Estimating Traffic Crash Counts Using Crowdsourced Data

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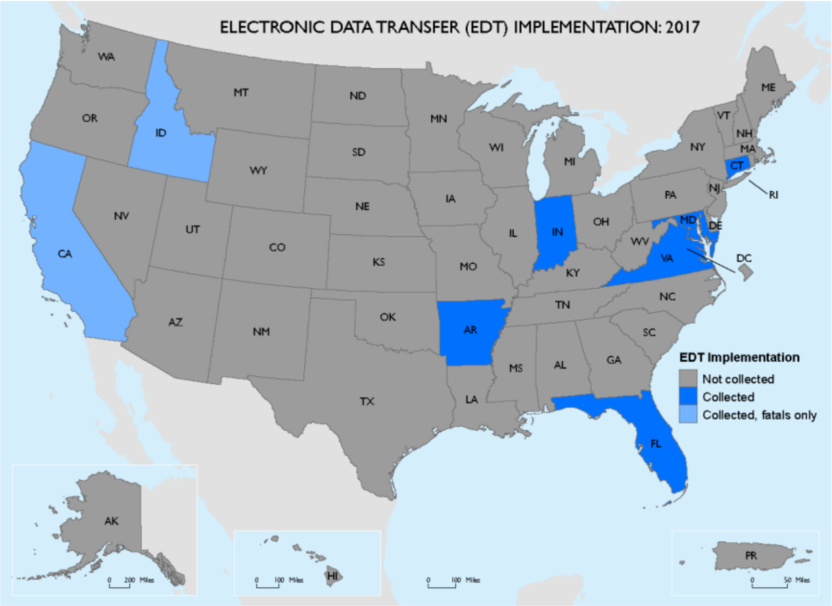
Challenge: Tracking crashes in near real-time

- Crash data are typically available for certain crashes, after several months
- EDT (Electronic Data Transfer) of police accident reports available nightly for nine states
- Waze incident data available where user reported, all 50 states and DC, every 2 minutes
- Waze and EDT could provide near-real time, granular estimates of crashes to inform safety policy and operations



Safety Data Initiative: Waze Pilot Project Overview

Objectives

- Use crowdsourced data insights to improve transportation safety

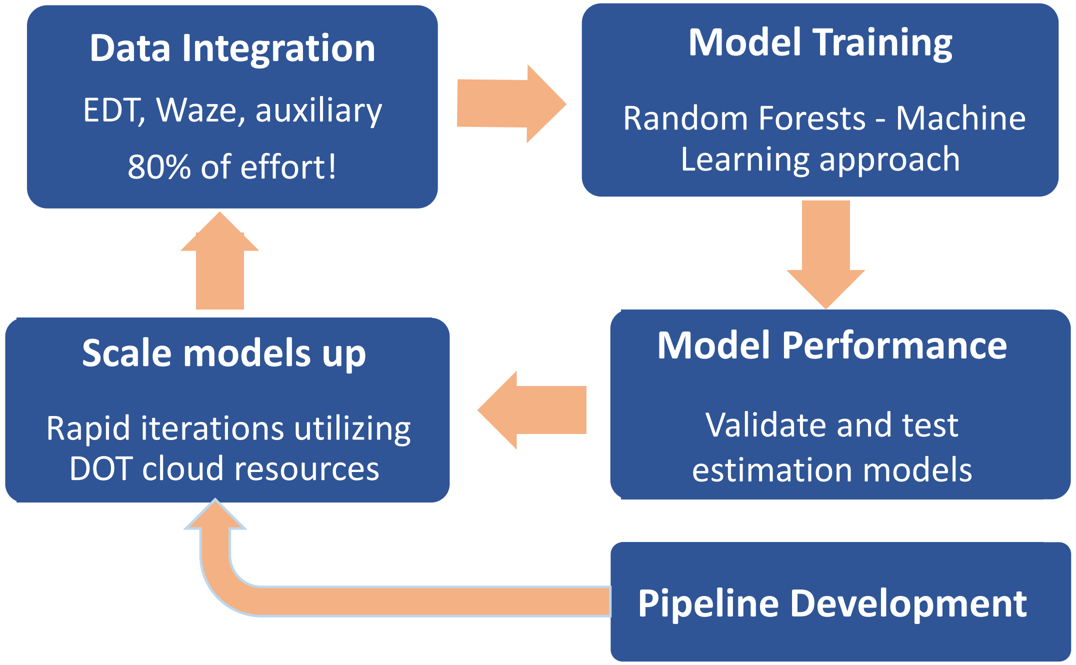
Questions

- **Can we integrate DOT data resources at large scales?**
- **Do Waze data support vision of a rapid crash indictor?**

