

MARKET SEGMENTATION TASK REPORT

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Problem Statement:-

Perform a comprehensive market segmentation analysis of India's Electric Vehicle (EV) market to identify and prioritize customer segments with the highest potential for EV adoption. This analysis should consider various segmentation criteria based on data availability, including geographical, demographic, psychographic, behavioral, and other relevant factors. 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 explanation:-

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:** 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. **Price Euro:** The price of the car is 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**: The car's fuel tank capacity in liters or gallons.

Data Pre-processing and Segmentation Extraction:

DATASET 1:-

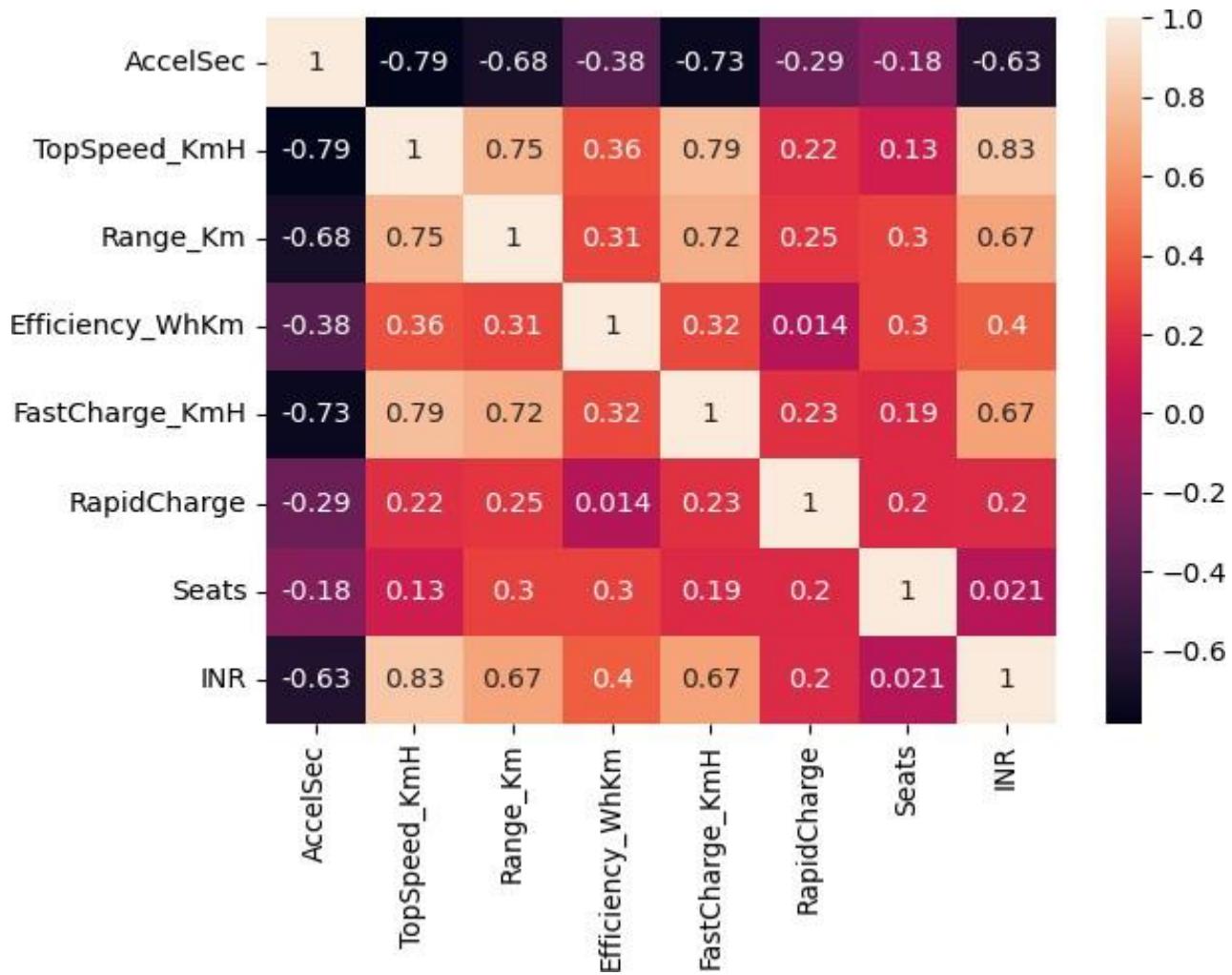
Packages and tools used:

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

Exploratory Data Analysis (EDA):

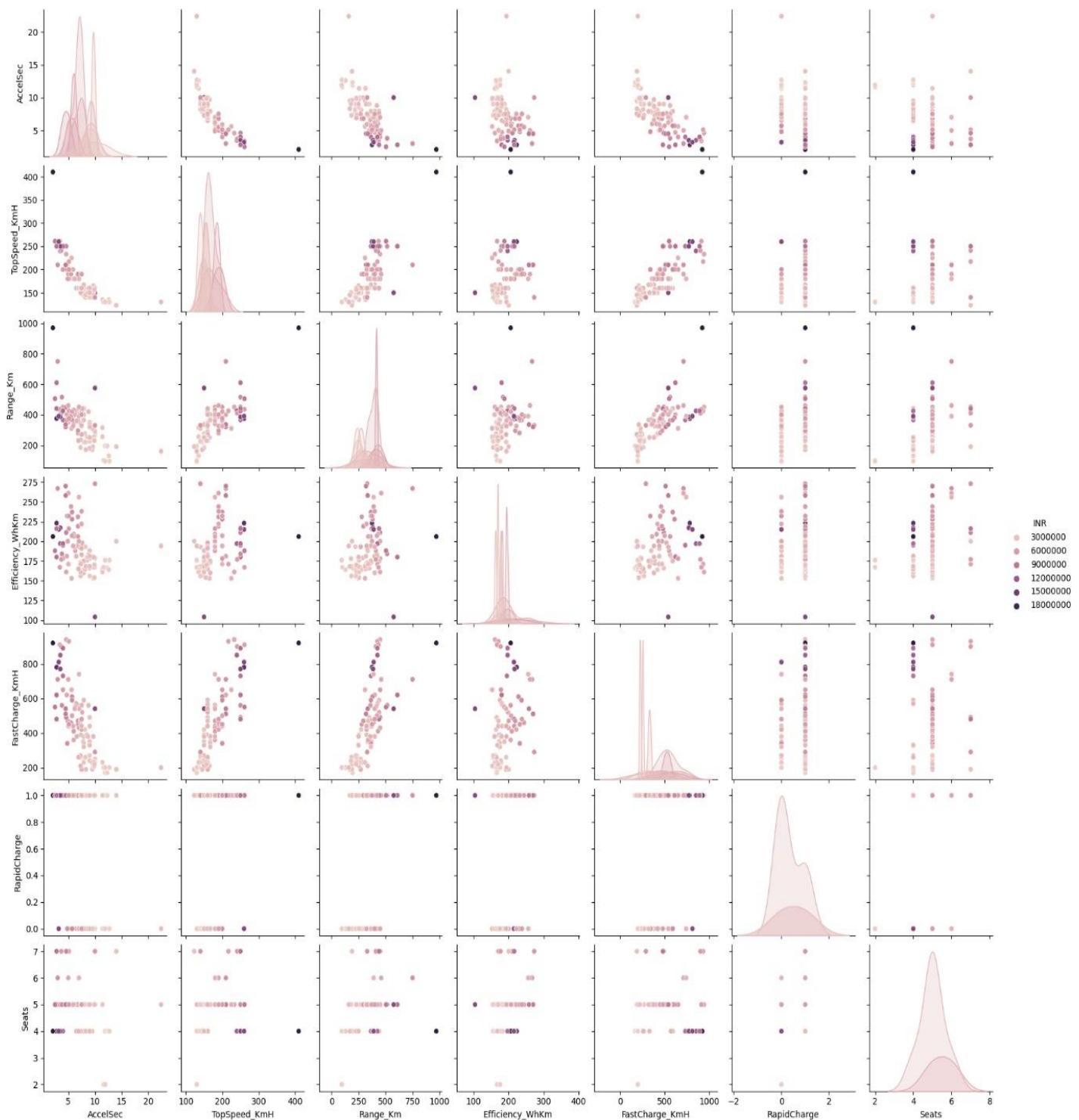
We started EDA with some data. We have compared our data in different aspects such as cars, top speed, price, etc.

Correlation Matrix is a matrix that shows the correlation between each other. The relationship between two variables is usually considered vital when their correlation coefficient value is more significant than 0.7



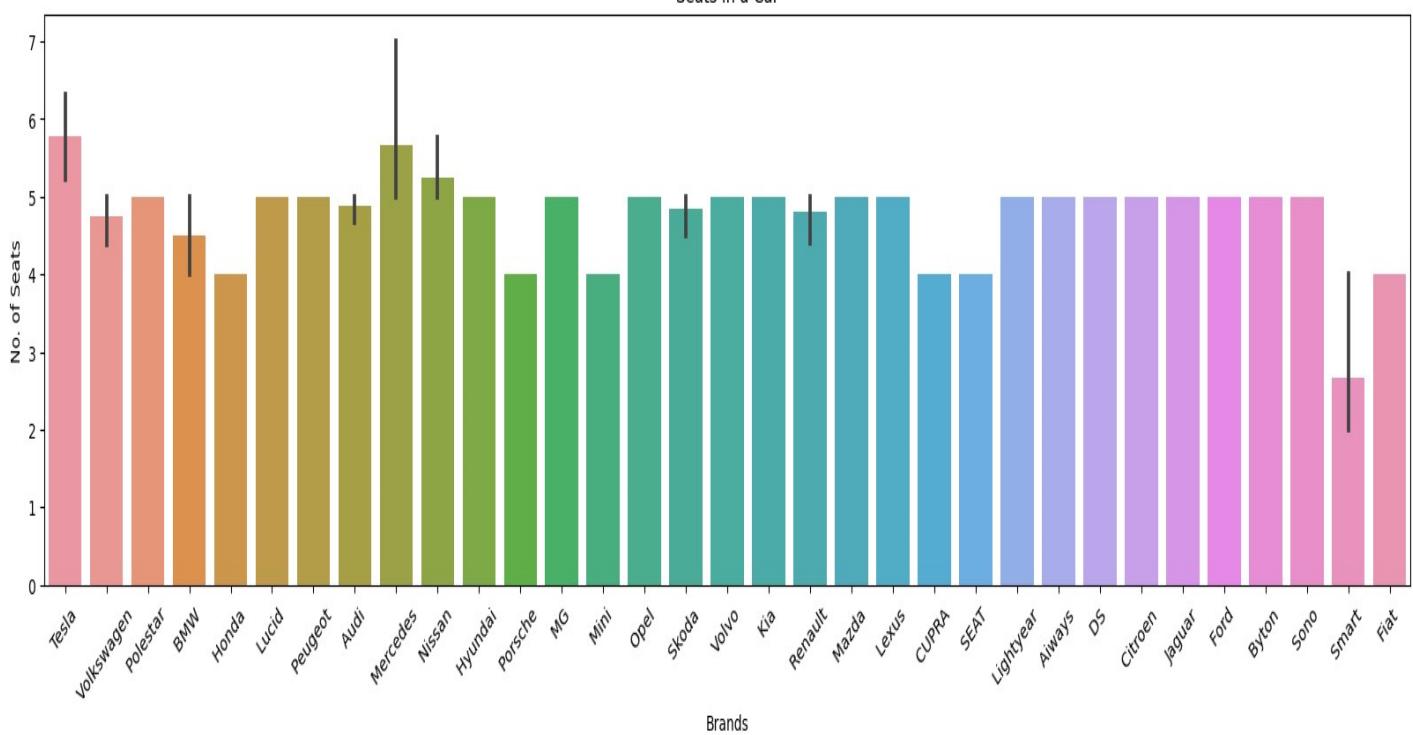
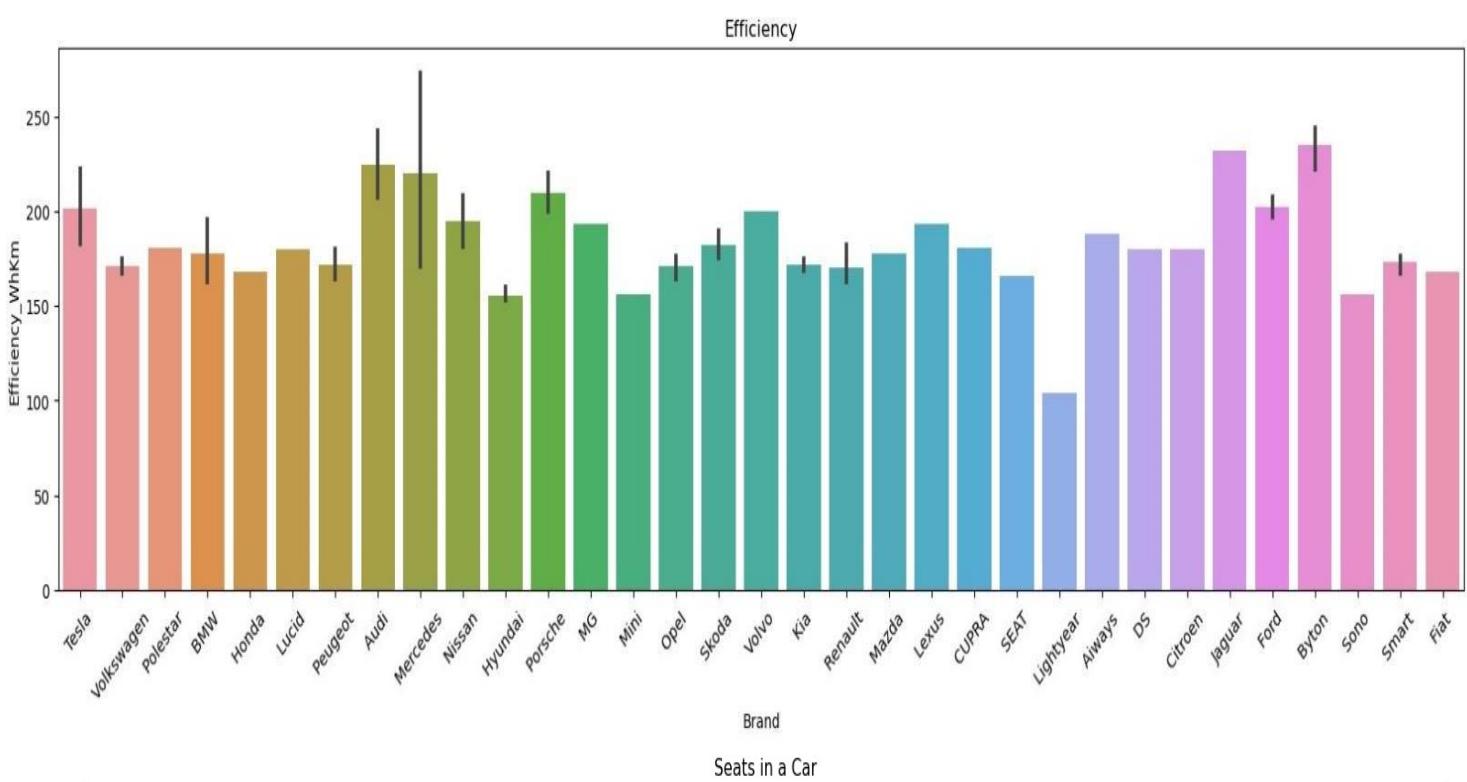
Pairplot to find how cost influences different aspects of a car :

A pair plot is a type of data visualization that allows you to explore the relationship between multiple variables in a dataset. The diagonal subplots provide histograms 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. We can observe the relationship between the price and each feature in the off-diagonal subplots.

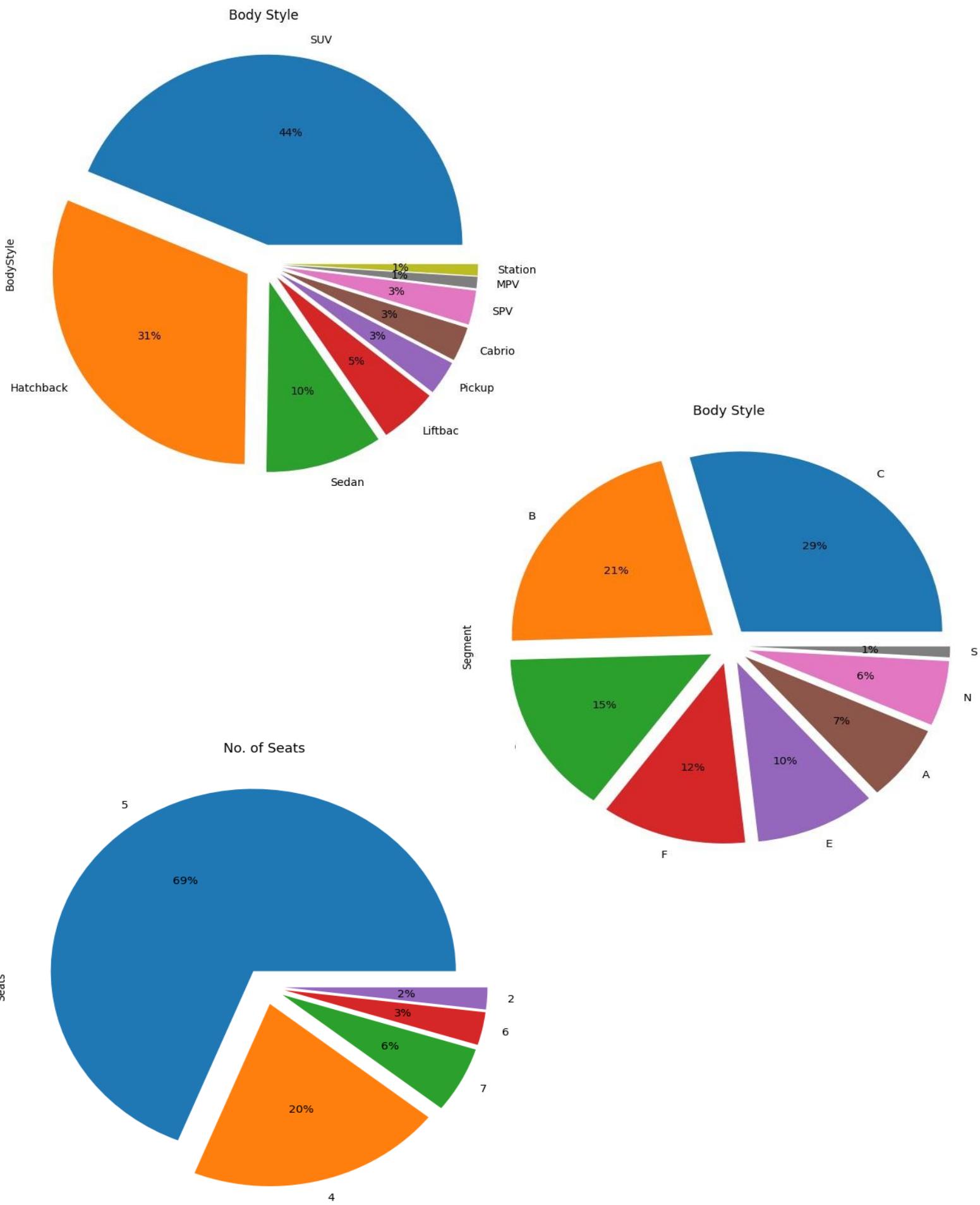


Bar plot:-

A bar plot, often called a bar chart, visually represents 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 valuable for data analysis and presentation.

