Electric Vehicle Market Segmentation

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Code implementation :- **GitHub**

Problem Statement :-

Perform a comprehensive market segmentation analysis of the Electric Vehicle (EV) market in India to identify and prioritize customer segments with the highest potential for EV adoption. This analysis should consider various segmentation criteria, including Geographic, Demographic, Psychographic, Behavioral, and any other relevant factors based on the availability of data. The goal is to recommend a strategic entry approach for our Electric Vehicle Startup by targeting the most promising customer segments, outlining their specific needs, preferences, and barriers to adoption, and providing actionable insights to tailor our products, marketing, and distribution strategies accordingly. This analysis should be based on extensive data collection, research, and analysis of the Indian EV market landscape.

Fermi Extraction :-

1. **Number of Electric Cars in a Hypothetical City:**
    - Population of the city: 1,000,000
    - Percentage of the population that owns a car: 20%
    - Percentage of car owners who own electric cars: 5%

    Estimation:
    - Number of car owners = 1,000,000 * 20% = 200,000
    - Number of electric car owners = 200,000 * 5% = 10,000

2. **Number of Cars Produced Annually in India:**
    - Total Population of India: 1.3 billion
    - Average Household Size: 4
    - Percentage of Households Owning a Car: 1 in 10
    - Average Car Life: 10 years

    Estimation:
    - Number of Households in India = 1,300,000,000 / 4 = 325,000,000 households
    - Number of Car-Owning Households = 325,000,000 / 10 = 32,500,000 households
    - Number of Cars Replaced Annually = 32,500,000 / 10 = 3,250,000 cars per year

3. **Number of Electric Cars Globally:**
    - Total World Population: Approximately 7.8 billion
    - Percentage of the global population that owns a car: Let's assume 15% (car ownership varies widely by country and region). Percentage of car owners who own electric cars: Let's assume 10% (considering the growing popularity of electric cars).

    Estimation:
    - Number of car owners globally = 7,800,000,000 * 15% = 1,170,000,000
    - Number of electric car owners globally = 1,170,000,000 * 10% = 117,000,000

So, based on these estimations, we can estimate that there are approximately 117 million electric cars globally.

Data sources :-

https://www.kaggle.com/code/divyanshugupta95/electric-vehicle-analysis
https://www.statista.com/topics/1487/automotive-industry/#topicOverview

Column explaination :-

DATASET 1 :-

1. **Brand:** The car's manufacturer or brand, e.g., "Tesla."
2. **Model:** The specific model of the car, e.g., "Model 3 Long Range Dual Motor."
3. **AccelSec:** Time in seconds for the car to accelerate from 0 to 100 km/h.
4. **TopSpeed_KmH**: Maximum speed the car can reach in kilometers per hour.
5. **Range_Km:** Electric range of the car on a full charge in kilometers.
6. **Efficiency_WhKm:** Energy efficiency in watt-hours per kilometer.
7. **FastCharge_KmH:** Fast-charging rate in kilometers gained per hour of charging.
8. **RapidCharge:** Indicates if the car supports rapid charging (Yes/No).
9. **PowerTrain:** Type of powertrain used in the car.
10. **PlugType:** Type of charging plug or connector.
11. **BodyStyle:** The car's body style or configuration, e.g., "Sedan."
12. **Segment:** Market segment or class to which the car belongs.
13. **Seats:** Number of seats in the car.
14. **PriceEuro:** Price of the car in Euros (€).

DATASET 2:-

1. **Make**: Car manufacturer or brand.
2. **Model**: Specific car model or name.
3. **Price**: Cost of the car in local currency.
4. **Year**: Manufacturing year of the car.
5. **Transmission**: Type of transmission system.
6. **Location**: Geographical location of the car listing.
7. **Color**: Exterior color of the car.
8. **Engine**: Engine details, including displacement.
9. **Max Power**: Maximum engine power in bhp and rpm.
10. **Max Torque**: Maximum engine torque in Nm and rpm.
11. **Drivetrain**: Type of drivetrain, e.g., FWD or AWD.
12. **Length**: Overall car length in millimeters.
13. **Width**: Overall car width in millimeters.
14. **Height**: Overall car height in millimeters.
15. **Seating Capacity**: Number of passengers the car can seat.
16. **Fuel Tank Capacity**: Car's fuel tank capacity in liters or gallons.

Data Pre-processing and Segmentation extraction :

DATASET 1 :-

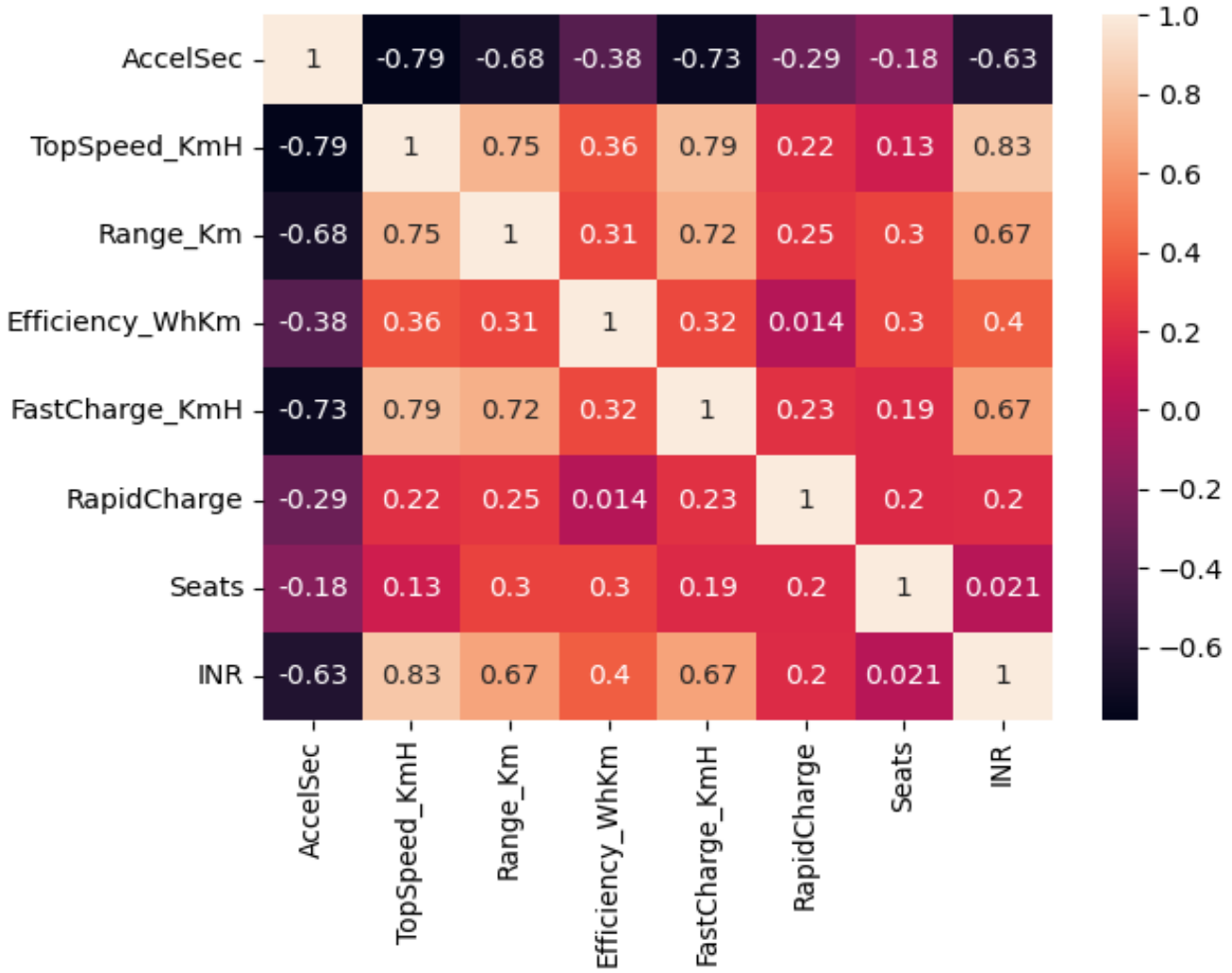
Packages and tools used:

1. NumPy
2. Pandas
3. Scikit Learn
4. Seaborn
5. Matplotlib

Exploratory Data Analysis (EDA):

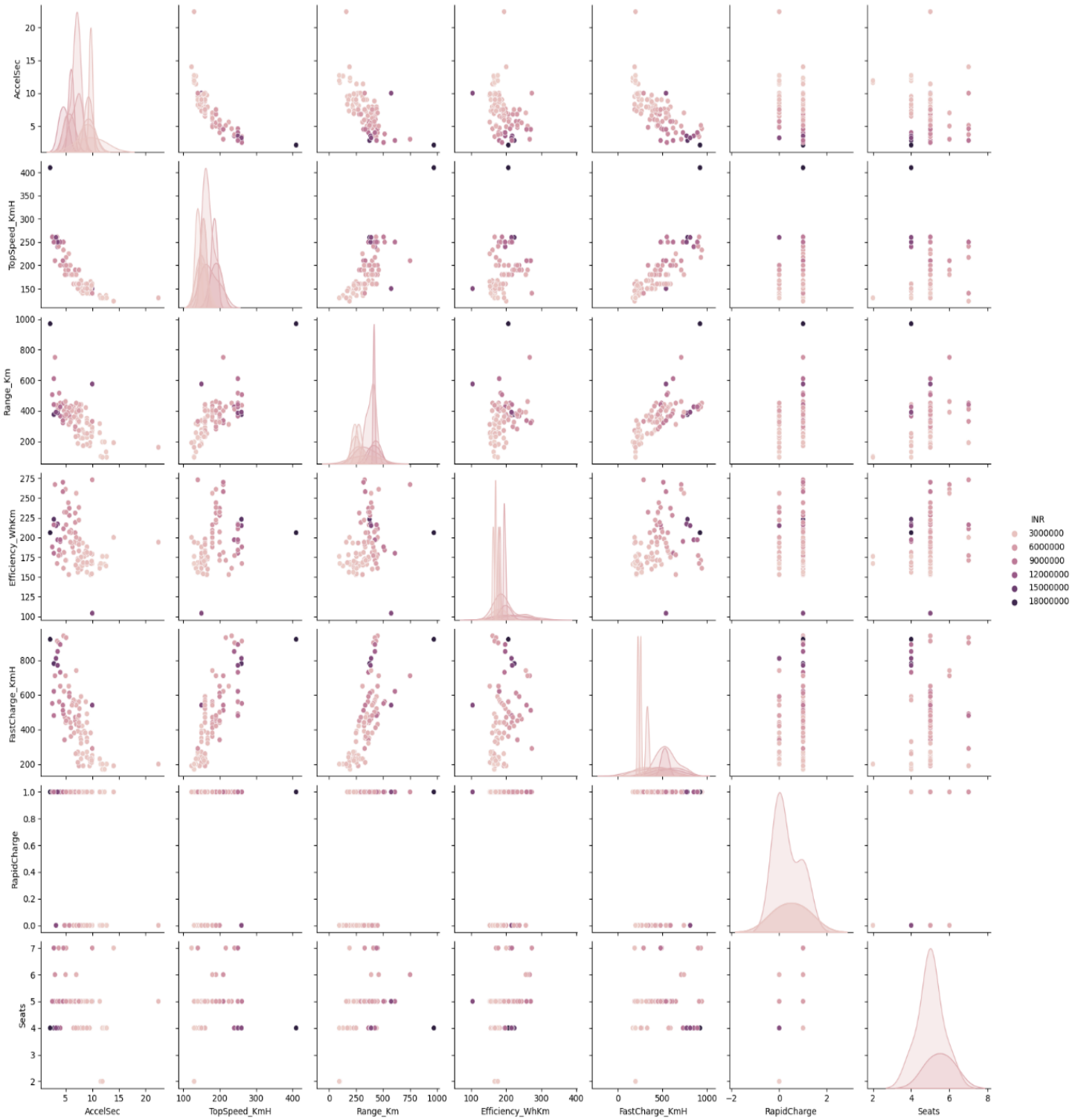
Started EDA with some data. In this we have compared our data in different aspects such as cars , top speed , price etc.

Correlation Matrix:- It is a matrix which simply shows the correlation between each other. The relationship between two variables is usually considered strong when their correlation coefficient value is larger than 0.7



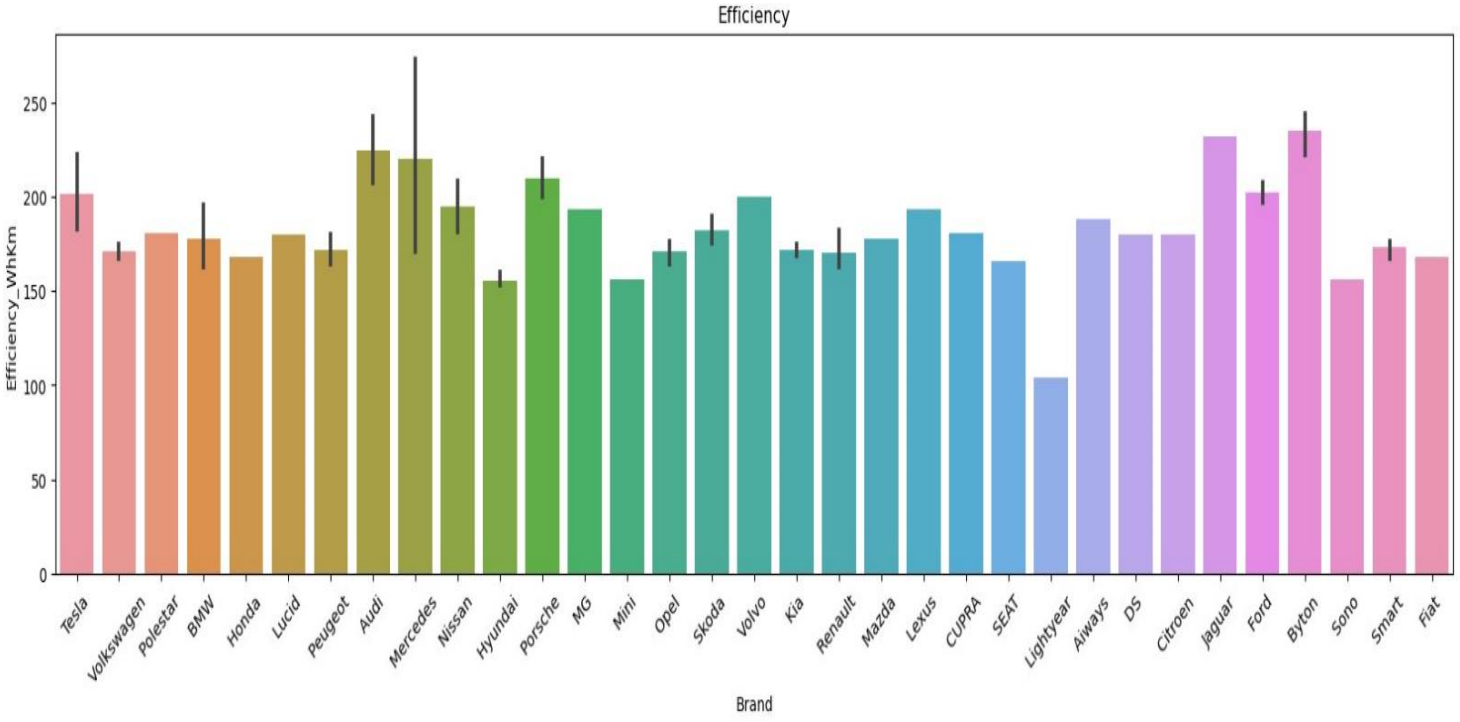
Pairplot to find how cost influences different aspects of a car :

