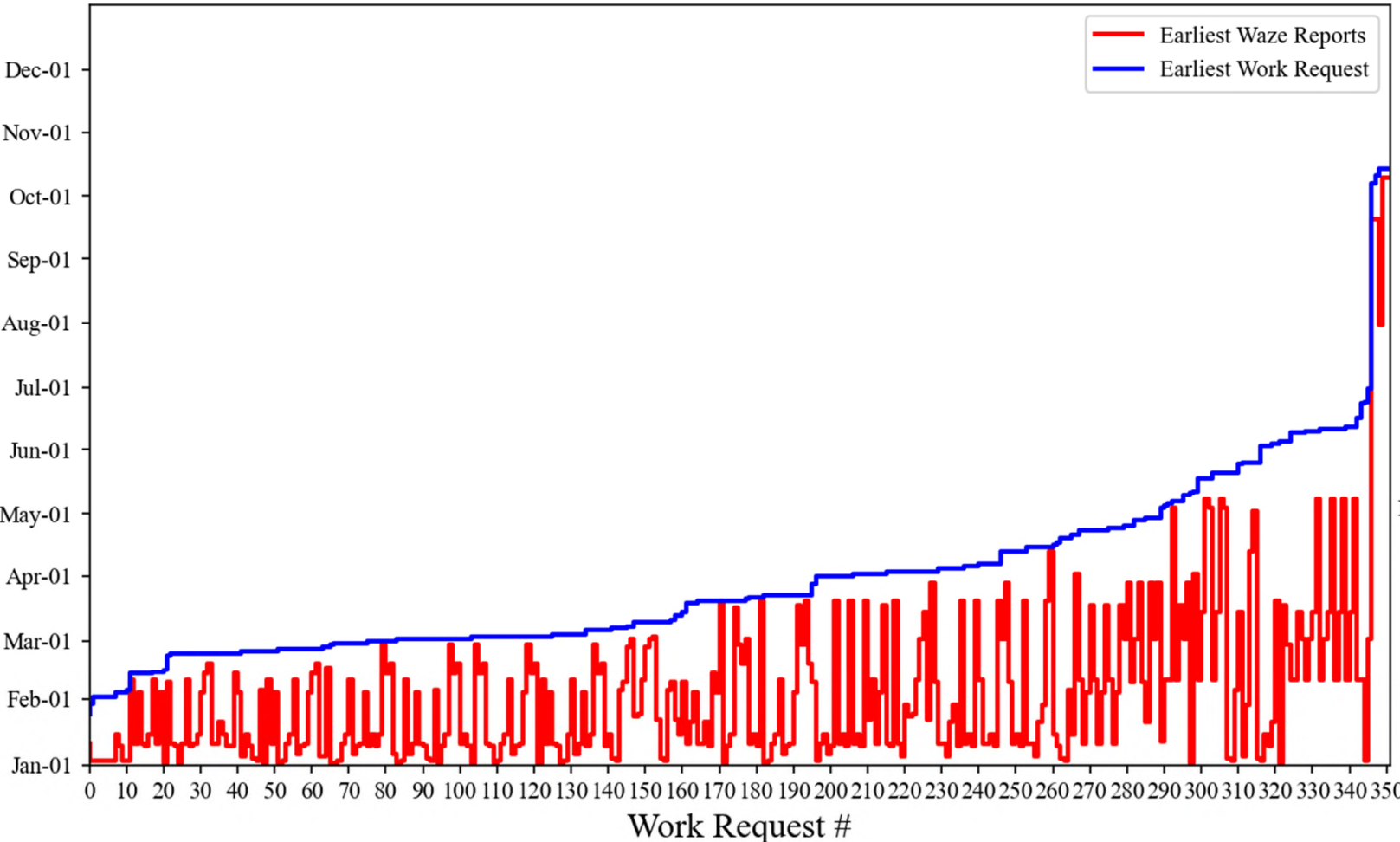


1

Date

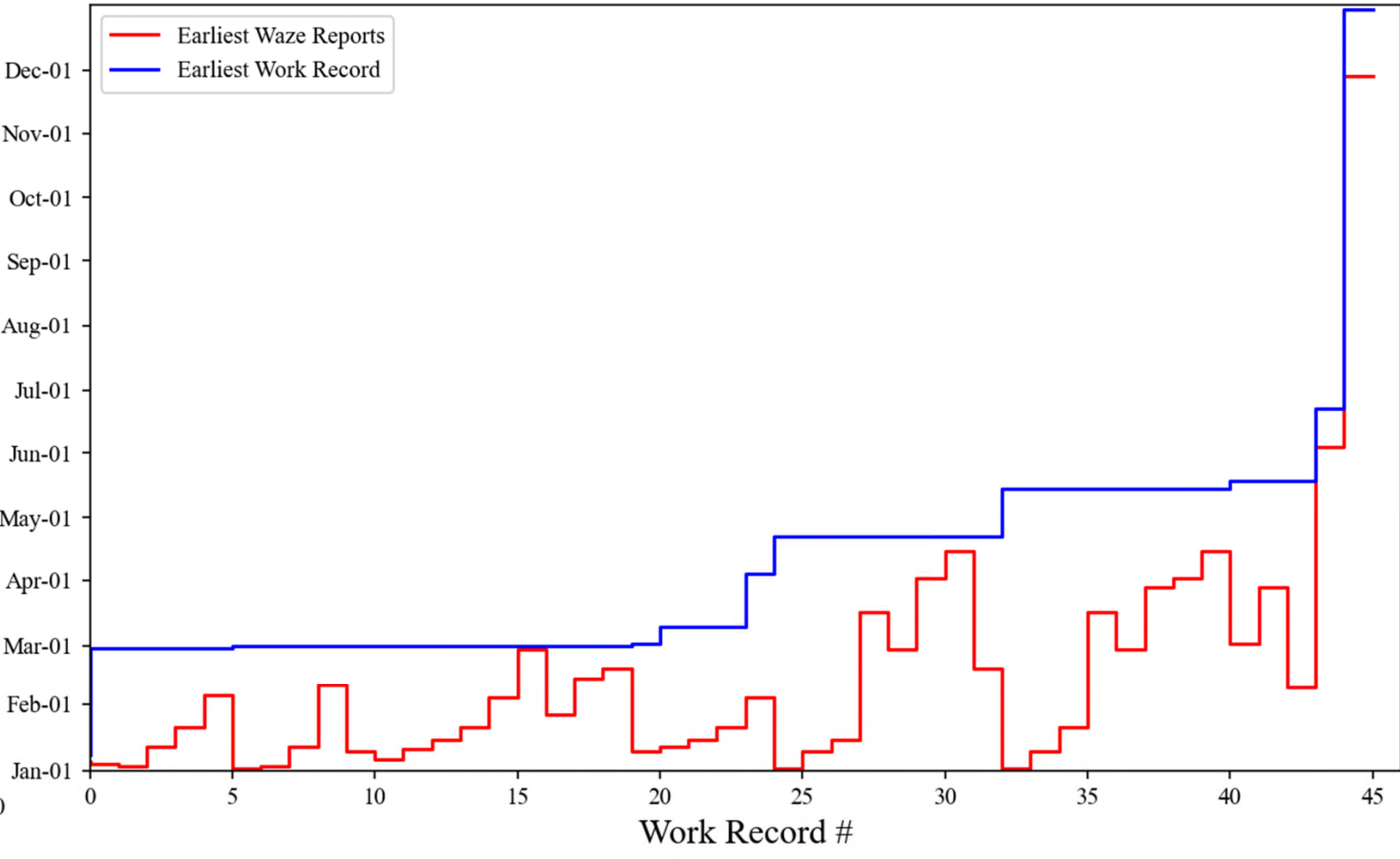
Topic 1. Pothole Detection

Results: early detection



