

ARTIFICIAL INTELLIGENCE TECHNIQUES FOR MODELING DYNAMIC  
TRAFFIC BEHAVIOR AT BOTTLENECKS

Yi Hou

Dr. Carlos Sun and Dr. Praveen Edara, Dissertation Supervisor

ABSTRACT

This dissertation applies artificial intelligence (AI) techniques to enhance the models of travel demand and traffic behavior at bottlenecks including natural lane reduction and work zone closure. AI models for accurately forecasting travel demand at work zone bottlenecks in urban areas were developed. Driving behavior models of lane changing at natural lane drops at freeway interchanges were proposed. Real-world datasets were used to develop and test the AI models.

The lane-changing models took into account factors such as gap acceptance in the target lane, vehicle speeds in the target lane, and distance to the end of the merge lane. Bayes classifier, classification tree, genetic fuzzy system, random forest, and AdaBoost were used to model the impact of these factors on driver lane-changing behavior. The models were built using traffic data collected by the Federal Highway Administration (FHWA) on a segment of southbound US Highway 101 in Los Angeles, California. To assess the quality of the models, they were tested on traffic data on Interstate 80 in San Francisco, California. The empirical results demonstrated superior performance of AI models over the conventional binary logit model. Random forest and AdaBoost yielded the highest prediction accuracies of 88.3% and 88.9%. The results also demonstrate that ensemble learning methods, such as random forest and Adaboost, produced even higher prediction accuracy than single classifiers.

Traffic forecast models are classified into two types based on the forecast horizon: daily, and short-term. None of numerous existing traffic flow forecasting models focus on work zone bottlenecks. Work zone bottlenecks create conditions that are different from both normal operating conditions and incident conditions. Four models were developed for forecasting traffic flow for planned work zone events. Both daily and short-term traffic flow forecasting applications were investigated. Daily forecast involves forecasting 24 hours in advance using historical traffic data, and short-term forecasts involves forecasting 1 hour, 45 minutes, 30 minutes, and 15 minutes in advance using real-time temporal and spatial traffic data. Models were evaluated using data from work zone events on two types of roadways - a freeway, I-270, and a signalized arterial, MO-141, in St. Louis, Missouri. The results showed that the random forest model yielded the most accurate daily and short-term work zone traffic flow forecasts. For freeway data, the most influential variables were the latest interval's look-back traffic flows at the upstream, downstream and current locations. For arterial data, the most influential variables were the traffic flows from the three look-back intervals at the current location only.