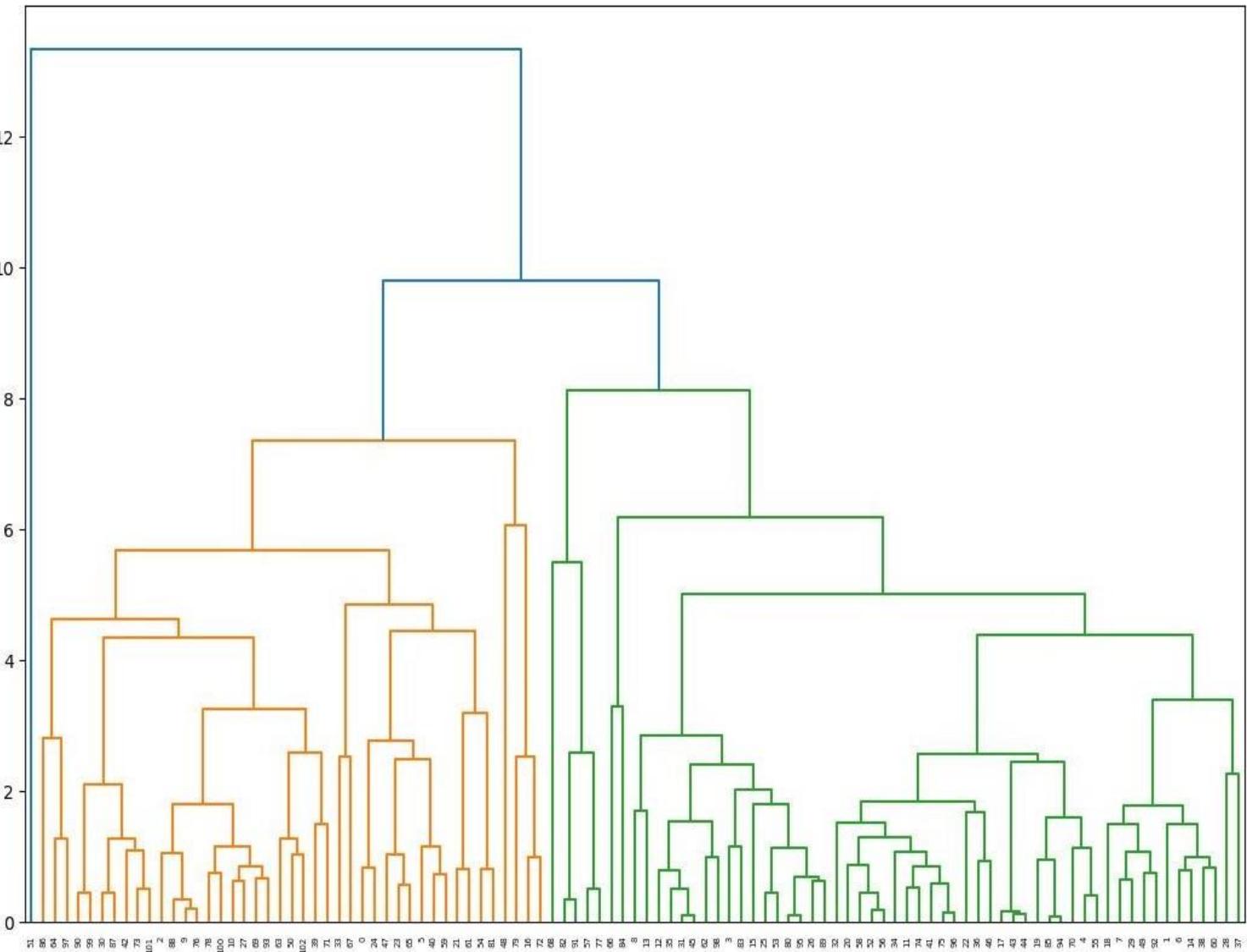


Pie chart:-



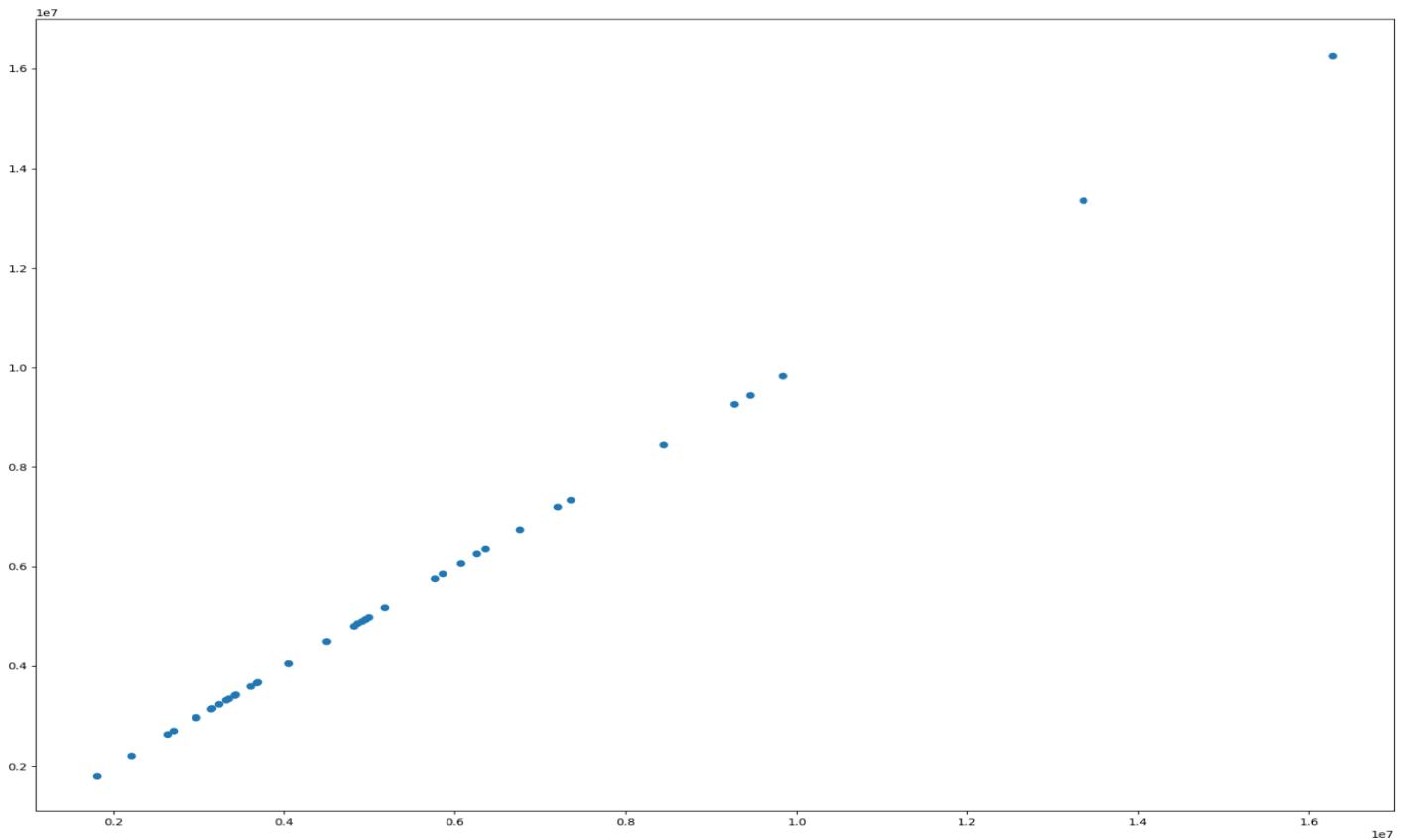
Dendrogram: -

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

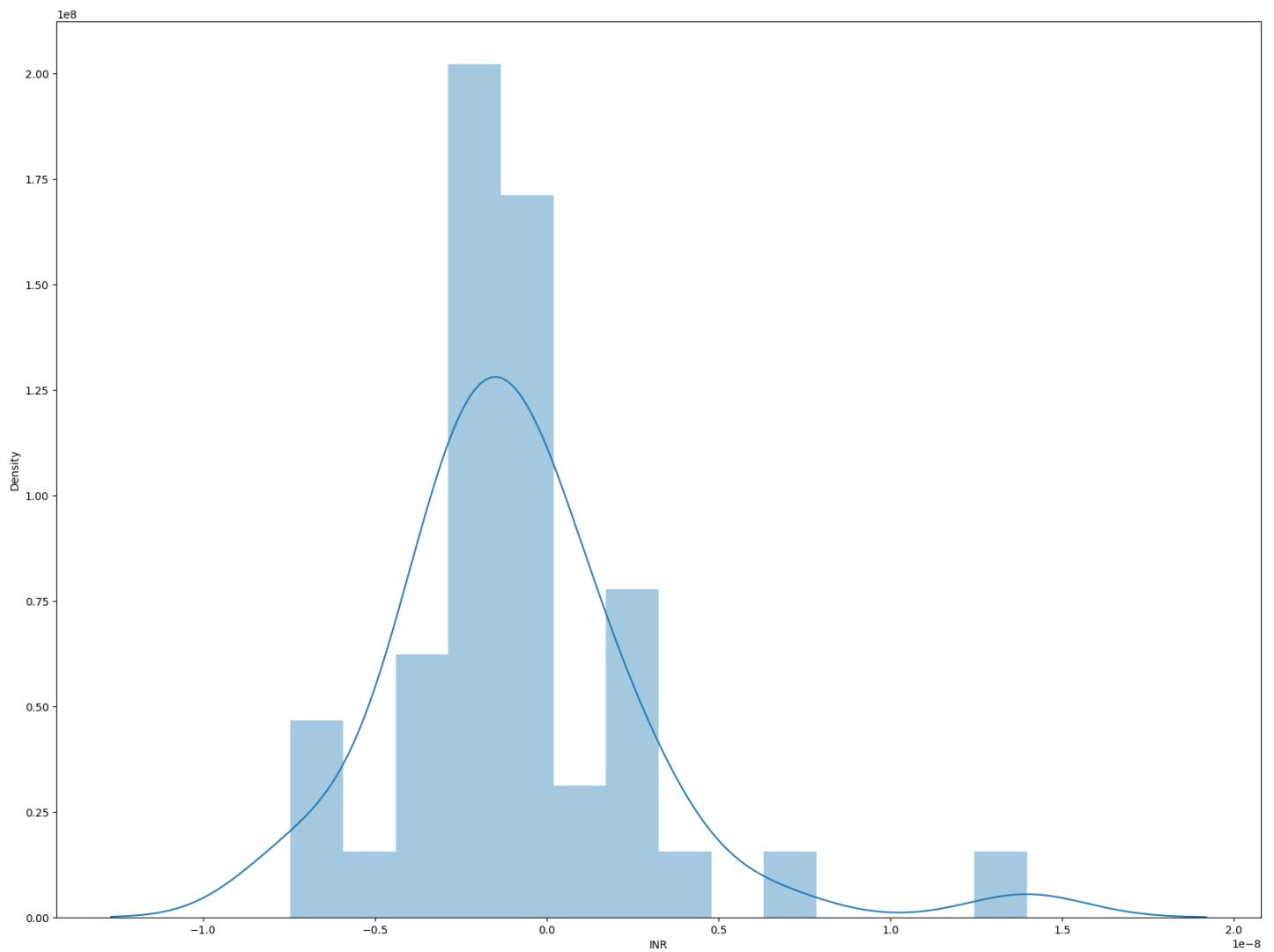


Prediction of Prices of most used cars:

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 mainly used to find 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, which is acquired similarly to a straight line, as seen in the figure below.



Density function, which is usually distributed:-



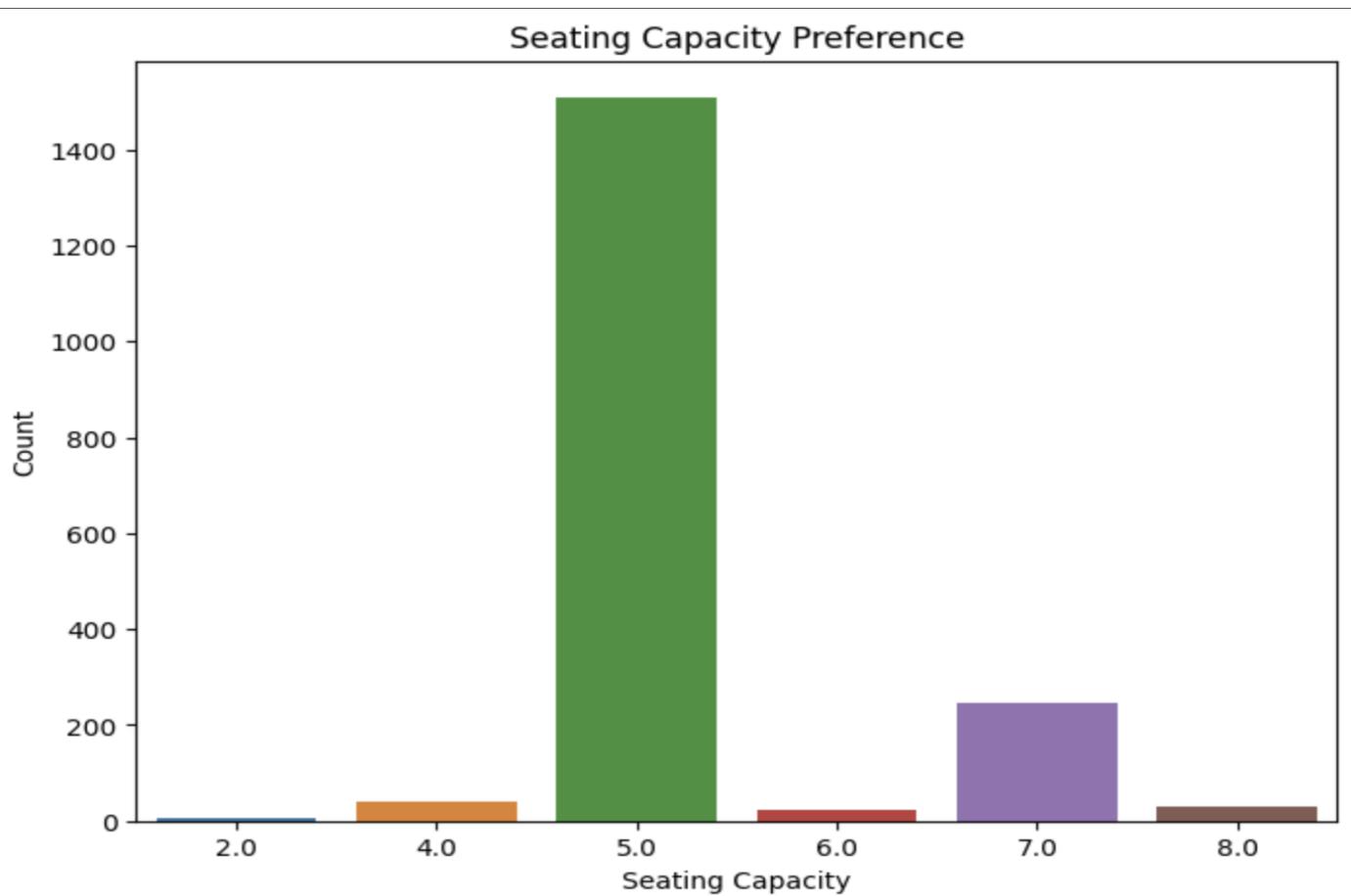
DATASET 2:-

Libraries Used:

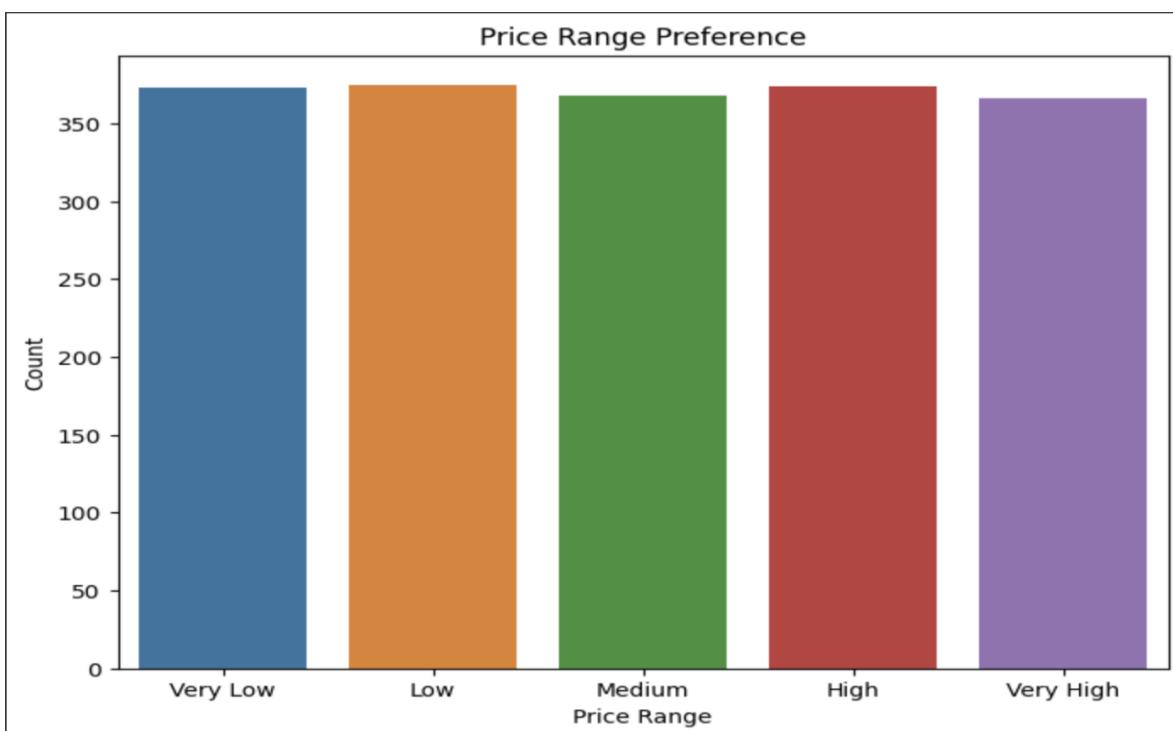
- a. Numpy
- b. Pandas
- c. Scikit Learn
- d. Seaborn

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. To conduct a practical market segmentation analysis for the Electric Vehicle (EV) market, specific columns, including seller type, fuel type, owner, and kilometers driven, were deemed irrelevant and thus excluded from consideration. To ensure data consistency, rows containing missing information about 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.



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

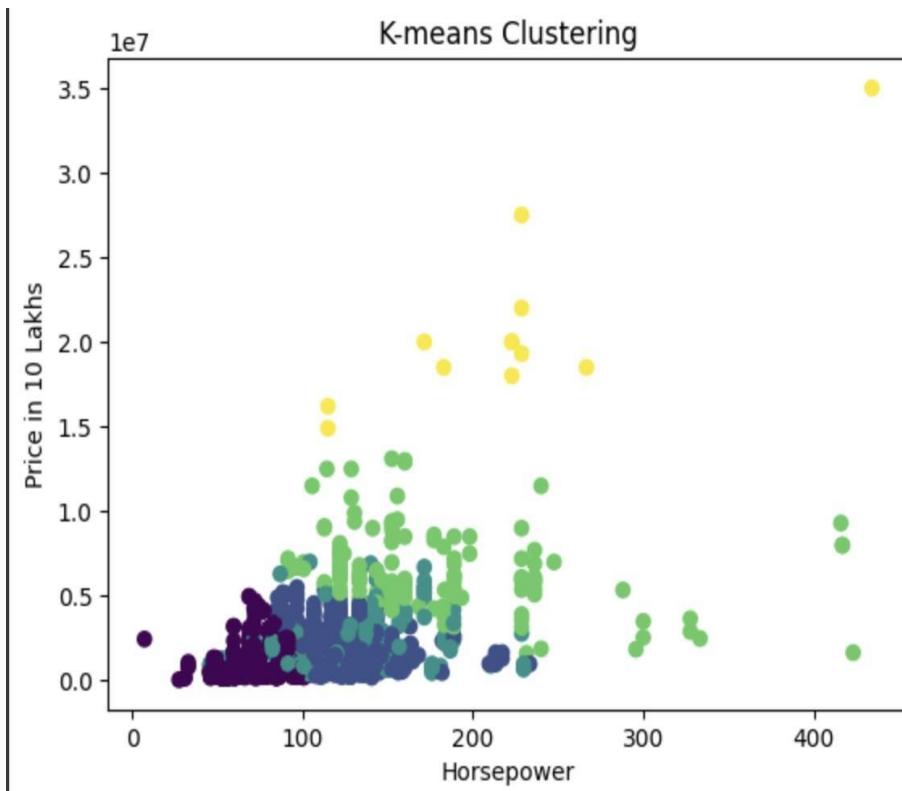
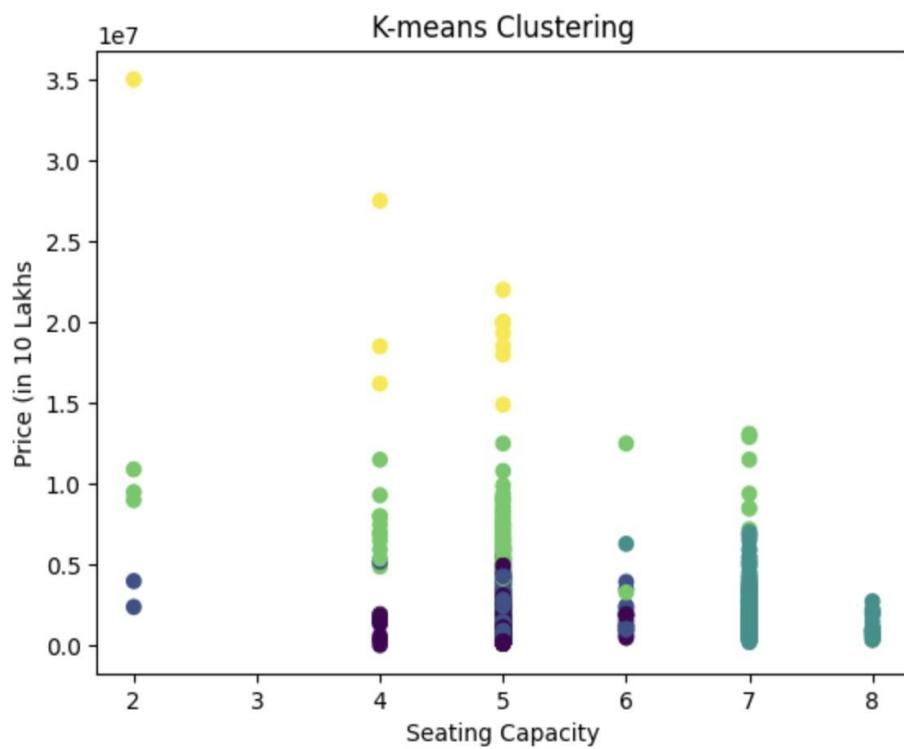


Upon examining the plot displaying the relationship between price and count of car models, a noteworthy observation emerges. The data indicates that the customer base is distributed relatively evenly across all price ranges, with only marginal variations in the number of customers. This finding suggests 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.

