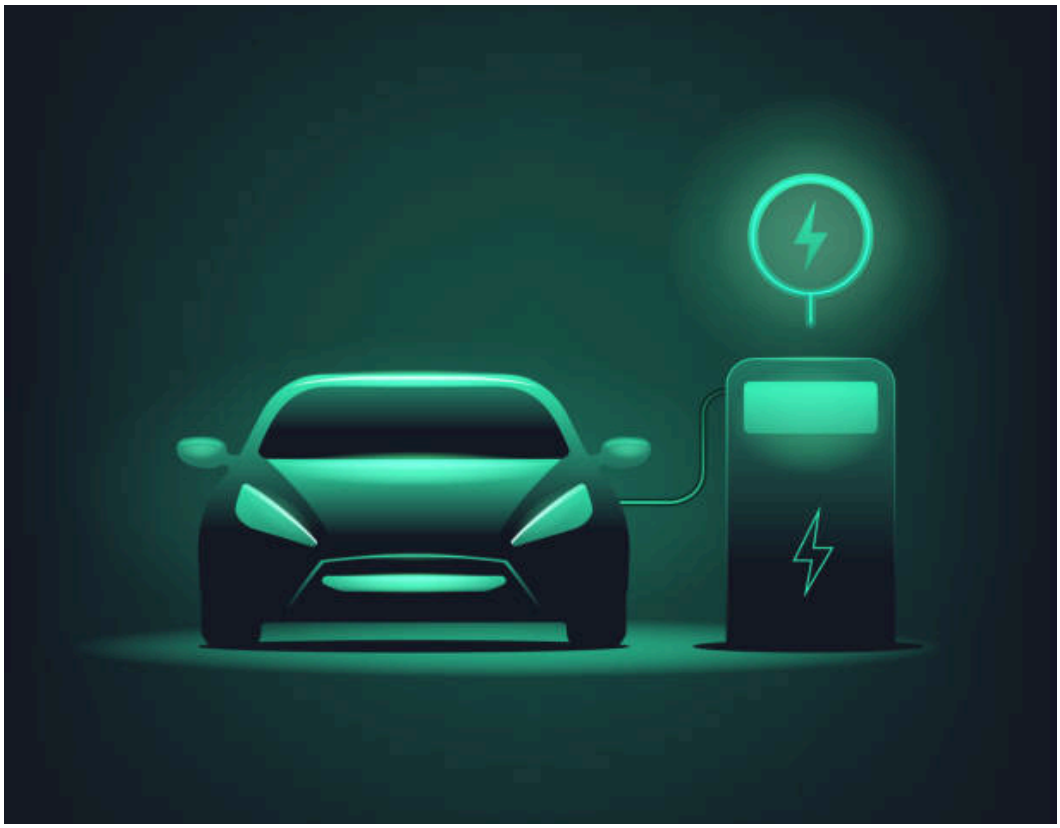
DETAILED REPORT OF MARKET SEGMENTATION ON ELECTRONIC VEHICLE STARTUP IN INDIA

Rania Binth Zubair



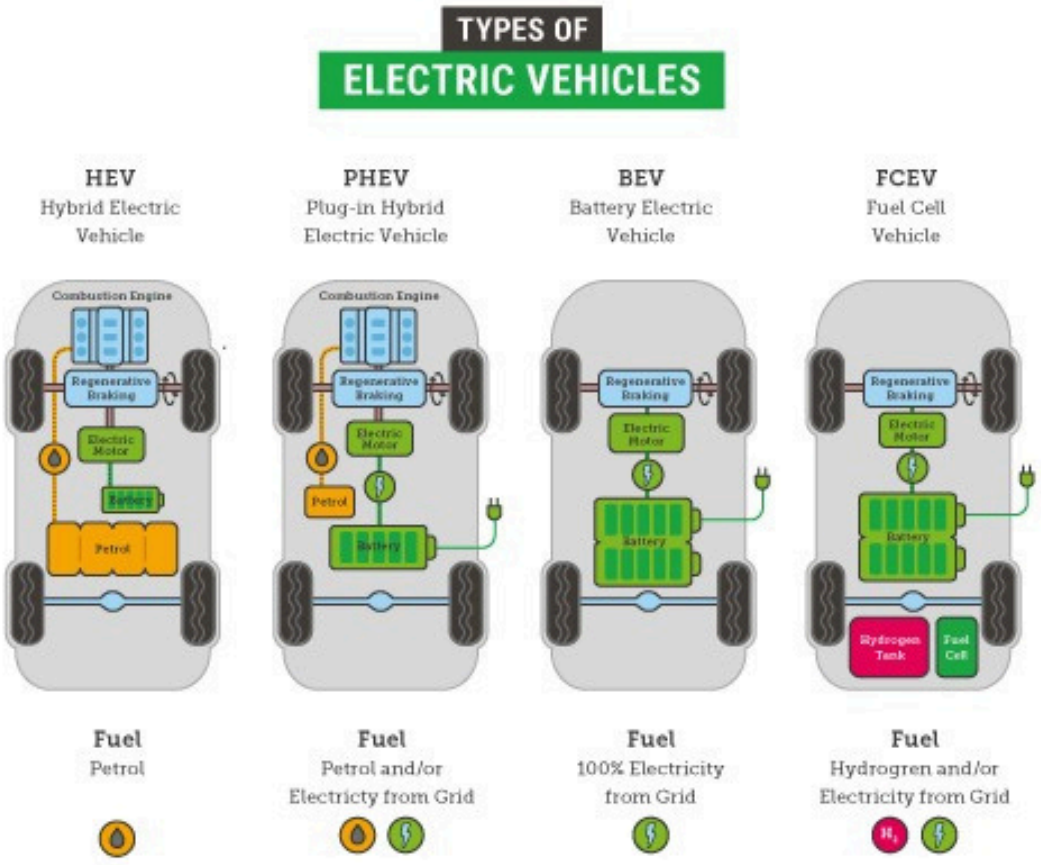
The Indian electric vehicle (EV) market is on the brink of remarkable expansion, fueled by government incentives and rising environmental consciousness. To support this growth, substantial investment in EV infrastructure, such as an extensive network of charging stations, is essential. Improvements in battery technology will enhance the affordability and performance of electric vehicles, making them more attractive to a wider audience. Partnerships between automotive leaders and tech startups are driving innovation and speeding up the EV transition in India. As the market evolves, we anticipate a significant increase in electric two-wheelers and commercial vehicles tailored to India's specific transportation needs. The future of EVs in India goes beyond emission reduction; it’s about developing sustainable urban mobility solutions for a greener future.

