Editorial

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Bridge Components Condition Rating Prediction Using Decision Tree Model

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Bridges are essential transportation infrastructures built to provide connections between physical obstacles. In the United States, a highway bridge consists of three major parts: deck, superstructure, and substructure. Their inspection and condition rating is heavily relied on visual inspection. Because of limited funding, a well-performed prediction model on bridge components condition can help to reduce labor cost, and assist decision makers with making better decisions regarding bridge preservation, rehabilitation and replacement decisions.

Generalized Linear Models (GLMs) are popular and favored by researchers because of the robust theoretical foundation and strong capability to establish and explain the relationship quantitatively between bridge condition and its explanatory factors. However, because the GLMs are relied on four main assumptions: assumed consistent linear relationship, constant variance for the residuals , no or little multicollinearity, and little or no autocorrelation in the data, the GLMs result in unfavorable prediction results and numerous errors when the assumptions are violated. The National Bridge Inventory (NBI) database is compiled by the Federal Highway Administration for all the bridges in the United States [1]. It rates the bridge condition with a standard scale from 0 to 9 where 9 represents an as new condition [2]. In addition, state agencies monitor the percentage of bridges with poor conditions (condition rating no greater than 4) [1]. Thus, when facing such an unbalanced distributed dataset, GLMs could underestimate the bridges with poor conditions because of the limited number of observations. Moreover, observations with missing value have to be deleted in a GLM or imputed with mean, median, or a specific value. When there is a high percentage of missing values, GLMs can result in bias once the missing values are not handled properly.

Decision tree is a data mining approach, and its powerful explanatory and predicting ability has been proved in many fields. The decision tree model partitions a dataset based on selected criteria (splitters) until the data in each category is considered as homogeneous. Different from GLMs, decision tree models are not limited with predefined assumptions. In addition, it handles missing values in certain variable by substituting them with another variable that can mimic the variable in a most way, which avoids deciding an arguable value to replace missing values [3].

This study examines the relationship between condition ratings of three main bridge components and 45 explanatory variables in NBI database. Based on the decision tree model, it is found that the decision tree model provides better prediction accuracy on the condition rating of deck, superstructure, and substructure than traditional GLMs, especially for the bridges with condition rating no greater than 4. Condition rating of deck, superstructure, and substructure has great effect on each other's condition ratings [4]. In addition, it is demonstrated that deck condition is related with deck structure type, bridge age, bridge roadway width, and base highway network. Superstructure condition is affected by roadway improvement cost, road width, and inspection frequency. Substructure condition is contributed by roadway impair cost, and deck width.

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