

ADVANCING SUSTAINABLE MOBILITY:

A Data Visualization Analysis of U.S. EPA Automotive Trends for Fuel Economy, CO₂ Emissions Reduction, and Cleaner Technologies in Alignment with SDGs 7 and 13

Members:
Inventado, Charles Fredric G.
Rodelas, John Vincent B.
Valles, James Vincent V.

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RATIONALE

PROBLEM

- **Transportation sector as one of the largest contributors of greenhouse gas emissions.**
 - Degrades the quality of air and catalysts of climate change.
- **Mobility or travelling through places is on demand today .**
 - Those heavily relying on traditional fossil fuels could face sustainability challenges in the future.



PURPOSE

- Use of data analysis and visualization techniques will help discover important trends and occurrences and discover long-term patterns in the dataset available regarding vehicle fuel and economy efficiency.

SDG ALIGNED GOALS



- Analyzing Carbon Dioxide (CO₂) Emissions and adoption of fuel-efficient and cleaner vehicle technologies.
- Promote sustainable consumption and to take urgent action on CO₂ emission reduction to combat climate change.



- Examining fuel economy and having better insight how vehicles advance toward clean and reliable energy.
- Better insight into how vehicles advance toward clean and reliable modern energy

STATEMENT OF THE PROBLEM

WHAT IS THE PROBLEM?

The persistent reliance of internal combustion engines, despite regulatory efforts, continues to drive CO₂ emissions, impede fuel economy improvements, and slow progress toward global climate and sustainability goals.



WHAT DO WE AIM TO SOLVE?

The aim is to gain deeper insights into historical trends, patterns, and barriers to accelerate the transition to sustainable and low-emission transportation and meet international climate commitments.

OBJECTIVES OF THE STUDY



EXPLORATION

Examine historical data of fuel economy, CO₂ emissions, and adoption of cleaner and fuel efficient vehicles.



VISUALIZATION

Form visualization to identify key patterns and factors that help or hinder the progress of SDG 7 and SDG 13.



ANALYSIS

Create feasible solutions from the analysis of the various visualizations and charts.



SOLUTIONS

Help make informed decisions for policymakers regarding CO₂ emissions and increase progress for cleaner vehicles.

DATASET



United States
Environmental Protection
Agency

United States Environmental Protection Agency (EPA) 2024 EPA Automotive Trends Report

Original Dataset Name:

A. Detailed Real-World Fuel Economy, CO₂ Emissions, and Vehicle Attribute and Technology Data

Dataset details

- **Total records**
 - 5500 vehicle records.
- **Time span**
 - 1975-2024
- **Data depth**
 - 56 indicators and 4 category.
- **Categorization**
 - Grouped by manufacturer, regulatory class, vehicle class, and model year.
- **Indicator themes**
 - Covers production, fuel efficiency, emissions, specs, drivetrain, and powertrain.
- **Availability**
 - Data is downloadable as a .CSV file.
- **Focus**
 - Solely focuses on vehicle characteristics, performance, efficiency, and emissions.

VARIABLES

VARIABLE NAME	VARIABLE TYPE	THEME
Manufacturer	Categorical Variables	Vehicle Origin & Brand
Regulatory Class	Categorical Variables	Vehicle Classification
Vehicle Type	Categorical Variables	Vehicle Classification
Real-World CO2 (g/mi)	EPA Indicator	Climate Action (SDG 13)
Real-World MPG	EPA Indicator	Clean Energy (SDG 7)
Horsepower (HP)	EPA Indicator	Vehicle Performance
CO2 emissions (per capita)	WDI Indicator	Climate Action (SDG 13)

METHODOLOGY

Significant columns to be used for the project

- Average CO2 Emissions per Mile (g/mi) : [Real-World CO2 (g/mi)]
- Average Vehicle Fuel Economy (MPG) : [Real-World MPG]
- Average Vehicle Weight (lbs) : [Weight (lbs)]
- Average Engine Horsepower (HP) : [Horsepower (HP)]
- Annual Change in Fleet Emissions (%) : [Real-World CO2 (g/mi) across diff. Model Year]
- Urban vs. Highway Emissions Disparity : [Real-World CO2_City (g/mi) and Real-World CO2_Hwy (g/mi)]

Other important columns for visualization:

- Manufacturer
- Model Year
- Regulatory Class and Vehicle Type
- Production (000)
- Powertrain Types
- Fuel Delivery Types
- Footprint Class

DATA PREPARATION

1.) Fix Data Formatting

- Renaming “Prelim. 2024” to “2024” on column “Model Year”

2.) Replace missing or null values

- Replace values of cells that are currently “-”
 - Replace these values with a simple imputation using the respective mean value of numerical data, and mode for categorical data of columns these missing or null values were located.