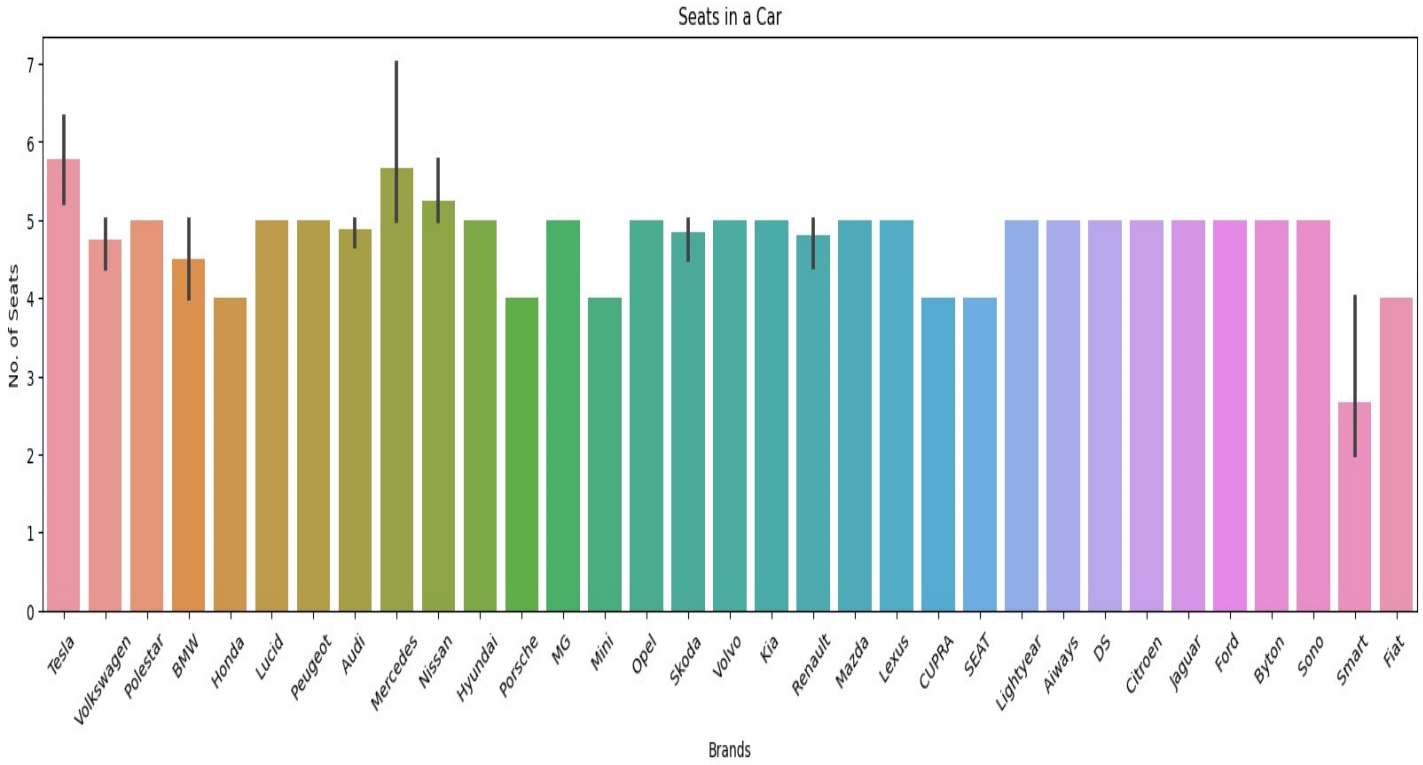
A pairplot is a type of data visualisation that allows you to explore the relationship between multiple variables in a dataset. The diagonal subplots provide histogram or kernel density plots for each feature. These plots display the distributions of the variables and allow us to understand the range and frequency of values for each feature. The off-diagonal subplots, we can observe the relationship between the price and each individual feature.



