PURDUE UNIVERSITY | School of Industrial Engineering

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MPG Optimization
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TEAM 20

Client Background

- Founded in 1965
- PepsiCo is a multi-billion-dollar company with 500+ different brands within the company portfolio.
- Primary business function is to Make, Move, and Sell Products

Transportation

- One of the largest privately owned fleets in North America.
- Various assets used to move food and beverage products

Straight Trucks | OTR/Transport Tractors | Delivery Tractors | Service/Support Vehicles | Trailers | Delivery Vans | Yard Tractors | Company Cars | Material Handling

Sustainability

PepsiCo Positive (Pep+) is PepsiCo's sustainability initiative to reduce emissions by 75% by 2030 and 100% by 2040.

pep+ pepsico positive planet + people

Problem Statement

PepsiCo engineers are looking for a model to aid their transportation fleet decisions which are currently based on data trends and expert opinions.

System Model

PepsiCo Fleet Engineers have an annual budget to spend across all company fleets. They currently use knowledge of industry trends as well as fleet performance reports to guide their purchasing and retiring decisions for each asset.

Project Scope

The team set out to create a quantitative model which will provide insights on variable importance as it relates to maximizing asset MPG.

This analysis focuses on:
- Middle Mile Trips (300-750 mile)
- Tractor Trailers and Straight Trucks
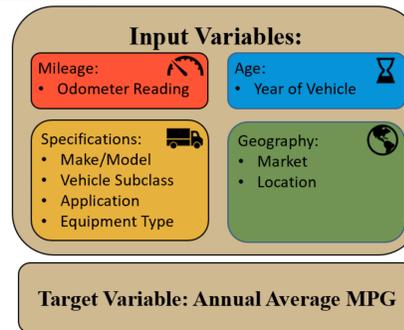- 2021 Beverage Fleet Data

Methodology

Random Forest Regression Model:
- Meant for large data sets
- Numerous input variables
- Multiple iterations of decision tree (prevents overfitting)

Variable Selection:

Input Variables:

Mileage:
- Odometer Reading

Age:
- Year of Vehicle

Specifications:
- Make/Model
- Vehicle Subclass
- Application
- Equipment Type

Geography:
- Market
- Location

Target Variable: Annual Average MPG

Data Manipulation/Preparation:
- Converted all data to yearly averages
- Normalized & One-Hot Encoded

Assumptions:
- 2021 Data is reflective of entire fleet history
- Model Variable Importance is reflective of mental model for team in decision making process
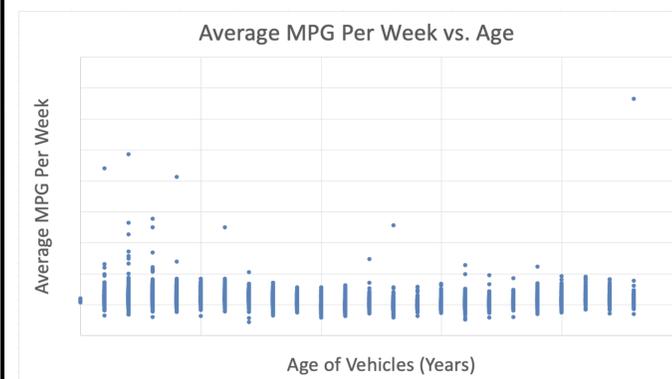
Variable Selection → Data Manipulation → Random Forest → Variable Importance

Results

Mean Absolute Error: 0.42 MPG
Accuracy (MAPE): 92.9%

MPG Model: Variable Importance %
- Age 31.9%
- Mileage 19.4%
- Geography 9.7%
- Specifications 38.9%
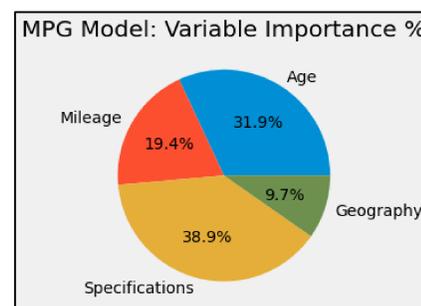
Discussion

Asset Depreciation (Age & Mileage):