3.) Check for Duplicate Values

- Removing records that are detected as duplicates
 - Currently there were no recorded duplicates.

4.) Selection of Relevant columns for the Study

- The columns mentioned beforehand on World Development Indicators (WDI) to be used and other important columns for analysis and visualization

DATA PREPARATION

5.) Monitoring Outliers

- Using Box and Whisker Plot to check outliers

6.) Scale the values for standardization

- Scaling values using StandardScaler() where the indicator columns are standardized to have zero mean and a standard deviation of 1

7.) Proper column labels

- If any, rename columns that may be difficult to understand, especially those with technical terms.

EXPLORATORY DATA ANALYSIS

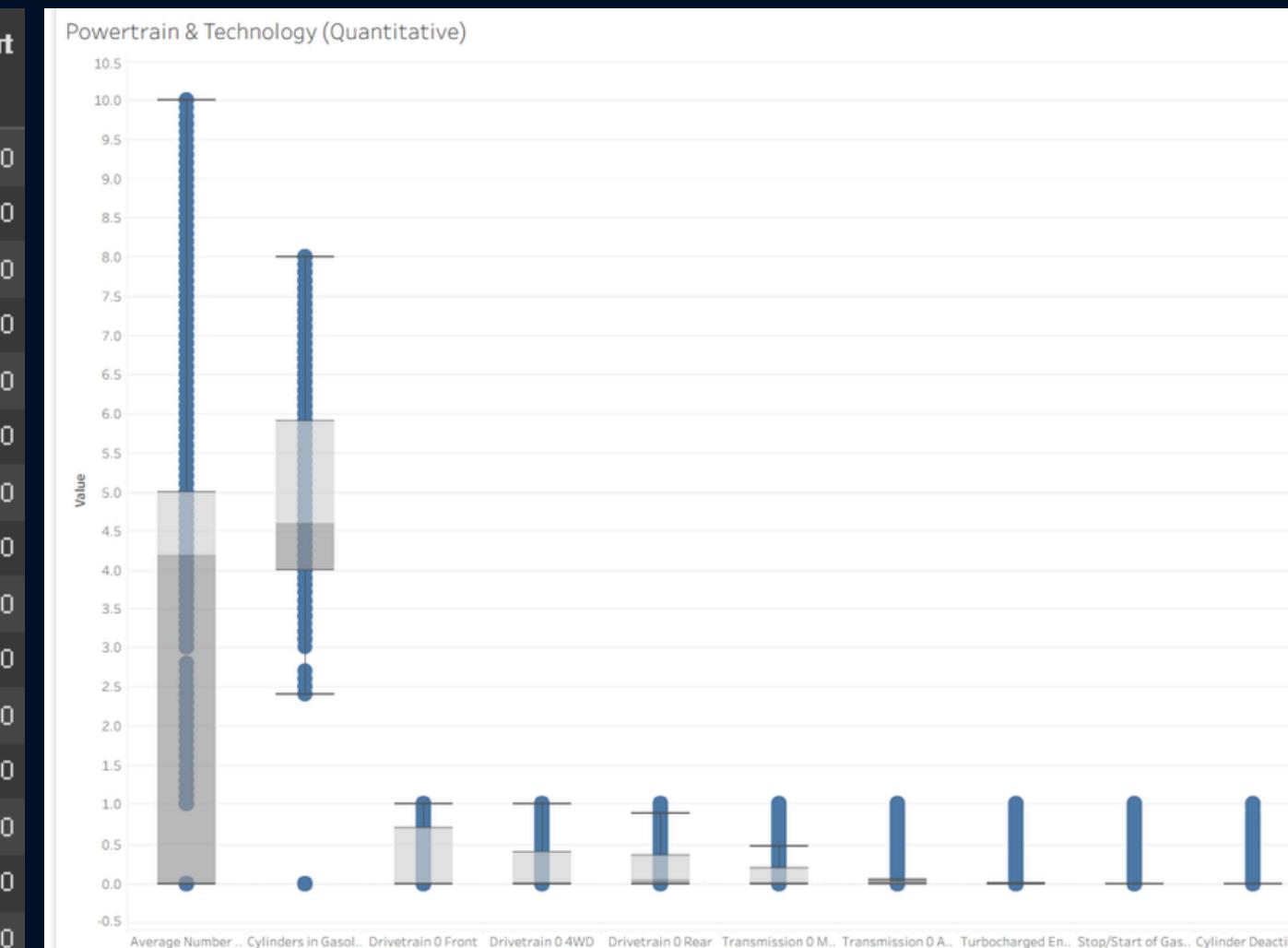
Horsepower (HP)_noNull	
count	5500.000000
mean	145.534697
std	99.689379
min	0.000000
25%	76.528850
50%	155.685450
75%	209.258150
max	566.456600