1. **Introduction**

Electric vehicles (EVs) are automobiles powered by one or more electric motors, using electrical energy stored in batteries. Unlike traditional internal combustion engine (ICE) vehicles, which rely on gasoline or diesel, EVs offer a cleaner, more efficient alternative.

Types of Electric Vehicles:

1. **Battery Electric Vehicles (BEVs):** These vehicles are powered exclusively by electricity stored in onboard batteries. BEVs have no internal combustion engine and produce zero tailpipe emissions.
2. **Plug-in Hybrid Electric Vehicles (PHEVs):** PHEVs feature both an electric motor and an internal combustion engine. They can be plugged in to recharge the battery and use gasoline or another fuel source for longer trips. They can operate on electric power alone for shorter distances.
3. **Hybrid Electric Vehicles (HEVs):** HEVs combine an internal combustion engine with an electric motor. Unlike PHEVs, HEVs do not need to be plugged in; their battery is charged through regenerative braking and the internal combustion engine.

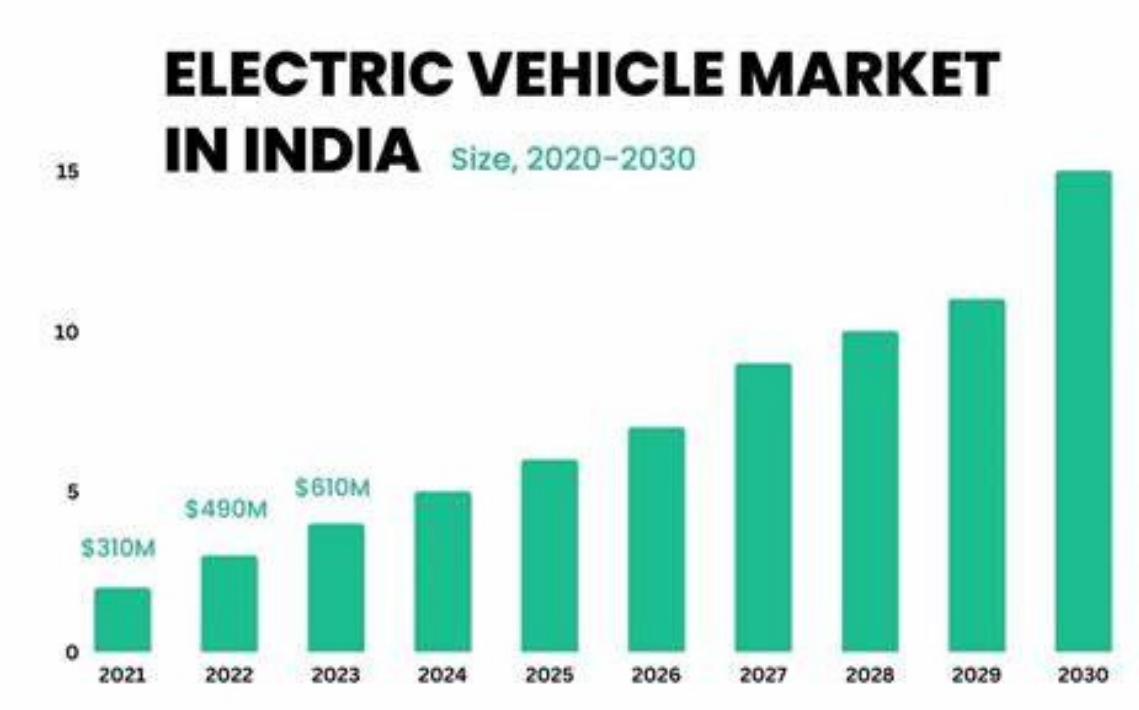


2. Market of Electric Vehicles in India

India's electric vehicle (EV) market, encompassing two-wheelers and three-wheelers, is projected to expand at a remarkable compounded annual growth rate (CAGR) of 90%, reaching $150 billion by 2030. Despite accounting for only 1.3% of total vehicle sales in the fiscal year 2020-21, the EV sector in India is experiencing rapid growth, particularly in the two-wheeler and three-wheeler segments. By 2030, the transition to high-speed electric mobility in India is expected to reduce carbon dioxide emissions by nearly one gigaton.

Globally, the EV market is also accelerating, with the International Energy Agency (IEA) forecasting up to 145 million electric vehicles on the road by 2030. India is becoming a significant player in this market, gaining momentum both domestically and internationally.

