Applications and Visualization of Trajectory Data

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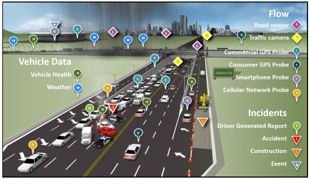
Background

- In 2016 Maryland SHA purchased 4 months of GPS trajectory data from INRIX

MDOT
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION



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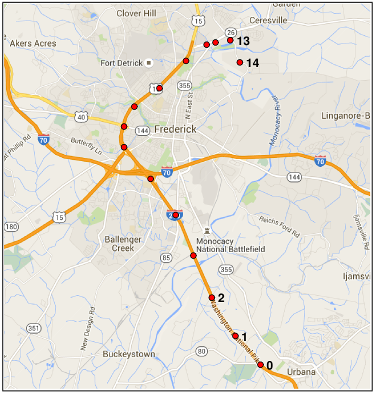
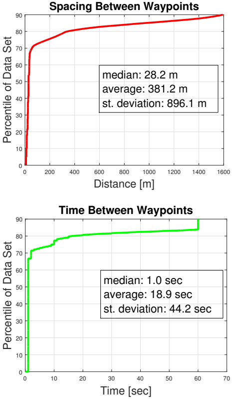
- INRIX collects terabytes of data from over 300 million mobile phones, cars, trucks, vans and other fleet vehicles via GPS
- SHA asked Center for Advanced Transportation Technology (CATT) to demonstrate use case scenarios

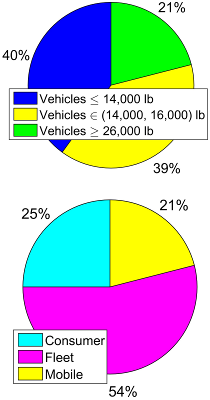
Trajectory Data Overview



Sample trip



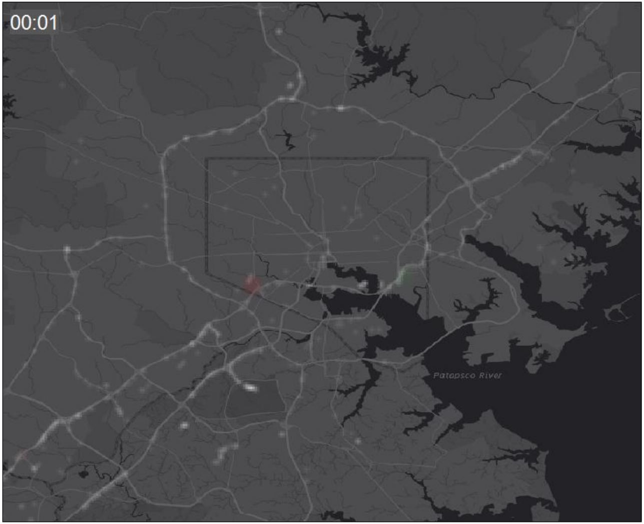
Waypoint statistics



Trip statistics

- 4 months of 2015 INRIX data (February, June, July, October)
- 20 million trips and 1.4 billion waypoints (112 GB)

A Day in Baltimore

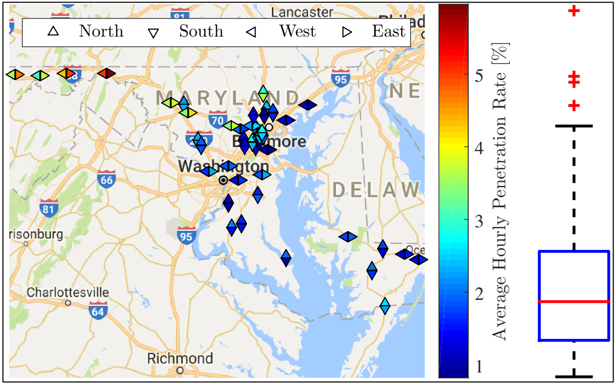


Animation

- Baltimore
- July 7, 2015
- Origins: green
- Destinations: red
- Way points: white