* SAMPLE STATISTICS AND NOT THE FINAL OUTPUT

DESCRIPTIVE STATISTICS

Explore significant statistical values and frequency counts

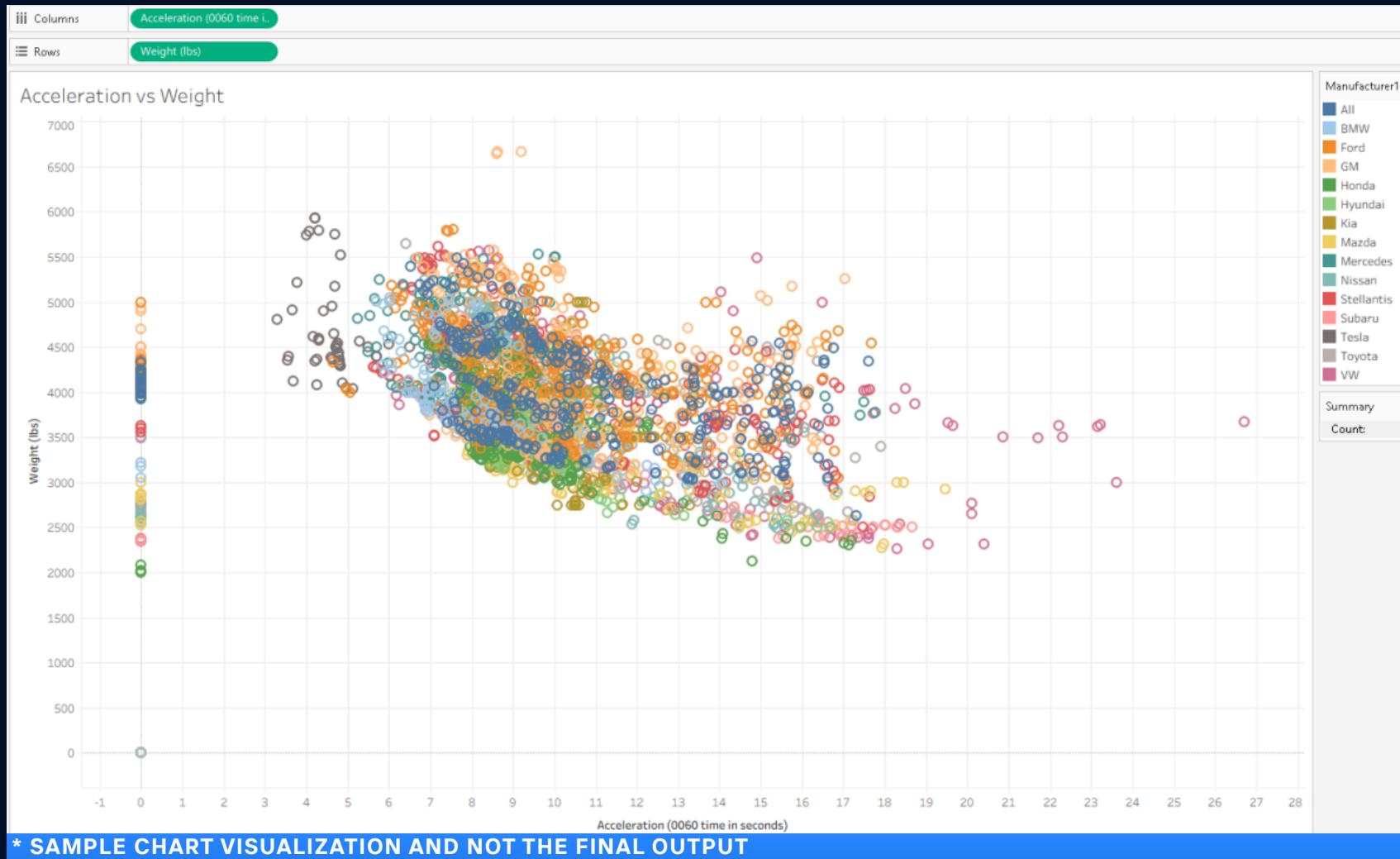
Manufacturer	count
All	400
Ford	400
GM	400
Stellantis	400
Honda	400
Mazda	400
VW	400
Toyota	400
Nissan	400
Kia	350
Mercedes	350
Subaru	300
BMW	300
Hyundai	300
Tesla	300