Earliest Work Request VS Earliest Waze Report

54 Days



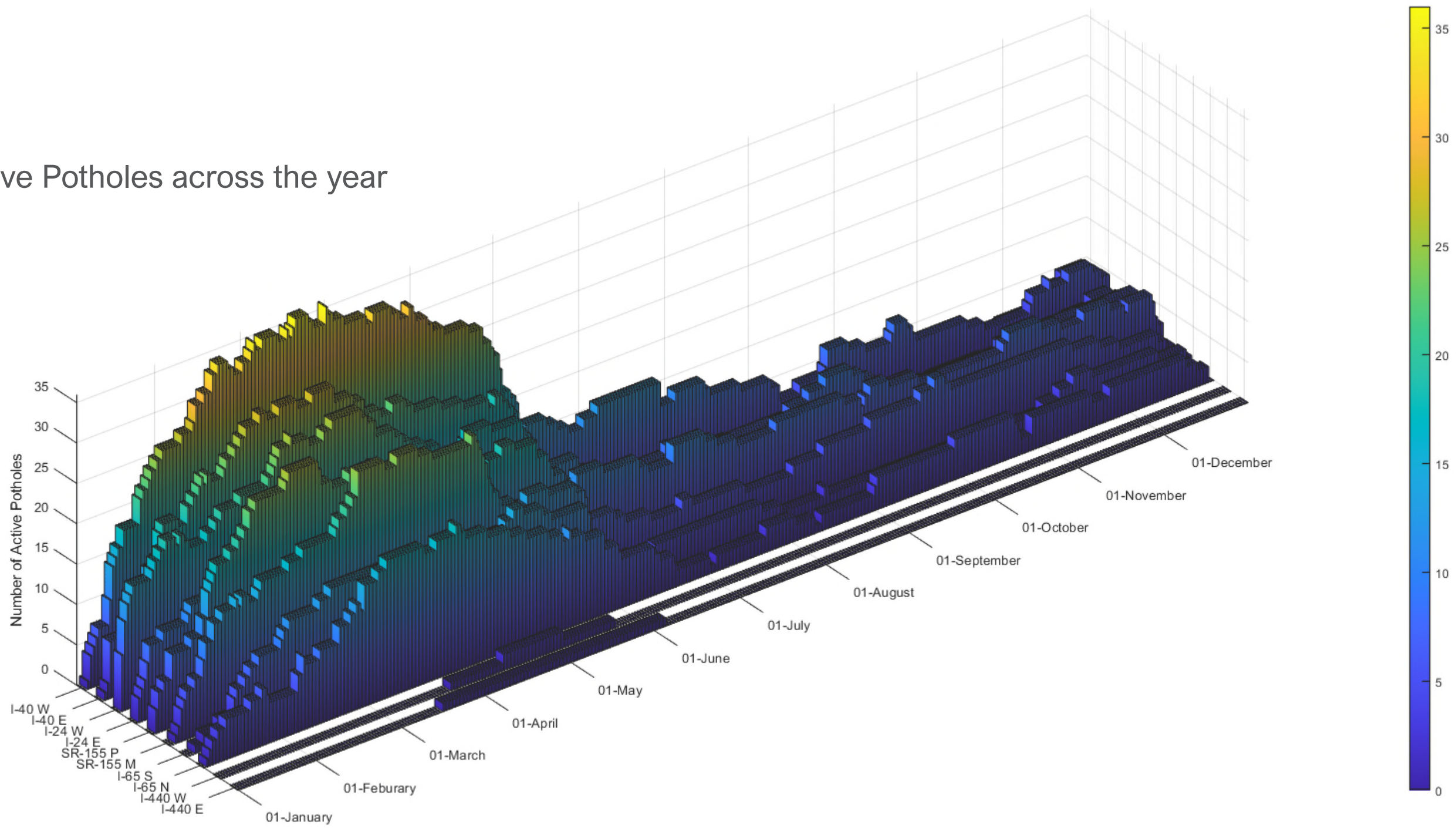
Earliest Work Record VS Earliest Waze Report

