# Mobility Data Analytic Center

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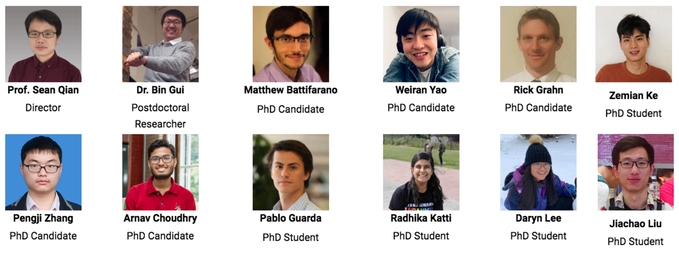
## Smart Mobility Decisions with ML/AI

Transportation systems are often characterized by complex multiscale multiphysics between heterogeneous travelers and network flow dynamics. Massive non-recurrent data collected over the years is likely noisy, biased, spatially and temporally sparse, siloed by its own sensing system, and not well exploited yet. Predicting those non-recurrent and out-of-distribution traffic impacts to inform decisions with a sufficient lead time is notoriously difficult. **Mobility Data Analytics Center** aims to integrate the **predictive power**, **interpretability** and **domain knowledge** of **physics-based network flow models** with **machine learning** to: (1) reveal the behavior information for both passenger transportation and freight transportation; (2) serve as a key instrument for managing transportation systems, and (3) target a range of users including legislators, transportation planners, travelers and private companies.

## Current Members




## Data Sources

1. GIS, demographics, economics, weather
2. Traffic counts on highways and major arterials
3. Travel time/speed: INRIX, HERE, TomTom, AVI, BT
4. Traffic incidents: RCRS/PD/911/311/PTC/PennDOT Crash/Road closures
5. Public Transit: APC-AVL, Park-n-ride, incidents
6. Parking: Transactions of on-street meters and occupancy of garage
7. Crowdsourced data: Waze alerts, Twitter

## Feature Projects

1. Real-Time Predictive Traffic Management Platform for Cranberry Township
2. Philadelphia region real-time traffic management (PennDOT)
3. First and last mile mobility services: case studies in Robinson and Moon Townships
4. Optimal Design of High-Frequency Public Transit System
5. High-Resolution Traffic Sensing with Autonomous Vehicles
6. Twitter-based incident detection (PennDOT)
7. Crash hotspot and causal analysis

## Green Light Go: Real-Time Predictive Traffic Management Platform for Cranberry Township

### Project Description

We build an Early Intervention System (EIS) which recommends optimal signal timing plans in real time under incidents by incorporating **domain knowledge developed with the traffic signal timing plans** tuned for possible incidents, and **learning from historical data** of both traffic and implemented signals timings.

1. Fuses **VISUM traffic simulation** tuned for predetermined nonrecurrent conditions into **data-driven traffic prediction models**;
2. RNNs for network traffic prediction 30 min ahead;
3. Metric learning for signal plan recommendation.
4. Model deployment in Cranberry Township, PA

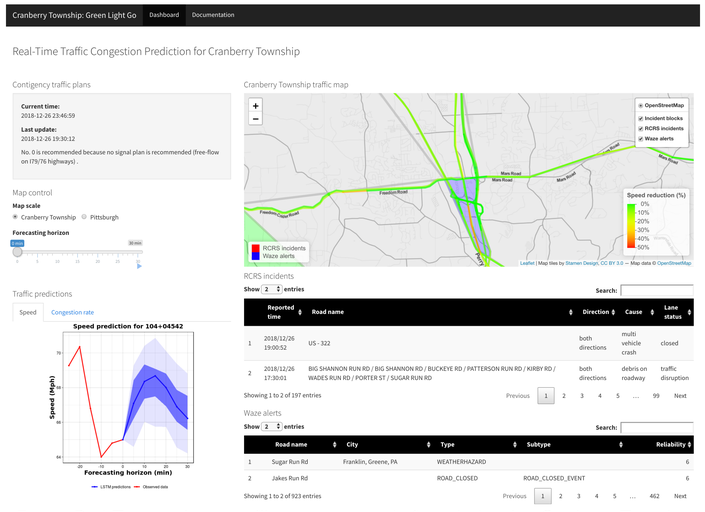



Figure: Real-Time predictive traffic management platform deployed in Cranberry Township

**Performance:** Field trials in Cranberry Township confirm that contingency signal timings are engaged **15-20 minutes earlier** after the deployment of our system.

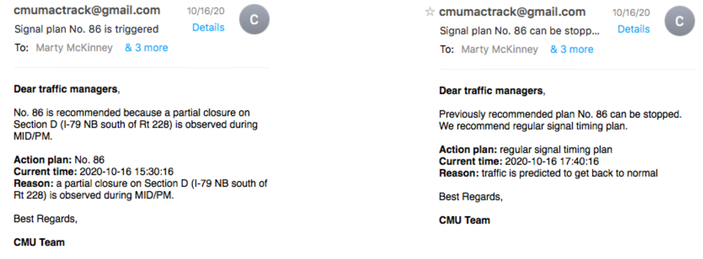



Figure: Traffic anomaly alerts and recommended plans sent to traffic managers by email.

## Philadelphia Region Real-Time Traffic Management

### Project Description

- We develop a physics-informed real-time traffic prediction framework which triggers non-recurrent traffic prediction for next one hour;

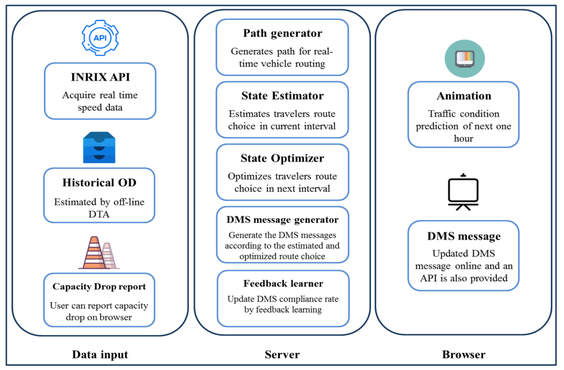



Figure: Physics-informed traffic prediction and DMS optimization.

- Dynamic Message Sign (DMS) is optimized in real-time using model-predictive control (MPC) scheme.

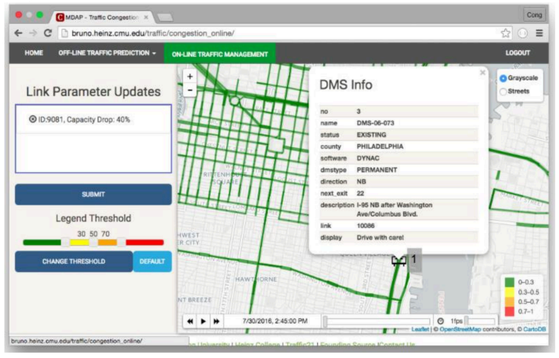



Figure: Web application for visualizing optimized DMS information.

## Discussion

Integrating machine learning and physics-based computational models provides a natural way for optimally **fusing multi-source traffic sensing data** collected on traffic network, **efficiently recovering the underlying process** and using it to achieve proactive management under **non-recurrent traffic conditions**. Fusing machine learning into computational model is needed for high-consequence applications across science and engineering, where machine learning approaches based on data alone are insufficient.

## Acknowledgements

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