VISUALIZE OUTLIERS

Using Box and Whisker plot to check outliers

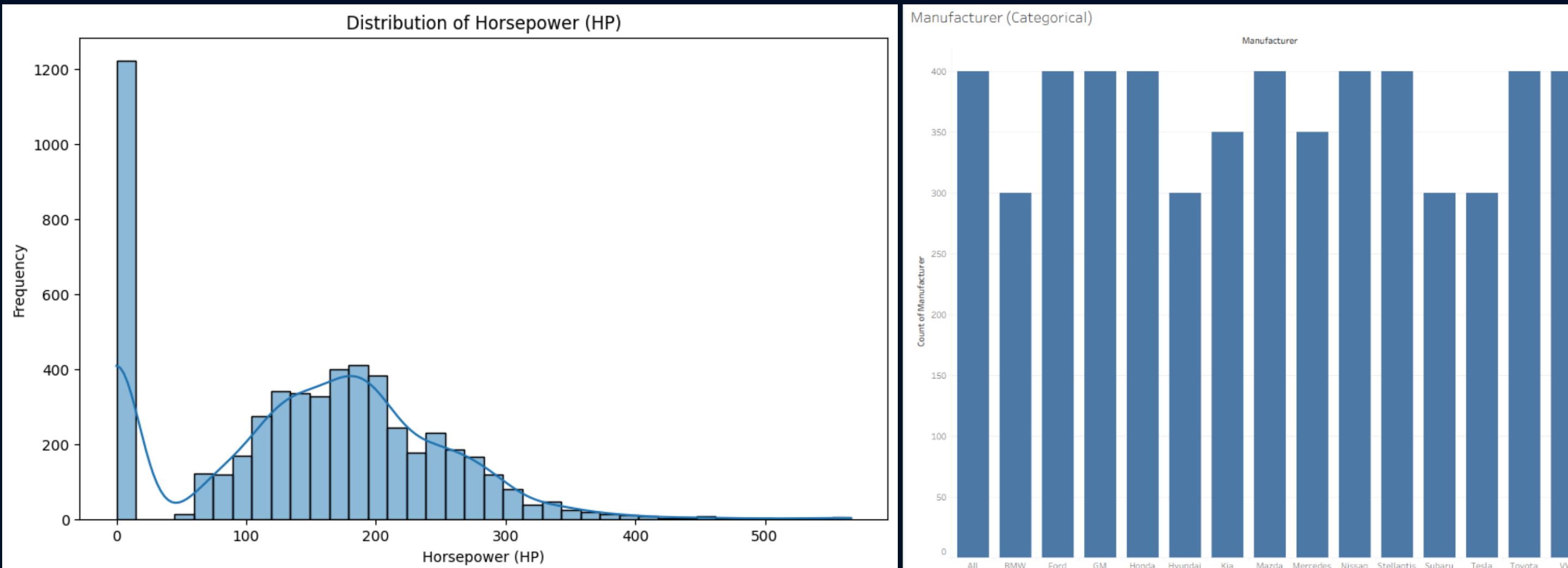
EXPLORATORY DATA ANALYSIS



CORRELATION OF COLUMNS

Using Scatter plot to
check relationship
between two variables.