52 Days

Topic 1. Pothole Detection

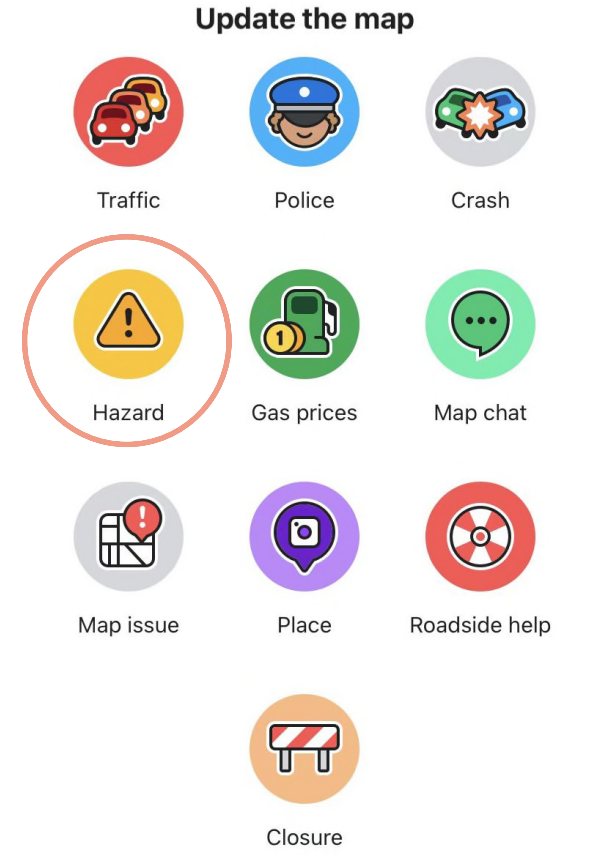
Results

Number of Active Potholes across the year

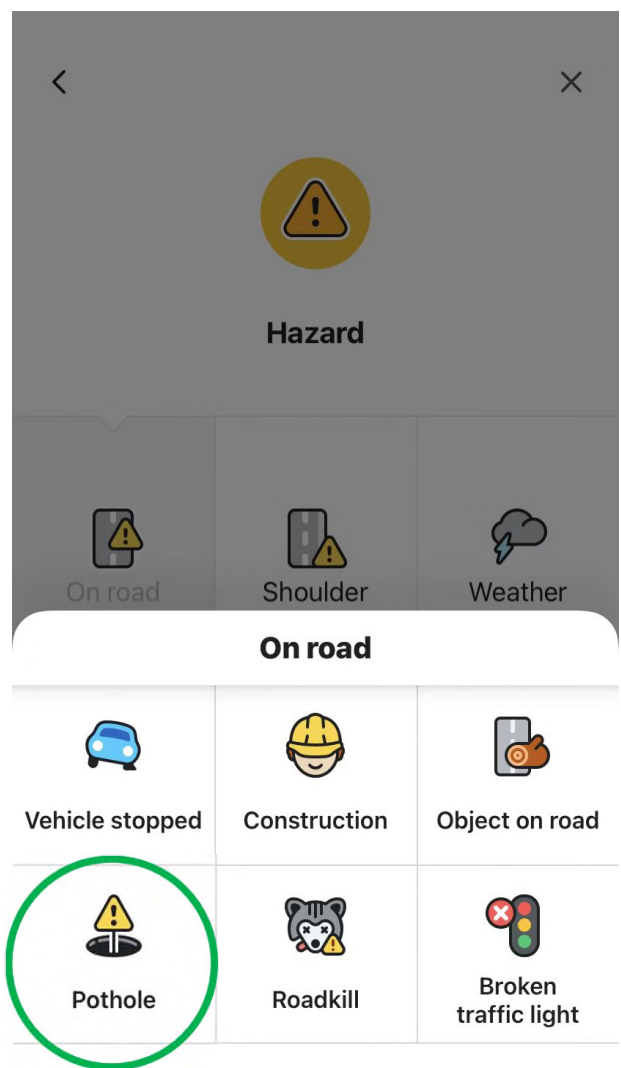


Topic 2

Can we use crowdsourced reports to evaluate the Pavement Condition?



Reports are public. Your Waze username will appear with your report.



Introduction & Background

Pavement evaluation

- 1. Evaluation is usually conducted once a year.
- 2. Collect the pavement condition data from Laser scanning.
- 3. Insensitive labor and cost.

Crowdsourced data

- Wide coverage of road network
- Low-cost
- Real-time

Topic 2. Pavement Condition Evaluation

Metrics

Standard Metrics

Waze report-based

1	International Roughness Index	IRI
2	Rut Depth	Rut Depth
3	Pavement Distress Index	PDI
4	Present Serviceability Index	PSI
5	Pavement Quality Index	PQI

