Improving Short-term Travel Speed Prediction with High Resolution Spatial and Temporal Rainfall Data

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Summary

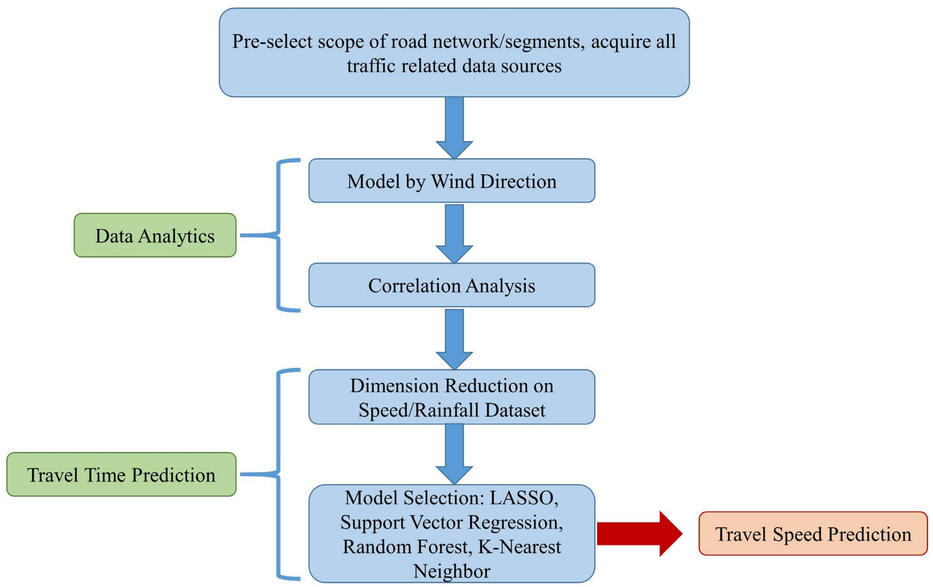
What we did:

- Incorporated high-resolution rainfall and wind data into a travel speed prediction model to asses how having **localized rainfall data** to predict travel speed compares to the classical method of utilizing a **single city-wide rain gauge**.
- The results show that, **high-resolution rainfall features in many instances are better predictors of future rainfall on the target segments**, leading to overall better prediction results.

Background

- In 2018, Pittsburgh, Pennsylvania recorded its wettest year on record since 1871 and 77 other cities across the United States (US) that same year also experienced record-setting rainfall.
- Studies from the National Highway Traffic Safety Administration (NHTSA) reveal that about 14% of vehicle crashes occur in adverse weather conditions.
- Existing broadcast emergency response systems such as flood warnings reach a wide-range of people, but the messages sent from this system are generic and do not include descriptive information (e.g., roads to avoid).
- In order to promote better management of the transportation system, we propose a data-driven approach to predict and quantify traffic conditions in real-time (i.e., 30 minutes ahead).

Method



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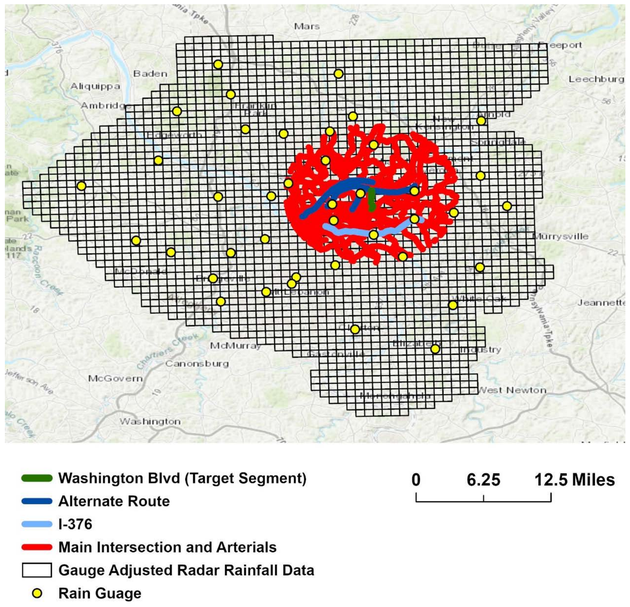
Case Study: Washington Boulevard (Pittsburgh, PA)

Rainfall Features

- **Gauge Adjusted Radar Rainfall**: Provides calibrated rainfall data at a resolution of 1-km by 1-km for Allegheny County
- **Rain Gauges**: Provides observed rainfall data; 33 rain gauges scatted throughout Allegheny County

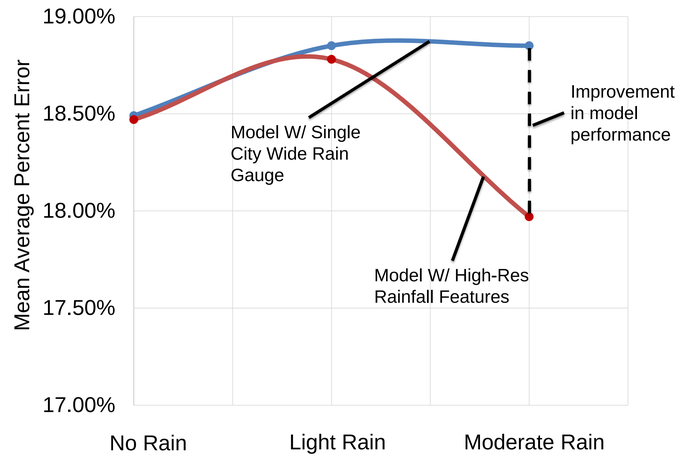
Other Features

- Speed: XD based speed data from INRIX, covers all main roads within a 6 mile radius of Washington Blvd.
- Incidents: PennDOT Road Conditions Reporting System
- Weather: Hourly Weather data from Darksky (e.g., humidity, visibility, temperature)
- Local Events: Home games of major sports teams (MLB, NFL, NHL)
- Temporal: information on day of week, hour, and whether the observed day is a Federal holiday



Exploring the Role of High-Resolution Rainfall Features

- For this analysis, **we ran each model with a single city-wide rain gauge and with high-resolution rainfall features, and compared model performance** during periods when there is no rain, light rain, and moderate to heavy rain**.**
- **The model with the single city-wide rain gauge** uses observed rainfall data from the rain gauge closest to Pittsburgh International Airport (PIT), which is about 4.8 km (3 mi) west).
- By comparing the results of the models we see that **incorporating high resolution rainfall features improves overall model performance** in all weather conditions.
- The **greatest improvements** in accuracy **from incorporating high resolution rainfall features** for Washington Blvd. **comes during moderate and heavy rainfall events** where MAPE improves from 18.8% to about 18.1%, a 3.9% improvement in travel speed prediction accuracy.



Conclusion

- The incorporation of high-resolution rainfall features offers overall improvements in model performance when compared to only using a single city-wide rain gauge, but the magnitude of improvement and those weather conditions where model performance improves is likely to vary by roadway segment.
- High-resolution features tend to have much higher correlations with future rainfall on Washington Blvd., leading to substantially better prediction results during certain rain events.

Future Work

- Utilize raw doppler radar and rain gauge features in a travel speed prediction model.
- Predict rare events such as roadway network flooding.
- Perform travel speed prediction on different facility types such as highways and rural roadways.