EXPLORATORY DATA ANALYSIS

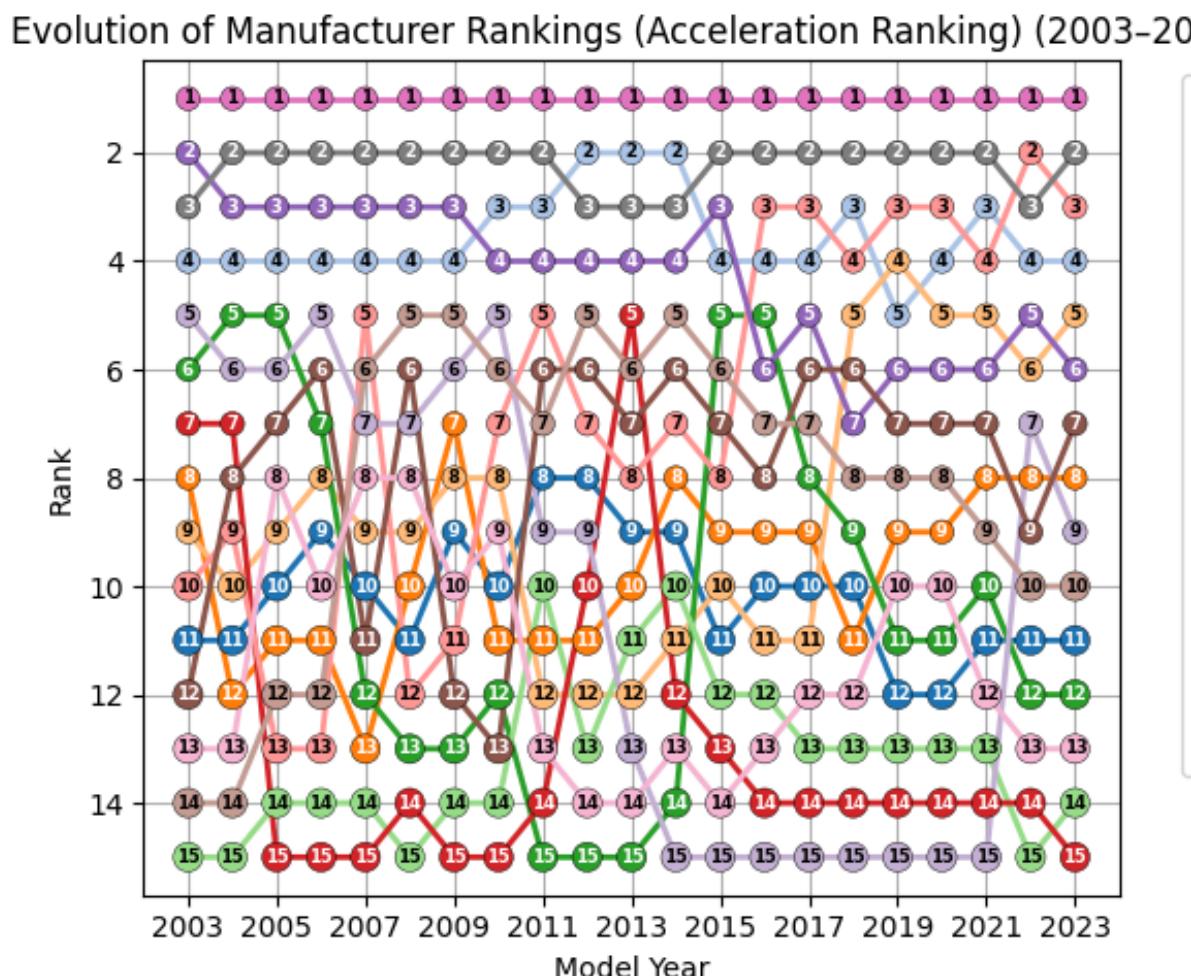


* SAMPLE CHART VISUALIZATION AND NOT THE FINAL OUTPUT

DISTRIBUTION ANALYSIS

Check the distribution of columns and visualize class frequency.