Vision

Rapid crash trend monitoring tool

Approach



Analysis: Challenges and Solutions

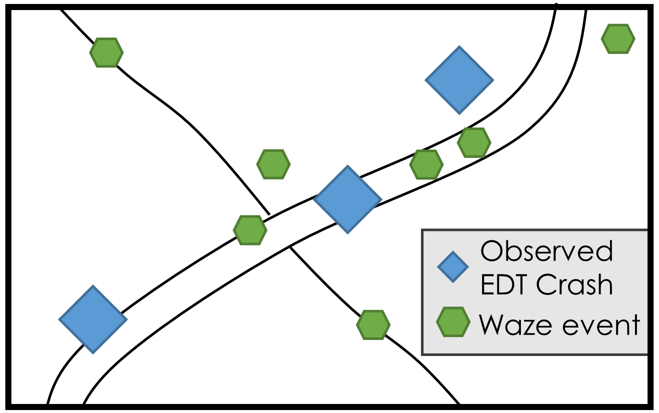
Challenges

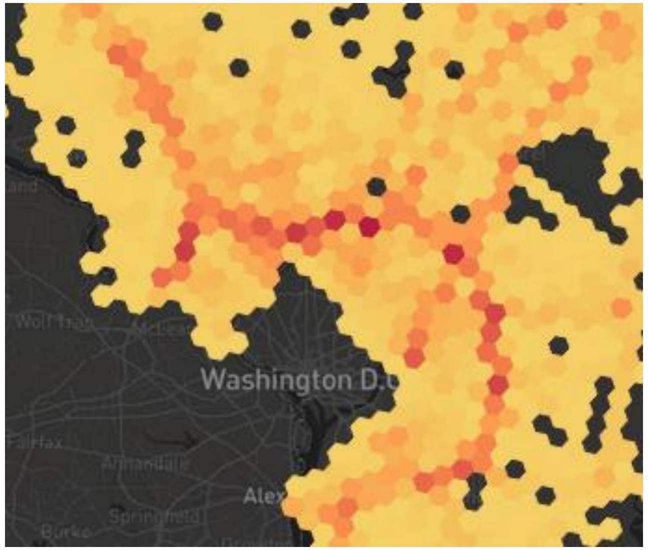
- Waze and EDT coordinates do not all align with FHWA road network
- How do we associate Waze events and EDT reports?
- Need to define zeros (time and places with no accidents)

Solutions

- Spatial aggregation of data to hexagonal grids (1-mile area)
- Match Waze to EDT on user-selected buffers in space and time
- Define zeros as grid cells and time periods with 1 or more non-accident Waze events but no EDT reports

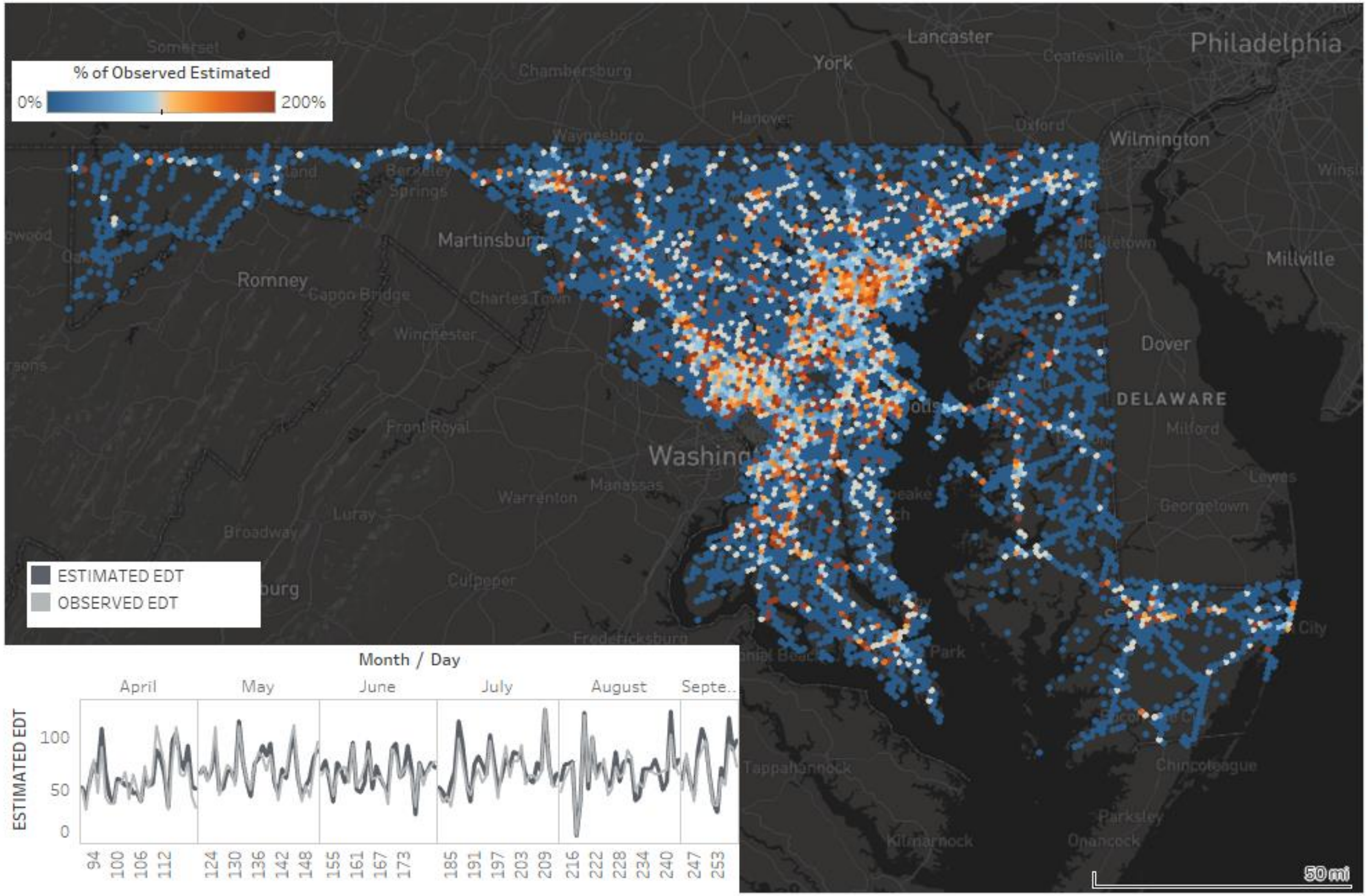
Observed data





Model Performance (April-Sept 2017 in MD)

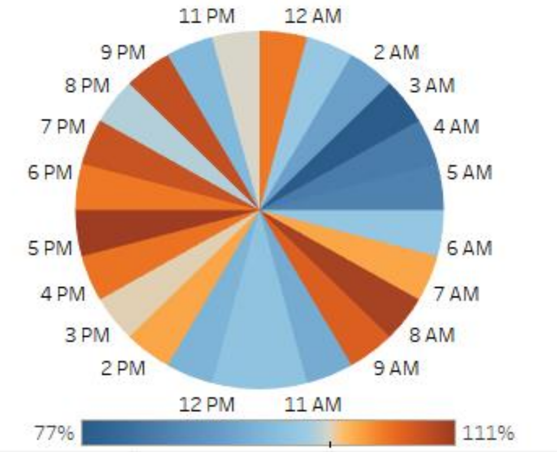
Model estimates highly accurate overall; miss some precise patterns



