COLORADO
Department of Transportation
Division of Transportation Development

Research Brief
Applied Research and Innovation Branch

Study Title
Data-Driven Bridge Management Using Descriptive and Predictive Machine Learning Models

Brief Type
Final

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August 2020 – July 2022

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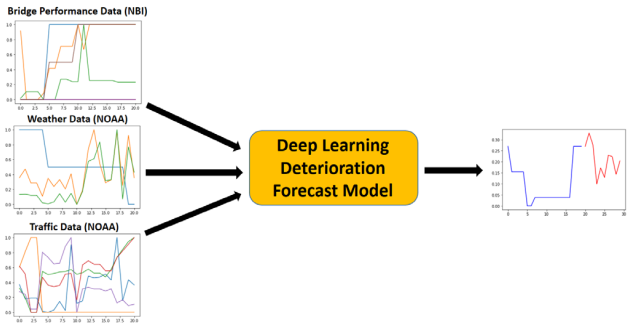
Managing Bridges with Artificial Intelligence Modeling

Study Objectives
Develop machine learning models for descriptive analysis of bridges by (1) objectively categorizing their quality and deterioration performance (2) finding hidden links between performance and structural properties (3) identifying features and characteristic behavioral and performance trends in each category.

Develop machine learning models for predictive analysis of bridges by accurate prediction of quantitative descriptors for deterioration state (e.g., condition ratings) as well as anomalies in the deterioration pattern of the bridge structure.

Background
Since the 1970's, several U.S. Acts have mandated all local and state transportation agencies across the nation to perform regular inspections of the bridges (and culverts) in their jurisdiction. These have generated valuable historical databases of bridge performance data which have remained considerably underutilized.

Methods
Developed advanced data-driven artificial intelligence (AI) models (deep learning) that can leverage historical bridge (and culvert) performance data, weather, and traffic data, to enable (1) accurate bridge deterioration forecasting (i.e., predictive analytics), and (2) effective bridge family generation or bridge subtyping (i.e., descriptive analytics).



Results
Using extensive experimental evaluation using multi-modal real datasets for all bridges in Colorado, we demonstrated that our proposed models significantly outperform existing models for both description and analysis.

Research Benefits
Creating a software tool that uses best models to facilitate effective bridge management for CDOT engineers. Improves on existing bridge management tools such as BrM (the AASHTO sponsored Bridge Management software), by making deterioration predictions using historical data like producing weather forecasts.

Recommendations for Implementation (or Next Steps)
Given the success of the proposed models, we plan to extend and enhance them to develop an end-to-end bridge management tool.