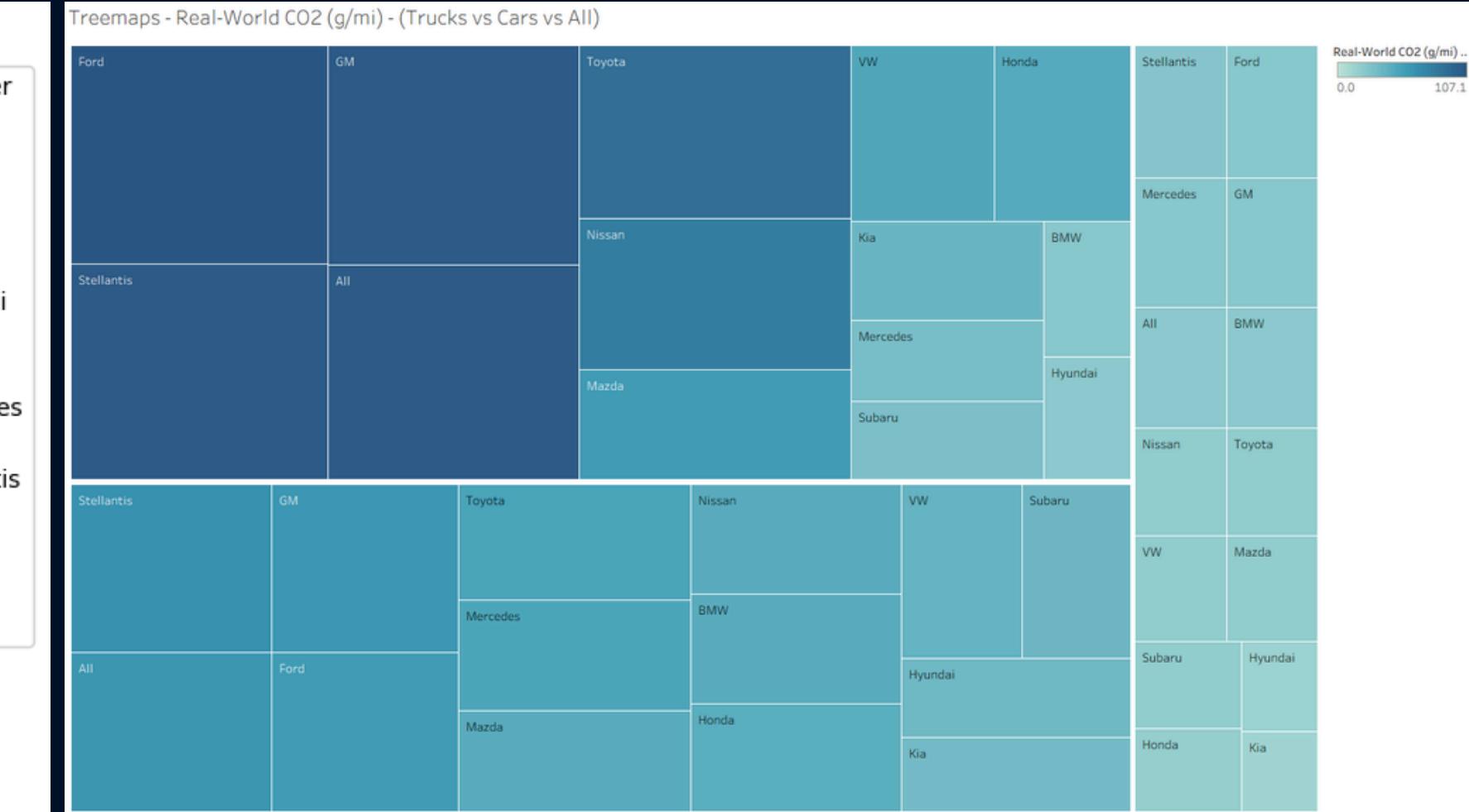
PLANNED VISUALIZATIONS



* SAMPLE CHART VISUALIZATION AND NOT THE FINAL OUTPUT

BUMP CHART

Assess how fuel economy rank of the vehicle types changed over time