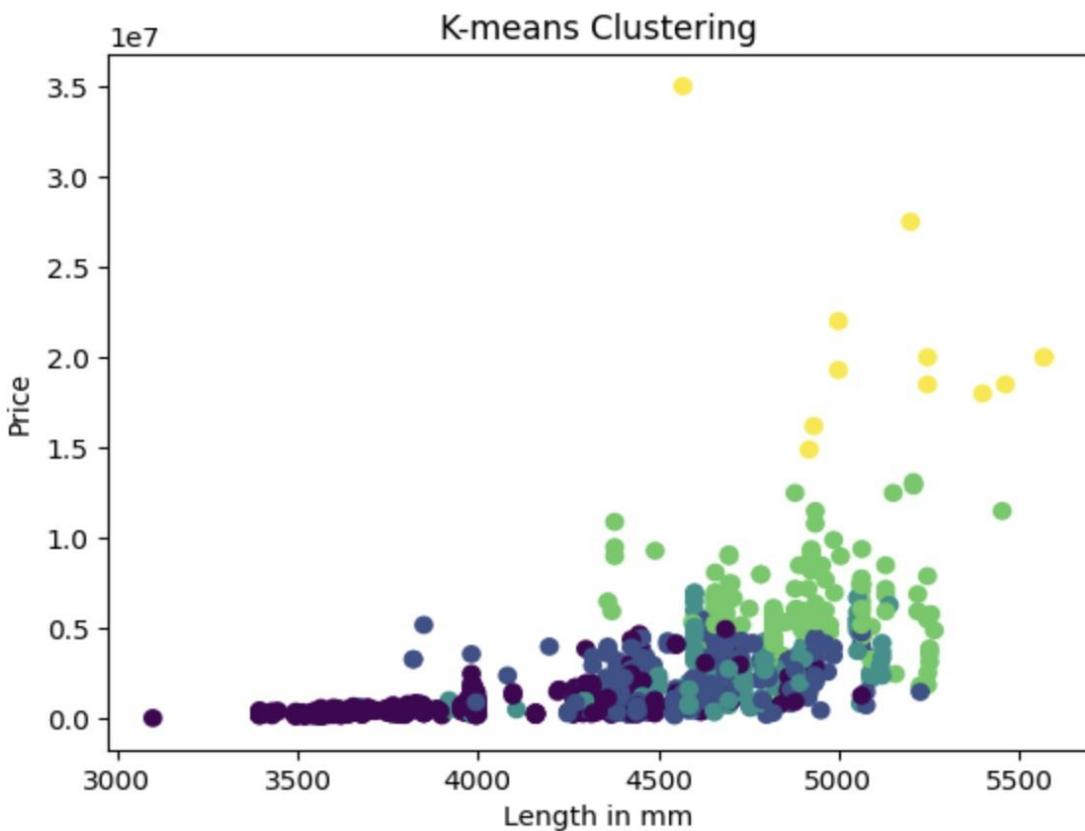
Segment Extraction :

Several insightful findings emerge by conducting K-means clustering on the provided dataset with three clusters and generating a scatter plot that visualizes the relationship between price (in 10 Lakhs) and seating capacity. 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, most customers prefer 5-seater vehicles, with a smaller percentage opting for 4-seaters.

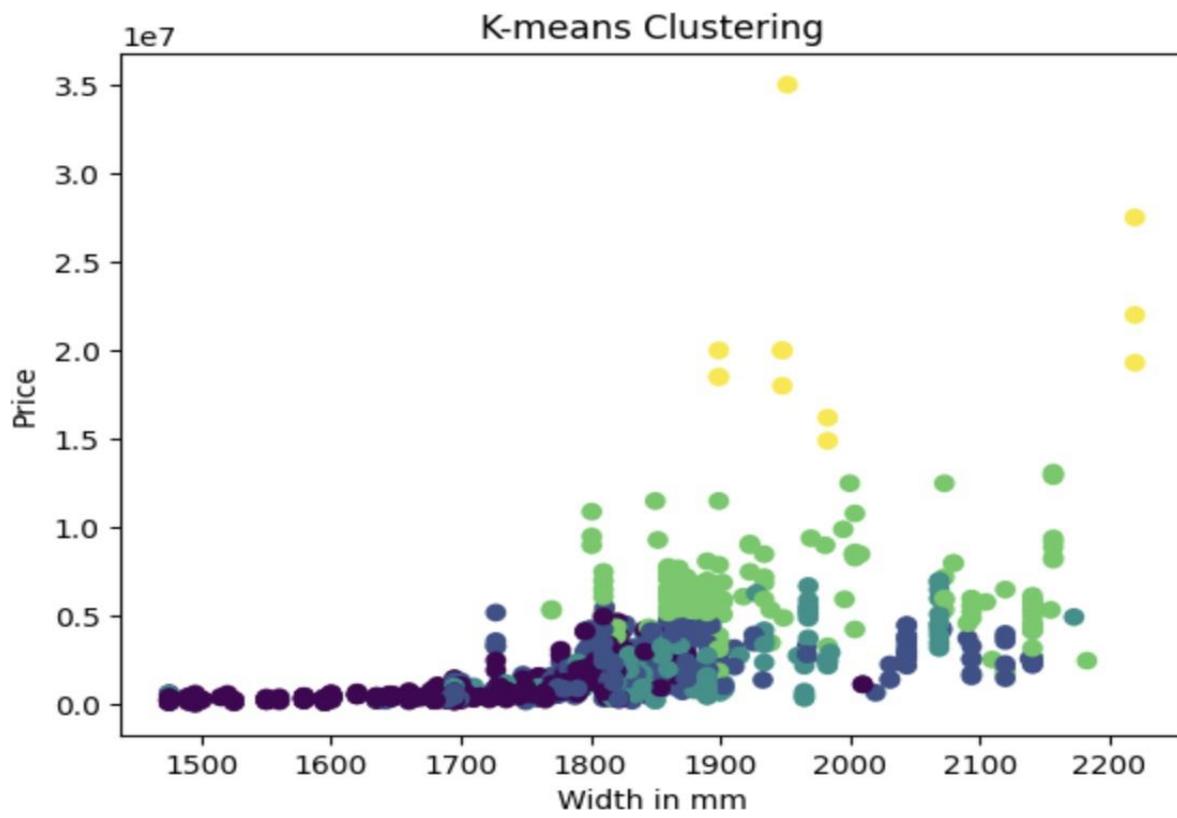
This suggests a shift in customer preferences based on price point, with higher-priced vehicles often featuring a seating capacity of 5 and lower-priced options accommodating larger groups with 7-seater configurations. These insights emphasize the importance of considering price range and seating capacity 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 ten lakhs, two segments emerge: one prioritizes features and compromises on horsepower, while the other values power and safety. Above ten 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 price and horsepower for effective EV market segmentation strategies.



Analyzing a scatter plot of car length versus price unveils compelling insights. Cars priced below five 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 five 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 for increased space or road stability. In contrast, vehicles above five lakhs cluster between 1850 and 2000 mm, with some exceeding 2000 mm. This reflects a 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. As a seasoned conductor selects the most talented musicians for each section, we have pinpointed the 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. We have curated our artful approach in the grand gallery of market opportunities. 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.

```
# Importing necessary dependencies
```

```
import numpy as np
import pandas as pd

data = pd.read_csv('3.csv')

data
```

```
      Unnamed: 0        Brand          Model
AccelSec \
0            0      Tesla    Model 3 Long Range Dual Motor
4.6
1            1  Volkswagen           ID.3 Pure
10.0
2            2   Polestar                2
4.7
3            3       BMW             iX3
6.8
4            4      Honda                 e
9.5
...
...            ...
...
98           98      Nissan          Ariya 63kWh
7.5
99           99      Audi   e-tron S Sportback 55 quattro
4.5
100          100      Nissan          Ariya e-40RCE 63kWh
5.9
101          101      Nissan          Ariya e-40RCE 87kWh Performance
5.1
102          102      Byton        M-Byte 95 kWh 2WD
7.5
```

```
      TopSpeed_KmH  Range_Km  Efficiency_WhKm  FastCharge_KmH
RapidCharge \
0            233      450            161            940
Yes
1            160      270            167            250
No
2            210      400            181            620
Yes
3            180      360            206            560
Yes
4            145      170            168            190
Yes
...
...
98           160      330            191            440
Yes
99           210      335            258            540
Yes
100          200      325            194            440
Yes
```

101	200	375	232	450
Yes				
102	190	400	238	480
No				
PowerTrain	PlugType	BodyStyle	Segment	Seats
0 AWD	Type 2 CCS	Sedan	D	5
1 RWD	Type 2 CCS	Hatchback	C	5
2 AWD	Type 2 CCS	Liftback	D	5
3 RWD	Type 2 CCS	SUV	D	5
4 RWD	Type 2 CCS	Hatchback	B	4
..
98 FWD	Type 2 CCS	Hatchback	C	5
99 AWD	Type 2 CCS	SUV	E	5
100 AWD	Type 2 CCS	Hatchback	C	5
101 AWD	Type 2 CCS	Hatchback	C	5
102 AWD	Type 2 CCS	SUV	E	5

[103 rows x 15 columns]

```
# code for converting euro to INR
data['INR'] = data['PriceEuro'] * 90.0346
```

data.head()

	Unnamed: 0	Brand	Model	AccelSec
0	0	Tesla Model 3 Long Range Dual Motor		4.6
1	1	Volkswagen ID.3 Pure		10.0
2	2	Polestar		2
3	3	BMW iX3		6.8
4	4	Honda e		9.5

RapidCharge	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH
0 Yes	233	450	161	940
1 No	160	270	167	250
2 Yes	210	400	181	620
3 Yes	180	360	206	560
4 Yes	145	170	168	190

PowerTrain	PlugType	BodyStyle	Segment	Seats	PriceEuro
0 AWD	Type 2 CCS	Sedan	D	5	55480
4.995120e+06					

```

1          RWD Type 2 CCS Hatchback      C   5 30000
2.701038e+06
2          AWD Type 2 CCS Liftback      D   5 56440
5.081553e+06
3          RWD Type 2 CCS SUV          D   5 68040
6.125954e+06
4          RWD Type 2 CCS Hatchback    B   4 32997
2.970872e+06

data.drop('Unnamed: 0' , axis = 1 , inplace = True)

data.head()

          Brand           Model AccelSec
TopSpeed_KmH \
0       Tesla  Model 3 Long Range Dual Motor  4.6
233
1 Volkswagen           ID.3 Pure  10.0
160
2 Polestar                  2  4.7
210
3 BMW                     iX3  6.8
180
4 Honda                   e  9.5
145

          Range_Km  Efficiency_WhKm FastCharge_KmH RapidCharge PowerTrain
\
0        450            161        940        Yes      AWD
1        270            167        250        No       RWD
2        400            181        620        Yes      AWD
3        360            206        560        Yes      RWD
4        170            168        190        Yes      RWD

          PlugType BodyStyle Segment Seats PriceEuro INR
0  Type 2 CCS     Sedan      D     5  55480 4.995120e+06
1  Type 2 CCS Hatchback     C     5  30000 2.701038e+06
2  Type 2 CCS Liftback      D     5  56440 5.081553e+06
3  Type 2 CCS     SUV       D     5  68040 6.125954e+06
4  Type 2 CCS Hatchback     B     4  32997 2.970872e+06

data.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 103 entries, 0 to 102
Data columns (total 15 columns):
 #   Column           Non-Null Count  Dtype  
--- 
 0   Brand            103 non-null    object 
 1   Model            103 non-null    object 

```

```

2   AccelSec          103 non-null      float64
3   TopSpeed_KmH     103 non-null      int64
4   Range_Km          103 non-null      int64
5   Efficiency_WhKm  103 non-null      int64
6   FastCharge_KmH   103 non-null      int64
7   RapidCharge       103 non-null      object
8   PowerTrain        103 non-null      object
9   PlugType          103 non-null      object
10  BodyStyle         103 non-null      object
11  Segment           103 non-null      object
12  Seats              103 non-null      int64
13  PriceEuro         103 non-null      int64
14  INR               103 non-null      float64
dtypes: float64(2), int64(6), object(7)
memory usage: 12.2+ KB

data.describe()

      AccelSec  TopSpeed_KmH    Range_Km  Efficiency_WhKm
FastCharge_KmH \
count  103.000000  103.000000  103.000000  103.000000
103.000000
mean    7.396117  179.194175  338.786408  189.165049
444.271845
std     3.017430  43.573030  126.014444  29.566839
203.949253
min     2.100000  123.000000  95.000000  104.000000
170.000000
25%     5.100000  150.000000  250.000000  168.000000
260.000000
50%     7.300000  160.000000  340.000000  180.000000
440.000000
75%     9.000000  200.000000  400.000000  203.000000
555.000000
max    22.400000  410.000000  970.000000  273.000000
940.000000

      Seats  PriceEuro      INR
count  103.000000  103.000000  1.030000e+02
mean    4.883495  55811.563107  5.024972e+06
std     0.795834  34134.665280  3.073301e+06
min     2.000000  20129.000000  1.812306e+06
25%     5.000000  34429.500000  3.099846e+06
50%     5.000000  45000.000000  4.051557e+06
75%     5.000000  65000.000000  5.852249e+06
max    7.000000  215000.000000  1.935744e+07

data.shape
(103, 15)

data.duplicated().sum()
0

```

```

data.isnull().sum()

Brand          0
Model          0
AccelSec       0
TopSpeed_KmH   0
Range_Km        0
Efficiency_WhKm 0
FastCharge_KmH 0
RapidCharge     0
PowerTrain      0
PlugType        0
BodyStyle       0
Segment         0
Seats           0
PriceEuro       0
INR             0
dtype: int64

data['RapidCharge'].replace(to_replace = ['No' , 'Yes'] , value = [0 , 1] , inplace = True)

data.head()

      Brand          Model  AccelSec
TopSpeed_KmH \
0      Tesla    Model 3 Long Range Dual Motor      4.6
233
1      Volkswagen           ID.3 Pure      10.0
160
2      Polestar            2          4.7
210
3      BMW                 iX3          6.8
180
4      Honda               e          9.5
145

      Range_Km  Efficiency_WhKm  FastCharge_KmH  RapidCharge PowerTrain
\
0      450          161          940          1          AWD
1      270          167          250          0          RWD
2      400          181          620          1          AWD
3      360          206          560          1          RWD
4      170          168          190          1          RWD

      PlugType  BodyStyle Segment  Seats  PriceEuro  INR
0  Type 2 CCS      Sedan      D      5      55480  4.995120e+06
1  Type 2 CCS  Hatchback      C      5      30000  2.701038e+06
2  Type 2 CCS  Liftback      D      5      56440  5.081553e+06

```

```

3 Type 2 CCS          SUV      D      5       68040  6.125954e+06
4 Type 2 CCS  Hatchback     B      4       32997  2.970872e+06

data_sortedPrice = data.sort_values('INR')

# plotting different aspects of the data

import matplotlib.pyplot as plt
import seaborn as sn
import plotly.express as px
import plotly.io as pio

# Plotting which brand has low price

fig = px.bar(data_sortedPrice , x = 'Brand' , y = 'INR' , color =
'Brand' , title = 'Car Price Low to High')
fig.show()

{"config": {"plotlyServerURL": "https://plot.ly"}, "data": [
{"alignmentgroup": "True", "hovertimeplate": "Brand=%{x}<br>INR=%{y}<extra></extra>", "legendgroup": "SEAT ", "marker": {"color": "#636efa", "pattern": {"shape": ""}}, "name": "SEAT ", "offsetgroup": "SEAT ", "orientation": "v", "showlegend": true, "textposition": "auto", "type": "bar", "x": ["SEAT "], "xaxis": "x", "y": [1812306.4634], "yaxis": "y"}, {"alignmentgroup": "True", "hovertimeplate": "Brand=%{x}<br>INR=%{y}<extra></extra>", "legendgroup": "Smart ", "marker": {"color": "#EF553B", "pattern": {"shape": ""}}, "name": "Smart ", "offsetgroup": "Smart ", "orientation": "v", "showlegend": true, "textposition": "auto", "type": "bar", "x": ["Smart ", "Smart ", "Smart "], "xaxis": "x", "y": [1925569.9902, 1983462.238, 2211699.949], "yaxis": "y"}, {"alignmentgroup": "True", "hovertimeplate": "Brand=%{x}<br>INR=%{y}<extra></extra>", "legendgroup": "Volkswagen ", "marker": {"color": "#00cc96", "pattern": {"shape": ""}}, "name": "Volkswagen ", "offsetgroup": "Volkswagen ", "orientation": "v", "showlegend": true, "textposition": "auto", "type": "bar", "x": ["Volkswagen ", "Volkswagen ", "Volkswagen ", "Volkswagen ", "Volkswagen ", "Volkswagen "], "xaxis": "x", "y": [1928631.1665999999, 2701038, 2872103.7399999998, 2971141.8, 3202980.895, 3510178.9502, 3685656.3855999997, 4051557], "yaxis": "y"}, {"alignmentgroup": "True", "hovertimeplate": "Brand=%{x}<br>INR=%{y}<extra></extra>", "legendgroup": "Skoda ", "marker": {"color": "#ab63fa", "pattern": {"shape": ""}}, "name": "Skoda ", "offsetgroup": "Skoda ", "orientation": "v", "showlegend": true, "textposition": "auto", "type": "bar", "x": ["Skoda ", "Skoda ", "Skoda ", "Skoda ", "Skoda ", "Skoda "], "xaxis": "x", "y": [2208908.8764, 3151211, 3376297.5, 3601384, 4051557, 4276643.5], "yaxis": "y"}, {"alignmentgroup": "True", "hovertimeplate": "Brand=%{x}<br>INR=%{y}<extra></extra>", "legendgroup": "Renault ", "marker": {"color": "#FFA15A", "pattern": {"shape": ""}}, "name": "Renault ", "offsetgroup": "Renault "
]
}

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Plotting which brand has top speed

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fig = px.bar(data, x = 'Brand', y = 'TopSpeed_KmH', color = 'Brand', title = 'Top Speed')
fig.show()

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# plotting which brand have fast charge

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fig.show()

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```

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```

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", "Renault", "Mazda", "Lexus", "CUPRA", "SEAT", "Lightyear", "Aiways  
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```

```

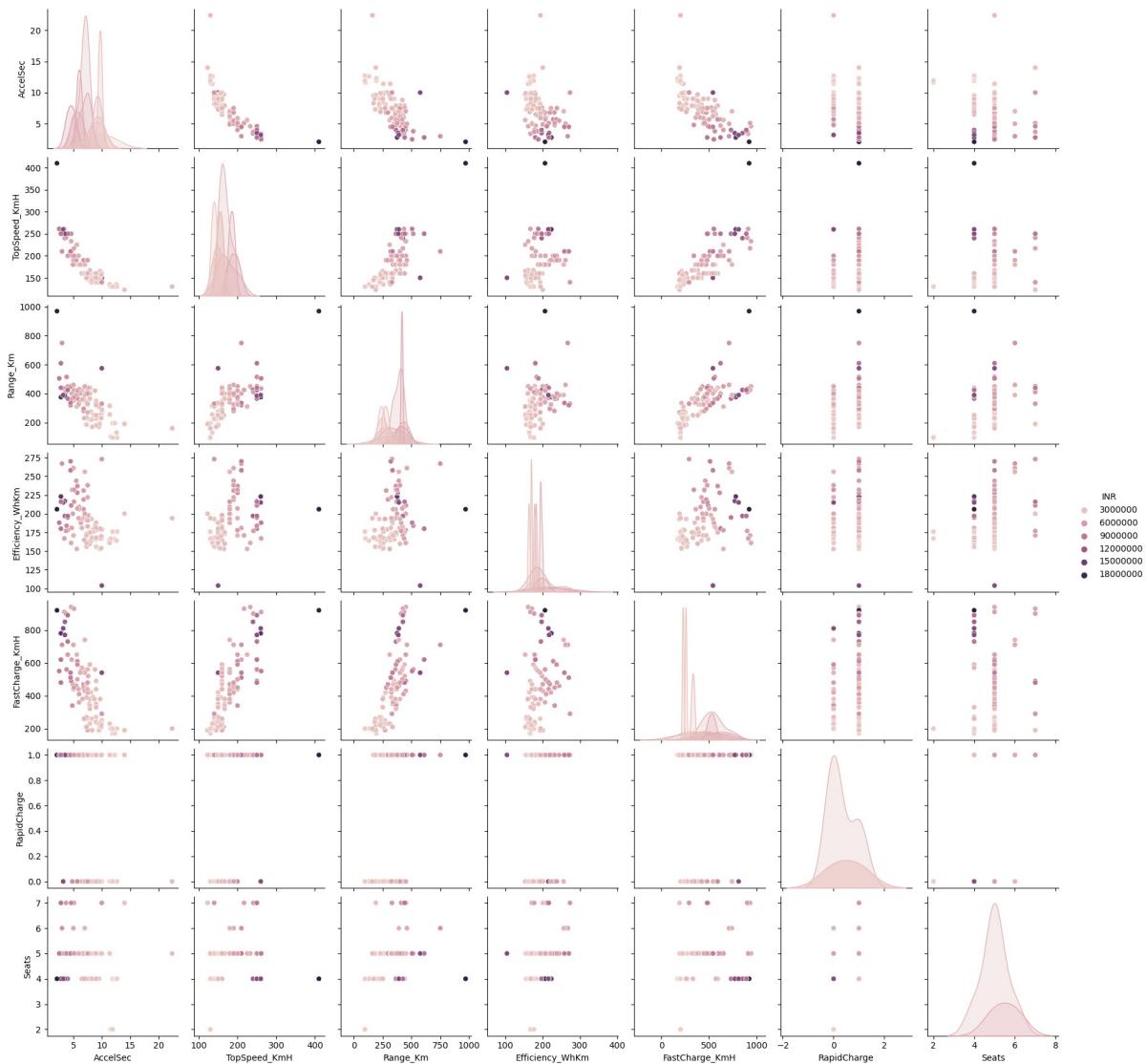
data.drop('PriceEuro' , axis = 1 , inplace = True)

# Pairplot of all the features based on price of the car

sns.pairplot(data , hue = 'INR')