Crashes by Day

Day Of Week	ESTIMATED EDT	OBSERVED EDT	PRCT OBSERVED
Monday	1,089	1,099	99.09%
Tuesday	1,623	1,602	101.31%
Wednesday	1,788	1,709	104.62%
Thursday	1,768	1,694	104.37%
Friday	1,922	1,840	104.46%
Saturday	1,945	1,869	104.07%
Sunday	1,390	1,413	98.37%

% Observed Estimated by Hour



SDI Waze Data Pipeline Development

Waze

- JSON files of events
- 2 min increments
- 50 States + DC

Secure Data Commons

https://portal.securedatacommons.com

- Monthly, state-aggregated, clipped Waze
- Add EDT, weather, census, roadway data
- Machine learning estimation of EDT-level crash events
- Hot spot, event sequence, special event analysis

Output

- Tabular and graphical outputs of model results
- Interactive dashboards

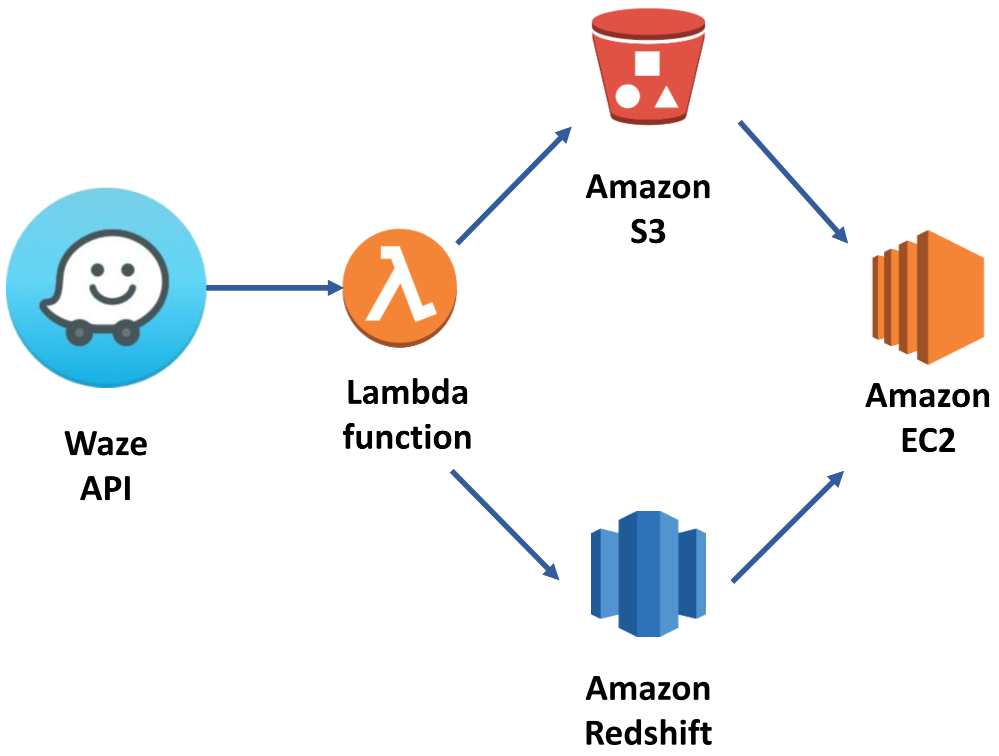
Technology platform

- AWS S3 buckets for curated data and team working folders
- AWS Redshift database for derived data
- RStudio + Jupyter on virtual computer
- GitHub integration for collaboration (private)