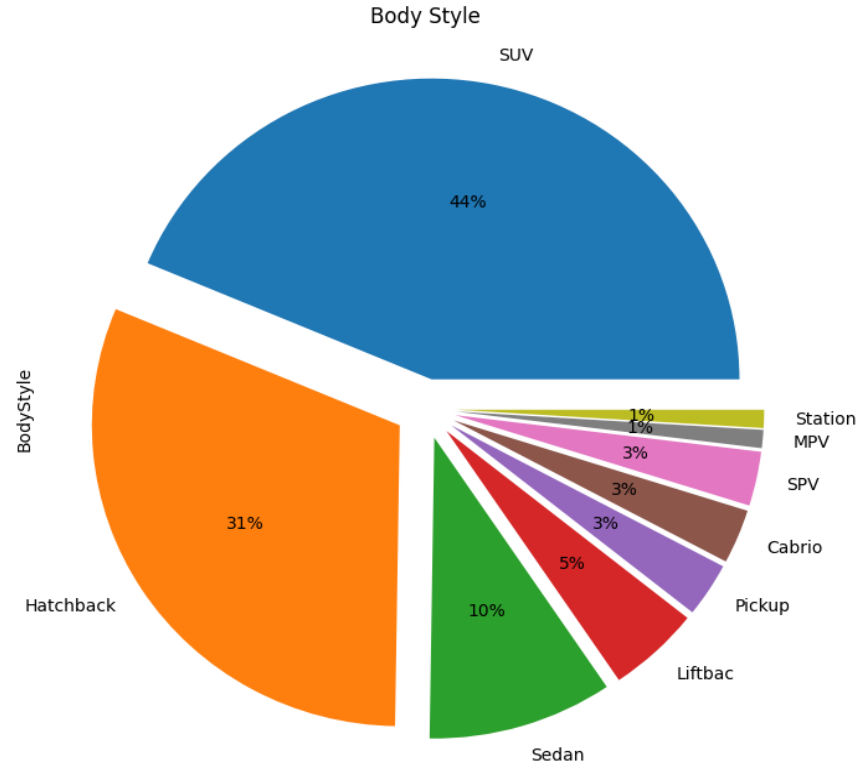
Bar plot :-

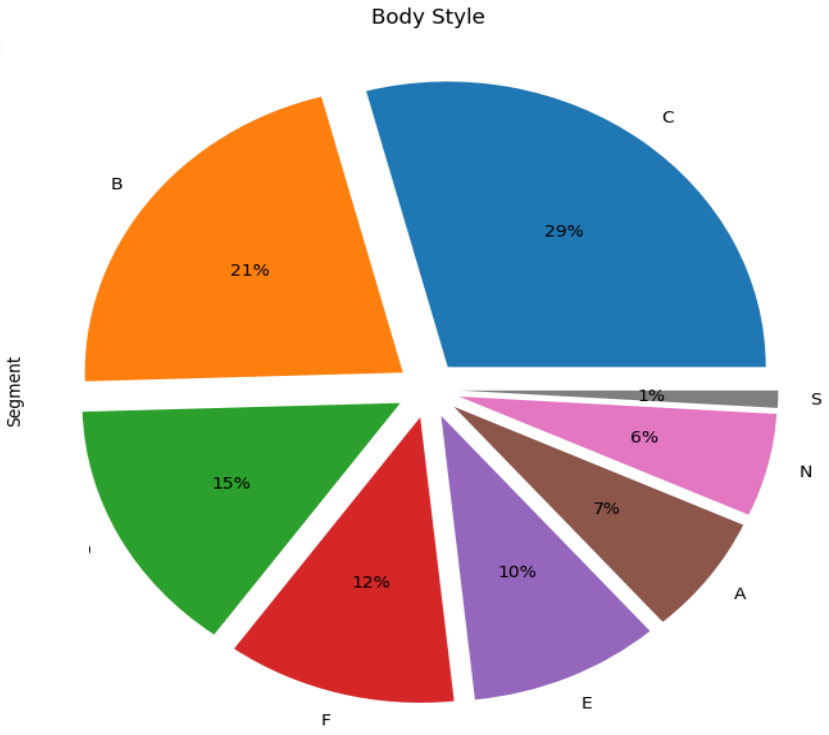
A bar plot, often referred to as a bar chart, is a visual representation of data using rectangular bars or columns. The horizontal axis typically displays categories or groups, while the vertical axis represents values, counts, or frequencies. The length or height of each bar corresponds to the data it represents, allowing for easy comparisons between different categories. Bar plots are widely used to showcase data comparisons, visualize distributions, rank categories, and display part-to-whole relationships, making them a valuable tool for data analysis and presentation.

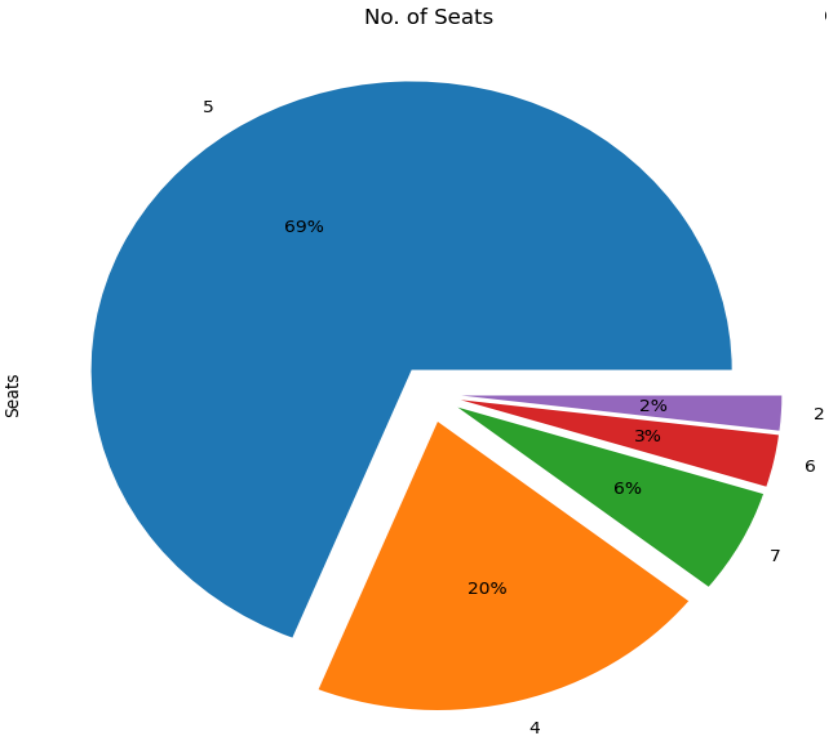




Pie chart :-

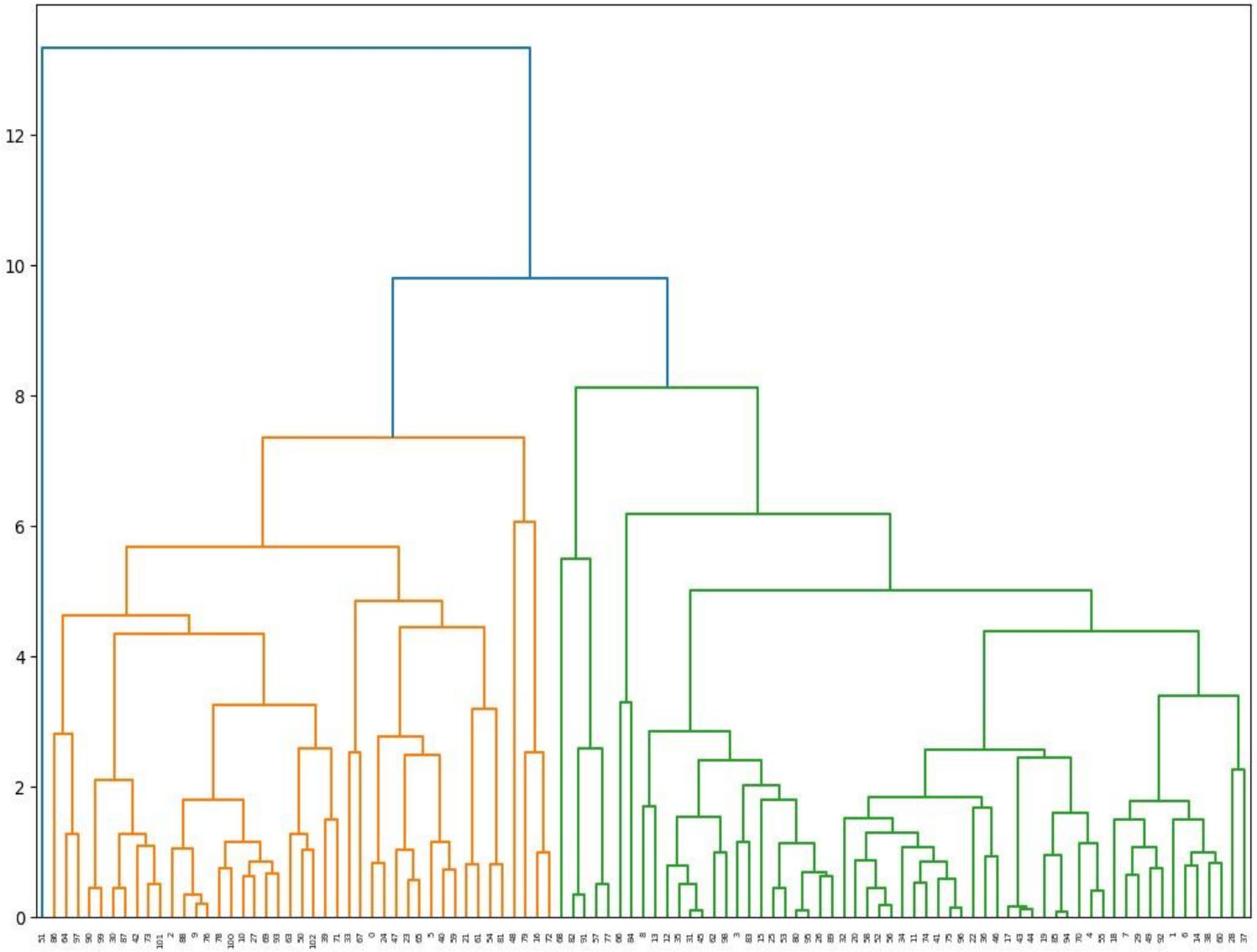

Body Style
SUV
44%
BodyStyle
31%
Hatchback
10%
Sedan
5%
Liftbac
3%
Pickup
3%
Cabrio
3%
SPV
1%
MPV
1%
Station