<seaborn.axisgrid.PairGrid at 0x2279af918a0>

```



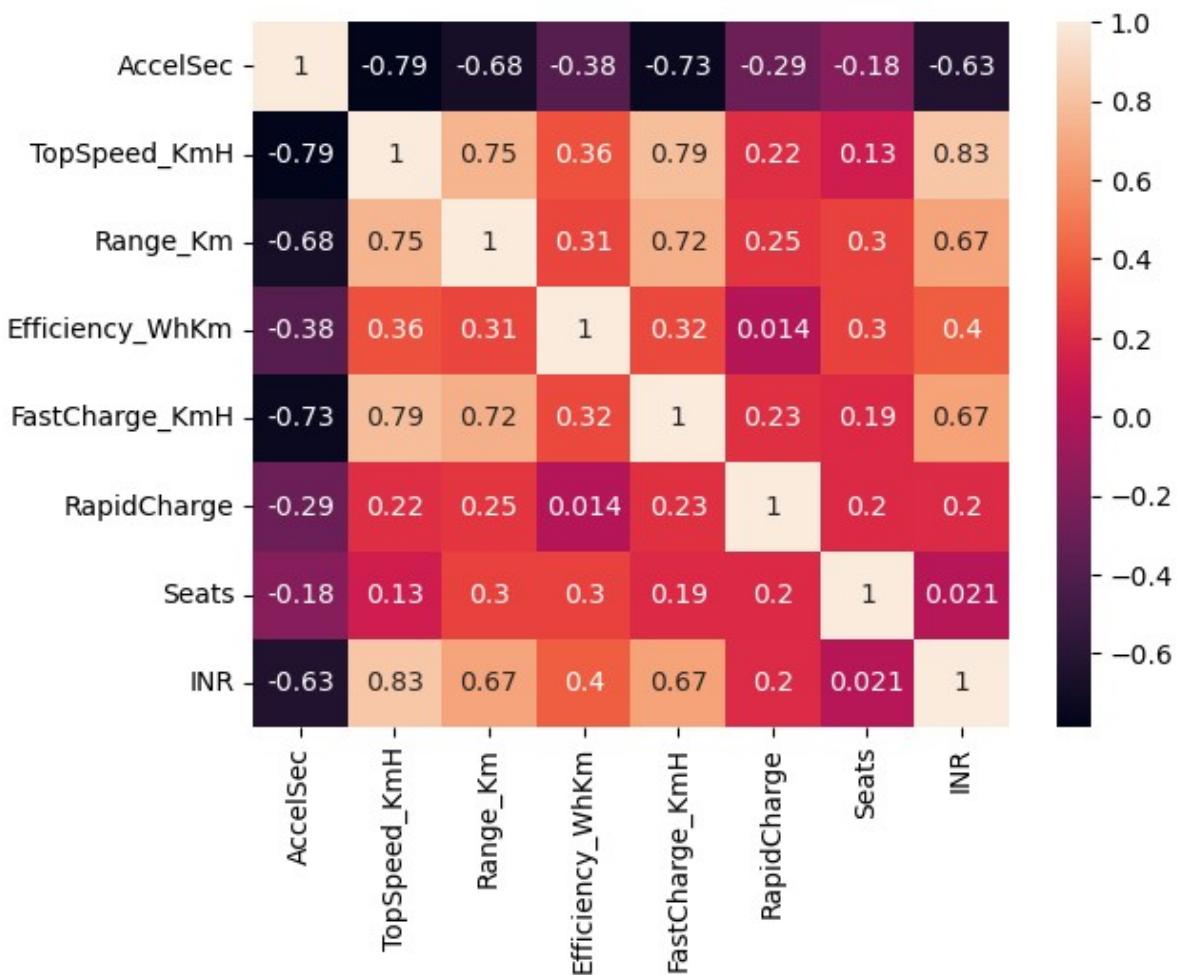
```
# plotting heatmap to show correlation among the features
```

```
sns.heatmap(data.corr() , annot = True)
```

```
C:\Users\gcaba\AppData\Local\Temp\ipykernel_19500\300221568.py:3:
FutureWarning:
```

The default value of numeric_only in DataFrame.corr is deprecated. In a future version, it will default to False. Select only valid columns or specify the value of numeric_only to silence this warning.

<Axes : >



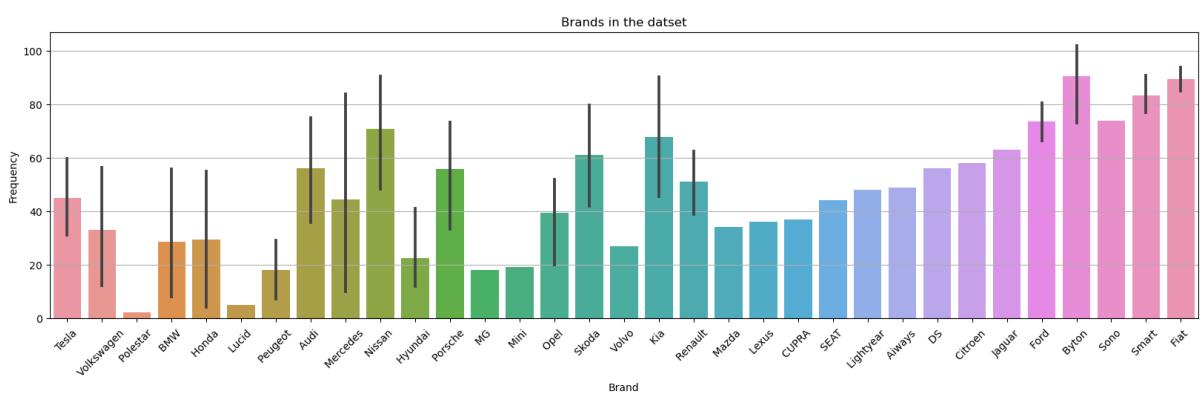
```
a = np.arange(0 , 103)
data.shape
(103, 14)

# Making comparison from the dataset
# Plotting the frequencies of the brand in the dataset

plt.figure(figsize = (20 , 5))
sn.barplot(x = 'Brand',y = a,data = data)
plt.grid(axis = 'y')
plt.title('Brands in the datset')
plt.xlabel('Brand')
plt.ylabel('Frequency')
plt.xticks(rotation = 45)

(array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14,
15, 16,
       17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31,
32]),
```

```
[Text(0, 0, 'Tesla '),
Text(1, 0, 'Volkswagen '),
Text(2, 0, 'Polestar '),
Text(3, 0, 'BMW '),
Text(4, 0, 'Honda '),
Text(5, 0, 'Lucid '),
Text(6, 0, 'Peugeot '),
Text(7, 0, 'Audi '),
Text(8, 0, 'Mercedes '),
Text(9, 0, 'Nissan '),
Text(10, 0, 'Hyundai '),
Text(11, 0, 'Porsche '),
Text(12, 0, 'MG '),
Text(13, 0, 'Mini '),
Text(14, 0, 'Opel '),
Text(15, 0, 'Skoda '),
Text(16, 0, 'Volvo '),
Text(17, 0, 'Kia '),
Text(18, 0, 'Renault '),
Text(19, 0, 'Mazda '),
Text(20, 0, 'Lexus '),
Text(21, 0, 'CUPRA '),
Text(22, 0, 'SEAT '),
Text(23, 0, 'Lightyear '),
Text(24, 0, 'Aiways '),
Text(25, 0, 'DS '),
Text(26, 0, 'Citroen '),
Text(27, 0, 'Jaguar '),
Text(28, 0, 'Ford '),
Text(29, 0, 'Byton '),
Text(30, 0, 'Sono '),
Text(31, 0, 'Smart '),
Text(32, 0, 'Fiat ')])
```



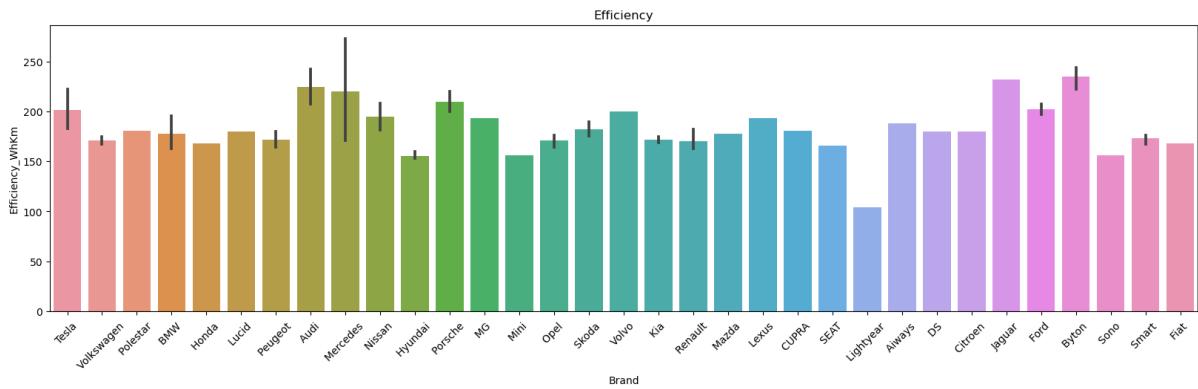
```
# Byton , Fiat and Smart have the more freqeucy and Polester being the least
```

```
# Plotting which car have the best efficency
```

```
plt.figure(figsize = (20 , 5))
sns.barplot(x = 'Brand' , y = 'Efficiency_WhKm' , data = data)
```

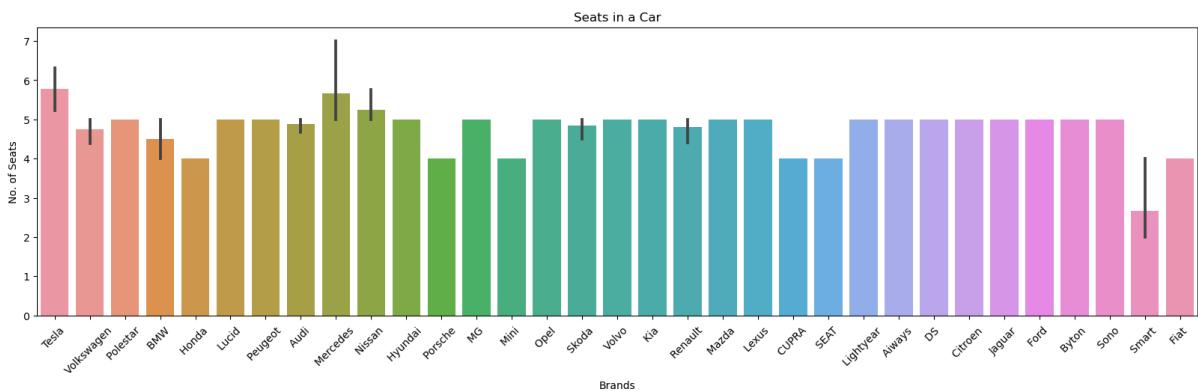
```
plt.title('Efficiency')
plt.xlabel('Brand')
plt.ylabel('Efficiency_WhKm')
plt.xticks(rotation = 45)

(array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14,
15, 16,
       17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31,
32]),  
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 Text(1, 0, 'Volkswagen '),
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 Text(3, 0, 'BMW '),
 Text(4, 0, 'Honda '),
 Text(5, 0, 'Lucid '),
 Text(6, 0, 'Peugeot '),
 Text(7, 0, 'Audi '),
 Text(8, 0, 'Mercedes '),
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 Text(29, 0, 'Byton '),
 Text(30, 0, 'Sono '),
 Text(31, 0, 'Smart '),
 Text(32, 0, 'Fiat ')])
```



Efficiency is best in Byton , Jaguar and Audi and least is Lightyear

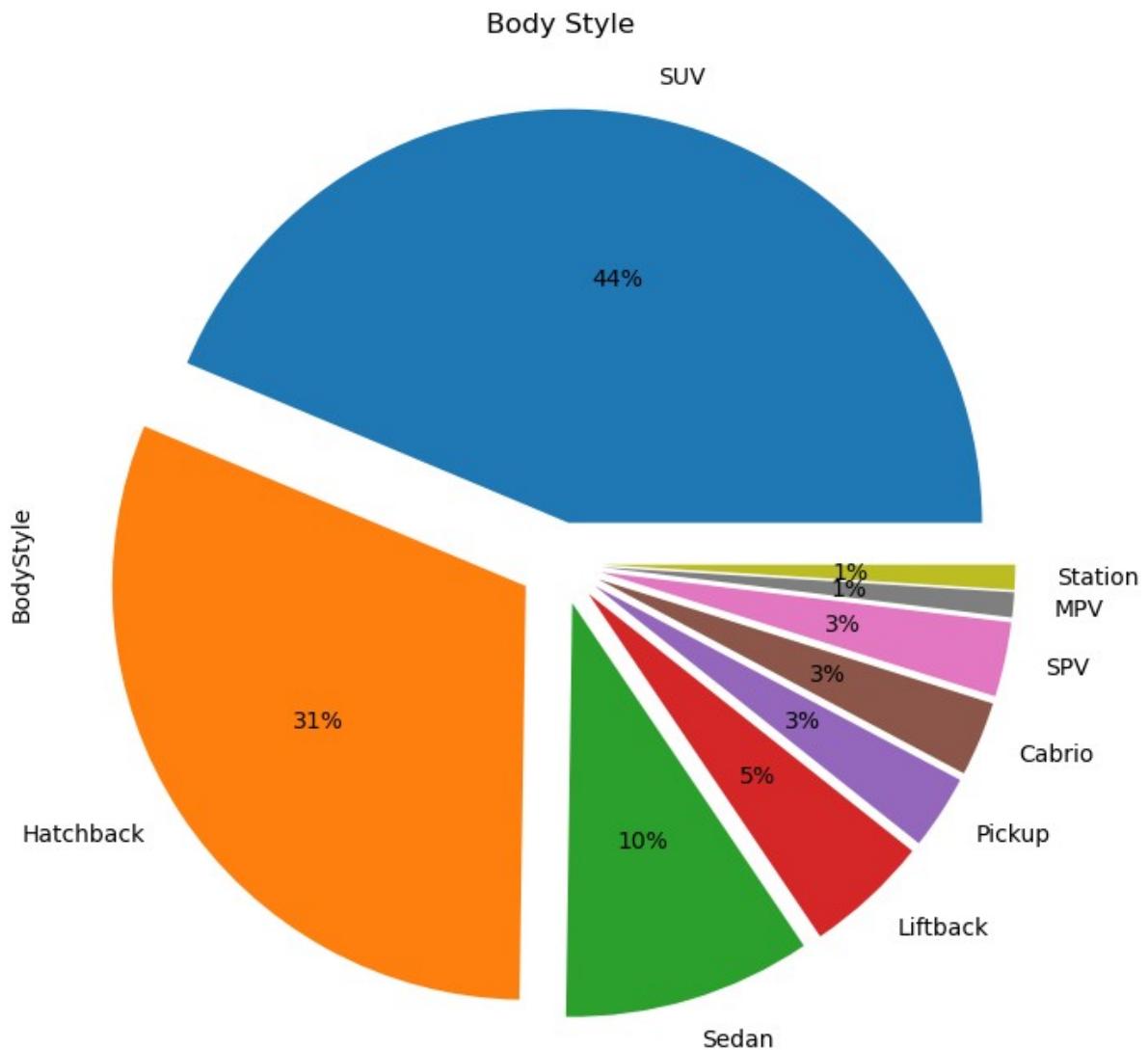
```
plt.figure(figsize = (20 , 5))
sn.barplot(x = 'Brand' , y = 'Seats' , data = data)
plt.title('Seats in a Car')
plt.xlabel('Brands')
plt.ylabel('No. of Seats')
plt.xticks(rotation = 45)
plt.show()
```



Majority of cars have 5 seats

```
data['BodyStyle'].value_counts().plot.pie(figsize = (8 , 15) ,
 autopct = '%.0f%%' , explode = (0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1))
plt.title('Body Style')

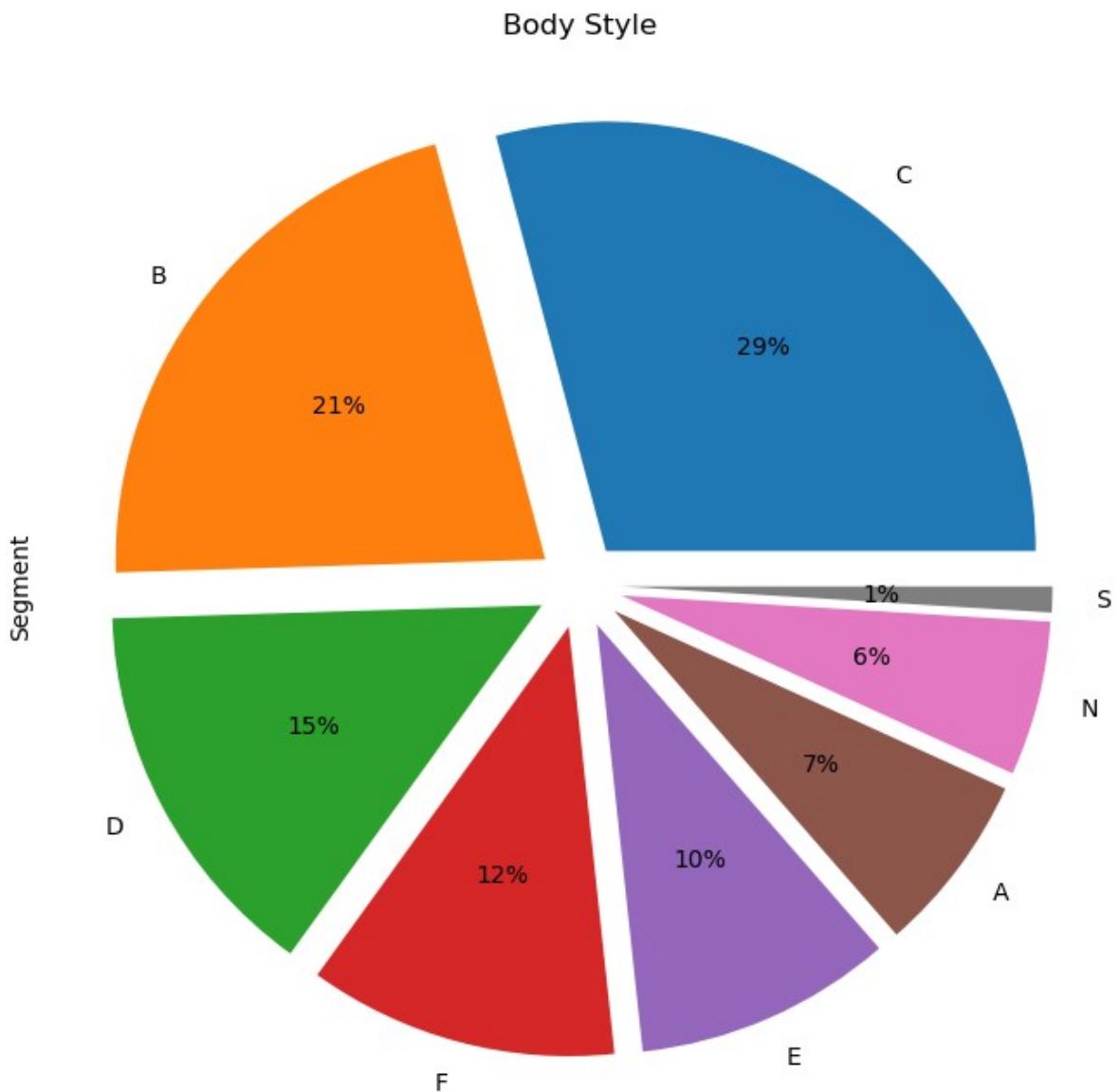
Text(0.5, 1.0, 'Body Style')
```



```
# SUV and Hatchback are popular among the customer
```

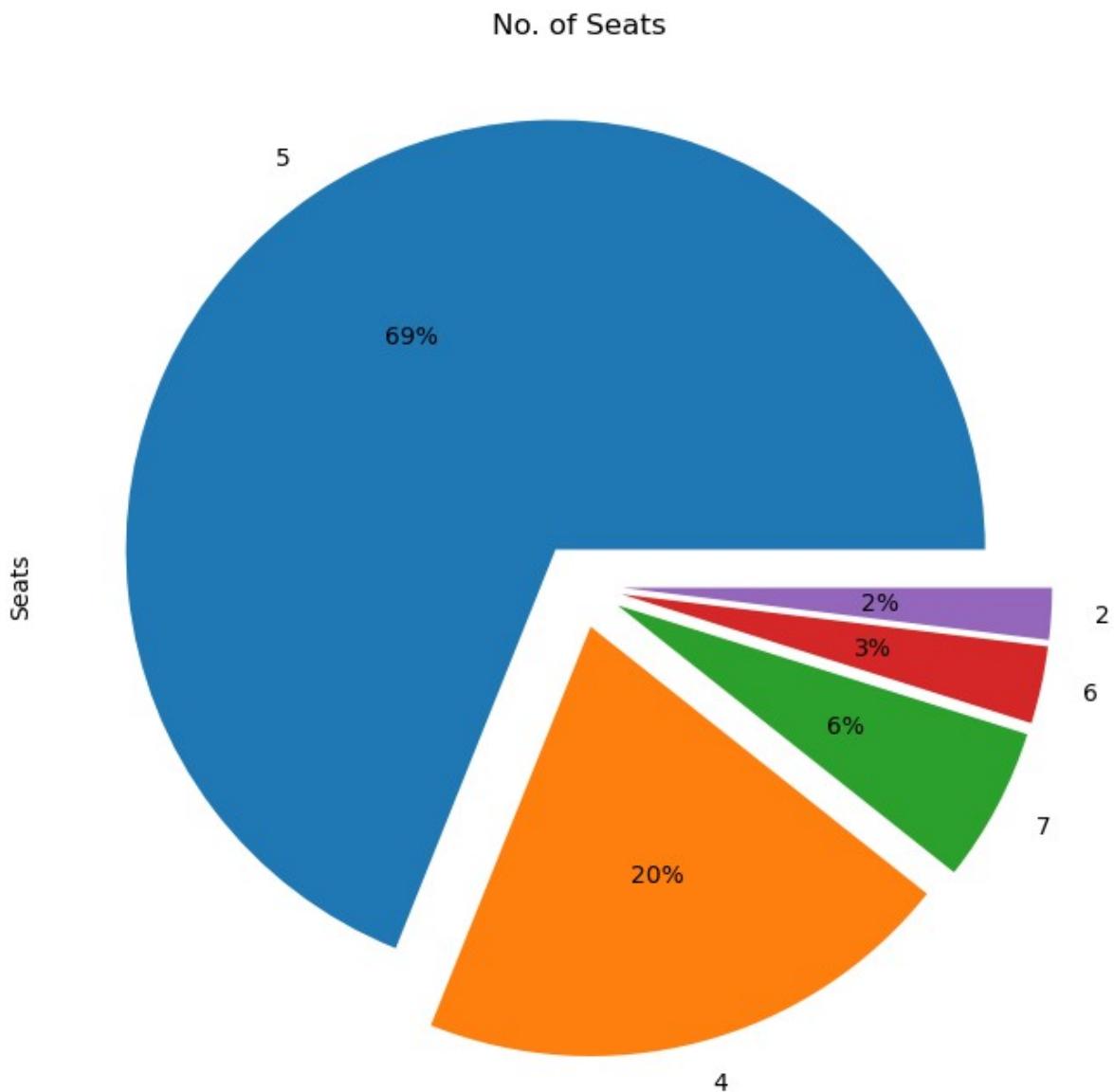
```
data['Segment'].value_counts().plot.pie(figsize = (8 , 15) ,  
 autopct='%.0f%%' , explode=(0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1))  
plt.title('Body Style')
```

