DATA-DRIVEN PREDICTION OF REGIONAL INCIDENTS AND FLOODING FOR TSMO

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IN THIS CASE STUDY YOU WILL LEARN:

1. How historical data can be used to predict weather and incident management.
2. How artificial intelligence (AI) neural network modeling can help traffic management systems predict when high risk events will occur.
3. How data from AI predictions can help emergency management plan and provide sufficient staff for traffic and weather events.

BACKGROUND

The Michigan Department of Transportation’s (MDOT) Southeast Michigan Transportation Operations Center (SEMTOC) serves as a center of incident and mobility management for the state-owned roadways in the Metro Detroit region, in coordination with first responders including the Michigan State Police (MSP), local police departments, fire departments, and towing companies. With three work shifts a day and 24/7 operations, it has been a critical tool for SEMTOC and first responder agencies to respond to incident and congestion events in a timely manner. It has been especially useful ahead of special events, such as sports, parades, and incremental weather events. A few minutes of improvement in response time could save a life or reduce delay significantly. SEMTOC is also a central hub for collecting, analyzing, and disseminating valuable traveler information, and maintains multiple databases for internal and external data. To advance Transportation Systems Management and Operations (TSMO) innovation for MDOT, and enhance the data-driven operations capability, SEMTOC is piloting an advanced incident and flooding prediction tool using different internal and external data sources and advanced statistical models.

TSMO PLANNING, STRATEGIES, AND DEPLOYMENT

The prediction tool, developed by AECOM, provides an estimate of future incidents and high-impact events handled by SEMTOC, by shift and per day for the prediction period. A second functionality of the tool is to forecast hourly probabilities of flooding on the state’s trunkline highways in the metro region for the same period of time. Note that an incident is defined here as any event that impacts or has the potential to impact traffic flow. In addition, high impact incidents refer to any incident that causes more than 50 percent of...
lane closures and significant delay of traffic on highways. In this tool, incident prediction is performed based on the development and utilization of a neural network (NN) model, which is a self-learning algorithm that captures and represents complex input/output relationships by mimicking the human brain in performing a particular task or function of interest. Historical weather and incident information was used to train and test the NN model. More than seven years of historical weather-related data from January 2011 to April 2018 were gradually obtained from Meteorological Terminal Air Reports (METAR) at the Coleman A. Young Municipal Airport in Detroit as the training data set. This weather station is located within Detroit's city limits to provide a base estimation of the Metro Detroit region's weather. The historical occurrence of incidents for the same time frame as the weather data was utilized within the model development. The historic incident and high-impact data are obtained from two of MDOT’s in-house incident database systems maintained at SEMTOC, Advanced Traffic Management System (ATMS) and the Call Tracking system. The prediction of flooding probabilities is a separate module in the prediction tool, which is based on the development of a Logit model, and uses historic flooding data and weather forecast data to estimate the probabilities of flooding on freeways in the Metro Detroit region. Weather forecast data, obtained from a meteorological website (www.intellicast.com), is applied to the model, to create a prediction for the future timeframe, which includes the total number of incidents and high-impact incidents for each shift/day, and hourly flooding probabilities, for the next ten days including the current day.

COMMUNICATIONS PLANNING AND EXECUTION

The compiled program user interface of the tool includes an incident prediction module, flooding prediction module, and historic data plots module. Incident prediction is broken down into the three work shifts (morning, afternoon and night), and the daily total number of incidents is also plotted. Historic average number of incidents and high impacts are plotted as a benchmark. The flooding prediction showed 100% of flooding probability in the evening of September 11, 2019, which has been verified by the historic flooding events during that evening. Prediction reports are generated with the tool on a daily basis, and shared with the stakeholders, including MDOT, first responders, and local transportation operations centers (TOCs). Then, staffing and resources are better planned prior to any predicted events. This proactive staffing is of high importance to incident management, especially during severe weather events, such as heavy rain and snowstorms in Michigan.

OUTCOMES, LEARNINGS AND PUBLIC BENEFITS

Since 2017, the AECOM control room management team has built the predictive analysis into one of the routine tasks at SEMTOC, and applied the prediction tool to generate incident and flooding prediction reports for situational awareness, and evaluate and adjust their planned staffing resources against predicted incident levels on a daily basis. The evaluations allow the management team to increase staffing levels in advance of periods for which increased incident activities are predicted, while also proactively supporting MDOT in preparing SEMTCO systems, devices and first responding partners. The historic results show that the prediction tool is a promising tool for the prediction of incidents and flooding events in the Metro Detroit region, with an accuracy rate ranging from 70 to 90 percent. In some instances, the accuracy rate has exceeded 90 percent. Ongoing post-analysis comparisons between incident predictions to actual outcomes indicate that the prediction accuracy is improving over time, as the model is updated with more recent historic data. Currently, the SEMTOC project team is working on extending the prediction from the general metro region to specific areas or corridors of the state highway network, which will end up with a heat map for future traffic conditions in the region. To sum up, the prediction tool at SEMTOC can

1. Provide short-term forecast of incident and flooding conditions in the region,
2. Improve the operator staffing at SEMTOC and other TOCs, and staff and resource planning for state police, local police departments, fire departments, and towing companies,
3. Facilitate decision making for TSMO and
4. Support quicker and more proactive responses of emergency agencies to incidents, and potential mitigation or avoidance of incident impacts or secondary incidents.

FURTHER INFORMATION

Program Website:  
https://www.michigan.gov/mdot/0,4616,7-151-9621_84998---,00.html
Michigan DOT TSMO Implementation and Strategic Plan  
Tech Paper on Prediction System  
White paper Summary - Data-Driven Prediction of Regional Incidents and Flooding  
NOCe Knowledge Center: https://transportationops.org/knowledge-center