Although India has been a late entrant to the electric vehicle sector, with electric vehicles comprising just about 0.1% of the total vehicle fleet, recent government initiatives have spurred growth. The government's Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme offers financial incentives to encourage EV purchases. Under FAME II, INR 10,000 crore ($1.4 billion) has been allocated for EV adoption and infrastructure development over the next three years. This support aims to accelerate the adoption of electric vehicles and strengthen India's position in the global EV market.



1. **Market Segmentation**

The global battery electric vehicle (BEV) market was valued at $267.1 billion in 2022. Over the past decade, this sector has seen rapid growth due to dwindling fossil fuel reserves and heightened awareness of global warming. BEVs offer a viable alternative to internal combustion engine (ICE) vehicles as they do not contribute to environmental pollution.

Market Analysis: The EV market research report offers insights into various aspects such as production and technology, sales volume, market size, policies, charging infrastructure, and key drivers and challenges in eleven major countries: The United States, Canada, China, India, Japan, South Korea, Germany, France, the Netherlands, Norway, and the United Kingdom.

India's Electric Vehicle Market: Revving Up

India's EV market is on a transformative path towards sustainability. Key trends include:

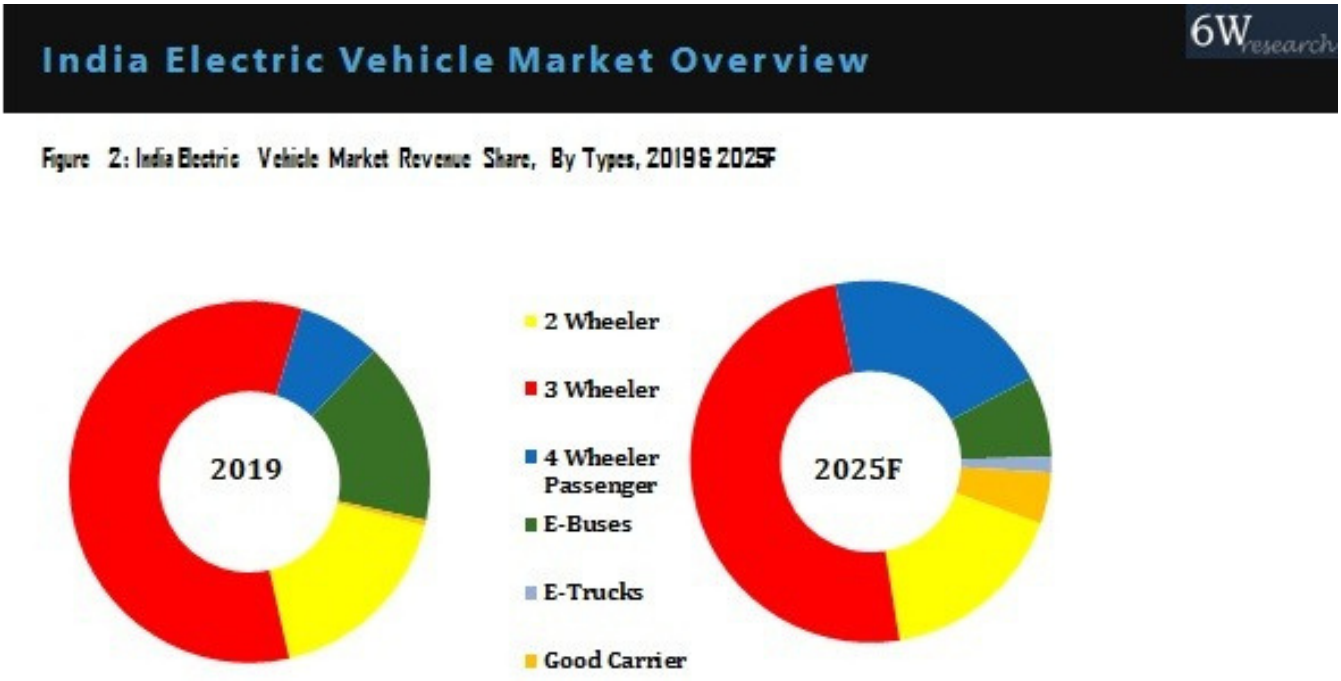
- **Growth Trajectory:** While comprehensive data for 2024 is not yet available, analysts forecast significant growth in electric two-wheelers, three-wheelers, and buses.
- **Government Initiatives:** The Indian government is actively fostering EV adoption through schemes such as FAME, which offer subsidies and support for infrastructure development. These measures aim to make EVs more affordable and widely accessible.
- **Market Dynamics:** Factors like rising fuel prices, increased environmental awareness, and government incentives are boosting consumer interest in EVs. This growing demand is drawing significant investments from both domestic and international automakers. Major players include Tata Motors, Mahindra & Mahindra, and emerging companies specializing in electric two-wheelers.

