CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-7034: Exploring the Use of Artificial Intelligence to Leverage TxDOT Data for Enhanced Corridor Management and Operations

Background

With the availability of richer, vast streams of data from Intelligent Transportation Systems (ITS), smart vehicles, connected infrastructure sensors, mobile phones, and more, the expected impacts on the ability to better manage roadways are considerable.

Given the volume and heterogeneity of currently available transportation data, traditional data analysis tools are often not sufficient to realize its potential. Artificial Intelligence (AI) and machine learning (ML) can drastically increase the ability of agencies to derive value from collected data. From uncovering patterns in the system conditions that may lead to designing better operational strategies to supporting enhanced decision making in complex situations, AI techniques may transform existing practices. Selecting and implementing an AI approach for a specific use case requires careful consideration and a good understanding of the assumptions and limitations of different techniques. It is also important to understand how and if AI can complement or replace modeling and analysis methods currently used in the transportation industry.

What the Researchers Did

This project explored the use and value of AI and ML in transportation taking a multi-pronged approach that includes a literature review, a workshop, a survey, the development of three prototype ML models for four high-priority use cases, and the field testing of one of the prototyped models. Initial tasks were exploratory in nature and led to a better understanding of the current and prospective uses of ML in transportation, corresponding data needs, and specific use cases of interest to TxDOT.

The literature review provided a background on artificial intelligence techniques and tools, and explored a range of transportation applications in system and service planning, operations, asset management, public safety and enforcement, communications, and business administration. Prototype model development was used to assess the value, challenges, and limitations of implementing several types of ML models to support the use cases prioritized by TxDOT. The prototypes leveraged emerging and traditional data sources: Wejo event data was used along CRIS data to build supervised and unsupervised learning models for understanding safety hot-spots and evaluating the effects of the pandemic on safety and traffic patterns; a microsimulation environment was used to explore the feasibility of adjusting traffic signal timing plans in a. real-time frontage road environment using reinforcement learning models; probe-based speeds from INRIX were combined with traffic volume data from TxDOT's ITS to generate short-term travel-time predictions on I-35, which could lead to more accurate driver information.

Short-term travel-time prediction models were

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Project Completed:
10/31/2023

selected for field testing given the promising results found during the prototyping and the maturity and widespread availability of the involved data sources

Field testing included the training of additional models in Austin and El Paso, and the development of a framework to expedite model training, testing, and evaluation, and to support real-time deployment. Real-time predictions were shared with TxDOT through a web-based application that also facilitated model evaluation.

What They Found

Prototype models that studied the impacts of the Pandemic on safety and traffic patterns suggest that connected vehicle data may be used to gain insights into changes in travel behavior. Researchers observed lower traffic volumes and higher instances of speeding after stay-at-home orders were issued, with speeding events increasing throughout the study area and most drastically near downtown. Data analyses also suggest that the highest percentage reduction in the number of trips occurred at locations with higher service sector and education opportunities.

Prototype experiments to use reinforcement learning (RL) to adjust traffic signal timing plans in real time suggest that it is possible to train models that respond in near-real time to anomalies and variations in roadway conditions, and which generate timing plans that are as efficient as those created using traditional approaches but also more equitable across roadways.

Prototype models to provide more accurate travel time information and corresponding field-testing experiments suggest that machine learning techniques can integrate speed and traffic volume data to produce more accurate travel time predictions in real-time, which may be most helpful for travelers deciding between alternative routes. The benefit of machine learning techniques over simpler approaches used in practice may depend on the characteristics of the corridors being analyzed and the availability of sufficient traffic volume data.

What This Means

Artificial intelligence and machine learning have the potential to support transportation planners and operators in their understanding and management of freeway corridors. The tools provided by AI may allow agencies to leverage emerging data sources more systematically and apply them to the solution of high-priority use cases. Our interviews with TxDOT data users suggest that TxDOT should expand upon its efforts to formalize data standards, efforts to bring personnel together, and efforts to create contracts that enable innovation. Prototype models demonstrate the potential value of machine learning techniques. Some such techniques may be adequate to implement in-house, while others are complex and may be better when used through data providers or vendors. In either approach, it is important for TxDOT to have access to streamlined data workflows and data management protocols/ frameworks such as the ones prototyped in this effort to facilitate in-house data validation and testing across multiple sources.

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Keyword: Research