1	Pothole Reports per Mile	PRM
---	--------------------------	-----

Topic 2. Pavement Condition Evaluation

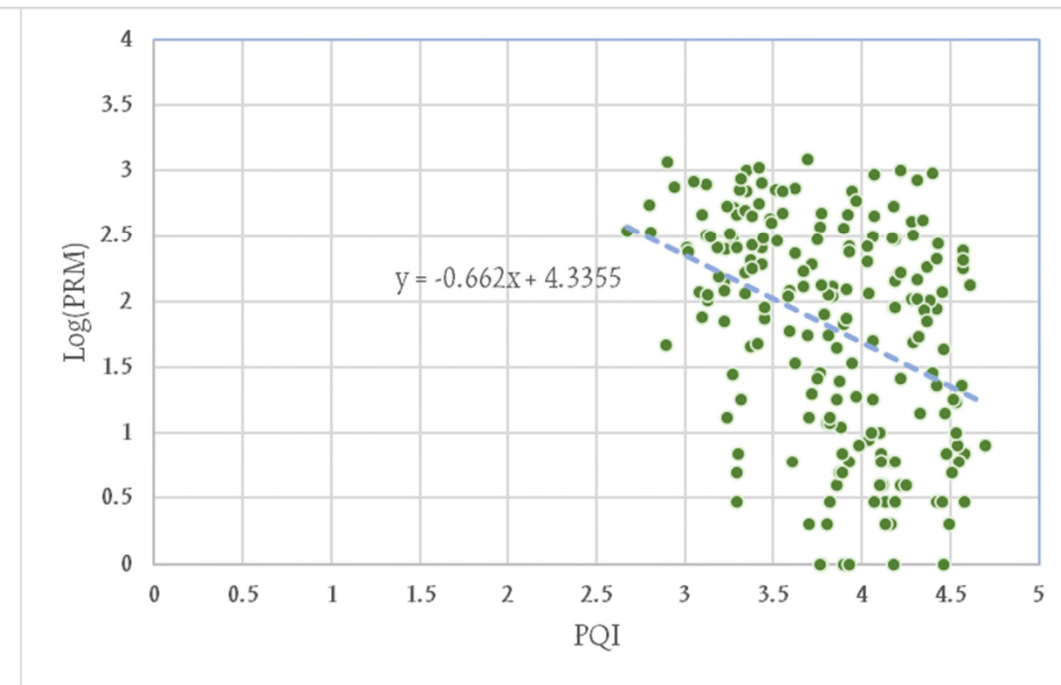
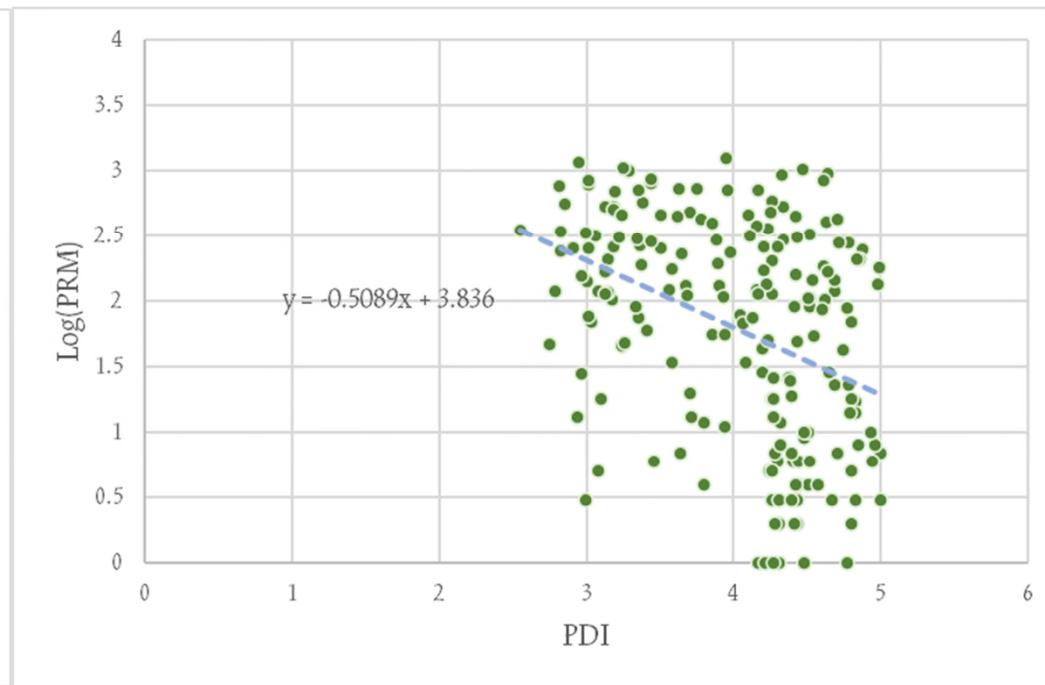
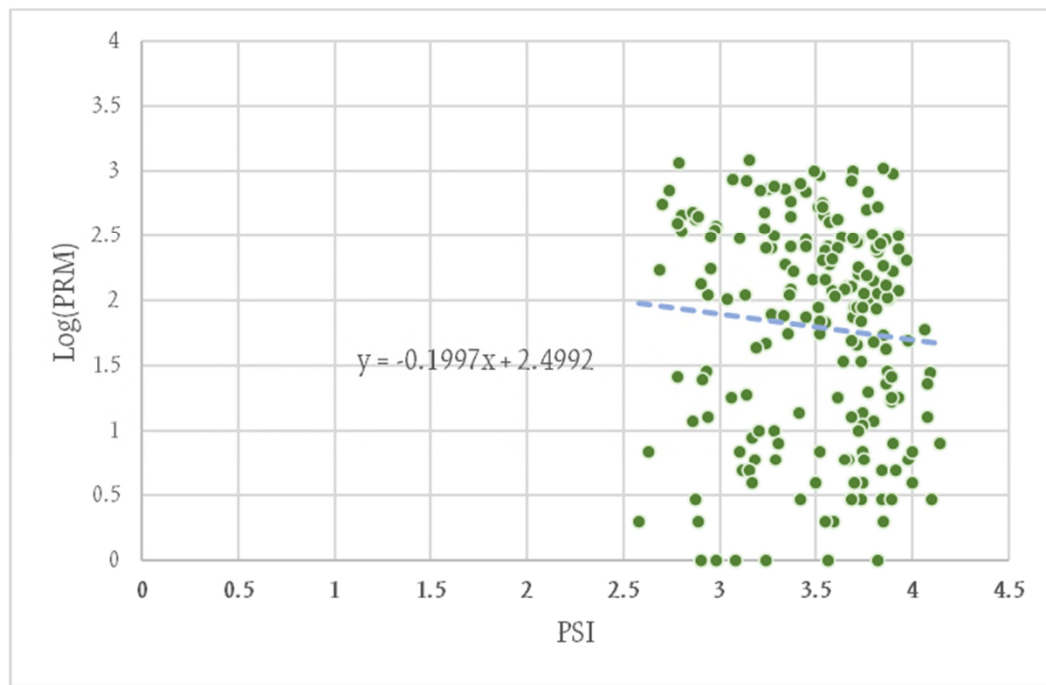