Recent Developments:

- State Policies: Numerous Indian states have introduced policies to encourage EV adoption, such as offering tax breaks and waiving registration fees.
- Charging Infrastructure: There is a heightened emphasis on expanding charging infrastructure to alleviate range anxiety, a significant concern for prospective EV owners.

The Future:

Supported by government initiatives, technological progress, and growing consumer interest, the Indian EV market is set for substantial expansion. The emphasis on sustainable transportation solutions indicates a promising future for EVs in India.



4. Fermi Estimation

A market segmentation analysis for the electric vehicle (EV) market in India, keeping in mind the available data and the feasibility of targeting different customer segments. Based on the categories of segments mentioned, we'll analyze the Indian EV market and propose a feasible strategy for your startup to enter the market.

1. **Geographic Segmentation:**

India's diverse geographic landscape allows for segmentation based on different regions, cities, and areas:

- **Urban Centers:** Major cities like Delhi, Mumbai, and Bangalore are key markets due to high urban congestion and pollution concerns.
- **Tier 2 and Tier 3 Cities:** Smaller cities with developing markets and infrastructure are emerging as potential growth areas for EV adoption.
- **Rural Areas:** Opportunities exist for last-mile connectivity solutions and agricultural use, which can benefit from EV integration.

2. Customer/Usage Segmentation:

Segmenting customers based on their usage patterns can provide insights into specific needs:

- **Daily Commuters:** Individuals who require EVs for regular commuting within city limits.
- **Commercial Fleets:** Businesses involved in delivery services, ride-sharing, and logistics can benefit from EVs.
- **Tourism and Rentals:** EVs suited for short-term rentals and tourism-related activities.
- Government and Public Sector: EVs used in government fleets and public transportation systems.

3. Vehicle Type Segmentation:

Different types of EVs cater to varying needs:

- Compact Urban EVs: Small vehicles designed for city commuting and short trips.
- Electric Sedans/Hatchbacks: EVs suitable for family use and longer journeys.
- Electric SUVs/Crossovers: Vehicles addressing the demand for larger, more versatile options.
- Commercial EVs: Vans and trucks designed for logistics and delivery operations.

4. Demographic Segmentation:

While demographic data may be more challenging to gather, some broad categories can be useful:

- Age Groups: Younger consumers may be more inclined to adopt new technologies.
- Income Levels: Higher-income individuals might be more able to invest in premium EV models.

5. **SWOT Analysis for Electric Vehicle Segmentation:**

A SWOT analysis explores the Strengths, Weaknesses, Opportunities, and Threats related to electric vehicles (EVs) within the automotive industry.

(A) Strengths:

- Environmental Benefits: EVs produce zero tailpipe emissions, which helps reduce air pollution and greenhouse gas emissions, contributing to a cleaner environment.
- Lower Operating Costs: Compared to traditional internal combustion engine vehicles, EVs have lower fuel and maintenance costs, making them more economical to operate in the long run.
- Innovative Technology: EVs incorporate advanced technologies such as cutting-edge batteries, regenerative braking, and connectivity features, showcasing innovation in the automotive sector.
- Government Incentives: Many governments provide incentives like tax credits and rebates to promote the adoption of EVs, making them more attractive to consumers.

(**B) Weaknesses:**

- Limited Range: Some EVs have a shorter driving range compared to gasoline-powered vehicles, which can be a concern for potential buyers.
- Charging Infrastructure Gaps: Despite growth in charging infrastructure, some areas still lack adequate access to charging stations, which can deter EV adoption.
- Higher Upfront Costs: The initial cost of EVs is generally higher than that of traditional vehicles, largely due to the expense of the battery.
- Battery Degradation: Over time, the performance and capacity of EV batteries can degrade, leading to a reduced driving range and potential additional costs.

(C) Opportunities:

- Increasing Demand: Rising environmental concerns and technological advancements are expected to drive higher demand for EVs.
- Advancements in Battery Technology: Continued improvements in battery technology could enhance driving ranges, reduce charging times, and improve overall performance.
- Diversification of Vehicle Types: EV technology can be extended to various vehicle segments, including passenger cars, SUVs, trucks, and public transportation, broadening the market potential.
- Smart Grid Integration: EVs have the potential to act as storage solutions for renewable energy and integrate with smart grids, contributing to greater energy efficiency and sustainability.