Body Style
Segment
C
29%
B
21%
15%
12%
F
10%
E
7%
A
6%
N
1%
S


No. of Seats
Seats
5
69%
4
20%
7
6%
6
3%
2
2%

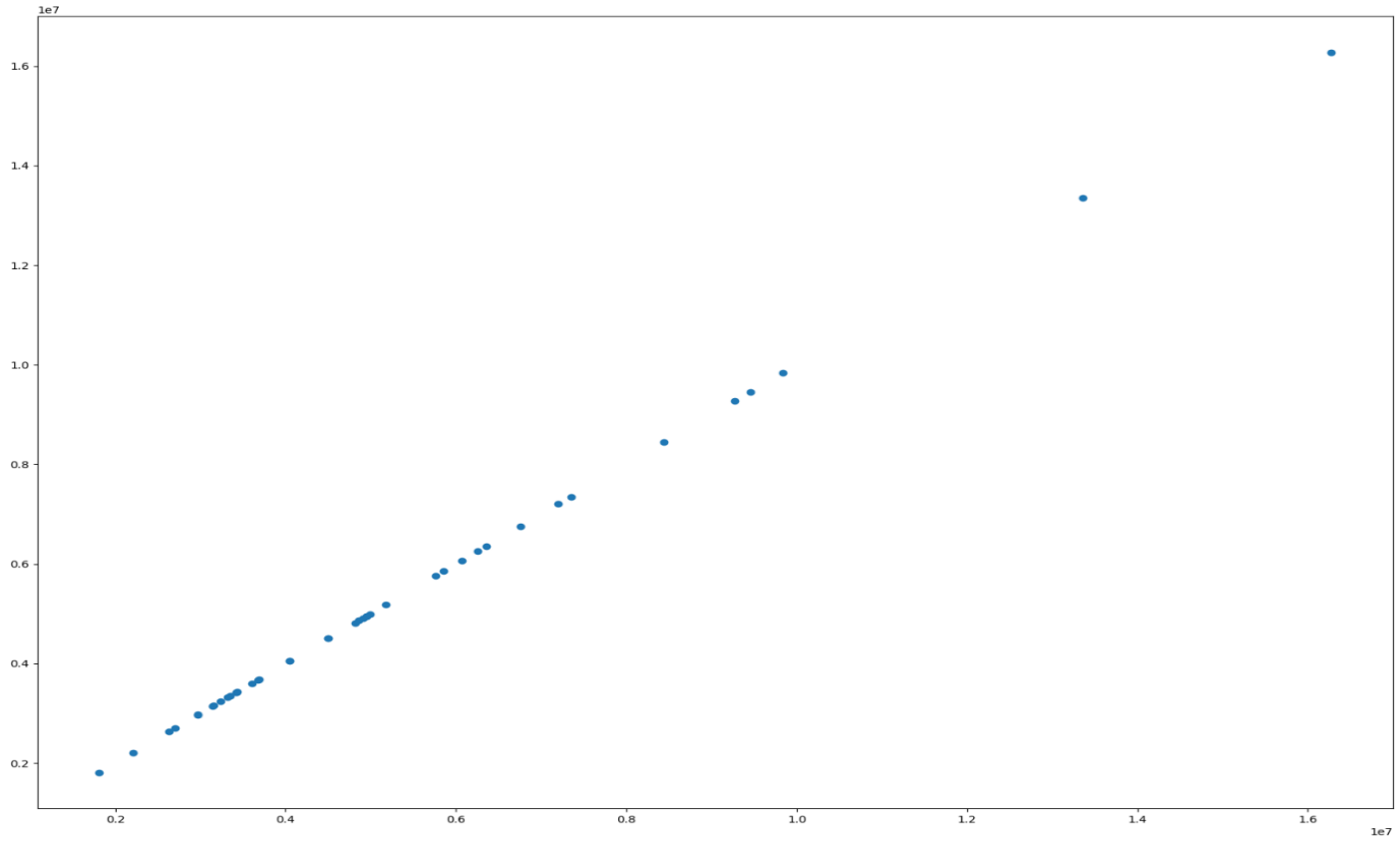
Dendrogram : -

A dendrogram is a tree-like diagram used in data analysis and clustering to illustrate hierarchical relationships among data points or clusters.

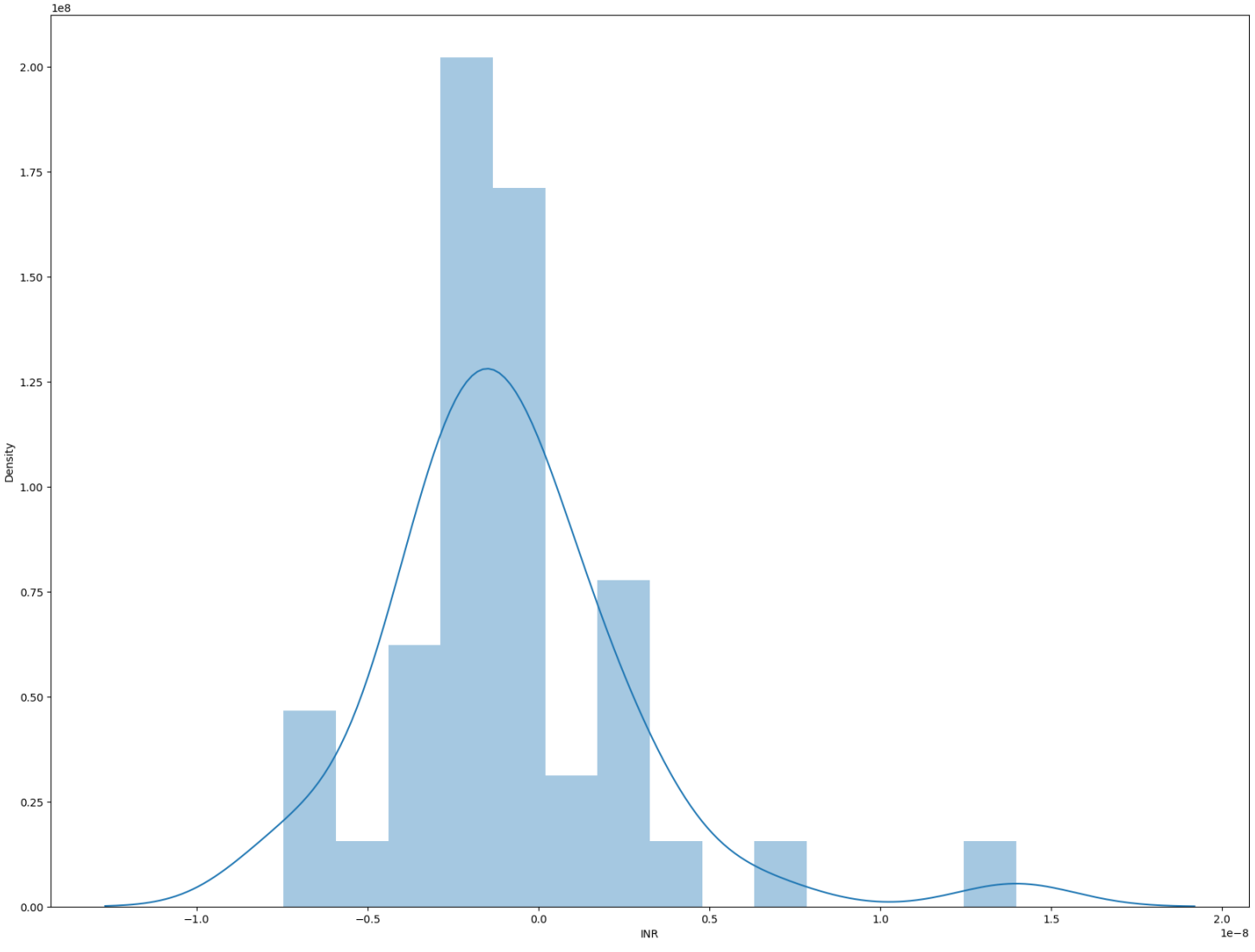


Prediction of Prices of most used cars:

Linear regression is a machine learning algorithm based on supervised learning. It performs a regression task. Regression models target prediction values based on independent variables. It is mostly used for finding out the relationship between variables and forecasting. Here we use a linear regression model to predict the prices of different cars from different brands. After we train the Linear Regression Model, we test the remaining 40% of data on the model.The obtained results are checked using a scatter plot between predicted values and the original test data set for the dependent variable and acquired similarly to a straight line as seen in the figure below.