Average MPG Per Week vs. Age
(y-axis: Average MPG Per Week; x-axis: Age of Vehicles (Years))
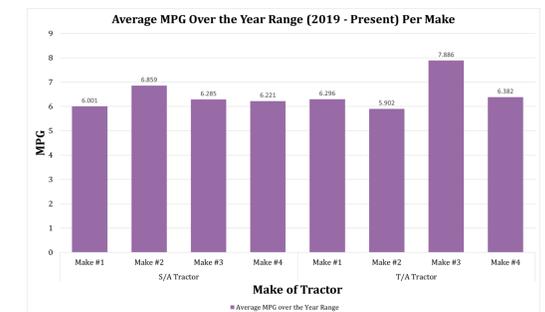
The average MPG as vehicles age does not indicate a clear age for retiring vehicles based on MPG efficiency alone. The same was found with make/ model as vehicles age.

Mileage vs Efficiency
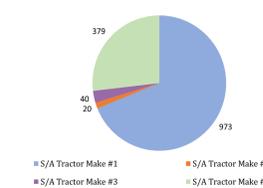(y-axis: Efficiency (MPG); x-axis: Odometer Reading (Miles); Range 1–Range 9)
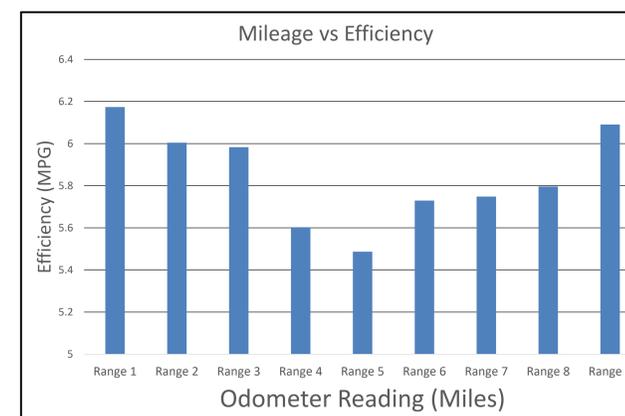
When comparing mileage and efficiency, the data shows a consistent downward trend over the first 5 mileage ranges, which alludes to the trend that a truck's efficiency decreases with continued use. After the fifth range, we start to see that efficiency trend upward again, we think this may be due to shifting older assets towards easier routes, which helps maintain efficiency goals later in an asset's useful life.
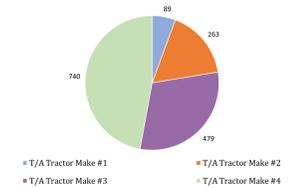
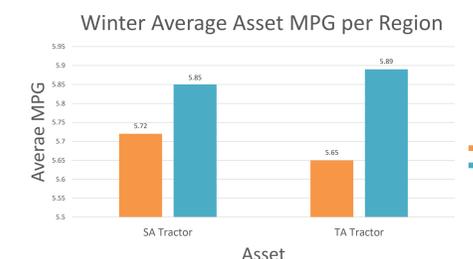## Discussion Cont.

Asset Specifications:

Average MPG Over the Year Range (2019 - Present) Per Make
(bars: Make #1 6.001, Make #2 6.459, Make #3 6.285, Make #4 6.221 [S/A Tractor]; Make #1 6.296, Make #2 5.902, Make #3 7.886, Make #4 6.382 [T/A Tractor])
x-axis: Make of Tractor; y-axis: MPG

Quantity of S/A Tractors Bought in the year range (2019 - Present)
(379, 40, 20, 973)
- S/A Tractor Make #1
- S/A Tractor Make #2
- S/A Tractor Make #3
- S/A Tractor Make #4

Quantity of T/A Tractors Bought in the year range (2019 - Present)
(89, 263, 740, 479)
- T/A Tractor Make #1
- T/A Tractor Make #2
- T/A Tractor Make #3
- T/A Tractor Make #4

Asset Geography:

Winter Average Asset MPG per Region
(SA Tractor: North 5.72, South 5.85; TA Tractor: North 5.65, South 5.89)
x-axis: Asset; y-axis: Average MPG
- North
- South

Based on the above plots, tandem axle tractors experience a larger impact due to the climatic conditions than single axle tractors. Therefore, allocating mostly single axle tractors to northern regions during the winter could lead to reductions in cost and emissions.

Future Endeavors:

- Food Fleet Data
- More years of Data

Scan Here for Appendix/References