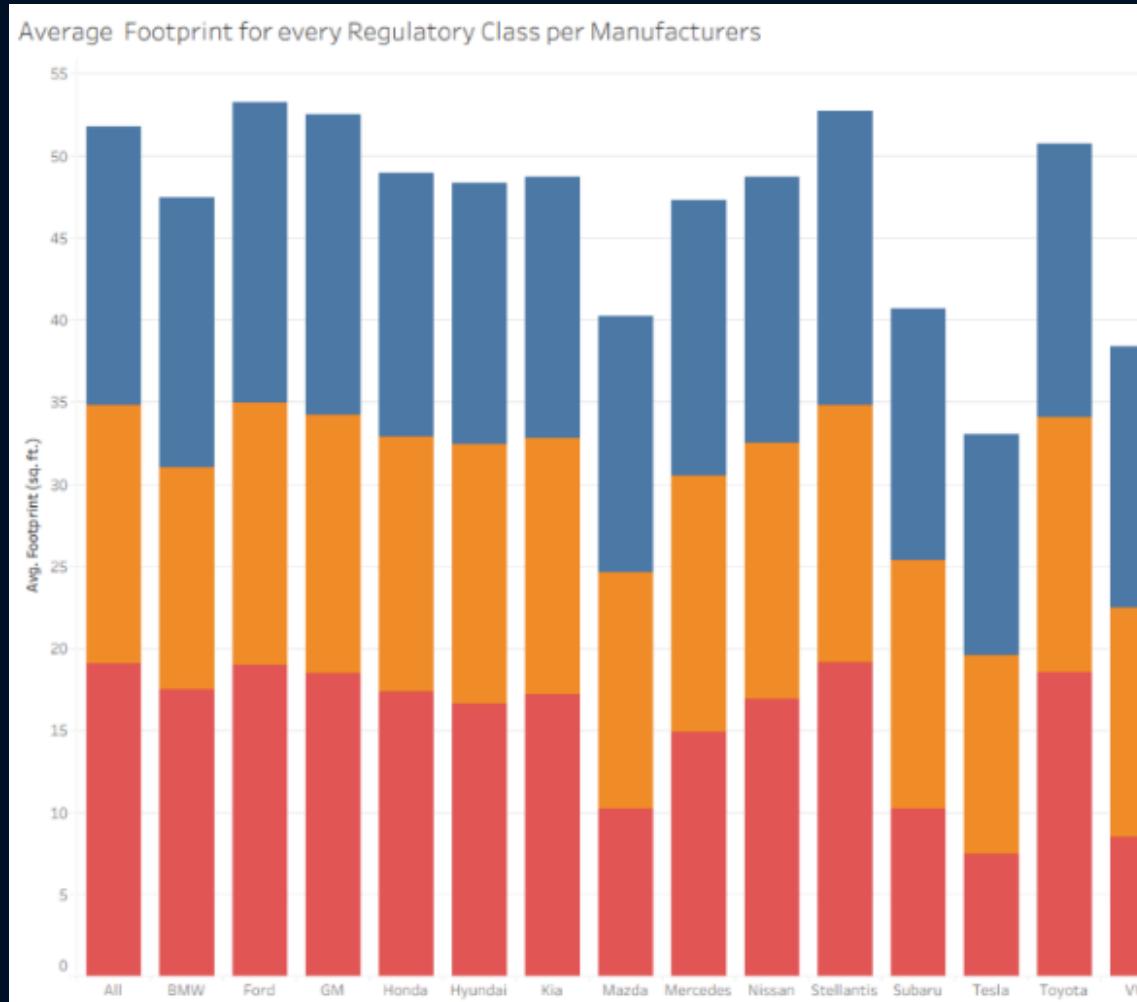


* SAMPLE CHART VISUALIZATION AND NOT THE FINAL OUTPUT

TREEMAP CHART

Display manufacturer and class contribution to the fleet (size) and their CO2 intensity (color).