Density function which is normally distributed :-



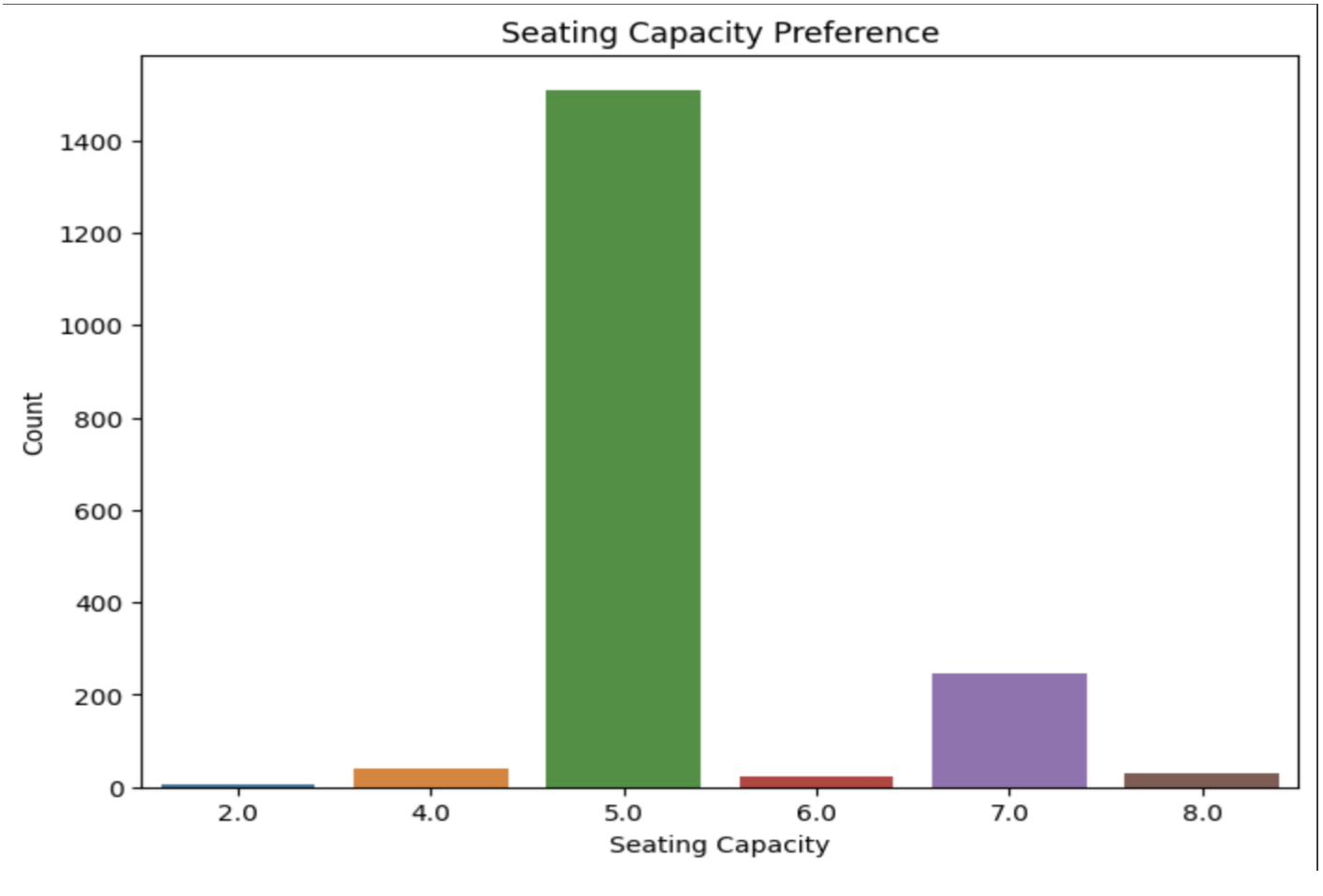
DATASET 2 :-

Libraries Used:

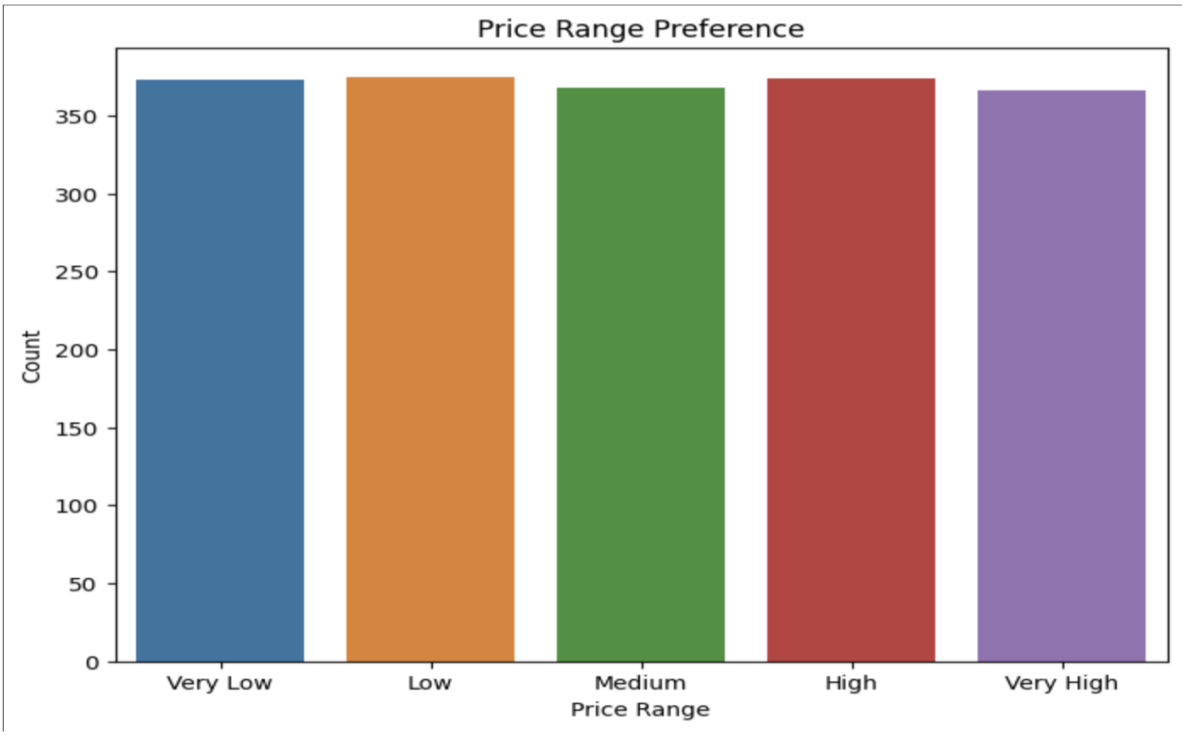
a. Numpy
b. Pandas
c. Scikit Learn
d. Seaborn

Exploratory Data Analysis:

The dataset comprised comprehensive information on car sales, encompassing key factors such as engine power, torque, length, width, height, fuel tank capacity, seating capacity, and price. In order to conduct an effective market segmentation analysis for the Electric Vehicle (EV) market, certain columns including seller type, fuel type, owner, and kilometres driven were deemed irrelevant and thus excluded from consideration. To ensure data consistency, rows containing missing information pertaining to engine specifications and dimensions were removed from the dataset. This meticulous data curation process aimed to uphold the integrity and reliability of the subsequent market segmentation analysis for the EV market.