(D) Threats:

- Competition: Increased entry of traditional automakers into the EV market could heighten competition and challenge the market share of existing EV manufacturers.

(B) Threats:

- Dependency on Raw Materials: EVs depend on minerals such as lithium, cobalt, and rare earth elements. Fluctuations in supply and prices of these materials could impact the production and cost of EVs.
- Infrastructure Strain: A rapid rise in EV adoption may put pressure on existing electricity grids and charging infrastructure, potentially leading to shortages or inefficiencies.
- Range Anxiety: Concerns about the driving range of EVs and the availability of charging stations may discourage potential buyers from making the switch.

6. Detailed Analysis

Collecting relevant data for EV segmentation is essential for making informed business decisions. Data collection should combine both primary (directly collected) and secondary (existing) sources. Collaborating with research organizations, academic institutions, and industry associations can also provide valuable insights. Ensure compliance with privacy regulations and ethical standards in data collection.

Accurate and current data reflecting market conditions and trends is crucial for effective segmentation analysis and strategy development.

Data set1 link:

https://github.com/RaniaBZ/Feynn_labs_Market-Segmentation/blob/main/customer_dataset.csv

Data set2 link:

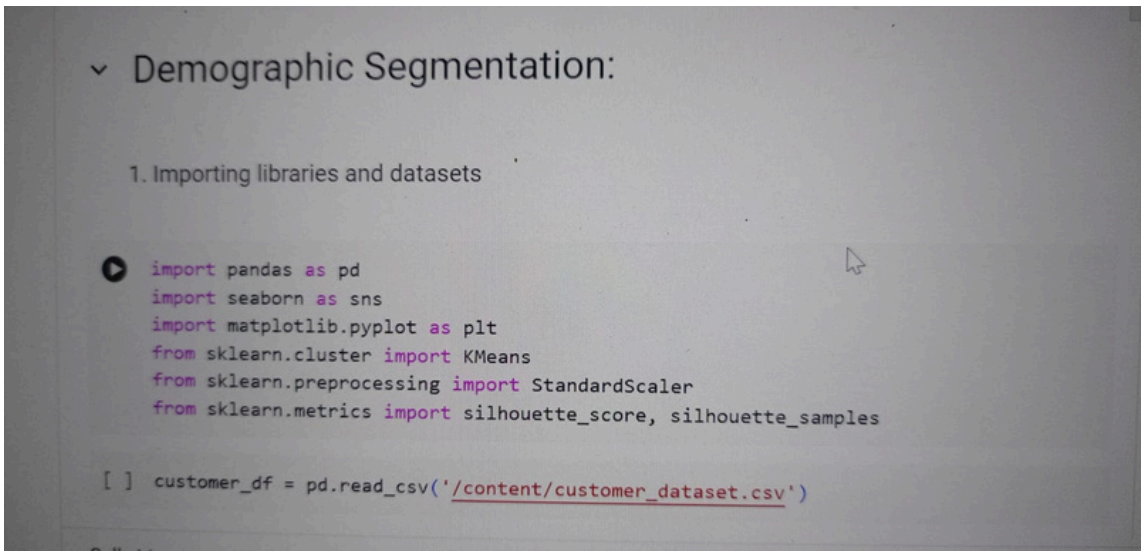
https://github.com/RaniaBZ/Feynn_labs_Market-Segmentation/blob/main/1_ev_charger_dataset.csv

Data set3 link:

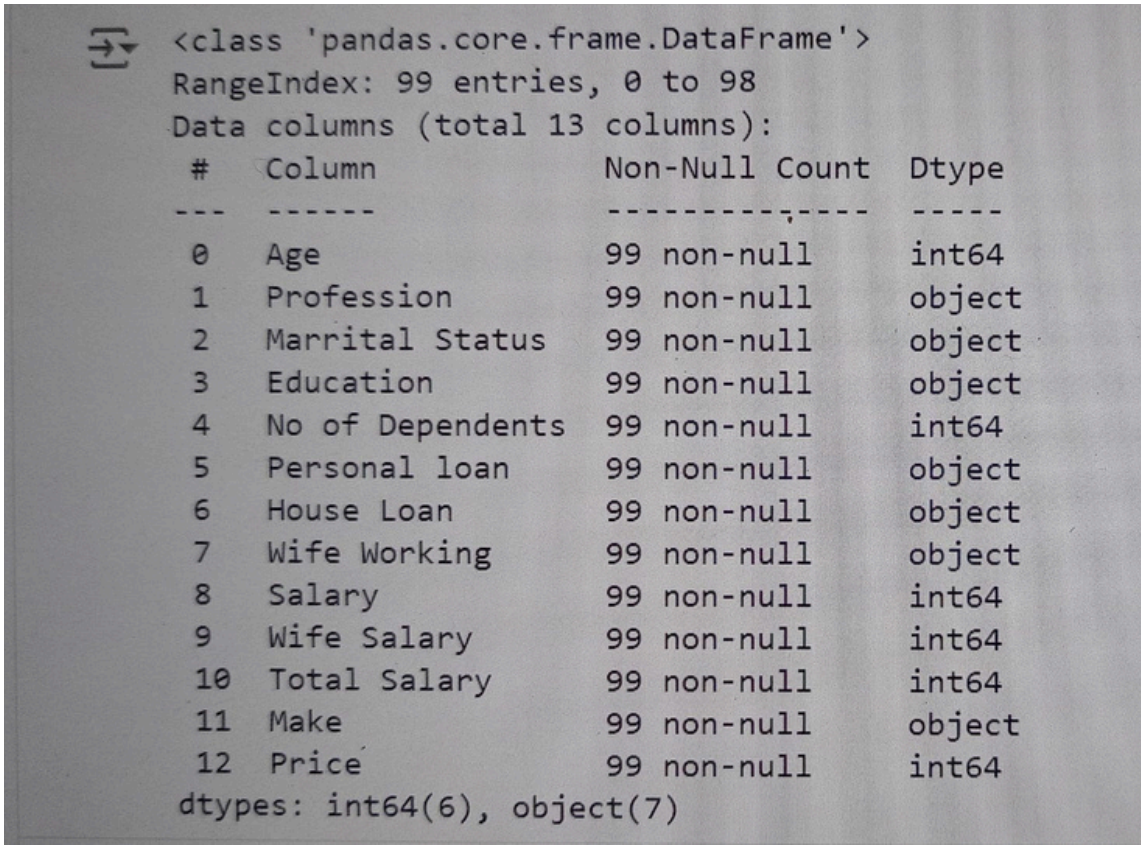
https://github.com/RaniaBZ/Feynn_labs_Market-Segmentation/blob/main/EV%20States.csv

1.Demographic segmentation

https://github.com/RaniaBZ/Feynn_labs_Market-Segmentation/blob/main/customer_dataset.csv

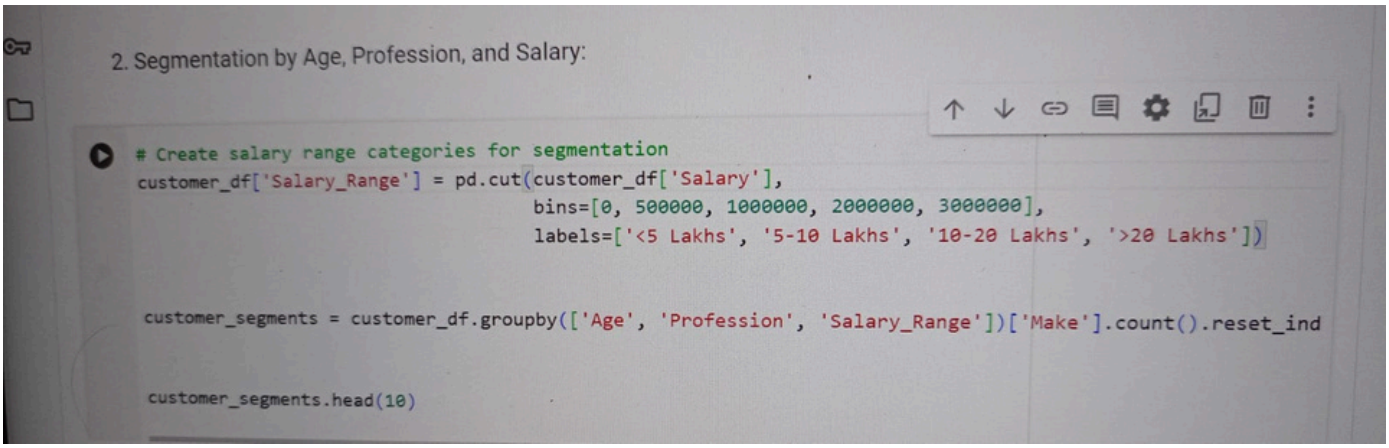


The DataFrame contains 99 entries and 13 columns, providing data related to individuals, including demographic details like age, profession, marital status, and education, as well as financial information such as the number of dependents, personal and house loan status, employment details of the wife, and both individual and combined salaries. It also includes data about a car purchase, including the car make and price. All columns are fully populated with no missing values, and the data types consist of integers for numerical values and objects for categorical or textual data, with a memory usage of approximately 10.2 KB.