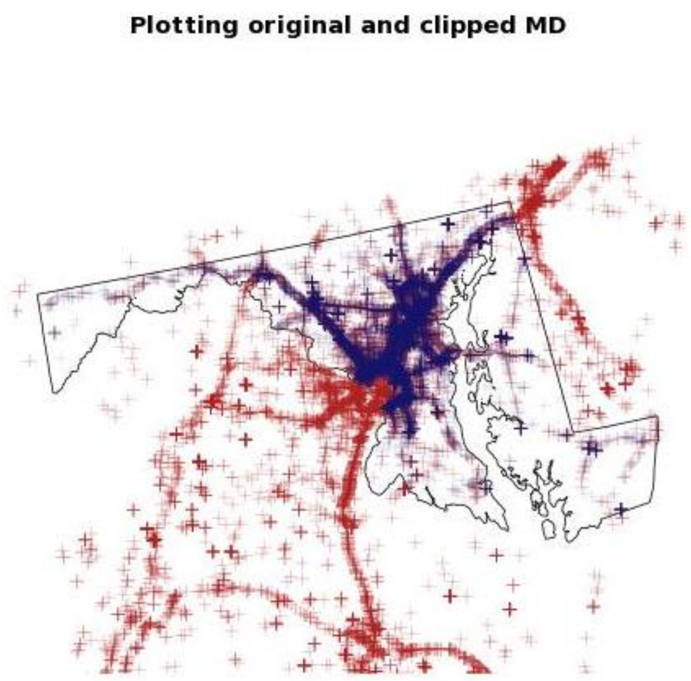
SDI Waze Data Pipeline Development

SDC

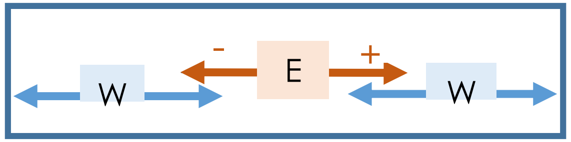
0. Waze Data Ingestion and Curation



1. Query, Clip, Reduce



2. Space-Time Match



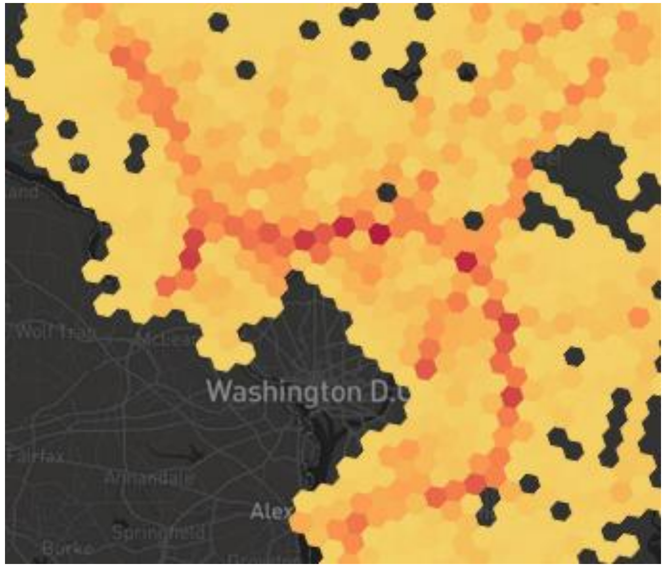
SDI Waze Data Pipeline Development

SDC

3. Grid and Urban Area Overlay

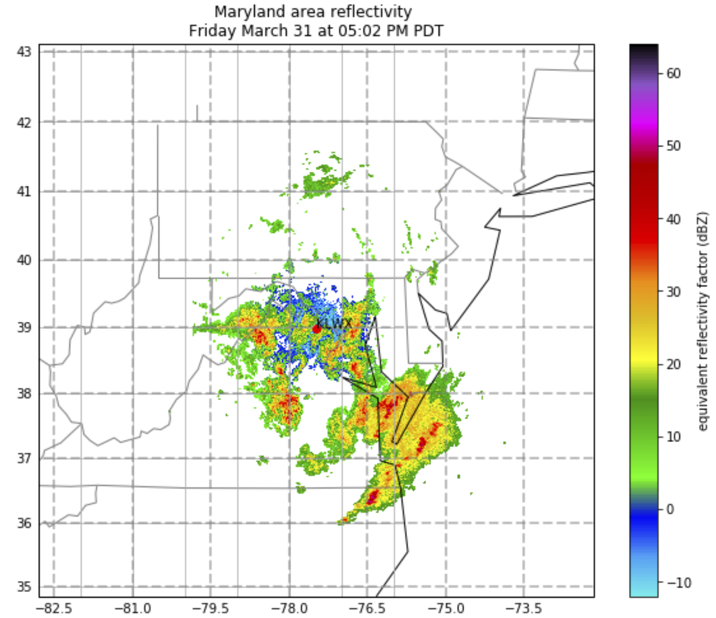
4. Grid Aggregation

5. Weather Overlay



Adding:

- Urban Areas
- Hexagonal grid tessellations

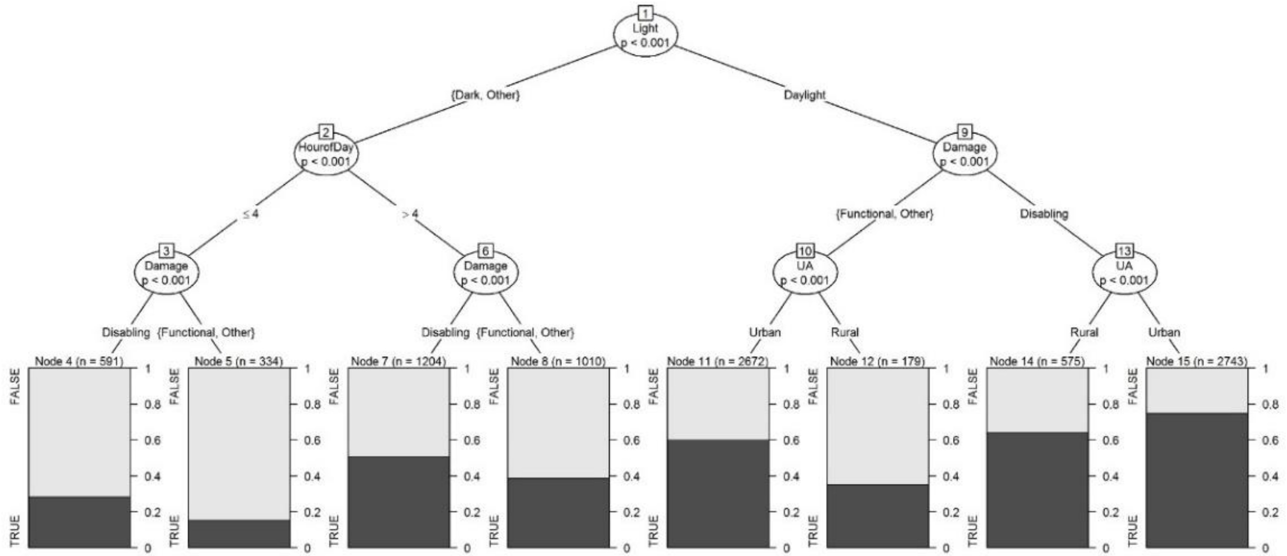


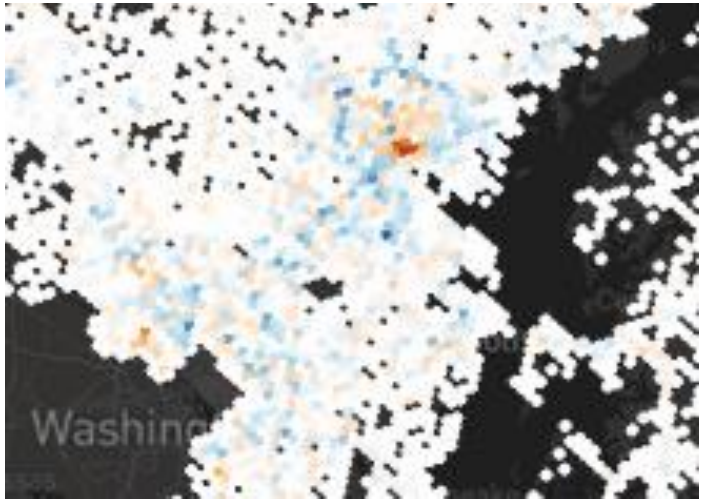
Adding:

- Raster weather reflectivity

SDI Waze Data Pipeline Development

ATA	ATA + Local
6. Modeling	**7. Visualization and Reporting**





Adding:

- FARS
- HPMS road class
- AADT
- LEHD

Statistical Approach: Supervised Classification

Random Forests

- Machine learning approach which minimizes overfitting
- Trained models on 70% of data using EDT reports as our labeled “ground-truth”
- Tested model performance using 30% of data to compare estimated EDT crashes with observed EDT crashes
- Rigorously trained and tested data feature combinations (50+ models)
- Best crash estimation models minimize False Positives and False Negatives

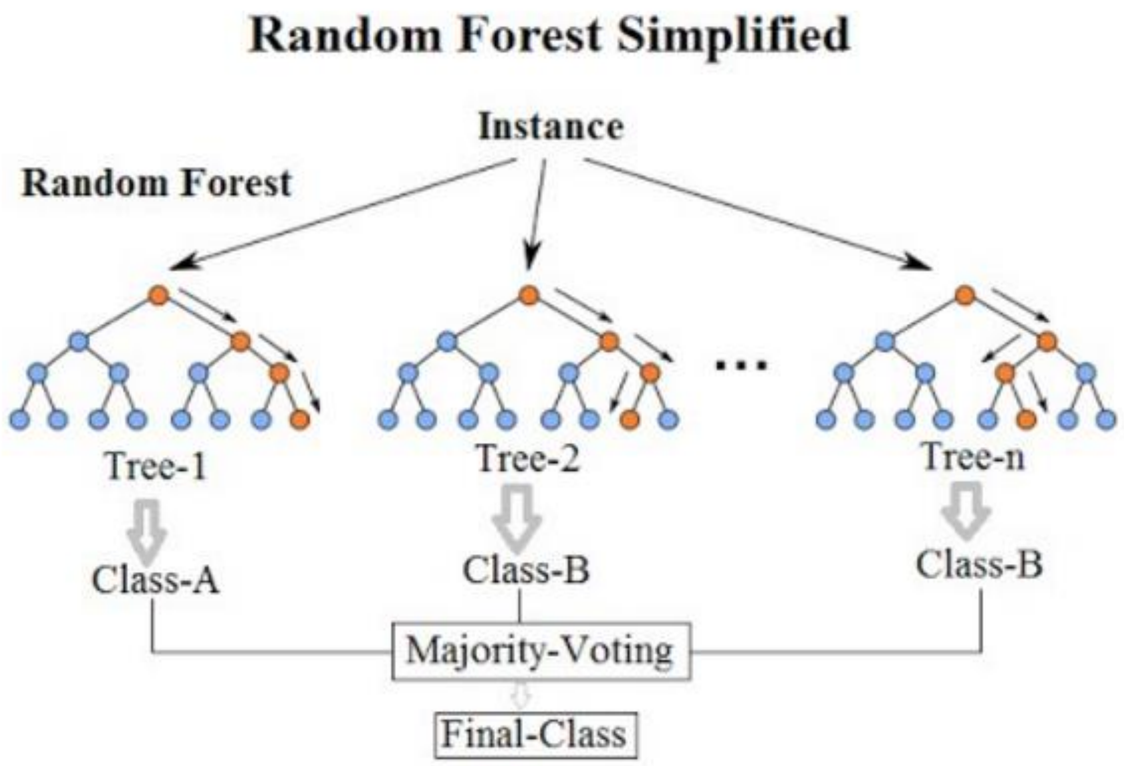


Image credit: https://medium.com/@williamkoehrsen/random-forest-simple-explanation-377895a60d2d

Results – what have we learned?

We can integrate DOT data resources at large scales

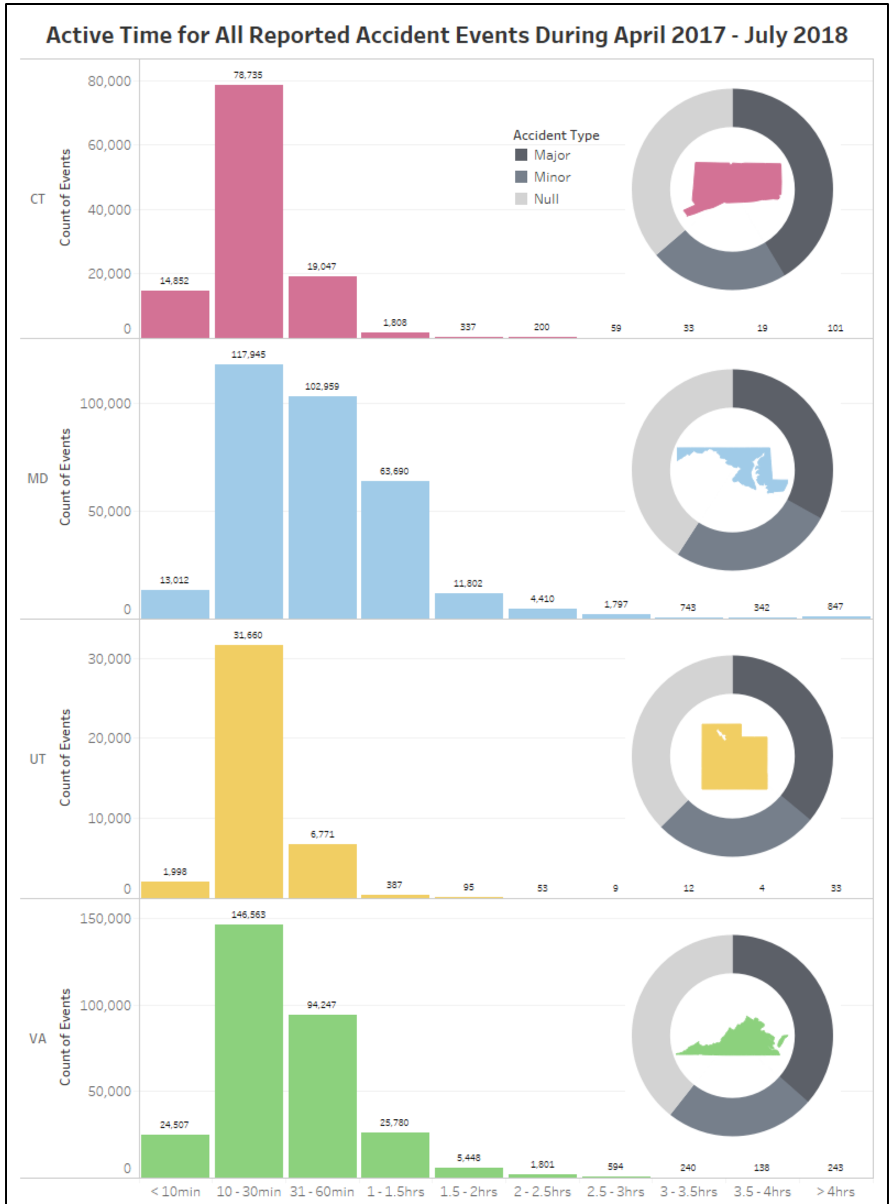
- Our data integration and analysis pipeline can support rapid crash estimates (when/where Waze signal present)
- Successfully integrated transportation data that are not originally intended to track traffic safety

