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 indicator?
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
Model Performance (April-Sept 2017 in MD)

Model estimates highly accurate overall; miss some precise patterns
SDI Waze Data Pipeline Development

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

**Secure Data Commons**
[https://portal.securedatacommons.com](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

0. Waze Data Ingestion and Curation

1. Query, Clip, Reduce

2. Space-Time Match

Plotting original and clipped MD

Waze API → Lambda function → Amazon S3 → Amazon EC2 → Amazon Redshift

SDC
SDI Waze Data Pipeline Development

3. Grid and Urban Area Overlay
4. Grid Aggregation
5. Weather Overlay

Adding:
- Urban Areas
- Hexagonal grid tessellations

Adding:
- Raster weather reflectivity
6. Modeling

Adding:
- FARS
- HPMS road class
- AADT
- LEHD

7. Visualization and Reporting
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
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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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
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

Potential Applications

- Incident Duration
- Clearance Times
- Secondary Crashes