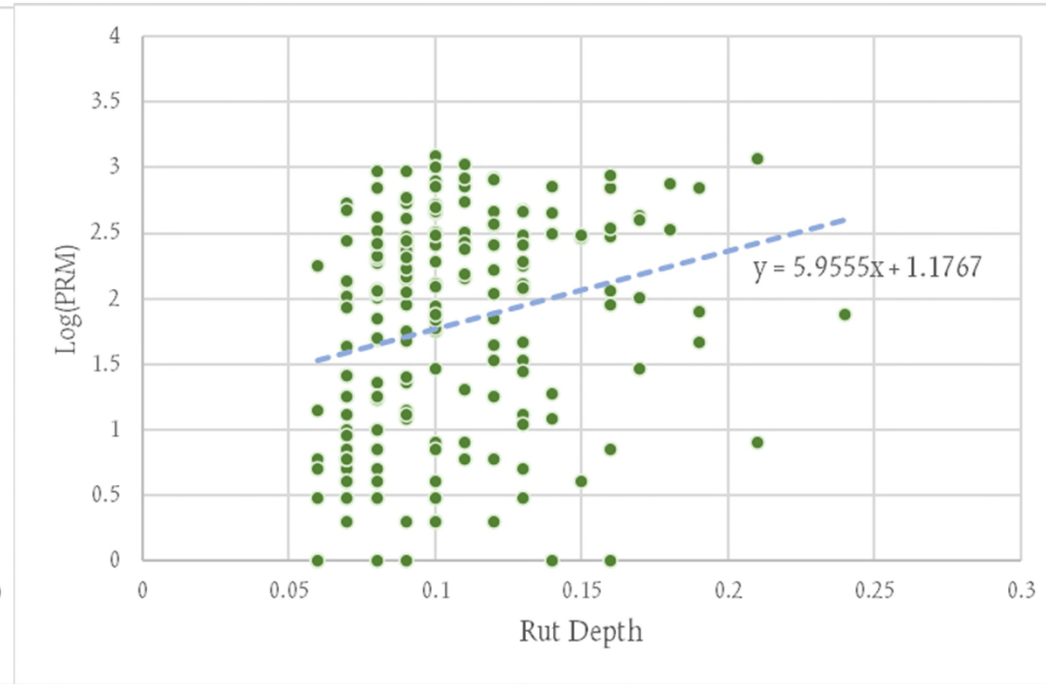
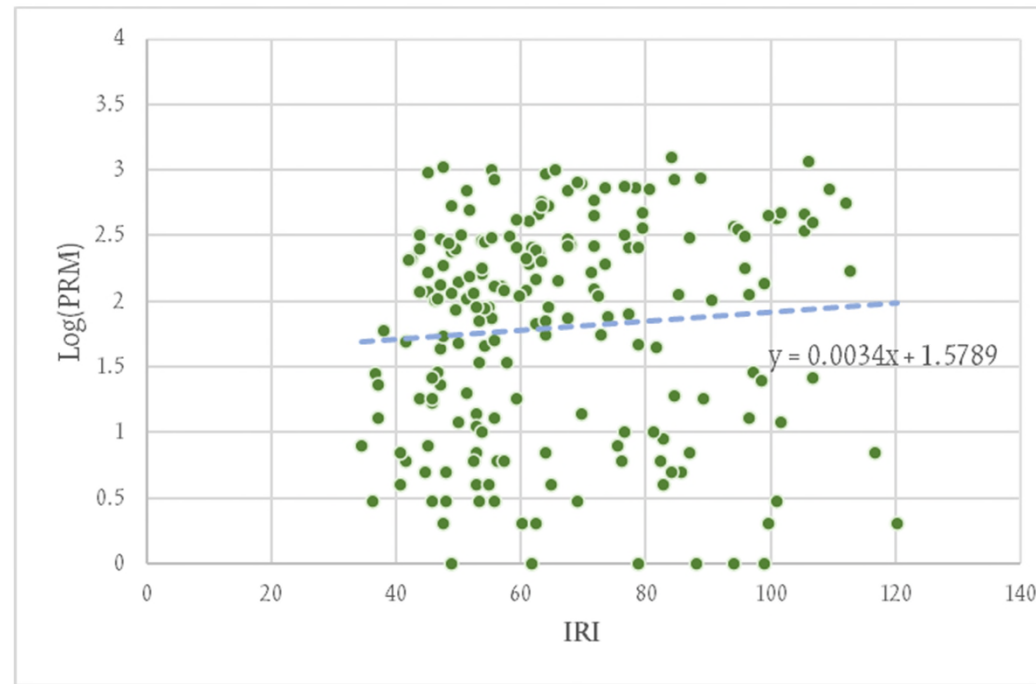
Correlation