```
Text(0.5, 1.0, 'Body Style')
```



```
# Most segments are in B and C
```

```
data['Seats'].value_counts().plot.pie(figsize = (8,15) , autopct = '%0.f%%' , explode = (0.1,0.1,0.1,0.1,0.1))
plt.title("No. of Seats")
Text(0.5, 1.0, 'No. of Seats')
```



```
# 5 seats are most preferable
# Model Making and Training
# 1. Linear Regression

data['PowerTrain'].replace(to_replace = ['RWD' , 'FWD' , 'AWD'] ,
value = [0 , 1 , 2] , inplace = True)

X = data[['AccelSec' , 'TopSpeed_KmH' , 'Range_Km' ,
'Efficiency_WhKm' , 'RapidCharge' , 'PowerTrain']]
Y = data['INR']

# Finding linear regression using ols method

import statsmodels.api as sm
```

```

X = sm.add_constant(X)
results = sm.OLS(Y , X)

models = results.fit()
models.summary()

<class 'statsmodels.iolib.summary.Summary'>
"""
                OLS Regression Results
=====

Dep. Variable:                      INR      R-squared:
0.721                               OLS      Adj. R-squared:
0.704
Method:                 Least Squares      F-statistic:
41.36
Date:                  Sat, 30 Sep 2023      Prob (F-statistic):
1.57e-24
Time:                      14:38:06      Log-Likelihood:
-1618.5
No. Observations:                  103      AIC:
3251.
Df Residuals:                      96      BIC:
3270.
Df Model:                           6

Covariance Type:            nonrobust
=====

                    coef      std err          t      P>|t|
[0.025      0.975]
-----
const        -9.283e+06    2.15e+06     -4.324      0.000  -
1.35e+07    -5.02e+06
AccelSec       1.578e+05    9.44e+04      1.672      0.098  -
2.96e+04      3.45e+05
TopSpeed_KmH     5.238e+04   7217.017      7.257      0.000
3.81e+04      6.67e+04
Range_Km        3268.2523   2037.375      1.604      0.112  -
775.905      7312.409
Efficiency_WhKm  1.059e+04   6330.081      1.674      0.097  -
1970.874      2.32e+04
RapidCharge      1.32e+05    4.05e+05      0.326      0.745  -
6.72e+05      9.36e+05
PowerTrain       4.714e+05    2.66e+05      1.771      0.080  -
5.69e+04      1e+06
=====

Omnibus:                  84.867      Durbin-Watson:
2.060

```

```

Prob(Omnibus):                  0.000   Jarque-Bera (JB):
741.645
Skew:                           2.644   Prob(JB):
8.99e-162
Kurtosis:                      15.036   Cond. No.
5.79e+03
=====
=====
```

Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 5.79e+03. This might indicate that there are strong multicollinearity or other numerical problems.

```

from sklearn.model_selection import train_test_split

X_train , X_test , Y_train , Y_test = train_test_split(X , Y ,
test_size = 0.2 , random_state = 42)

from sklearn.linear_model import LinearRegression

lr = LinearRegression()
lr.fit(X_train , Y_train)
pred = lr.predict(X_test)

# R2 Score

from sklearn.metrics import accuracy_score , r2_score

r2_scoree = r2_score(Y_test , pred)
r2_scoree *100

53.134843829797106

# Around 53% of the dependant variable has been explained by the
# independant variables

# 2. Logistic Regression

X1 = data[['INR']]
Y1 = data[['RapidCharge']]

X1_train , X1_test , Y1_train , Y1_test = train_test_split(X1 , Y1 ,
test_size = 0.2 , random_state = 42)

from sklearn.linear_model import LogisticRegression

lor = LogisticRegression()

lor.fit(X1_train , Y1_train)
pred = lor.predict(X1_test)
pred
```

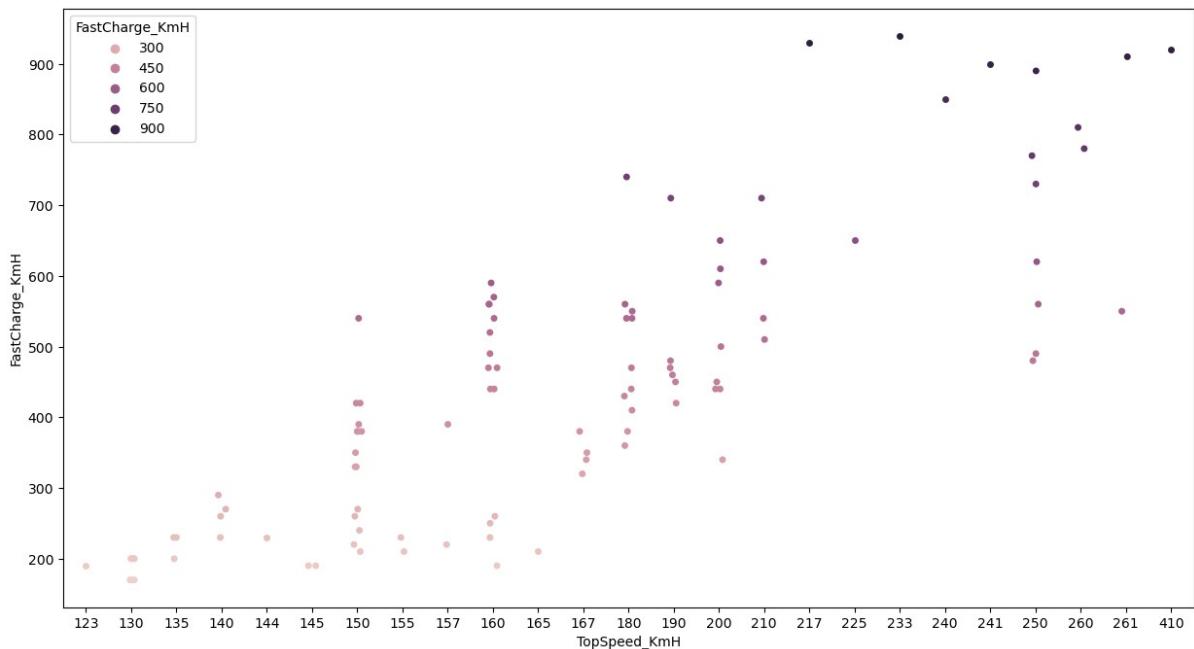
```
C:\Users\gcaba\anaconda3\lib\site-packages\sklearn\utils\validation.py:1143: DataConversionWarning:
```

```
A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
```

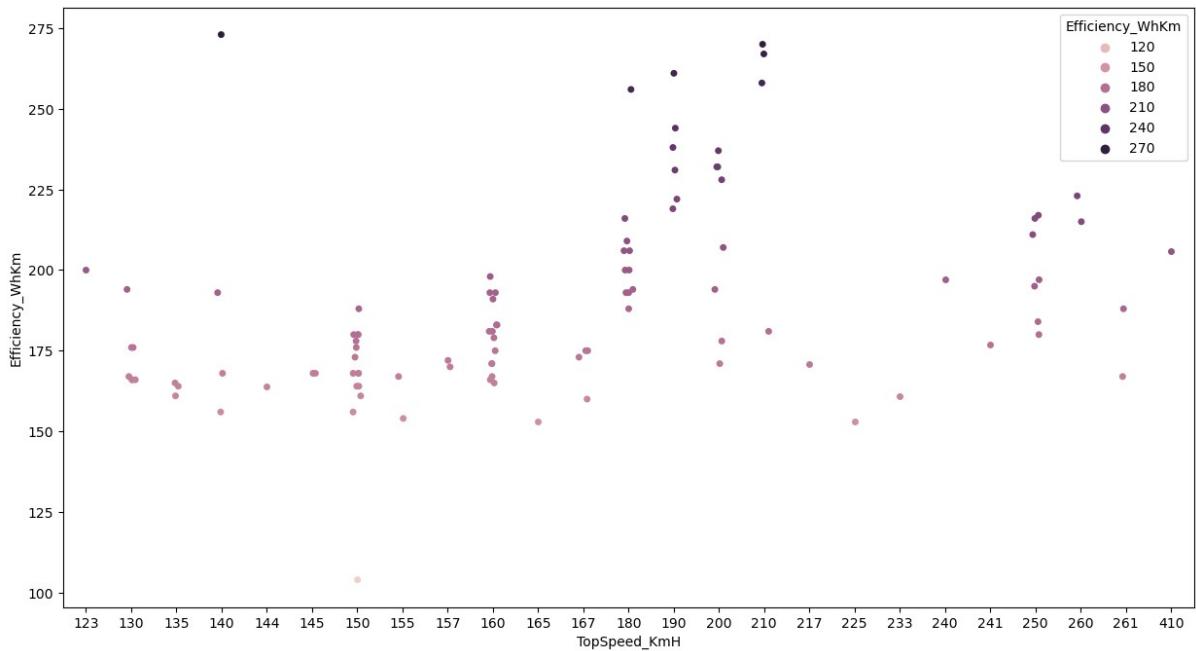
```
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1],  
      dtype=int64)
```

CLUSTERING

```
plt.subplots(figsize = (15 , 8))  
sn.stripplot(x = 'TopSpeed_KmH' , y = 'FastCharge_KmH' , data = data  
, hue = 'FastCharge_KmH' , legend = True , jitter = True)  
plt.show()
```



```
plt.subplots(figsize = (15 , 8))  
sn.stripplot(x = 'TopSpeed_KmH' , y = 'Efficiency_WhKm' , data =  
data , hue = 'Efficiency_WhKm')  
  
<Axes: xlabel='TopSpeed_KmH', ylabel='Efficiency_WhKm'>
```



```
# Applying PCA for dimension reduction
```

```
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler

x = ['AccelSec' , 'TopSpeed_KmH' , 'Range_Km' , 'Efficiency_WhKm' ,
'FastCharge_KmH' , 'RapidCharge' , 'PowerTrain' , 'Seats' , 'INR']

x = data.loc[:, x].values
x = StandardScaler().fit_transform(x)
```

```
pca = PCA(n_components = 9)
```

```
s = pca.fit_transform(x)
```

```
data1 = pd.DataFrame(s, columns=['PC1',
'PC2','PC3','PC4','Pc5','PC6','PC7','PC8','PC9'])
data1
```

	PC1	PC2	PC3	PC4	Pc5	PC6
PC7 \						
0	2.429225	-0.554599	-1.147772	-0.882791	0.839988	-0.959297
0.998880						
1	-2.322483	-0.345449	0.896473	-1.305529	0.079598	0.235116
0.213678						
2	1.587851	0.008899	-0.650523	0.041024	0.593537	-0.698248
0.058718						
3	0.291018	-0.000150	-0.307702	-0.514196	-1.608861	0.291624
0.364999						
4	-2.602679	-0.626489	-0.888088	0.585294	-0.802108	0.027387
0.084955						
...
...						

```
98 -0.297170 0.446713 -0.463601 0.102542 -0.346005 -0.100457  
0.031080  
99 2.335018 0.630747 0.985883 1.560112 -0.817327 -0.121906  
0.164115  
100 0.780642 0.426821 -0.298636 0.708598 0.481728 -0.540071 -  
0.139753  
101 1.540920 0.698754 0.422384 1.094921 -0.298113 -0.307992 -  
0.363230  
102 0.915051 0.261495 2.410642 0.188002 0.340820 0.015609 -  
0.171875
```

	PC8	PC9
0	0.711148	-0.396662
1	-0.544135	-0.181867
2	0.248837	-0.202775
3	-0.235543	0.261663
4	-0.507790	-0.049904
..
98	0.202253	0.145390
99	-0.255651	0.141023
100	-0.048733	-0.367509
101	0.127251	-0.190397
102	0.567633	-0.200822

[103 rows x 9 columns]

```
data1.head()
```

	PC1	PC2	PC3	PC4	Pc5	PC6
PC7 \						
0	2.429225	-0.554599	-1.147772	-0.882791	0.839988	-0.959297
	0.998880					
1	-2.322483	-0.345449	0.896473	-1.305529	0.079598	0.235116 -
	0.213678					
2	1.587851	0.008899	-0.650523	0.041024	0.593537	-0.698248
	0.058718					
3	0.291018	-0.000150	-0.307702	-0.514196	-1.608861	0.291624
	0.364999					
4	-2.602679	-0.626489	-0.888088	0.585294	-0.802108	0.027387 -
	0.084955					

	PC8	PC9
0	0.711148	-0.396662
1	-0.544135	-0.181867
2	0.248837	-0.202775
3	-0.235543	0.261663
4	-0.507790	-0.049904

Finding the correlation coefficient between the original variable and the components

```
loadings = pca.components_
features = pca.n_features_
pc = ['PC' + str(i) for i in list(range(1 , features + 1))]
```

```

loadings_df = pd.DataFrame.from_dict(dict(zip(pc , loadings)))
loadings_df[ 'Variable' ] = data1.columns.values
loadings_df = loadings_df.set_index('Variable')
loadings_df

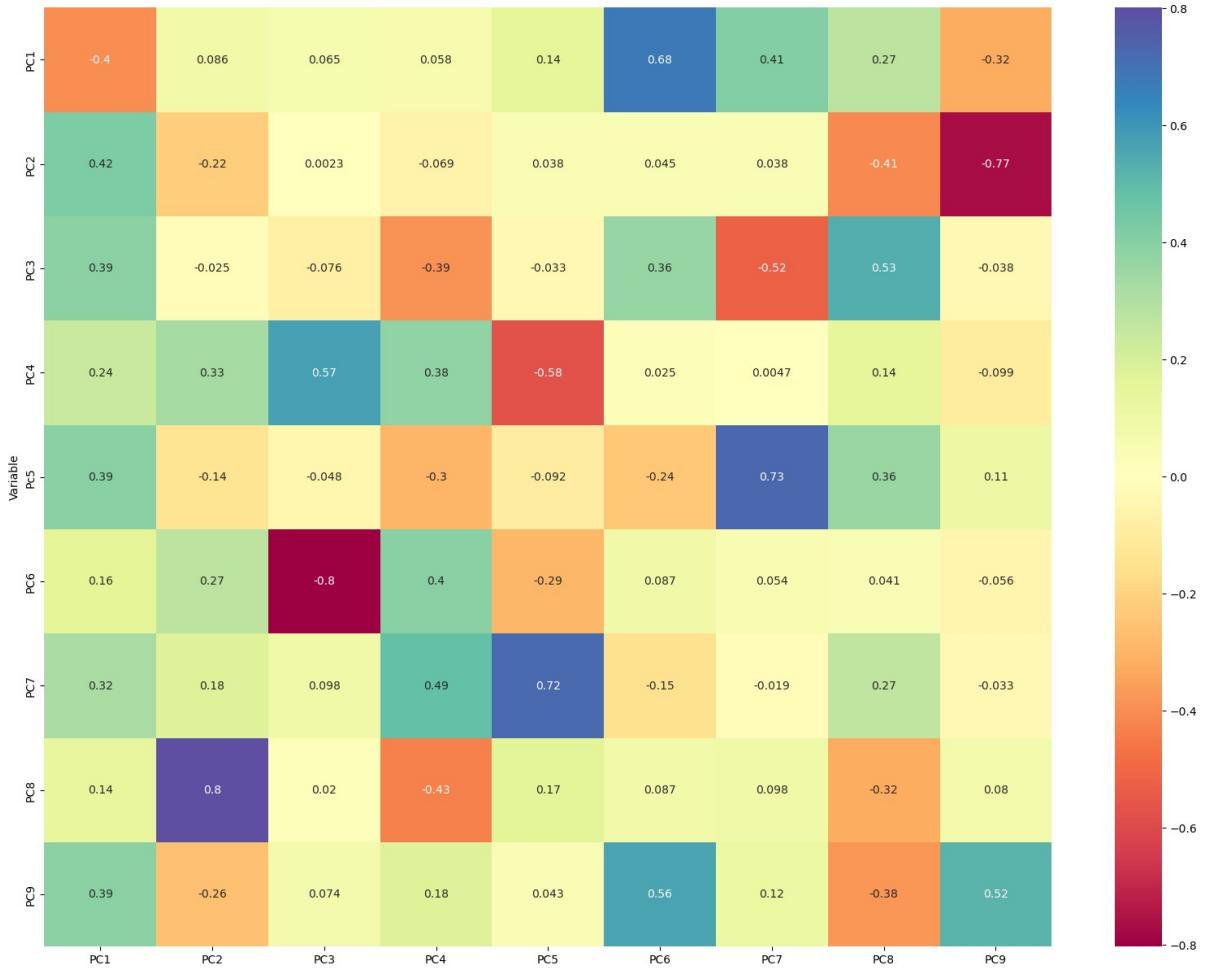
C:\Users\gcaba\anaconda3\lib\site-packages\sklearn\utils\
deprecation.py:101: FutureWarning:
Attribute `n_features_` was deprecated in version 1.2 and will be
removed in 1.4. Use `n_features_in_` instead.

          PC1        PC2        PC3        PC4        PC5        PC6
\ Variable
PC1      -0.396410  0.086150  0.064757  0.058253  0.144548  0.676910
PC2       0.421973 -0.216762  0.002272 -0.068523  0.038208  0.045212
PC3       0.389544 -0.024746 -0.076295 -0.387135 -0.032841  0.364461
PC4       0.238316  0.330919  0.571780  0.380475 -0.575143  0.024863
Pc5       0.394519 -0.138428 -0.047650 -0.296483 -0.092366 -0.237914
PC6       0.157195  0.269920 -0.803300  0.395300 -0.292581  0.086978
PC7       0.322888  0.180494  0.098293  0.486554  0.722814 -0.149888
PC8       0.140425  0.801307  0.019535 -0.428983  0.165256  0.086668
PC9       0.389779 -0.262265  0.073787  0.179862  0.043293  0.558706

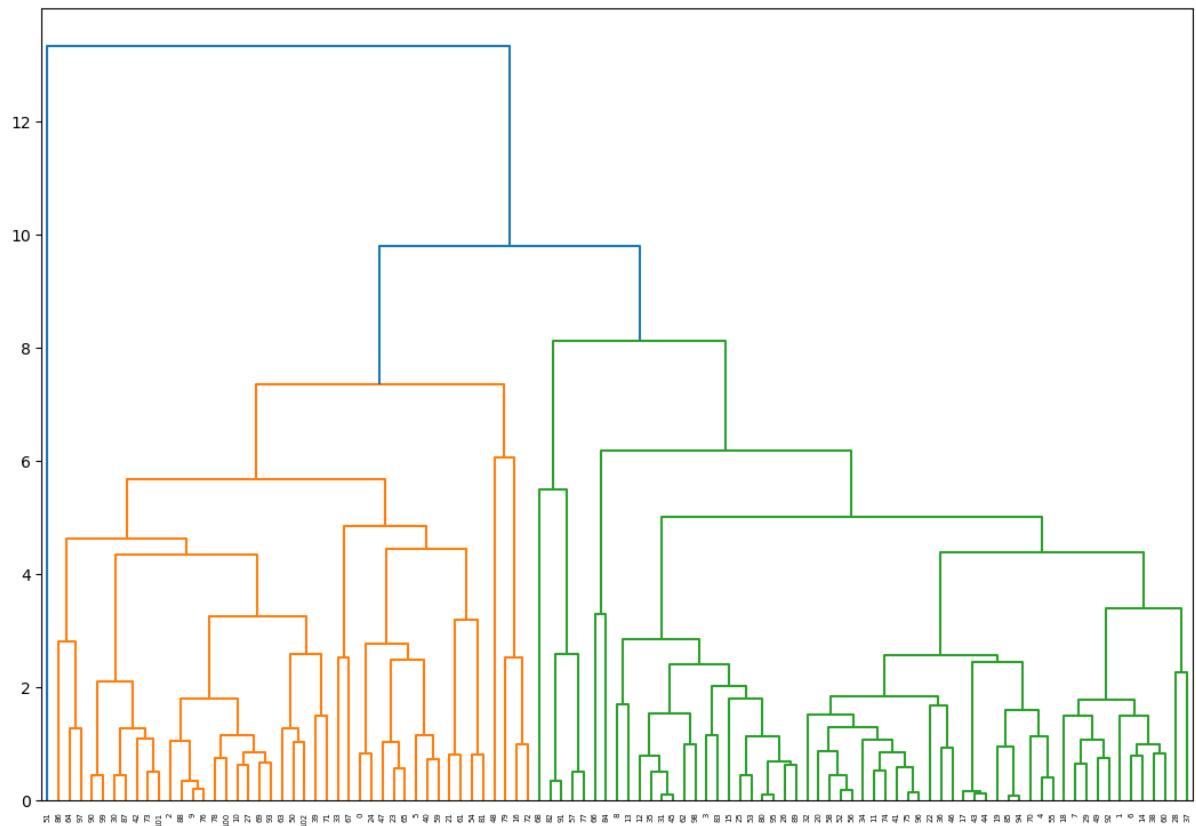
          PC7        PC8        PC9
Variable
PC1      0.412498  0.270655 -0.324562
PC2      0.037576 -0.413810 -0.770777
PC3     -0.520811  0.534180 -0.038015
PC4      0.004703  0.144167 -0.098954
Pc5      0.728208  0.358365  0.105702
PC6      0.053875  0.040830 -0.056056
PC7     -0.019098  0.265275 -0.033267
PC8      0.098379 -0.320750  0.079999
PC9      0.118043 -0.382139  0.517207

