

Big Data Analysis and Machine Learning Practices for Assessing Road Diet Influences on Traffic Operation and Efficiency Using High-Resolution GPS Trajectory Data

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Abstract

Big data analytics and advanced machine learning techniques are leveraged in this research to establish a robust data-driven framework, aiming to quantitatively evaluate the effects of roadway speed management strategies, such as Road Diet, on traffic patterns and transportation efficiency, and further bridge intelligent machine learning algorithms with sustainable and robust roadway design. Machine learning-based feature selection algorithms, including Information Gain, Gain Ratio, Gini Index, and Entropy Analysis, are applied to mine effective predictive features. Meanwhile, Naive Bayes Classifier and rule-based machine learning classification methods are used to provide solid probabilistic support for traffic operation and efficiency pattern identification, which substantially improved prediction reliability through multi-model fusion. Field studies are carried out on a 6.79-km Houston roadway corridor using a 10 Hz GPS logger to obtain more than 500,000 high-resolution field data records, and the MOVES3 model is adopted to measure energy, sustainability, and efficiency-related performance indexes. Results verify that the Road Diet strategies could effectively reduce speed fluctuation and enhance transportation efficiencies, while big data-based feature selection algorithms can accurately capture key influencing factors. Such an integrated machine learning analytical approach provides credible technical guidance for intelligent transportation system design and optimization.