Table 1. Pearson Correlation Analysis

	I-40		I-24		I-65	
Metric	ρ	p-value	ρ	p-value	ρ	p-value
IRI	0.449	0.0003	0.186	0.1696	-0.118	0.4817
Rut Depth	-0.138	0.2939	0.288	0.0315	0.040	0.8131
PSI	-0.462	0.0002	-0.205	0.129	0.114	0.494
PDI	0.008	0.952	-0.310	0.0203	-0.257	0.1198
PQI	-0.079	0.5481	-0.321	0.016	-0.156	0.3498
	I-440		SR-155		Overall	
IRI	0.444	0.0852	0.390	0.0488	0.0412	0.5904
Rut Depth	0.157	0.5620	0.189	0.3561	0.243	0.0014
PSI	-0.441	0.0871	-0.392	0.0474	-0.055	0.4755
PDI	0.049	0.8574	-0.553	0.0034	-0.370	0.0000
PQI	-0.319	0.2278	-0.562	0.0028	-0.354	0.0000

Topic 2. Pavement Condition Evaluation

Overall Correlation



Contribution

- ❖ Pothole Detection:
 - ❖ Discover Pothole sooner than work request
 - ❖ Provide accurate location
 - ❖ Complement the work request where the pothole was not found in regular patrol
 - ❖ Provide insights for manual spot patching or resurfacing
 - ❖ Inspect the pavement

- ❖ Pavement Condition Evaluation
 - ❖ Pothole Report Per Mile is strongly correlated with the standard evaluation metrics.
 - ❖ The association differs from the routes.
 - ❖ Overall, the Proposed index could supplement the pavement condition evaluation.
 - ❖ Monitoring the pavement condition more frequently.

