Improving Multi-Stop Truckload Pricing using Random Forest Regression

Garrett Clark, Chase Cottrell, Nicholas Jaco, Madeline Suellentrop, Jaclyn Walls

University of Arkansas College of Engineering Industrial Engineering

J.B. Hunt Integrated Capacity Solutions

J.B. Hunt Multi-Stop Routes

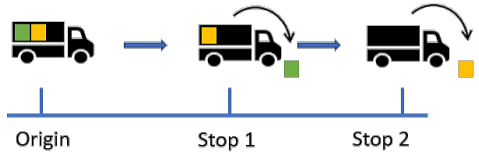
J.B. Hunt Transport Services, Inc. is a Fortune 400 company in Lowell, Arkansas that provides transportation and logistics solutions using trucks and trains to move freight across North America. Within J.B. Hunt, Integrated Capacity Solutions, (ICS) conducts third-party logistics, by pairing non-contract customers with third-party carriers.

Intermodal

Truckloads

ICS plans multi-stop truckload routes for their customers. Multi-stop truckloads combine Less-Than-Truckload customer orders with a single origin and multiple destinations. These truckload routes require only one driver and one truck, reducing labor costs and delivery time.

Multi-Stop Truckloads

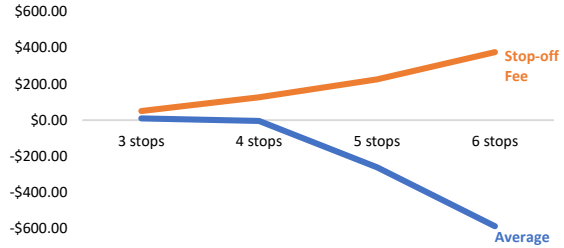


Error in Multi-Stop Cost Predictions

J.B. Hunt's multi-stop cost predictions have a Mean Absolute Percent Error (MAPE) of 20.1%. Our evaluation of the current system revealed error in the rate per mile (RPM) used in the predictions. If J.B. Hunt were to switch and use a Transcore Rate instead of a Market Rate than they could decrease to 14.2%.

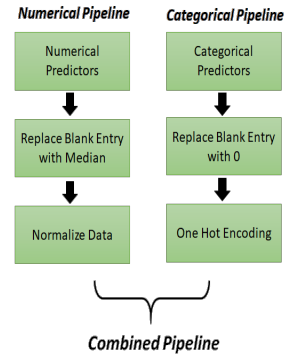
RPM using Market Rate =	20.1%
− RPM using Transcore Rate =	14.2%
Difference in MAPE	+ 5.9%

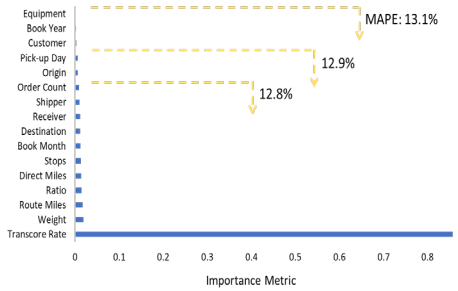
For every multi-stop route, J.B. Hunt adds a stop-off fee that increases with the total number of stops. We found that as the number of stops on a route increases, the error in ETP predictions also increases, thus adding a fee for more stops increases the tendency to overpredict.



Model Implementation

We created our random forest regression model in the programming language Python. We used data pipelines to chain together multiple estimators and automate the machine learning process. Within these pipelines, we were able to fill null values and use one hot encoding to assign integer values to string characters.





We then performed feature engineering to score the importance of our predictors, and we found the largest decrease in error using the 11 most important predictors. By improving our code with these steps, we were able to reduce the MAPE to 12.5%.

Outdated ETP Software

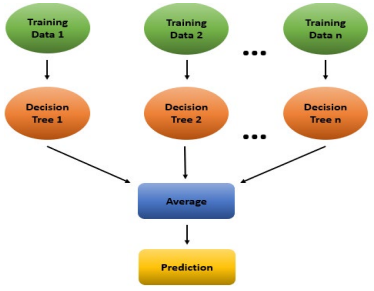
J.B. Hunt asked us to update their cost prediction process for multi-stop routes. Currently, they use their own software, ETP, to predict these costs, and this process has not been evaluated in approximately 10 years. The equation used for multi-stop routes in ETP is simple:

$$\hat{c} = (r * m + s) * p$$

$\hat{c}$ = estimated cost of multi-stop shipments
r = freight market rate per mile to the final destination
m = total miles along the route
s = assigned fee based on the number of stops on the route
p = J.B. Hunt profit margin

Random Forest Regression Approach

Our approach to multi-stop cost prediction included building a random forest model, a collection of decision trees used for both classification and regression in machine learning. Random forest uses a parallel tree-growing approach and has the necessary ability to handle large datasets.



Impact Analysis

Improved estimation precision will lead to higher customer satisfaction resulting in revenue retention and growth for J.B. Hunt's multi-stop truckload business line.