Waze data support rapid crash indicator

- With Waze signal, models produce good overall estimates for multiple states
- Foundation for tool for rapid tracking of traffic safety trajectories

Results – what have we learned?

- Potential for Waze data to support analysis of roadway incident clearance times
- Sequence of event analysis shows potential for crash precursor early warning
- Waze data can evaluate impact of special events using heat maps
- Beginning partnerships with state agencies to deliver usable tool



Results – what have we learned?

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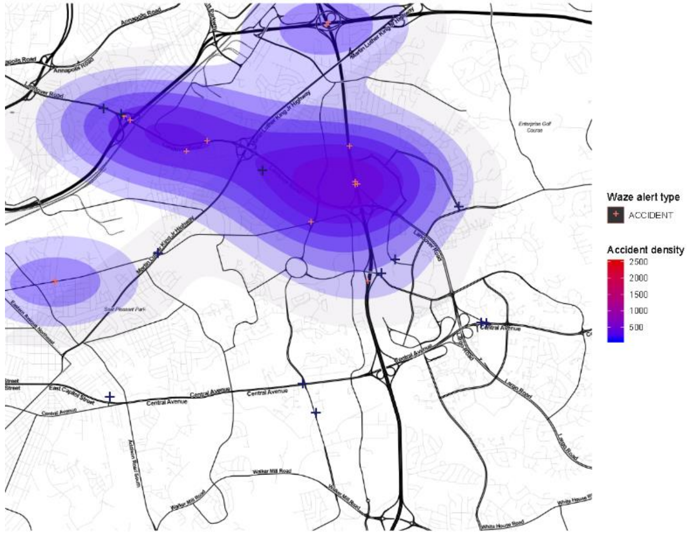
Special event



No special event

Next Steps

- Full year modeling on multiple states
- Partnerships with state or local DOTs to identify use cases
- Cross-state Waze data assessment & dashboard
- Applications of segment-based models

Potential Applications

Rapid crash trend monitoring tool

- Flag anomalies
- Short-term intervention assessment
- Cross-state comparisons
- Effectiveness models

- Incident Duration
- Clearance Times
- Secondary Crashes

Additional Slides

Evaluating Model Performance

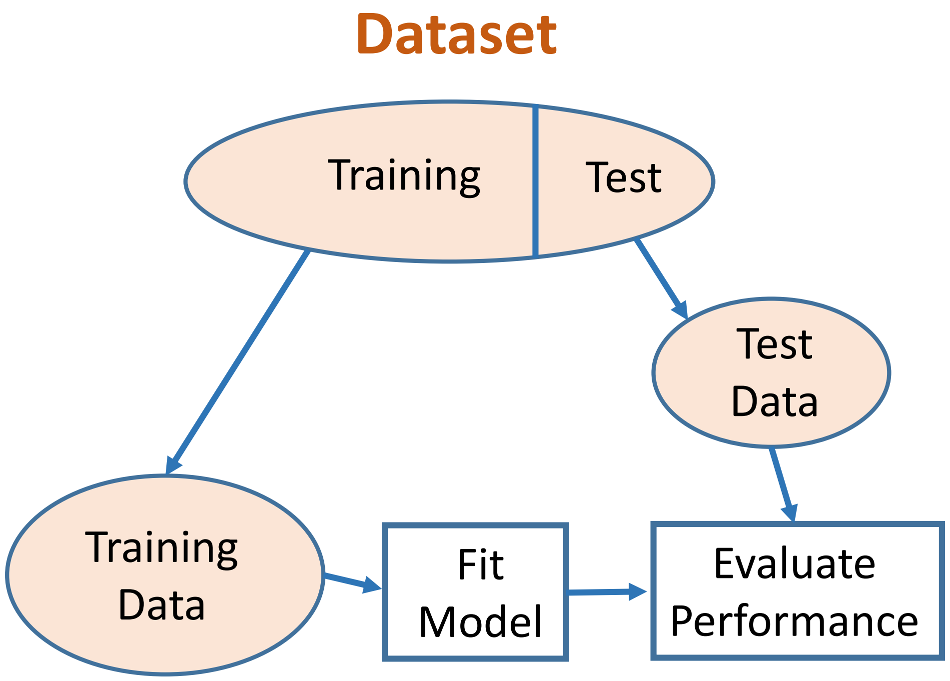
Divide data into training and testing subsets

- Training data: Select **70%** of observations (random by rows, whole days, or whole weeks)
- Test data: Remaining **30%** of observations

Training: fit model parameters with a large set of known EDT crashes, associated Waze events and other predictors

Testing: apply fitted model parameters to a new set of Waze events and other predictors to generate estimated EDT crashes