To ascertain the prevailing customer preferences in the market regarding car seating capacity, a thorough analysis was conducted. Specifically, a plot was generated comparing the count of car models against their respective seating capacities. The resulting plot provided valuable insights, distinctly indicating that the majority of customers exhibit a strong inclination towards 5-seater cars. This finding underscores the significance of accommodating the demand for vehicles with a seating capacity of five, thereby facilitating targeted market segmentation strategies for the Electric Vehicle (EV) market.

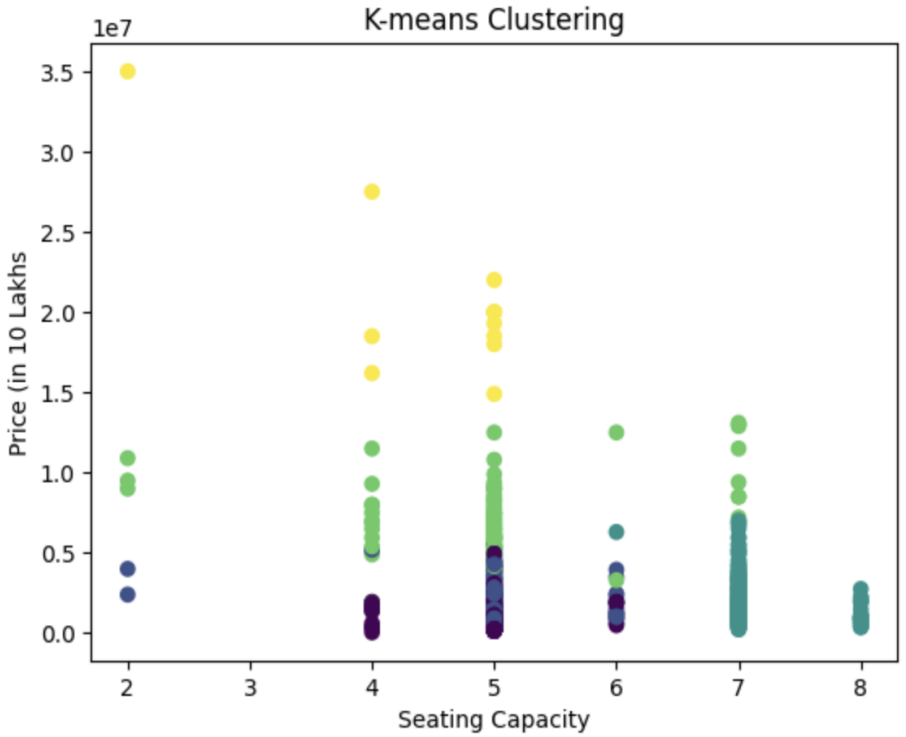


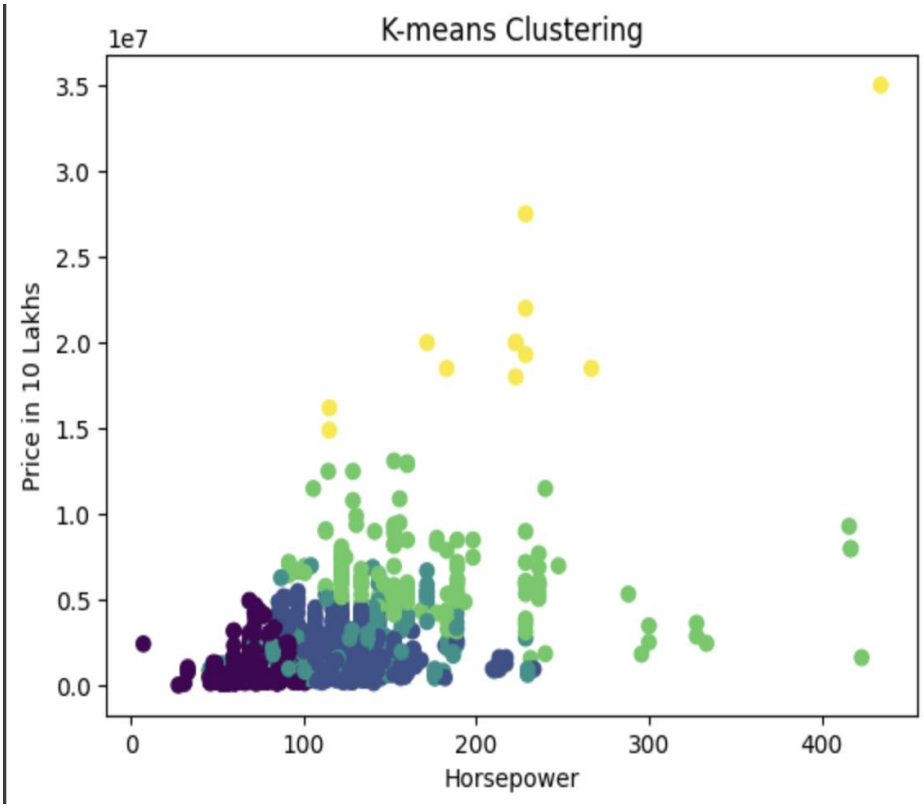
Upon examining the plot displaying the relationship between price and count of car models, a noteworthy observation emerges. The data indicates that the customer base is distributed relatively evenly across all price ranges, with only marginal variations in the number of customers. This finding suggests that the market for Electric Vehicles (EVs) encompasses a diverse range of price preferences, with no significant skew towards any particular price segment. Such market dynamics imply the importance of catering to customers across various price points when formulating effective market segmentation strategies for the EV market.

Segment Extraction :

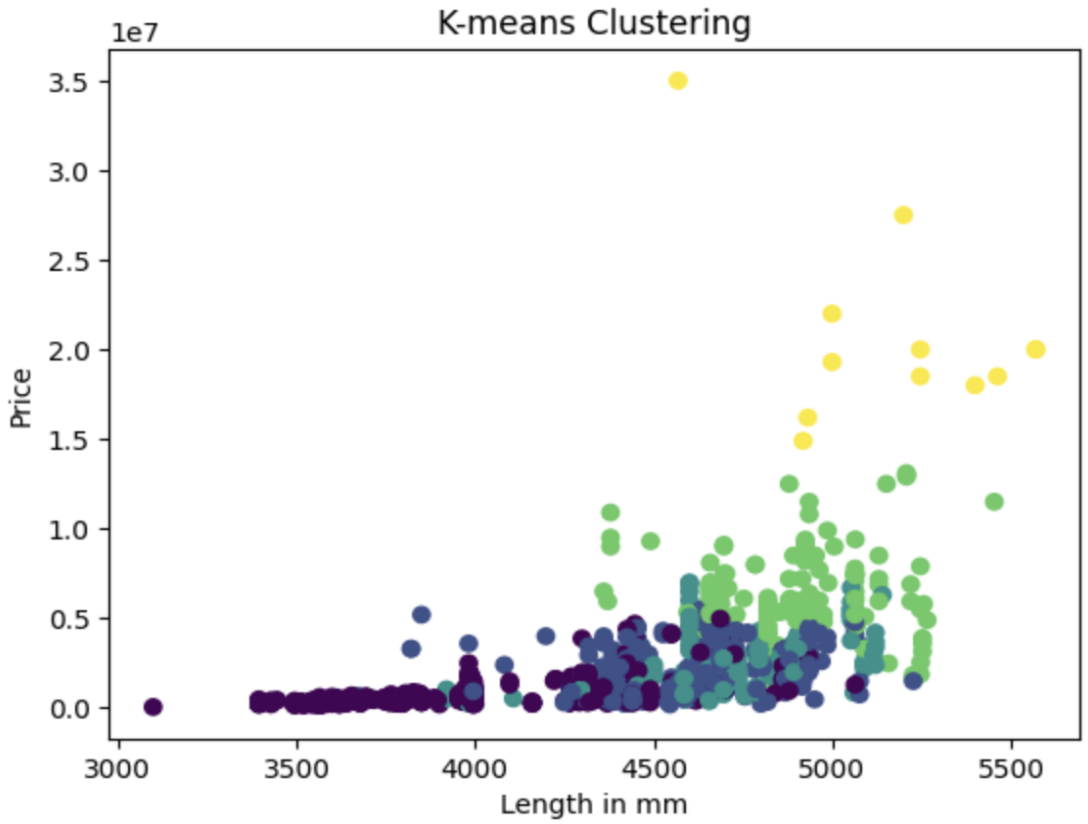
By conducting K-means clustering on the provided dataset with three clusters and generating a scatter plot that visualises the relationship between price (in 10 Lakhs) and seating capacity, several insightful findings emerge. Notably, when examining the price range below 15 lakhs, a considerable proportion of customers display a preference for 7-seater cars. However, as the price range surpasses 15 lakhs, the majority of customers exhibit a preference for 5-seater cars, with a smaller percentage opting for 4-seaters.

