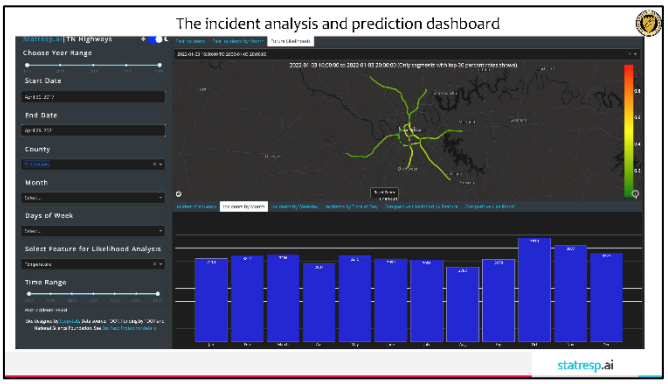
TDOT Department of Transportation

Research Summary

Collaborative Research Project to Coordinate the Data from the CRASH Predictive Analytics Program Between TDOT and TDOSHS



Project Number:
RES 2019-02

TDOT Lead Staff:
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Principal Investigator(s):
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Vanderbilt University

Project Term:
December 2018 to July 2021

WHAT WAS THE RESEARCH NEED?

Emergency response to incidents like road accidents is a major concern for first responders. Standard approaches to predict road accidents rarely scale to large geographic areas due to extremely high sparsity in data and difficulties in gathering data. Furthermore, accidents are influenced by several risk factors that must be considered in predictive models. To improve TDOT's Emergency Response Management (ERM) practices, the agency partnered with researchers from Vanderbilt University to better forecast road accidents on the interstate network.

WHAT WERE THE RESEARCH OBJECTIVES?

The main objective of this study was to improve the current CRASH Predictive Analytics application for highway safety patrol vehicles deployment. To work towards this goal, objectives of this research were to:

1) identify the best practices for data storage, integration, and maintenance infrastructure for predictive modeling,
2) develop state-of-the-art machine learning algorithms for predicting the risk of highway incidents, and
3) collaborate with TDOT and Tennessee Highway Patrol to identify best practices for model integration with existing programs.

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WHAT WAS THE RESEARCH APPROACH?

A spatio-temporal machine learning pipeline was designed to address the problem. The pipeline used a combination of synthetic resampling, non-spatial clustering, and learning from data can efficiently forecast the spatial and temporal dynamics of accident occurrence, even under sparse conditions. To evaluate the design machine learning model, conventional performance metrics such as accuracy, precision, recall, F1 score, Spearman correlation and Pearson correlation were used. A simulation strategy was used to measure the response time of responders and the number of unattended accidents and used it to evaluate the accuracy of predictive models (accidents can be unattended when all resources, HELP trucks, are busy responding to other accidents). For this purpose, an allocation strategy was developed that modifies the well-known p-median problem to evaluate the performance of the models.

WHAT WERE THE FINDINGS?

Key findings include:

1. Conventional metrics such as correlation and accuracy might be misleading in such a sparse condition. F1-score that balances the precision and recall is a much better alternative and correlates with the response performance.
2. It was observed that the proposed forecasting pipeline resulted in significant savings in response times. To consider the uncertainty, more than 2000 simulations were run.
3. The simulation results showed up to 19% average improvement in response time when 20 HELP trucks were available.
4. Using the prediction pipeline and proactive ERM, responders can be placed closer to the accident-prone zones.
5. The allocation approach improves resource allocation in general, which was observed across the spectrum of forecasting models used and the number of available responders.

IMPLEMENTATION AT TDOT

The research team developed a novel pipeline to forecast road accidents in the state of Tennessee on the interstate network for TDOT to implement to improve ERM practices. The developed pipeline is efficacious, applicable in practice, and open source: https://tn.statresp.ai/. Even though the proposed approach showed promising results, the prediction can be improved by collecting more accident data or utilizing transfer learning techniques to reduce the detrimental influence of insufficient data, incorporating spatial correlation by using graph theory for more accurate analysis, and leveraging crowd-sourced data platforms (such as Waze) to improve the results.

MORE INFORMATION

Find the final report here: https://www.tn.gov/content/dam/tn/tdot/long-range-planning/research/final-reports/res2019-final-reports/RES2019-02_Final_Report_Approved.pdf.

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