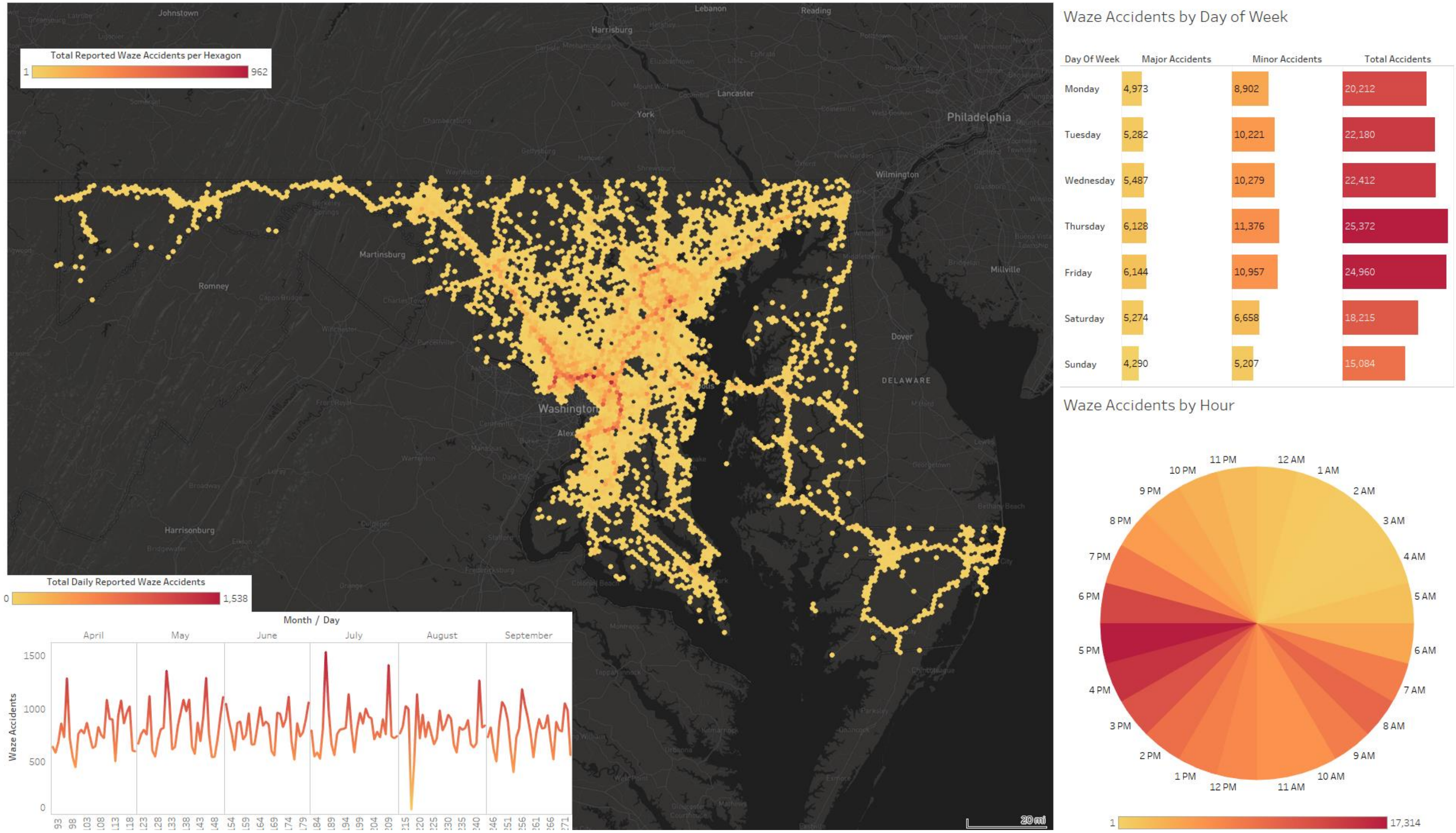
Compare estimated EDT crashes to observed EDT crashes in the test data set to evaluate model performance



Waze Data: Distribution in Space and Time

Six months of geolocated Waze data for Maryland (April - September, 2017)