This suggests a shift in customer preferences based on price point, with higher-priced vehicles often featuring a seating capacity of 5 and lower-priced options accommodating larger groups with 7-seater configurations. These insights emphasise the importance of considering both price range and seating capacity as crucial factors in market segmentation for the Electric Vehicle (EV) market. Additionally, further exploration and analysis of other variables in the dataset may provide additional valuable insights for effective segmentation strategies.

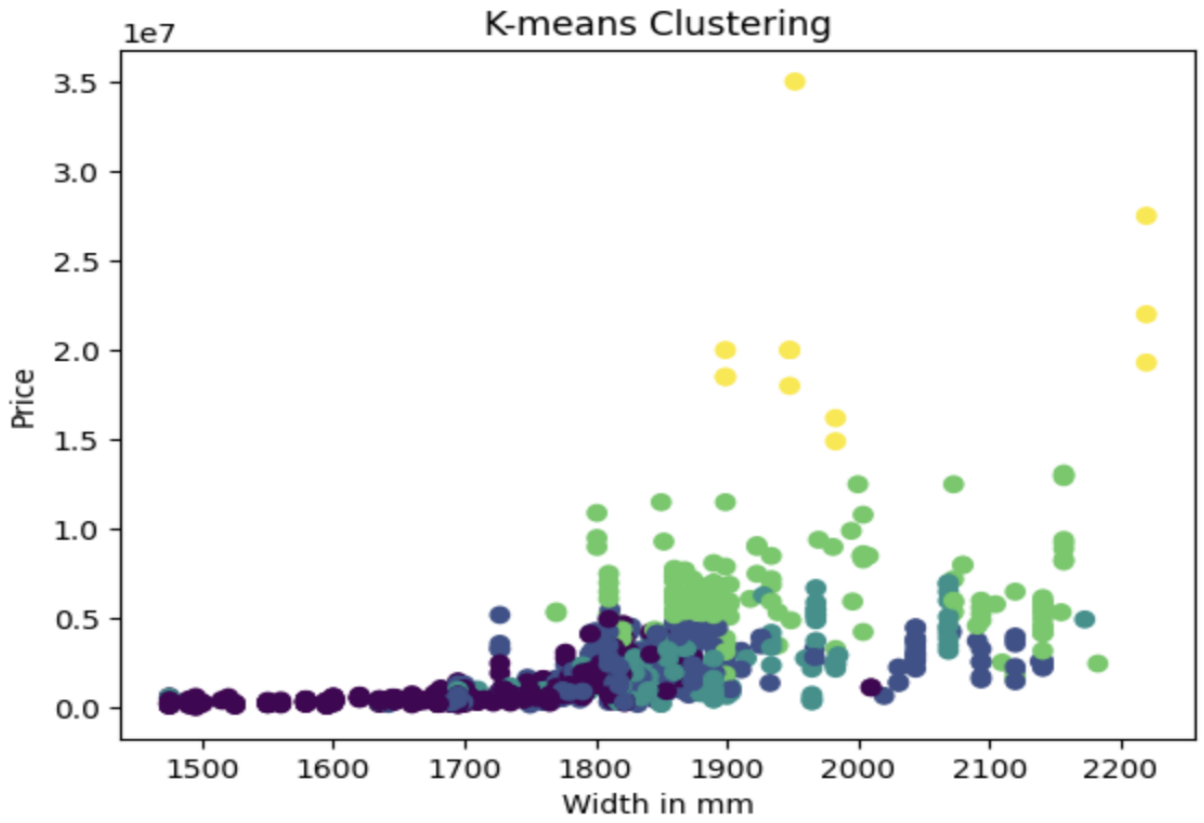




Visualizing the scatter plot of price versus horsepower for cars in the dataset reveals four distinct clusters, offering valuable insights into customer preferences. Below 10 lakhs, two segments emerge: one prioritizing features and compromising on horsepower, while the other values power and safety. Above 10 lakhs, most cars exceed 200 horsepower, with a niche market seeking lower horsepower options despite the higher price. These insights emphasize the importance of considering both price and horsepower for effective EV market segmentation strategies.



Analyzing a scatter plot of car length versus price unveils compelling insights. Cars priced below 5 lakhs are predominantly under 4 meters long, indicating a preference for affordability and compactness. These customers favor smaller, urban-friendly cars for cost-effective transportation. Conversely, cars priced above 5 lakhs cluster between 4.5 to 5.5 meters in length, suggesting a preference for slightly larger vehicles in this price range, likely for added comfort and features. These findings emphasize the interplay between price and car length in shaping customer preferences. Leveraging this knowledge can drive effective market segmentation strategies, catering to diverse customer choices and budgets.



Analyzing the scatter plot of car width versus price unveils distinct patterns and insights for market segmentation. In the sub-5 lakhs price range, cars exhibit a width range of 1500 to 1900 mm, with most falling between 1800 and 1900 mm. This suggests customers prioritize wider cars, possibly for increased space or road stability. In contrast, cars above 5 lakhs cluster between 1850 and 2000 mm, with some exceeding 2000 mm. This reflects a separate segment valuing broader cars, potentially associating width with comfort, luxury, or road presence. These findings emphasize the role of price in shaping width preferences, aiding effective market segmentation for tailored offerings.

CONCLUSION :

In the grand symphony of the Electric Vehicle (EV) market, our strategic composition concludes with a crescendo of insights and harmonized market segmentation. Just as a seasoned conductor selects the most talented musicians for each section, we have pinpointed the most optimal market segments to fine-tune our offerings.

Imagine our strategy as a painter's palette, with distinct colors representing different customer preferences. For the sub-15 lakhs price range, we've chosen the vibrant shade of 7-seater configurations to resonate with the rhythm of family-oriented affordability. In contrast, the canvas above 15 lakhs is adorned with 5-seater cars, each stroke depicting advanced technology, safety, and dynamic performance.
Customizing the marketing mix is our brushstroke of brilliance. We blend product offerings, pricing strategies, promotional techniques, and distribution channels like an artist mixing colors to create a masterpiece. We paint affordability, spaciousness, and eco-friendliness in the 7-seater segment while adding sophistication, innovation, and exhilaration to the 15 lakhs and above segment.

Picture our strategy as a ship setting sail, calculating potential profits in the early market is our compass. It guides us through uncharted waters, helping us navigate toward the treasure trove of profitability. In the grand gallery of market opportunities, we have curated our artful approach. By targeting the right segments with tailored offerings and harmonizing our marketing mix, we aim to create a masterpiece in the EV market—a symphony of success that resonates with customers and reverberates with profits.