# Correlation matrix through heatmap
plt.rcParams['figure.figsize'] = (20 , 15)
sn.heatmap(loadings_df , annot = True , cmap = 'Spectral')
plt.show()

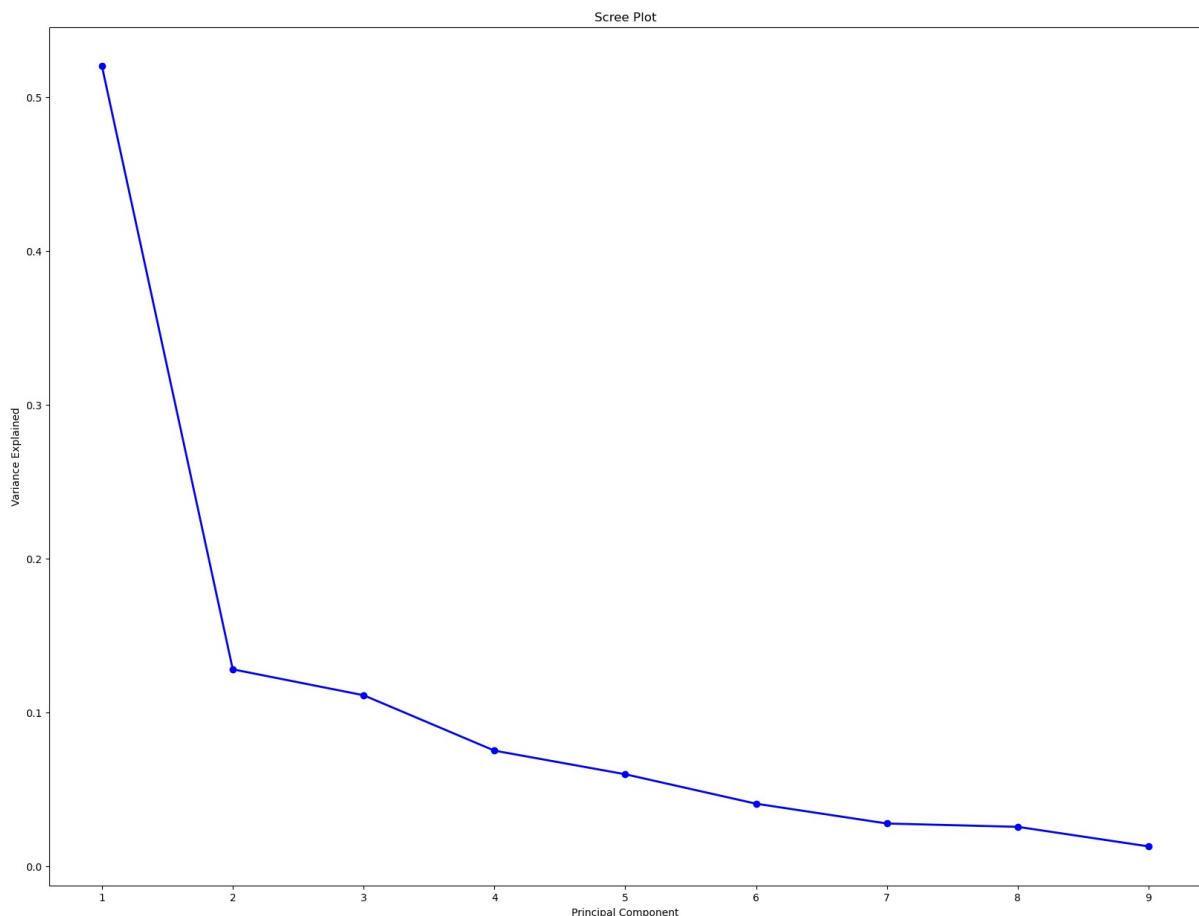
```



```
from scipy.cluster.hierarchy import linkage , dendrogram
linkage = linkage(data1 , 'complete')
plt.figure(figsize = (13 , 9))
dendrogram(linkage , orientation = 'top')
plt.show()
```



```
PC_values = np.arange(pca.n_components_) + 1
plt.plot(PC_values , pca.explained_variance_ratio_ , 'o-' ,
linewidth = 2 , color='blue')
plt.title('Scree Plot')
plt.xlabel('Principal Component')
plt.ylabel('Variance Explained')
plt.show()
```



```
from sklearn.cluster import KMeans

kmeans = KMeans(n_clusters = 4 , random_state = 1234)
kmeans.fit(s)

labels = kmeans.labels_
centroid = kmeans.cluster_centers_

C:\Users\gcaba\anaconda3\lib\site-packages\sklearn\cluster\
_kmeans.py:870: FutureWarning:
The default value of `n_init` will change from 10 to 'auto' in 1.4.
Set the value of `n_init` explicitly to suppress the warning
C:\Users\gcaba\anaconda3\lib\site-packages\sklearn\cluster\
_kmeans.py:1382: UserWarning:
KMeans is known to have a memory leak on Windows with MKL, when
there are less chunks than available threads. You can avoid it by
setting the environment variable OMP_NUM_THREADS=1.

print('labels')
print(labels)
print()
```

```

print('centers of cluster')
print(centroid)

labels
[2 3 2 0 0 1 3 3 0 2 2 0 0 0 3 0 1 3 3 0 0 2 0 1 1 0 0 2 3 3 2 0 0 2
0 0 0
 0 3 2 2 0 2 3 3 0 0 1 0 3 2 1 0 0 2 0 0 3 0 1 3 2 0 2 0 1 0 2 3 2 0
2 1 2
 0 0 2 3 2 1 0 2 3 0 2 0 2 2 2 0 2 3 3 2 0 0 0 0 0 2 2 2 2]

centers of cluster
[[ -9.63875953e-01  7.14078379e-02 -6.69729916e-01 -2.00066932e-01
 -3.10583174e-01  9.10303437e-02 -5.13212658e-02 -4.57042120e-02
 7.42717750e-02]
 [ 3.77594045e+00 -1.59679237e+00 -1.05923663e-01  3.07865757e-01
 1.47468304e-01  2.06467629e-01  2.75760195e-01 -2.50165978e-01
 -3.72964068e-02]
 [ 1.58938048e+00  7.31466796e-01  4.32889213e-01  2.41682908e-01
 1.05189480e-01 -2.41010221e-01 -2.97483033e-02  1.39302659e-01
 -3.63575697e-02]
 [-2.53351525e+00 -5.49375944e-01  8.07128331e-01 -1.26826289e-01
 4.31776154e-01  9.60198070e-02  1.84124693e-02 -1.91833629e-03
 -8.33162238e-02]]

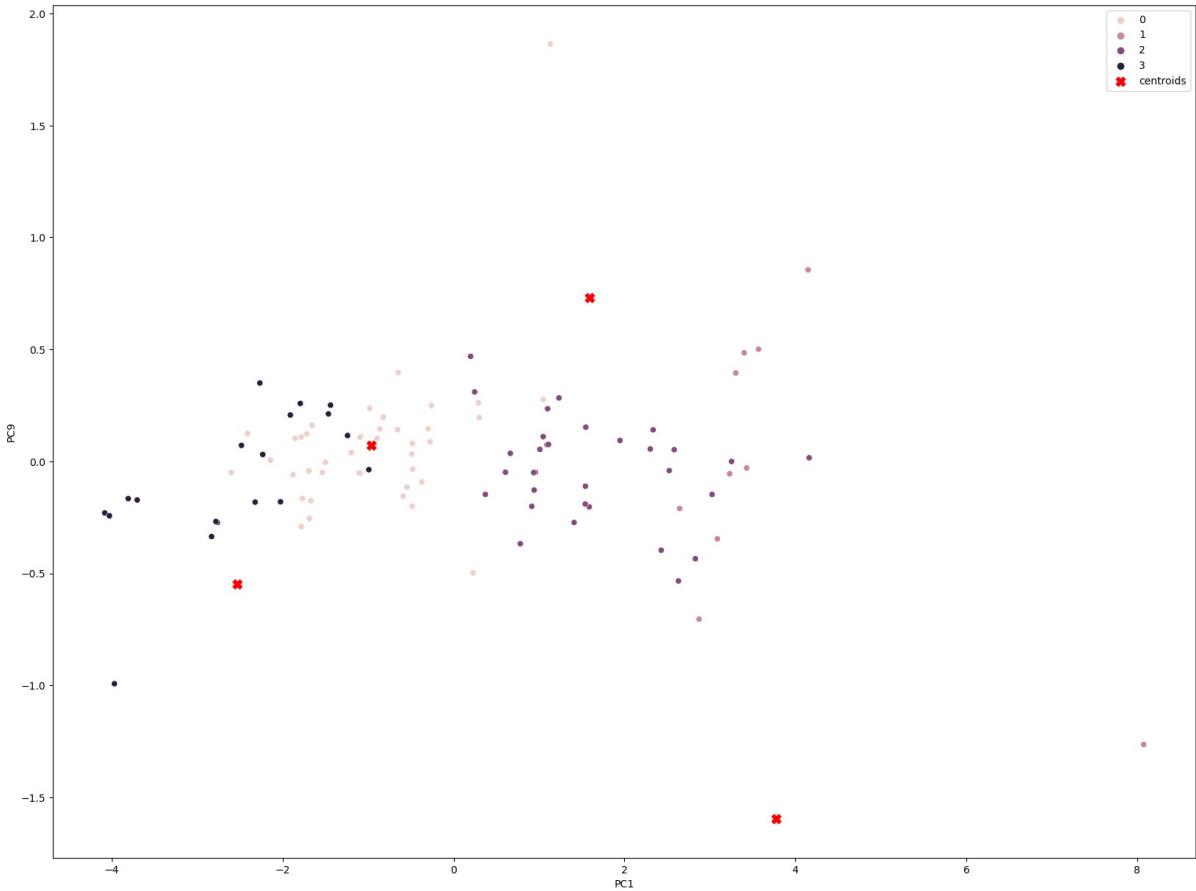
from collections import Counter

Counter(kmeans.labels_) ## to see the cluster size

Counter({2: 32, 3: 19, 0: 42, 1: 10})

sn.scatterplot(data = data1, x="PC1", y="PC9", hue=kmeans.labels_)
plt.scatter(kmeans.cluster_centers_[:,0],
            kmeans.cluster_centers_[:,1],
            marker="X", c="r", s=80, label="centroids")
plt.legend()
plt.show()

```



```
# Applying LINEAR REGRESSION in the PCA data on the basis of COST
```

```
X = data1
Y = data['INR']

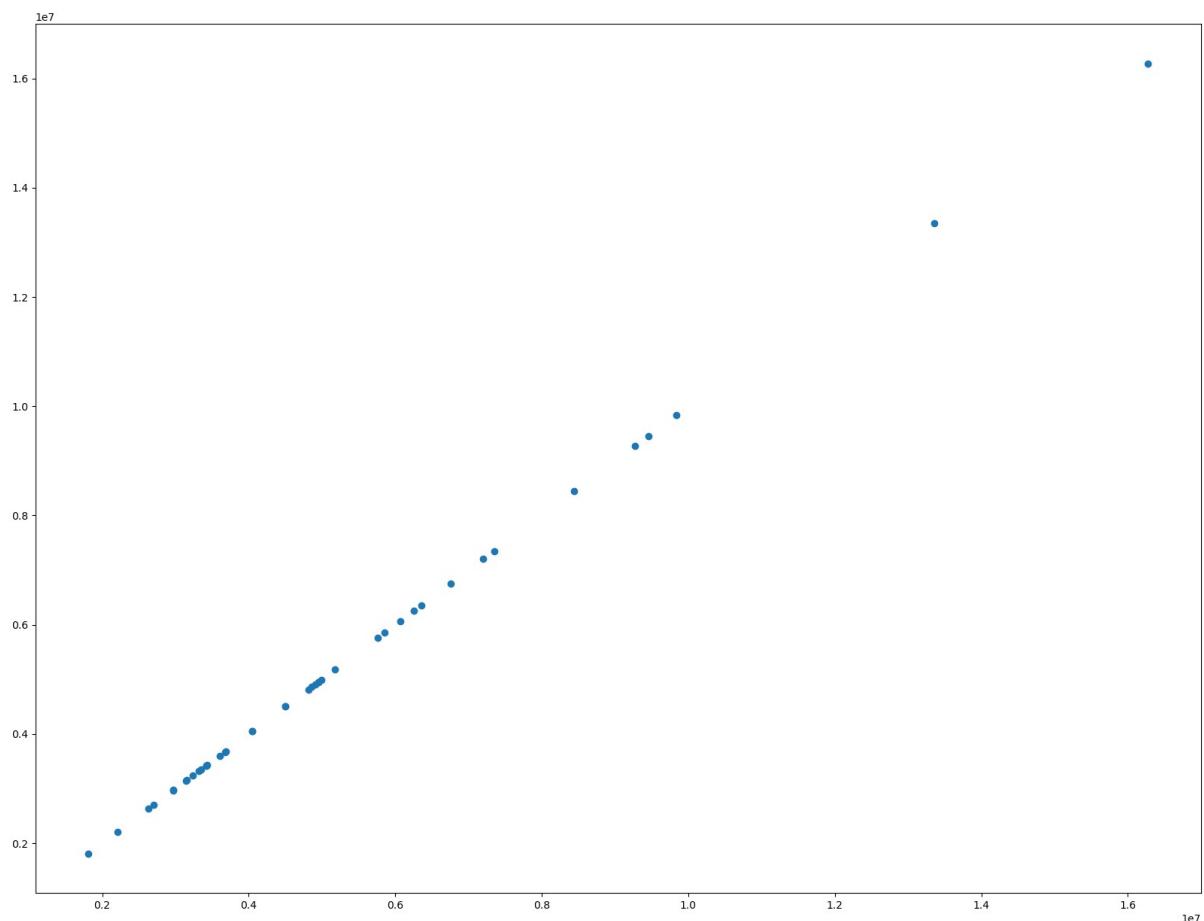
X_train , X_test , Y_train , Y_test = train_test_split(X , Y ,
test_size = 0.4 , random_state = 42)

lr = LinearRegression()
lr.fit(X_train , Y_train)
pred = lr.predict(X_test)

pred

array([ 6064550.5868      , 4951903.          , 4501730.          ,
       9268611.89700001, 7350334.7094      , 7201867.65400001,
       8445245.48      , 3316604.5602      , 6255964.1464      ,
       4995119.608     , 2701038.          , 3430768.433       ,
       4816851.1       , 3142207.54      , 5176989.5       ,
       2970871.6962    , 13352221.21460001, 6752595.          ,
       3672961.507     , 2971141.8       , 4501730.          ,
       3601384.         , 3151211.          , 3421314.79999999,
       1812306.4634    , 4051557.          , 3685656.3856      ,
       5762214.4       , 4051557.          , 4951903.          ,
       6359233.8326    , 2632071.4964      , 5852249.          ,
       3234132.8666    , 3422845.3882      , 4904634.835      ,
```

```
9453633.00000001, 4861868.4 , 9840961.84920001,
3352618.4002 , 16276545.02260001, 2211699.949 ])
plt.scatter(Y_test , pred)
<matplotlib.collections.PathCollection at 0x227a451c3a0>
```



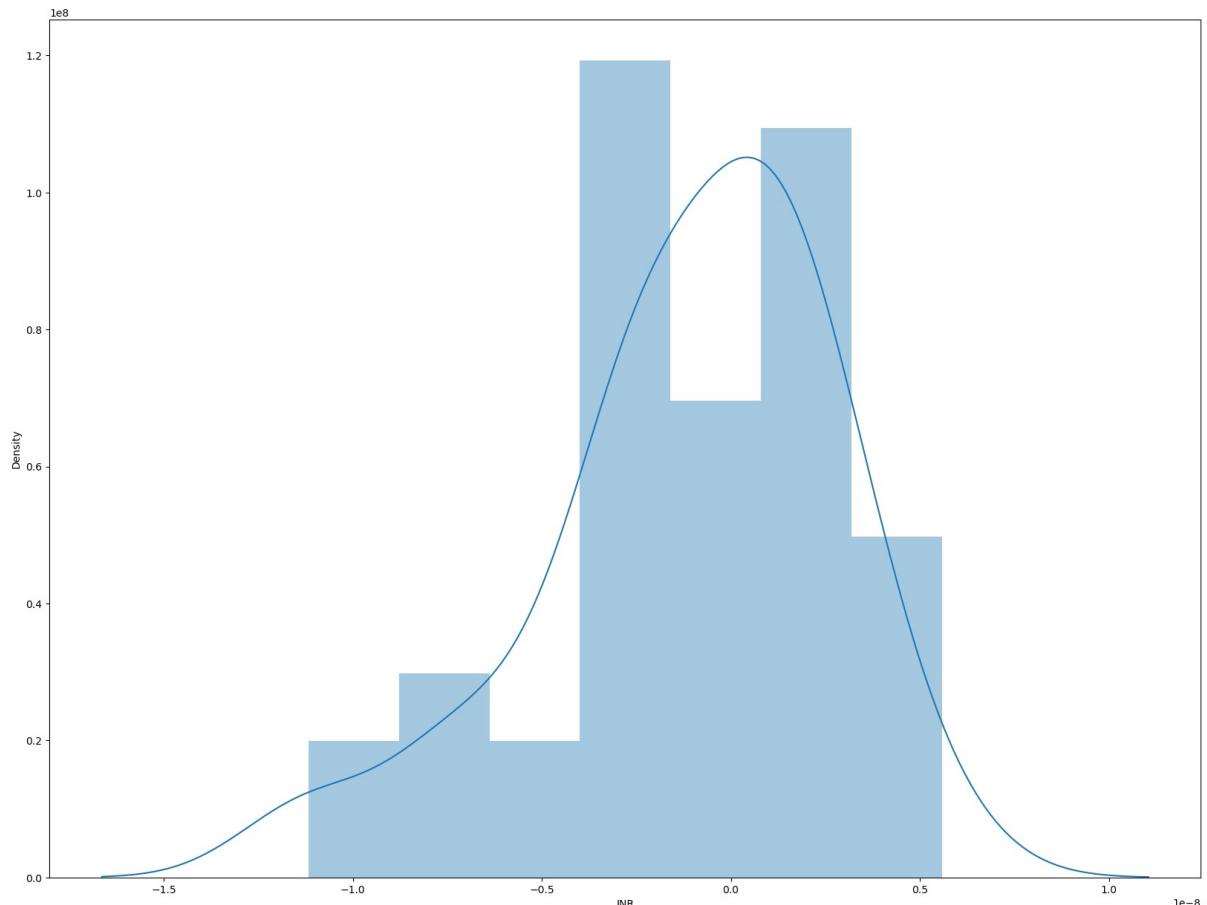
```
sn.distplot((Y_test-pred))
C:\Users\gcaba\AppData\Local\Temp\ipykernel_19500\2624994182.py:1:
UserWarning:

`distplot` is a deprecated function and will be removed in seaborn
v0.14.0.

Please adapt your code to use either `displot` (a figure-level
function with
similar flexibility) or `histplot` (an axes-level function for
histograms).