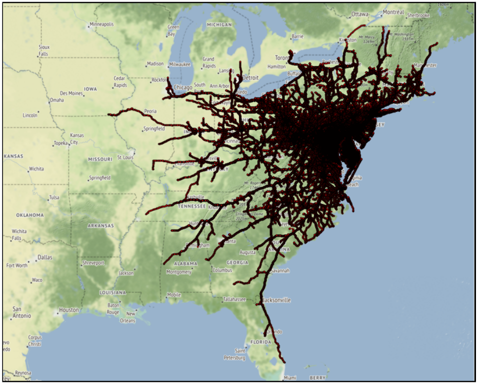
Penetration Rate

- Hourly penetration rates of GPS traces are computed at 45 Automatic Traffic Recorder (ATR) locations over the 4 month period

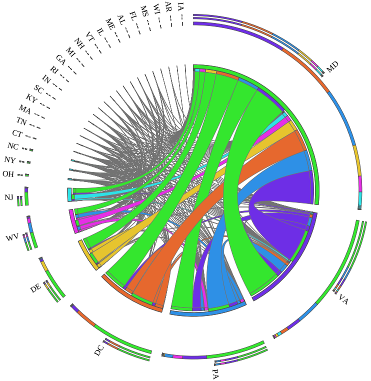


- Avg hourly penetration rates: 0.9% to 5.4% (median = 1.9%)

Origin-Destination Extraction



Trips from June 2015

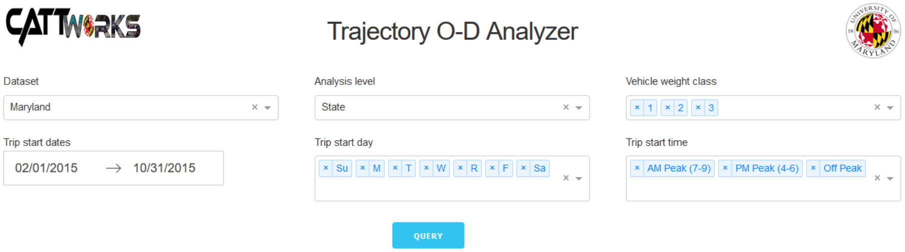


Trips between MD and other states

- Estimate O-D matrices (state, county, zipcode, TAZ) for planning purposes

How to extract O-D data?

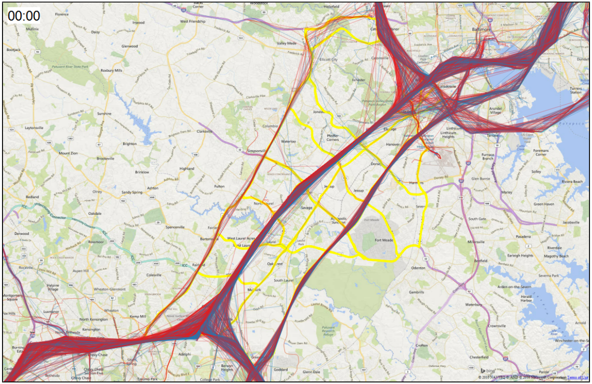
- Created database with web interface to perform queries
  - Optimized for O-D queries at state, county, zipcode, TAZ level
  - Specify dates of interest, vehicle weight class, day of week, and time

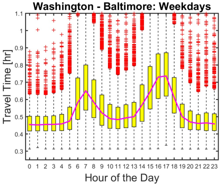


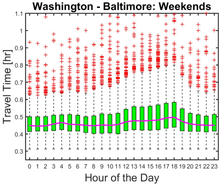
Trajectory O-D Analyzer Web Application

- Filter results by origin, destination, counts, trip time, distance
- Visualize top origins & destinations, and time & distance distributions
- Download O-D matrices for further processing