- ❖ Future Study
 - ❖ Ramp pothole detection
 - ❖ Local street pothole detection

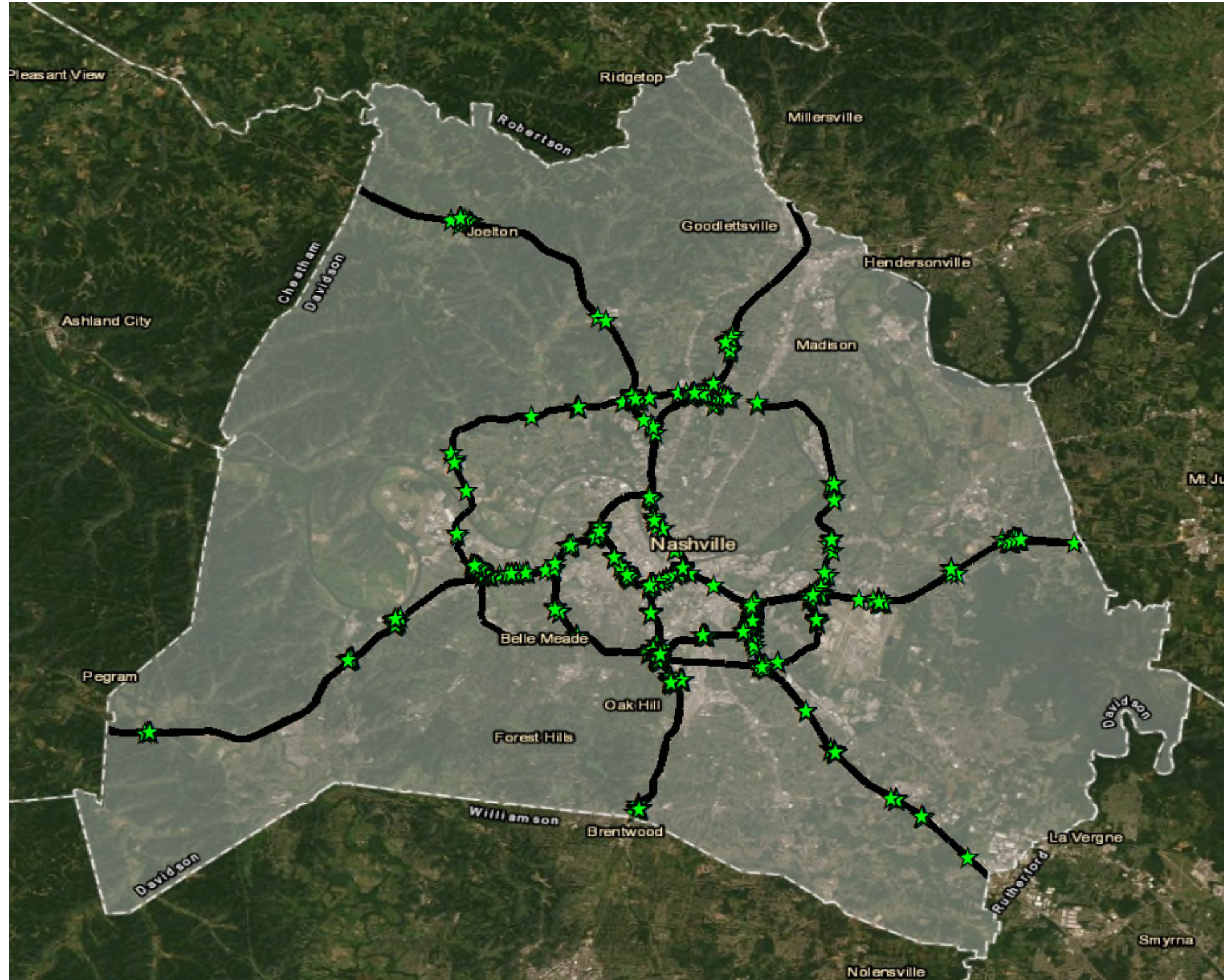
Potholes on the Ramp

Briley Pkwy and I-40

Briley Pkwy and I-65

Briley Pkwy and I-24

Truck Traffic?





Thank you!

Yangsong Gu

ygu17@vols.utk.edu

*Special thanks to TDOT for continued support,
and
all organizers of this TSITE meeting!*



THE UNIVERSITY OF
TENNESSEE
KNOXVILLE