For a guide to updating your code to use the new functions, please
see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751
```

```
<Axes: xlabel='INR' , ylabel='Density'>
```



```
from sklearn.metrics import mean_absolute_error , mean_squared_error  
  
print('MAE' , mean_absolute_error(Y_test , pred))  
print('MSE' , mean_squared_error(Y_test , pred))  
print('RMSE' , np.sqrt(mean_squared_error(Y_test , pred)))  
  
MAE 2.9436445661953516e-09  
MSE 1.5701570747959717e-17  
RMSE 3.962520756785978e-09
```

Getting Insights from vehicle market dataset

Importing necessary libraries

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
```

Reading the Dataset and Performing elementry data refining

```
df = pd.read_csv('car details v4.csv')
df
```

Dropping irrelevant columns like 'Kilometers','Fuel Type','Seller Type','Owner' Dropping rows with blank values in them. (Rows with either of Drivetrain, Engine, Fuel Tank Capacity as NaN)

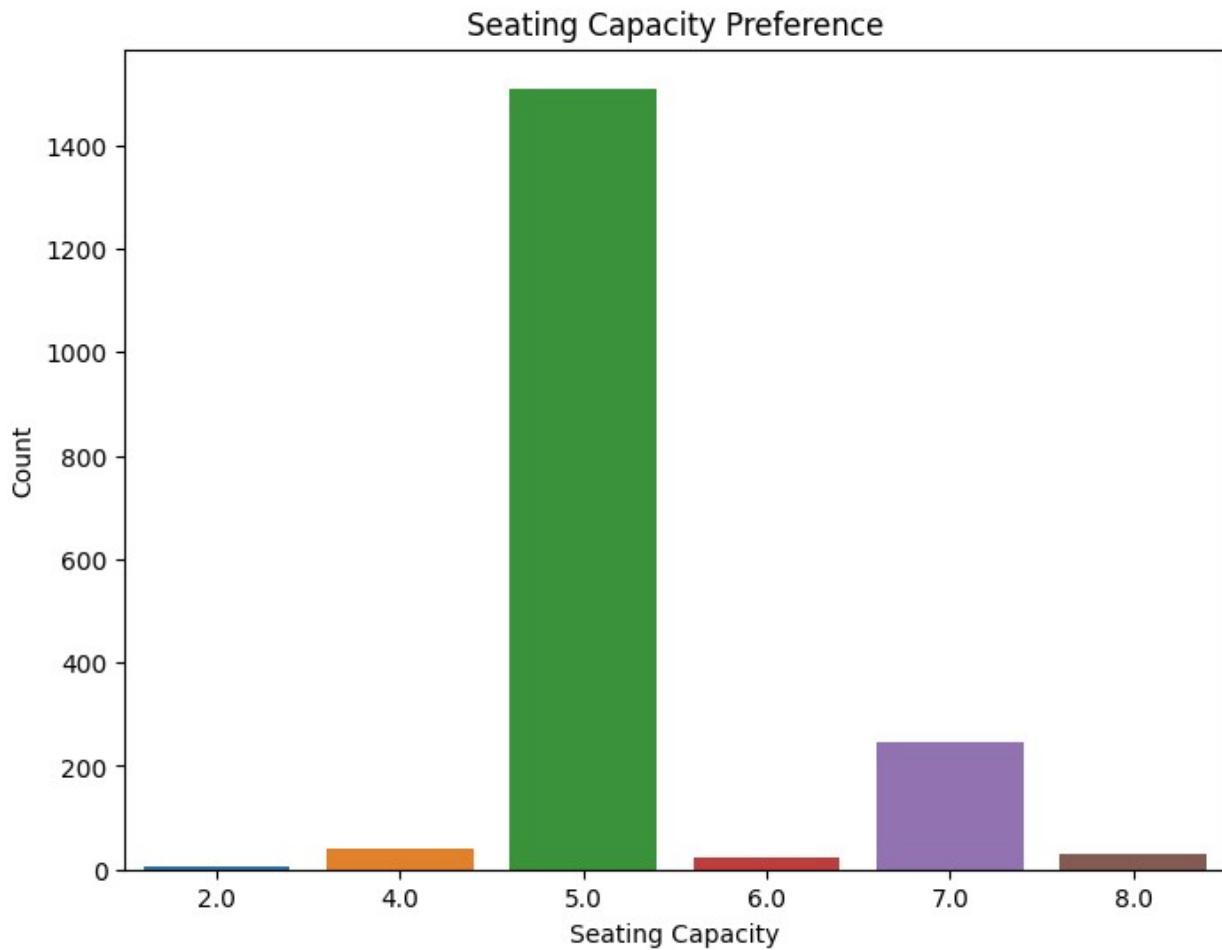
```
df.drop(['Kilometer','Fuel Type','Owner','Seller
Type'],axis=1,inplace=True)
df.set_index(df.Model, inplace=True)
df.drop(df.loc[df.Drivetrain.isnull(),:].index, axis=0, inplace=True)
df.drop(df.loc[df.Engine.isnull(),:].index, axis=0, inplace=True)
df.drop(df.loc[df['Fuel Tank
Capacity'].isnull(),:].index, axis=0, inplace=True)

df
df.columns

Index(['Make', 'Model', 'Price', 'Year', 'Transmission', 'Location',
'Color',
       'Engine', 'Max Power', 'Max Torque', 'Drivetrain', 'Length',
'Width',
       'Height', 'Seating Capacity', 'Fuel Tank Capacity'],
      dtype='object')
```

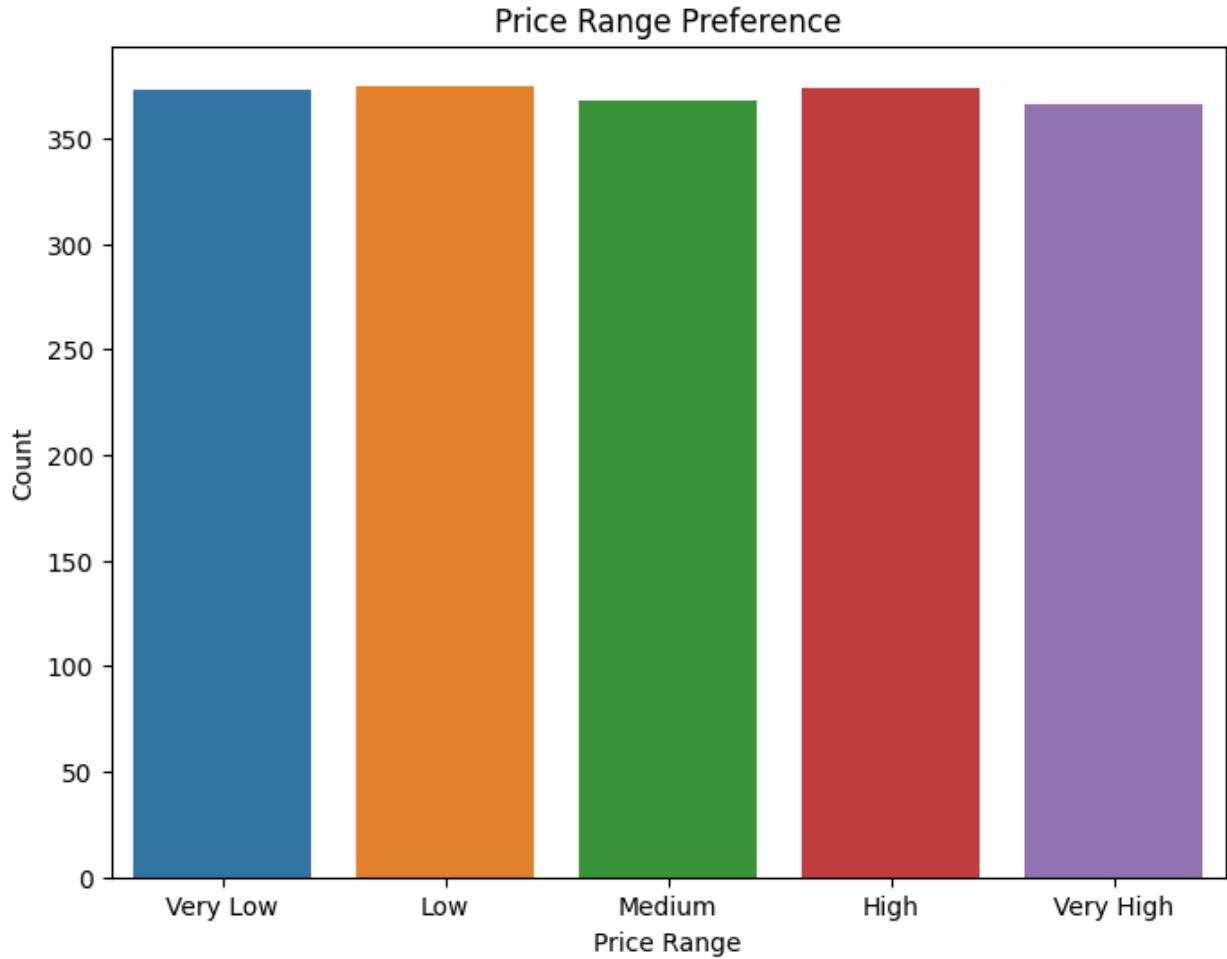
Plot showing count of the customers prefering given no. of seats in car. We can conclude that majority of customers prefer 5 seater car.

```
seating_counts = df['Seating Capacity'].value_counts()
plt.figure(figsize=(8, 6))
sns.barplot(x=seating_counts.index, y=seating_counts.values)
plt.title('Seating Capacity Preference')
plt.xlabel('Seating Capacity')
plt.ylabel('Count')
plt.show()
```



Plot showing Price Range vs Count, Not useful yet.

```
df['Price Range'] = pd.qcut(df['Price'], q=5, labels=['Very Low',  
'Low', 'Medium', 'High', 'Very High'])  
price_counts = df['Price Range'].value_counts()  
plt.figure(figsize=(8, 6))  
sns.barplot(x=price_counts.index, y=price_counts.values)  
plt.title('Price Range Preference')  
plt.xlabel('Price Range')  
plt.ylabel('Count')  
plt.show()
```



Converting the Max Torque Column from the form 'Nm @ rpm' to two separate columns containing Torque, Rpm and Calculation Horsepower using the formula $HP = \frac{\text{Torque} * \text{rpm}}{5252}$. Removing cc unit from Engine column.

Converting the Max Power column from the form ' bhp @ rpm' to one column containing power as 'bhp'

```

df['Max Torque'] = df['Max Torque'].str.replace(' Nm', '') # Remove
'Nm' from torque values
df['Max Torque'] = df['Max Torque'].str.replace(' rpm', '') # Remove
'rpm' from torque values
df['Torque'] = df['Max Torque'].str.split('@').str[0].str.strip() # Extract the value before @@
df['rpm'] = df['Max Torque'].str.split('@').str[1].str.strip() # Extract the value before @@
df['Horsepower'] = (df['Torque'].astype(float) *
df['rpm'].astype(float)) / 5252
df.drop('Max Torque', axis =1 , inplace =True)

df['Engine'] = df['Engine'].str.replace(' cc', '') # Remove 'cc' from

```

```

torque values

df['Max Power'] = df['Max Power'].str.replace(' bhp', '') # Remove
'bhp'
df['Max Power'] = df['Max Power'].str.replace(' rpm', '') # Remove
'rpm' from torque values
df['Power'] = df['Max Power'].str.split('@').str[0].str.strip() # Extract the value before '@'
df.drop('Max Power', axis =1 , inplace =True)

df

from sklearn.cluster import KMeans
from sklearn.preprocessing import StandardScaler

# Select the columns to use for clustering
selected_columns = ['Price', 'Seating Capacity', 'Horsepower']

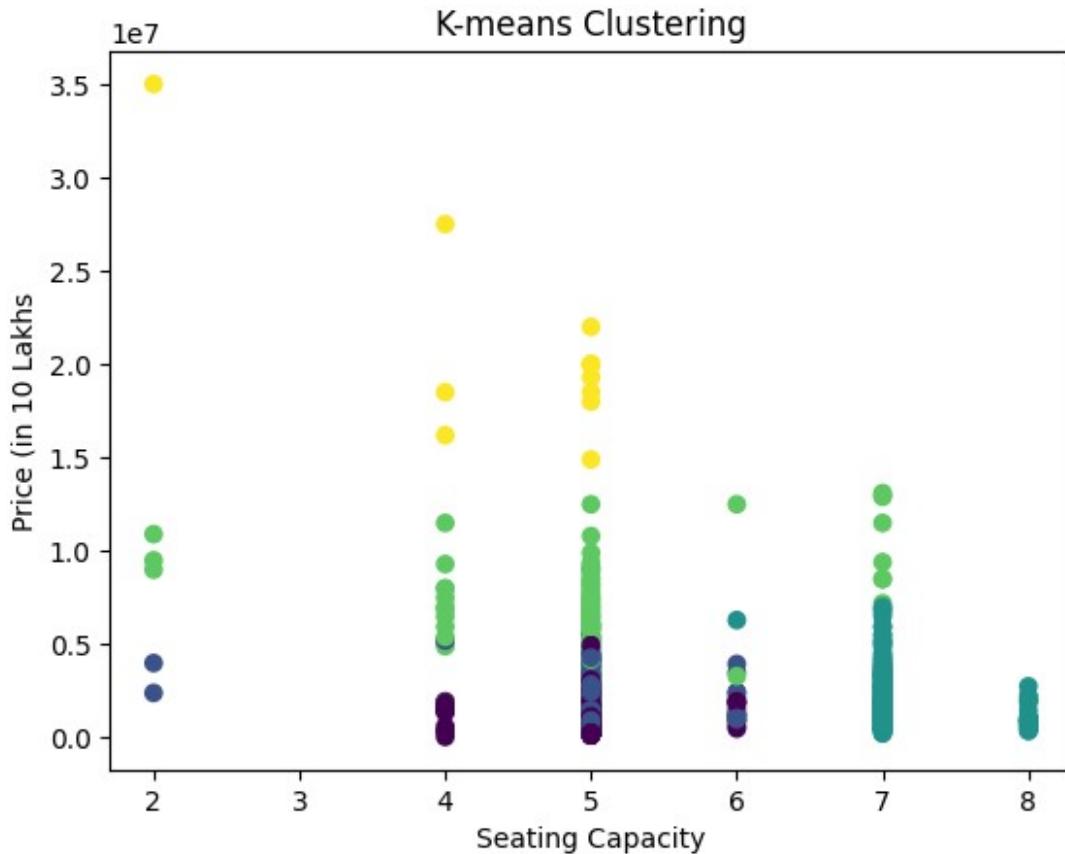
# Preprocess the data by scaling the selected columns
scaler = StandardScaler()
df_scaled = scaler.fit_transform(df[selected_columns])

# Apply K-means clustering
kmeans = KMeans(n_clusters=5, random_state=42, n_init=10)
kmeans.fit(df_scaled)
labels = kmeans.labels_

# Add the cluster labels to the dataframe
df['Cluster'] = labels

# Plot the clusters
# y=df['Price']
# y_array = np.array(y).reshape(-1, 1)
# scaler.fit(y_array)
# df['Price'] = scaler.inverse_transform(y_array)
plt.scatter(df['Seating Capacity'], df['Price'], c=labels,
cmap='viridis')
plt.xlabel('Seating Capacity')
plt.ylabel('Price (in 10 Lakhs)')
plt.title('K-means Clustering')
plt.show()

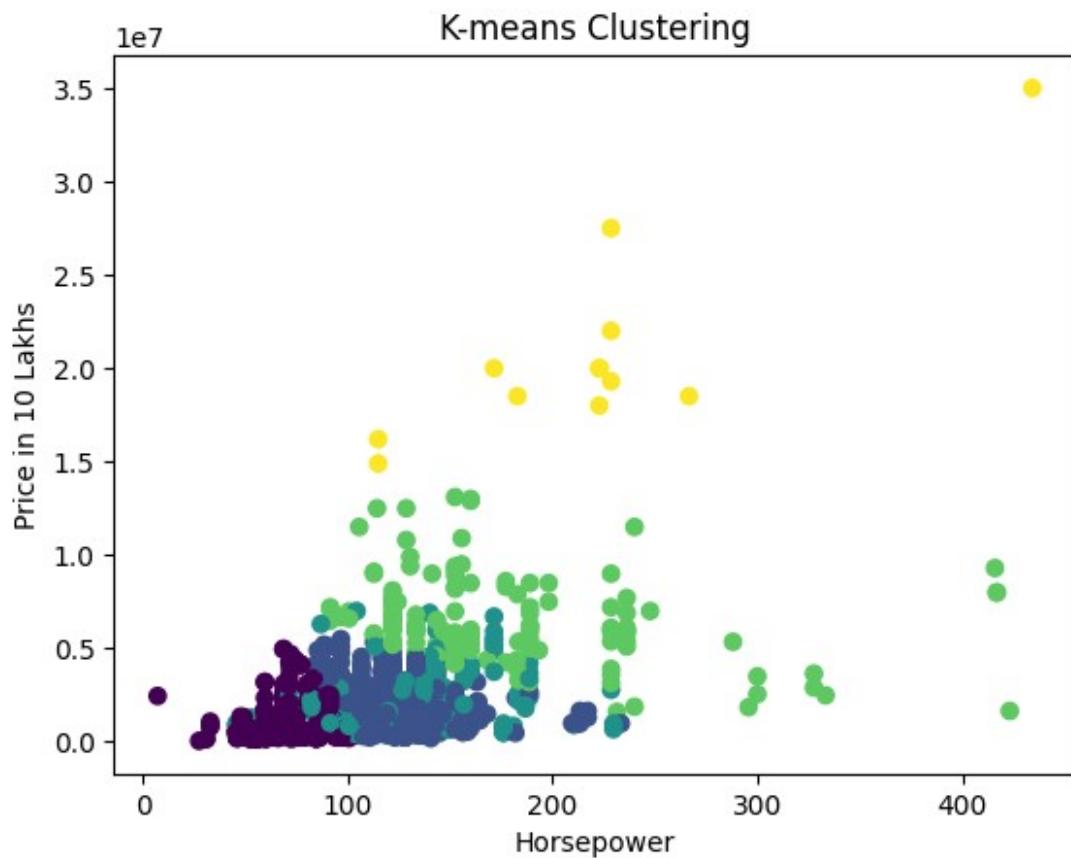
```



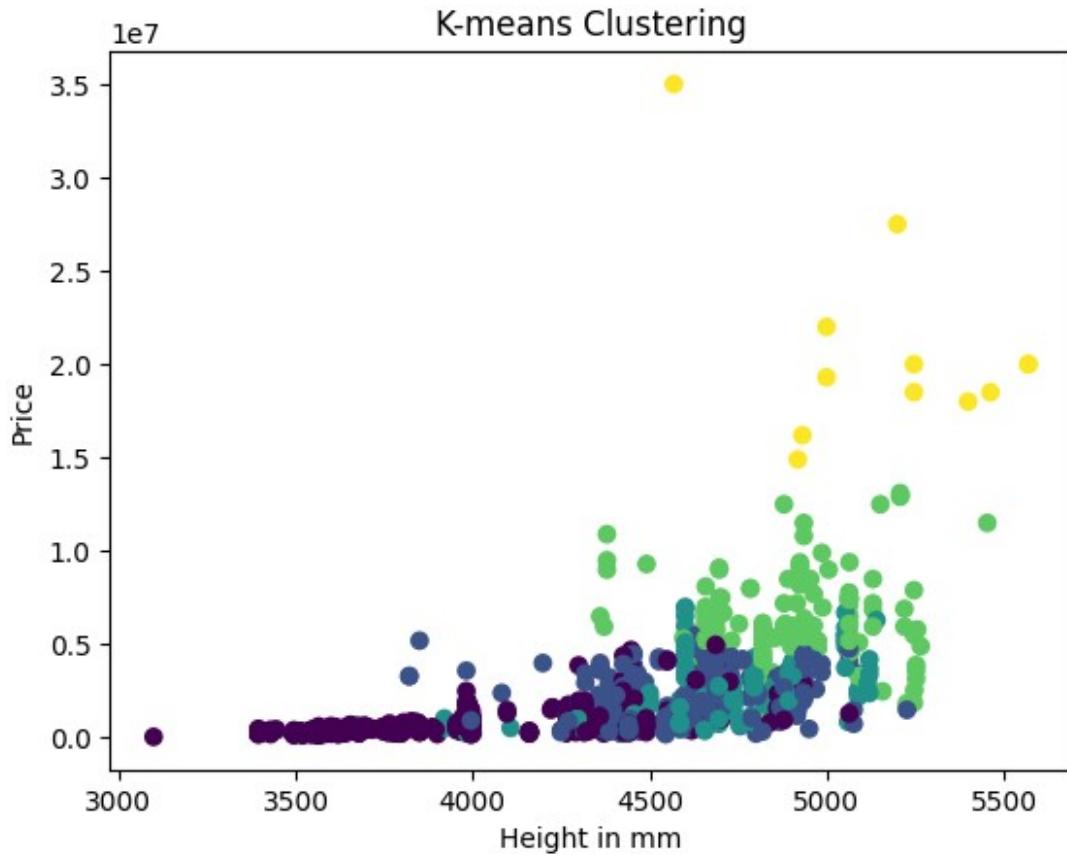
From the plot above, we can infer that in the range of 5 Lakh rupees there customers are mainly clustered in two groups with preference for 5 seats and 7 seats respectively. For Price close to 10 Lakhs and above, majority of people prefer 5 seater cars followed by 4 seaters.

From the scatter plot below we can get the idea of horsepower for corresponding price range. Below the budget of 5 laks horsepower is less than 200. Further we can see two clusters, one preferring features with horsepower compromised and other cluster with powerful engines.