Analyze Single O-D Pair

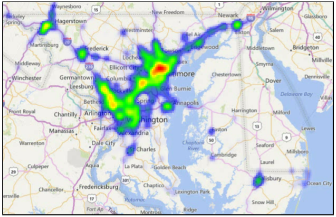




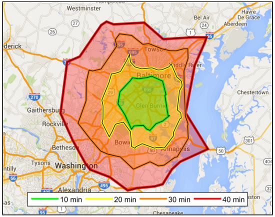


- Compute trip-based performance measures
- Determine distribution of traffic along major routes
- Estimate turning movements at major intersections

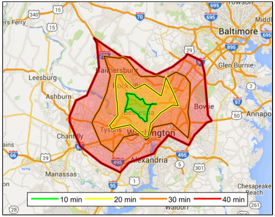
Activity Zones and Isochrones



Heat map of trip origins



BWI airport



Walter Reed

- Heat map of trip origins reveals main trip generators
  - BWI airport, Walter Reed, NIH, Fort Mead
- Trips originating in these activity zones are used to derive isochrones
  - Compare peak and off-peak isochrones

Transit

Goal

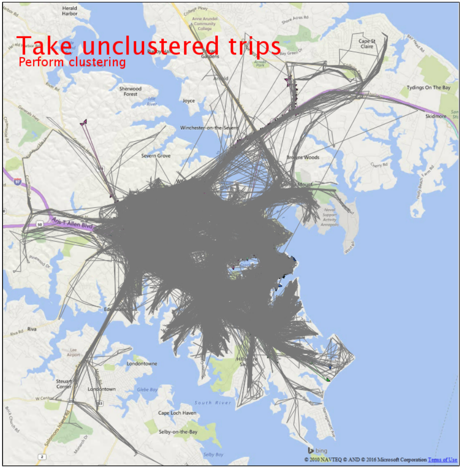
- Evaluate, redesign, or build from scratch routes for public transit

Intuition

- If many people travel between the same origin and destination, transit should connect these locations

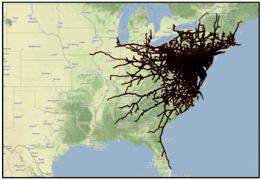
Approach

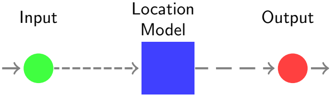
- Find clusters of trips with similar origins and destinations
- Consider modifying existing transit routes based on these clusters

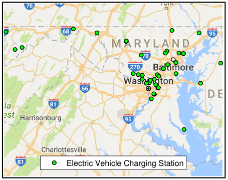


Current and Planned Work

- Use trajectory data to allocate **electric vehicle** charging stations



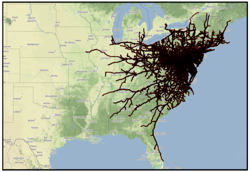


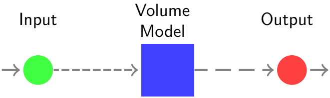


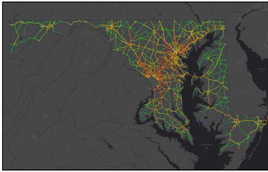
- Use trajectory data to evaluate **signal timing**
  - Compute vehicle-hour delays before and after signals were re-timed
- Use trajectory data to evaluate impact of **work zones** on mobility
  - Compute vehicle-hour delays before and after setting up a work zone

Primary Research Focus: Volume Estimation

- Agencies need hourly traffic speeds and volumes to compute various performance measures (e.g., vehicle-hour delays)
  - Speeds are available throughout USA ✓
  - Volumes are NOT available throughout USA ✗
- Use trajectory data to estimate **hourly traffic volumes** on statewide road network

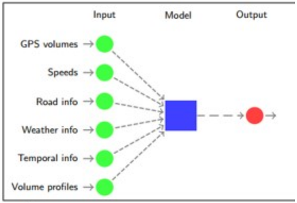


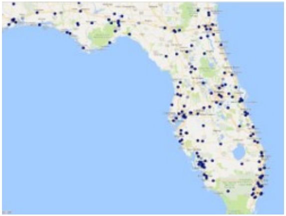




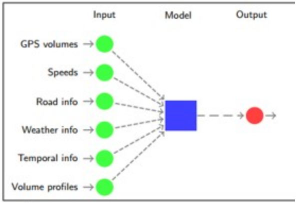
High Level Approach

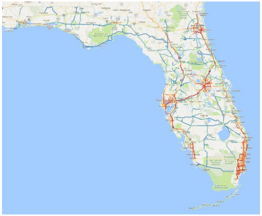
- Develop and train model using data from continuous count stations