Spatiotemporal Distribution of Reported Waze Accidents in Maryland

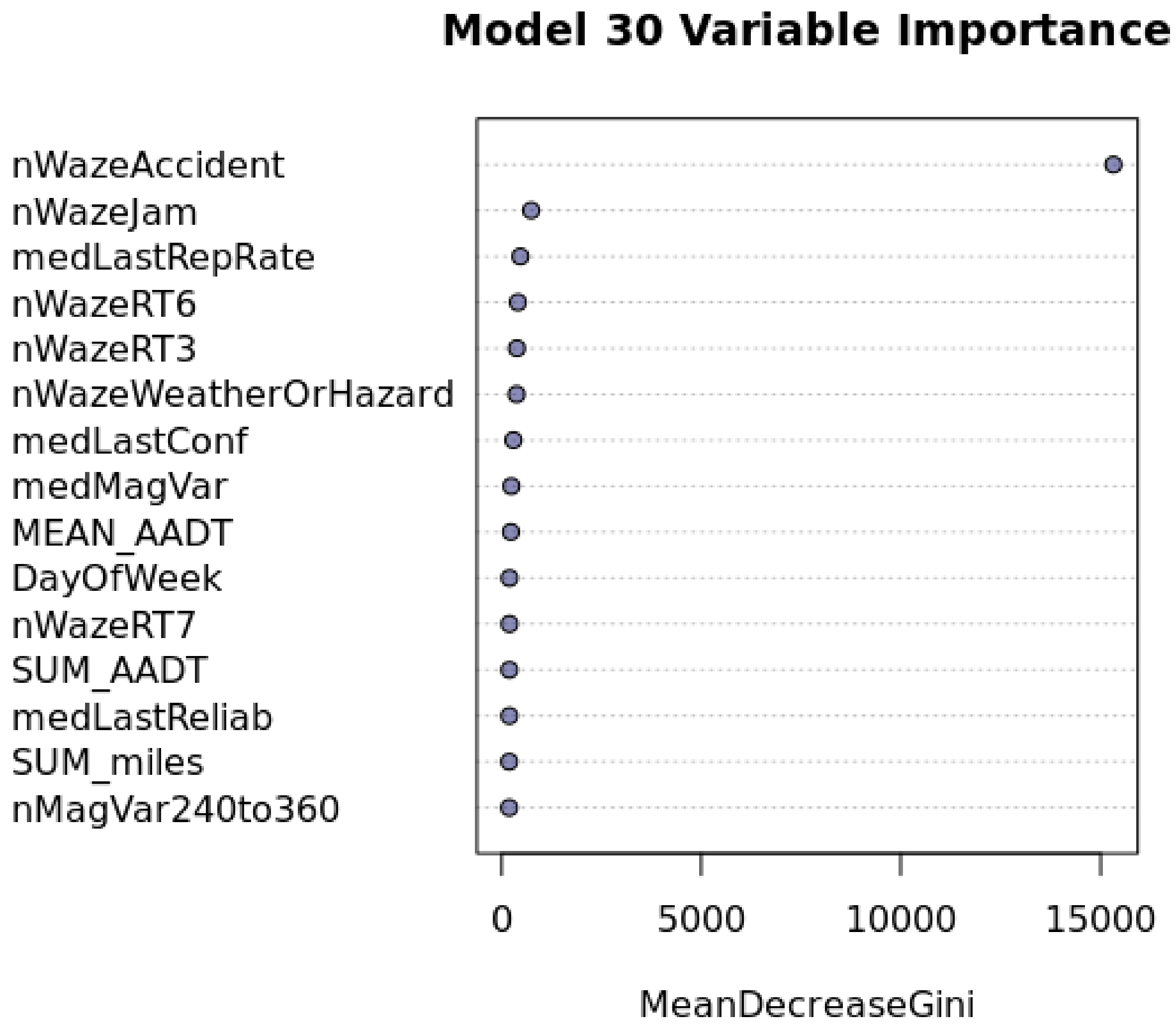


Variable Importance: Waze Accidents (April-Sept)

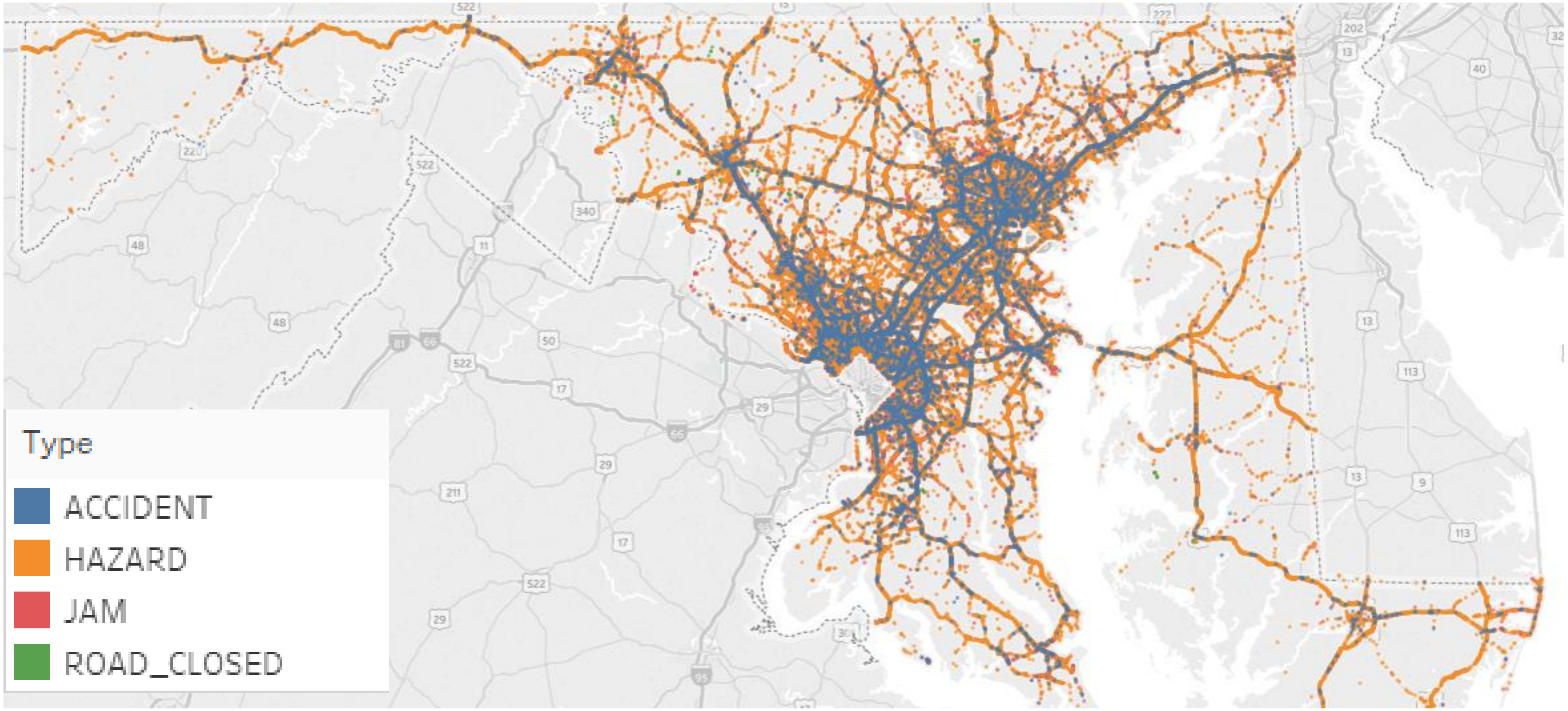
Mean decrease in Gini impurity:

- Variable is useful in separating a node of mixed classes (both 0 and 1 EDT crashes, in our case) into two nodes with pure classes (all 0 or all 1 EDT crashes).

- Across all nodes in all the trees, how much does this variable decrease node impurities, averaged over all trees?



Waze Data: Jams and Crash Sequence Analysis



April, 2017 MD

WazeUniqueCounts

Type	
ACCIDENT	15,139
HAZARD	242,787
JAM	180,347
ROAD_CLOSED	1,130

Potential Applications

- Incident Duration
- Clearance Times
- Secondary Crashes