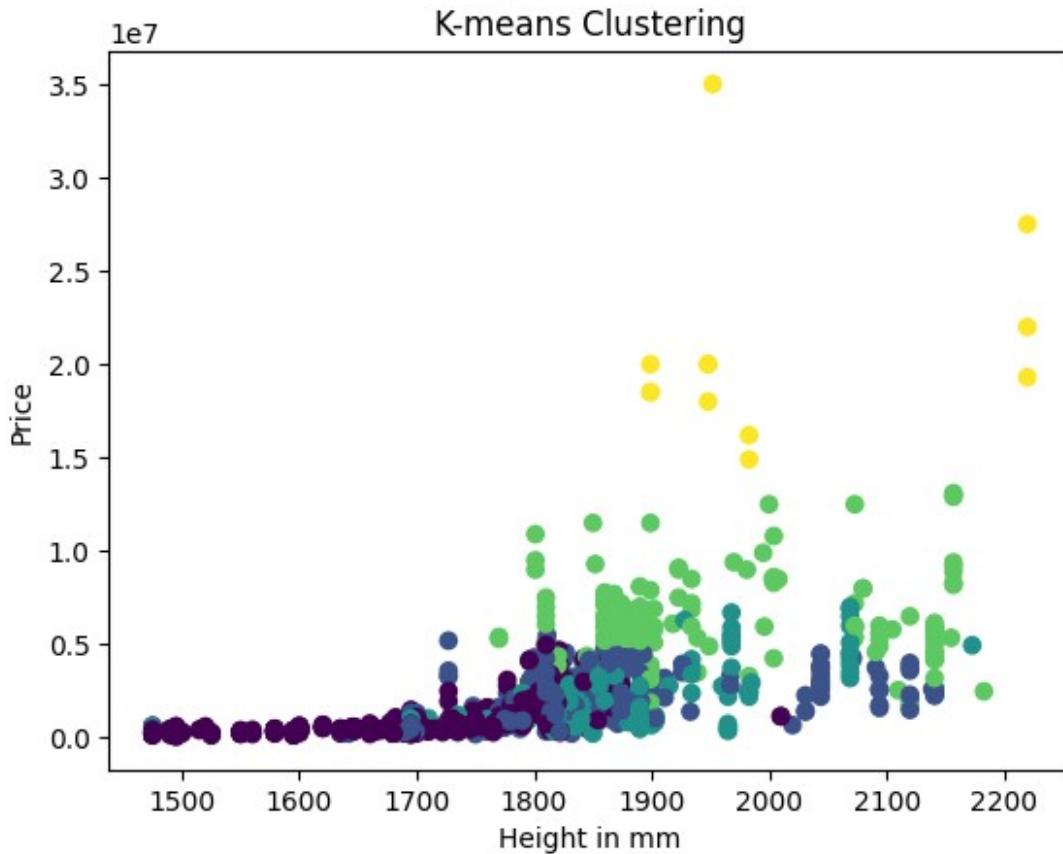
```
plt.scatter(df['Horsepower'], df['Price'], c=labels, cmap='viridis')
plt.xlabel('Horsepower')
plt.ylabel('Price in 10 Lakhs')
plt.title('K-means Clustering')
plt.show()
```



```
plt.scatter(df.Length , df['Price'], c=labels, cmap='viridis')
plt.xlabel('Height in mm')
plt.ylabel('Price')
plt.title('K-means Clustering')
plt.show()
```



```
plt.scatter(df.Width , df['Price'], c=labels, cmap='viridis')
plt.xlabel('Height in mm')
plt.ylabel('Price')
plt.title('K-means Clustering')
plt.show()
```



Below this are the attempts to segment the given dataset more accurately and gaining more insights.

```
X = df.loc[:,['Price','Engine','Length','Width','Height','Seating Capacity','Fuel Tank Capacity','Torque','Horsepower','Power']]

from sklearn.decomposition import PCA
pca = PCA(n_components=10)
pca.fit(X)
print(pca.explained_variance_ratio_)
print(pca.singular_values_)

[9.99999928e-01 5.84305913e-08 8.95443114e-09 2.66911615e-09
 9.96781242e-10 4.26641284e-10 1.32100541e-10 5.44552424e-11
 7.60439018e-12 4.16118335e-14]
[1.04850720e+08 2.53449579e+04 9.92179920e+03 5.41695428e+03
 3.31033055e+03 2.16572282e+03 1.20510179e+03 7.73733286e+02
 2.89136972e+02 2.13884769e+01]

pca_components = pd.DataFrame(pca.components_, columns = X.columns)
pca_components
```

```

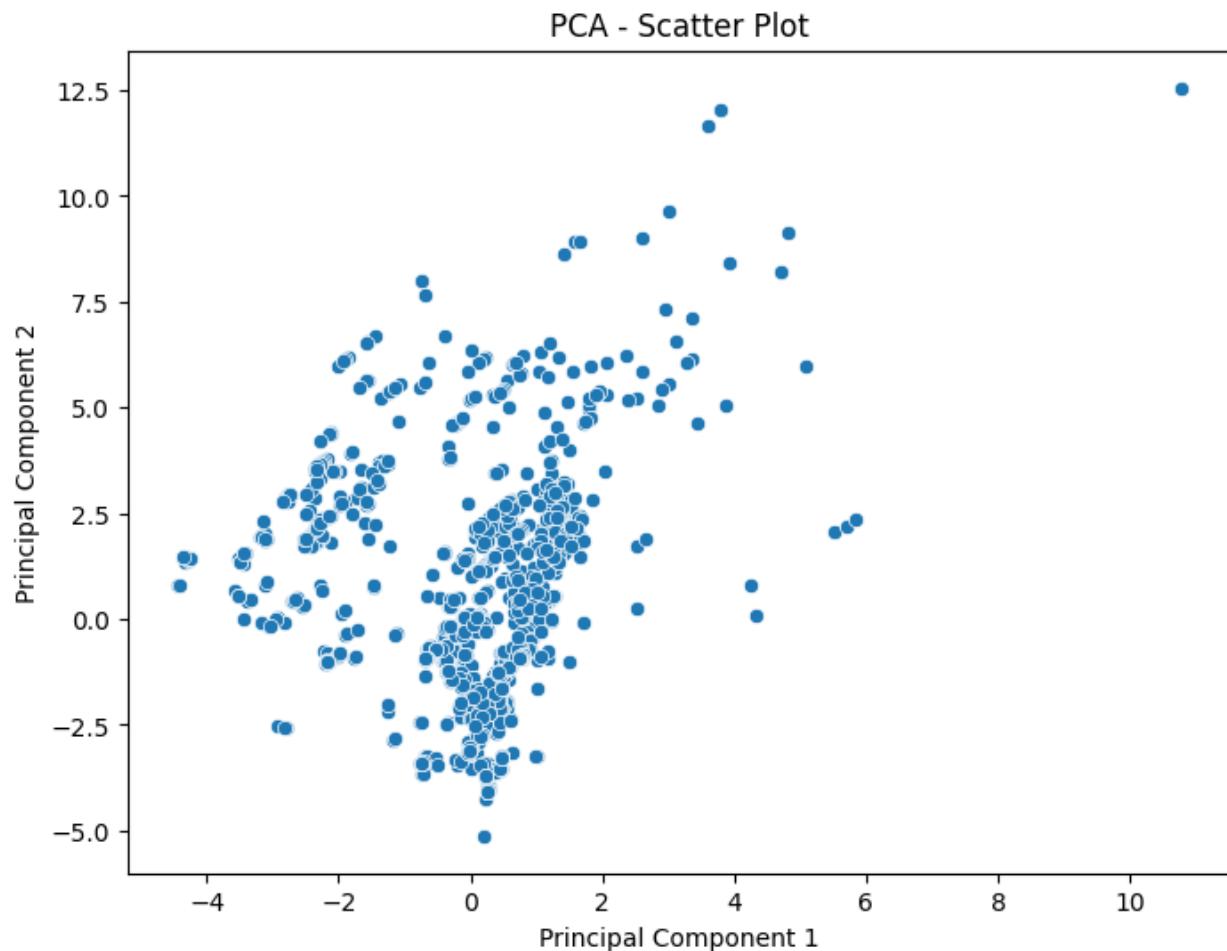
selected_columns = ['Price', 'Engine', 'Length', 'Width', 'Height',
'Seating Capacity','Fuel Tank Capacity', 'Torque', 'Horsepower',
'Power']

# Preprocess the data by scaling the selected columns
scaler = StandardScaler()
df_scaled = scaler.fit_transform(df[selected_columns])

# Apply PCA with 2 components
pca = PCA(n_components=10)
components = pca.fit_transform(df_scaled)

# Create a scatter plot of the components
plt.figure(figsize=(8, 6))
sns.scatterplot(x=components[:, 1], y=components[:, 0])
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.title('PCA - Scatter Plot')
plt.show()

```



```

from sklearn.mixture import GaussianMixture

n_components = range(2, 9)
models = []
for n in n_components:
    model = GaussianMixture(n_components=n)
    model.fit(X)
    models.append(model)

import matplotlib.pyplot as plt
aic = [model.aic(X) for model in models]
bic = [model.bic(X) for model in models]
icl = [model.lower_bound_ for model in models]

plt.plot(n_components, aic, label='AIC')
plt.plot(n_components, bic, label='BIC')
plt.plot(n_components, icl, label='ICL')
plt.xlabel('Number of Components')
plt.ylabel('Value of Information Criteria')
plt.legend()
plt.show()

best_model = models[2]

kmeans = KMeans(n_clusters=4, n_init=10)
kmeans.fit(X)
kmeans_clusters = kmeans.predict(X)
mixture_clusters = best_model.predict(X)

table = np.column_stack((kmeans_clusters, mixture_clusters))
print(table)

mixture_model = GaussianMixture(n_components=4)
mixture_model.fit(X, kmeans_clusters)

new_mixture_clusters = mixture_model.predict(X)
table = np.column_stack((kmeans_clusters, new_mixture_clusters))
print(table)

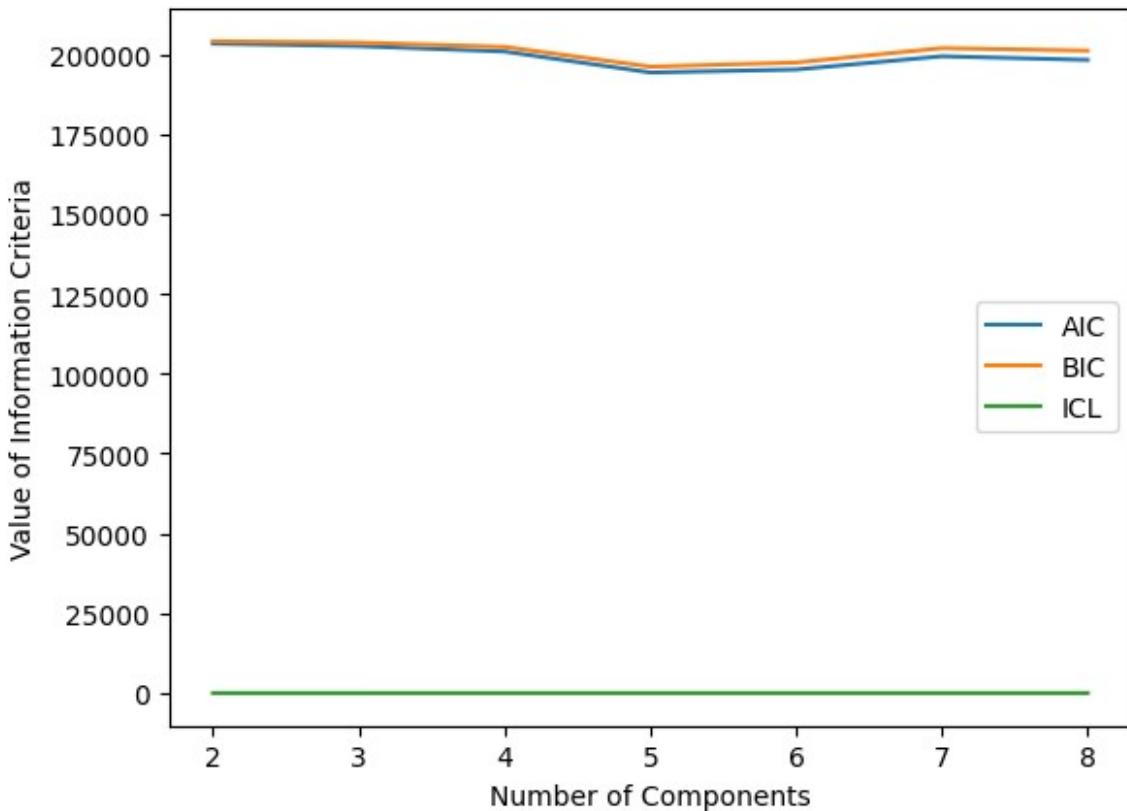
log_likelihood = mixture_model.score(X)
print(log_likelihood)

log_likelihood_best = best_model.score(X)
print(log_likelihood_best)

[[0 1]
 [0 1]
 [0 1]
 ...
 [0 1]]

```

```
[0 1]
[1 0]]
[[0 0]
 [0 0]
 [0 0]
 ...
 [0 0]
 [0 0]
 [1 2]]
-53.997351157739416
-53.99735115773943
```



```
from sklearn.cluster import AgglomerativeClustering

# Preprocess the data by scaling the selected columns
scaler = StandardScaler()
df_scaled = scaler.fit_transform(df[selected_columns])

# Apply hierarchical clustering
cluster = AgglomerativeClustering(n_clusters=2)
cluster_labels = cluster.fit_predict(df_scaled)

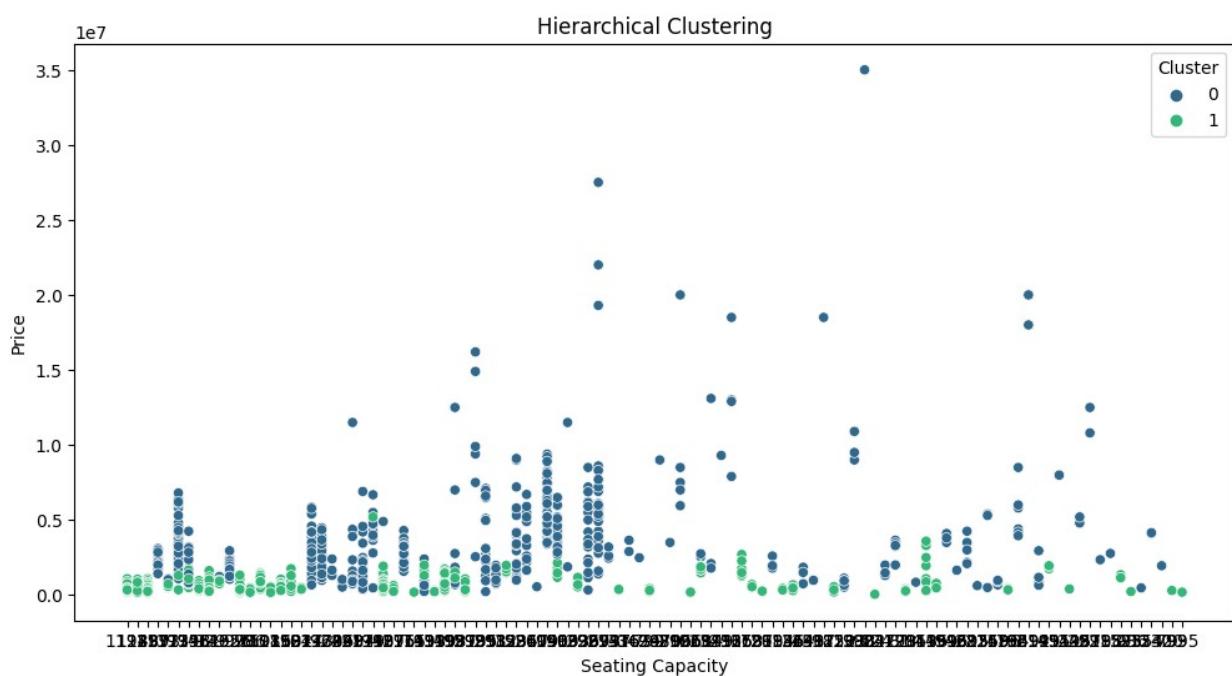
# Add cluster labels to the dataframe
```

```

df['Cluster'] = cluster_labels

# Visualize the clusters
plt.figure(figsize=(12, 6))
sns.scatterplot(data=df, x='Engine', y='Price', hue='Cluster',
palette='viridis')
plt.xlabel('Seating Capacity')
plt.ylabel('Price')
plt.title('Hierarchical Clustering')
plt.show()

```



```

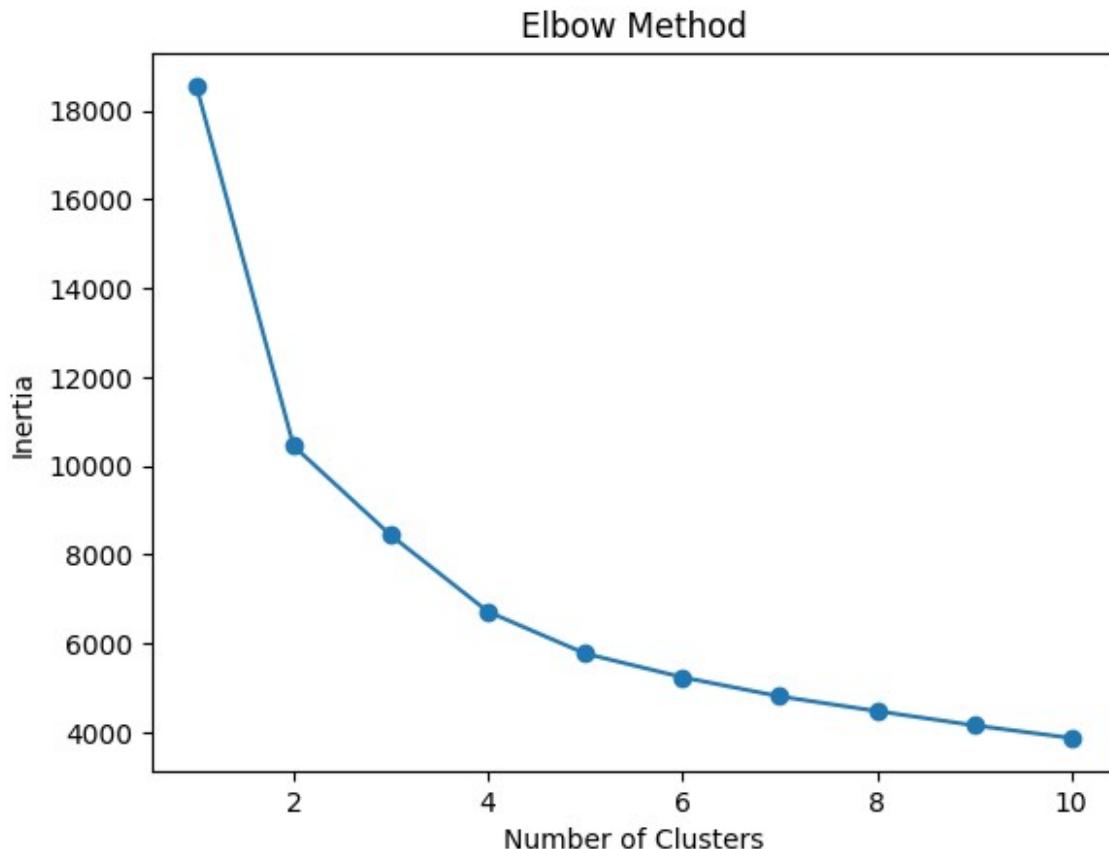
selected_columns = ['Price', 'Engine', 'Length', 'Width', 'Height',
'Seating Capacity', 'Fuel Tank Capacity', 'Torque', 'Horsepower',
'Power']

# Preprocess the data by scaling the selected columns
scaler = StandardScaler()
df_scaled = scaler.fit_transform(df[selected_columns])

# Perform K-means clustering for different numbers of clusters
clusters = range(1, 11)
inertias = []
for n_clusters in clusters:
    kmeans = KMeans(n_clusters=n_clusters, random_state=42, n_init=10)
    kmeans.fit(df_scaled)
    inertias.append(kmeans.inertia_)

```

```
# Plot the inertia values
plt.plot(clusters, inertias, marker='o')
plt.xlabel('Number of Clusters')
plt.ylabel('Inertia')
plt.title('Elbow Method')
plt.show()
```



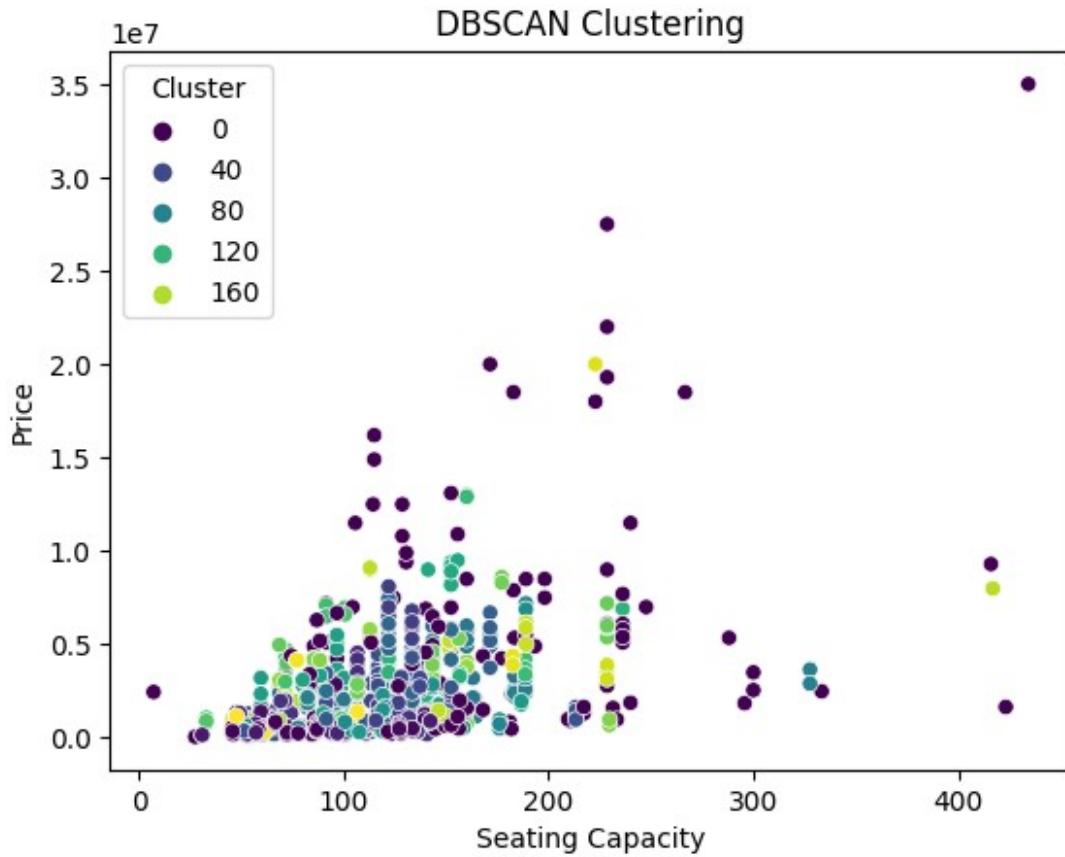
```
from sklearn.cluster import DBSCAN

# Perform DBSCAN clustering
dbscan = DBSCAN(eps=0.5, min_samples=2)
cluster_labels = dbscan.fit_predict(df_scaled)

# Add cluster labels to the dataframe
df['Cluster'] = cluster_labels

# Visualize the clusters
sns.scatterplot(data=df, x='Horsepower', y='Price', hue='Cluster',
palette='viridis')
plt.xlabel('Seating Capacity')
plt.ylabel('Price')
```

```
plt.title('DBSCAN Clustering')
plt.show()
```



```
from sklearn.mixture import GaussianMixture

# Perform Gaussian Mixture Models clustering
gmm = GaussianMixture(n_components=4, random_state=42)
cluster_labels = gmm.fit_predict(df_scaled)

# Add cluster labels to the dataframe
df['Cluster'] = cluster_labels

# Visualize the clusters
sns.scatterplot(data=df, x='Horsepower', y='Price', hue='Cluster',
palette='viridis')
plt.xlabel('Seating Capacity')
plt.ylabel('Price')
plt.title('Gaussian Mixture Models Clustering')
plt.show()
```