- Apply trained model to state road network





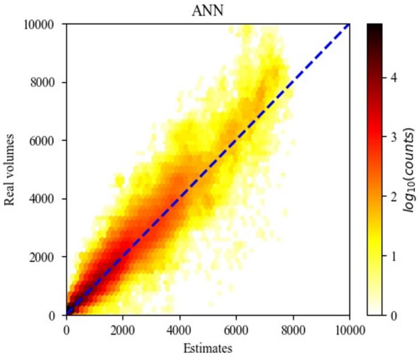
Model Accuracy: Florida

Summary

- Overall: $R^2 = 0.83$, $MAPE = 25\%$
- $\uparrow$ Avg hourly GPS counts $= \uparrow$ accuracy
- $\uparrow$ Avg hourly traffic volume $= \uparrow$ accuracy
- $\uparrow$ Road class $= \uparrow$ accuracy

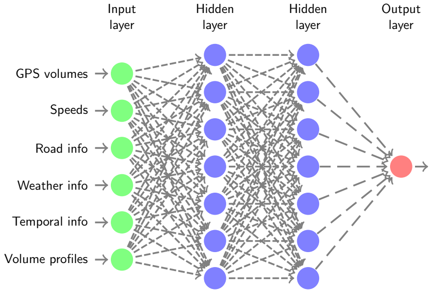
Takeaways

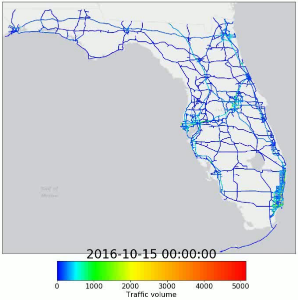
- Estimates meet requirements for most planning and operational purposes
- Results are very promising!



Statewide Hourly Volume Estimation

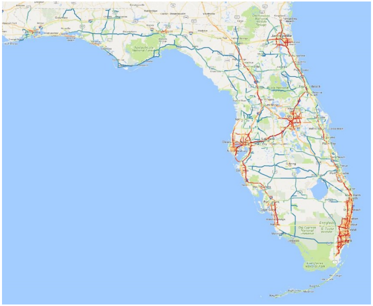
- Generate hourly volume estimates at each road segment for 3 months



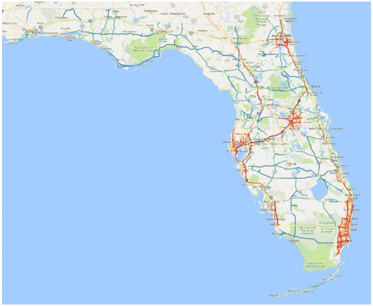


Next Steps

- Aggregate hourly estimates to calculate AADT & AAWDT
  - Initial results: $R^2 = 0.86$, $MAPE = 15\%$
- Estimate hourly truck volumes
  - Initial results promising on high functional road classes



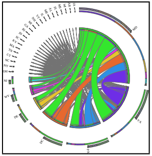
AADT

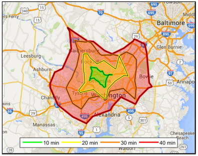


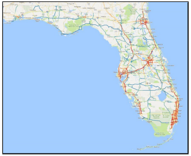
AAWDT

Conclusions

- GPS trajectories can be used for various applications in planning and operations
    - O-D matrices, traffic splits, public transit, signal timing, volume estimation







- CATT Lab is developing a suite for the analysis of trajectory data
- Trajectory data can be a valuable resource to transportation agencies

Q&A

Contact Information

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Acknowledgments

Maryland SHA