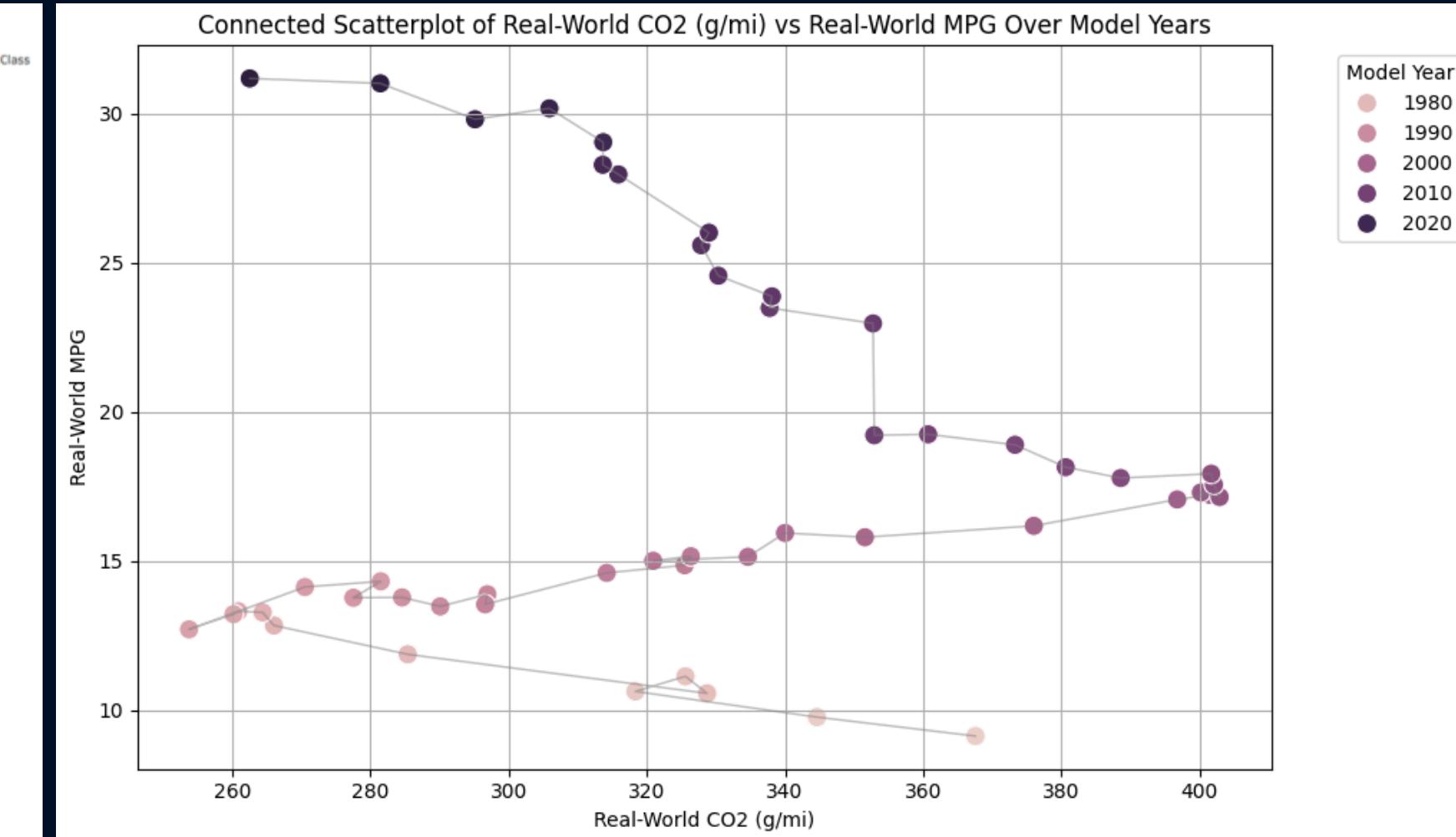
PLANNED VISUALIZATIONS



* SAMPLE CHART VISUALIZATION AND NOT THE FINAL OUTPUT

STACKED BAR CHART

Track the rate and mix of cleaner technology adoption over time.
Visualizes technological transition.



* SAMPLE CHART VISUALIZATION AND NOT THE FINAL OUTPUT

DUAL AXIS LINE CHART

Tracks CO2 reduction against vehicle mass/size trends.

THANK YOU!

"I rate that Evey/10" -



WE APPRECIATE YOUR
TIME AND INTEREST.