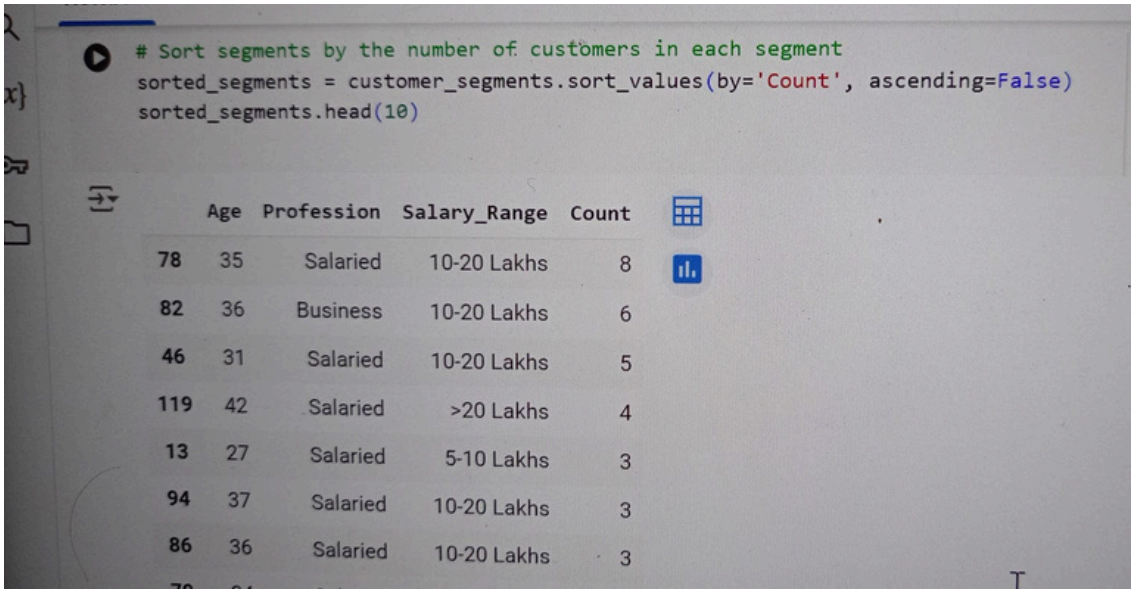


Segmentation by Age, Profession and Salary

The code creates a new column called Salary_Range in the DataFrame to categorize customers based on their salary into four ranges: <5 Lakhs, 5-10 Lakhs, 10-20 Lakhs, and >20 Lakhs. It then groups the customers by Age, Profession, and the new Salary_Range to count how many customers fall into each segment based on their car make. The result is a new DataFrame, customer_segments, which displays the first 10 rows to provide an overview of the segmentation by showing the count of customers within each unique combination of age, profession, and salary range



This code sorts the customer_segments DataFrame in descending order based on the 'Count' column, which represents the number of customers in each segment. By doing so, it identifies the segments with the highest number of customers, allowing for a better understanding of the most common combinations of age, profession, and salary range among customers. The head(10) function displays the top 10 segments, helping to quickly identify the most significant customer groups in terms of size



	Age	Profession	Salary_Range	Count
78	35	Salaried	10-20 Lakhs	8
82	36	Business	10-20 Lakhs	6
46	31	Salaried	10-20 Lakhs	5
119	42	Salaried	>20 Lakhs	4
13	27	Salaried	5-10 Lakhs	3
94	37	Salaried	10-20 Lakhs	3
86	36	Salaried	10-20 Lakhs	3

The code uses Matplotlib and Seaborn to create a bar plot that visualizes the top 10 customer segments by vehicle ownership. It plots the Count of customers on the x-axis against the Age on the y-axis, with different colors representing various Salary_Range categories. This visual helps to easily identify which age groups and salary ranges have the most vehicle ownership among the top customer segments, providing insights into the demographics and financial status of the most significant customer groups. The plot is titled "Top 10 Customer Segments by Vehicle Ownership" to clearly indicate its purpose.

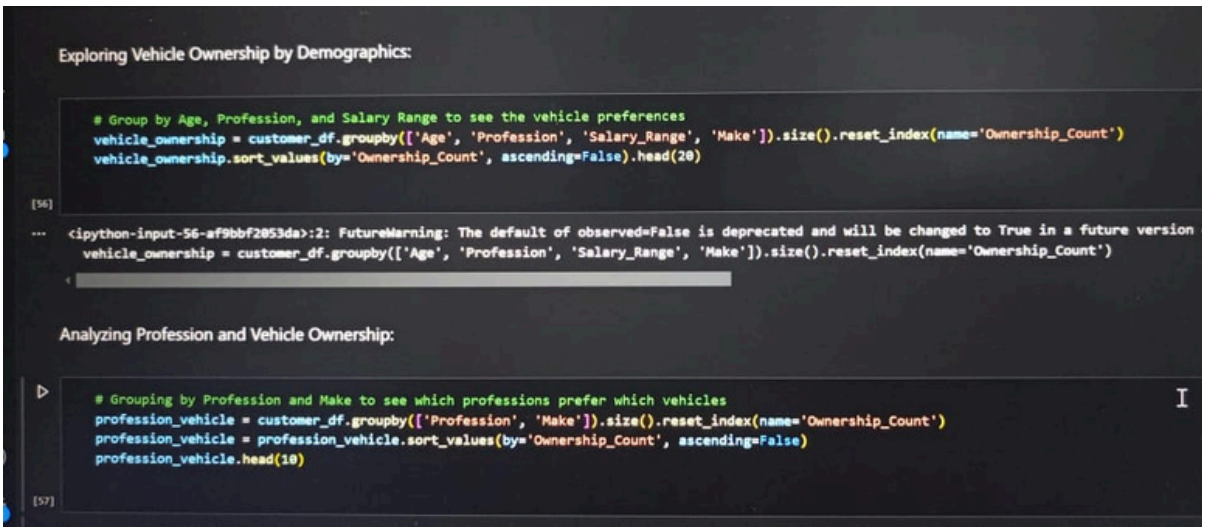
4.Visualizing the Data:

```
import matplotlib.pyplot as plt
import seaborn as sns

# Plotting the top 10 customer segments
plt.figure(figsize=(14, 7))
sns.barplot(data=sorted_segments.head(10), x='Count', y='Age', hue='Salary_Range')
plt.title('Top 10 Customer Segments by Vehicle Ownership')
plt.xlabel('Number of Customers')
plt.ylabel('Age')
plt.show()
```

Data visualization

- Exploring Vehicle Ownership by Demographics: The first part groups the data by Age, Profession, Salary_Range, and Make to analyze vehicle preferences across different demographics. It counts the number of customers for each combination, resulting in a DataFrame (vehicle_ownership) that shows the vehicle ownership count for each demographic segment. The results are then sorted in descending order by Ownership_Count to identify the top 20 most common vehicle preferences among various age groups, professions, and salary ranges.
- Analyzing Professional Vehicle Ownership: The second part groups the data by Profession and Make to determine which vehicles are preferred by customers of different professions. It creates a DataFrame (profession_vehicle) that shows the count of vehicles owned by each profession. This DataFrame is sorted by Ownership_Count in descending order to reveal the top 10 vehicle preferences across different professional groups. This helps to understand the vehicle choices associated with different professions.

Exploring vehicle owner ship by demographics



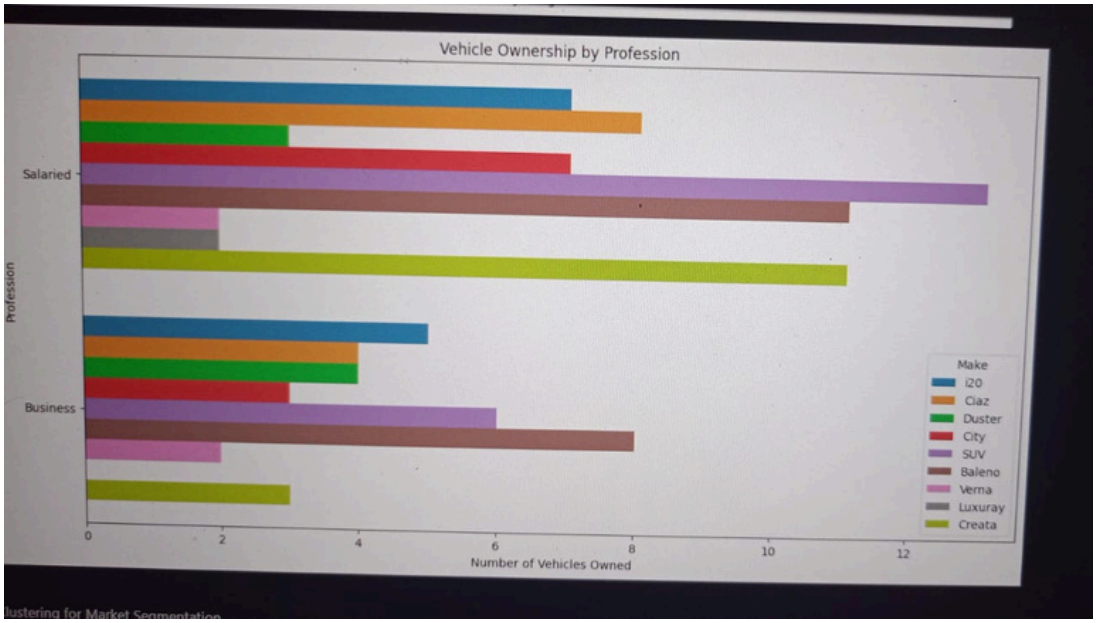
CODE

```
# Vehicle ownership by age group
plt.figure(figsize=(14, 7))
sns.countplot(data=customer_df, x='Age', hue='Make')
plt.title('Vehicle Ownership by Age Group')
plt.xlabel('Age')
plt.ylabel('Number of Vehicles Owned')
plt.show()

# Vehicle ownership by salary range
plt.figure(figsize=(14, 7))
sns.countplot(data=customer_df, x='Salary_Range', hue='Make')
plt.title('Vehicle Ownership by Salary Range')
plt.xlabel('Salary Range')
plt.ylabel('Number of Vehicles Owned')
plt.show()

# Vehicle ownership by profession
plt.figure(figsize=(14, 7))
sns.countplot(data=customer_df, y='Profession', hue='Make')
plt.title('Vehicle Ownership by Profession')
plt.xlabel('Number of Vehicles Owned')
plt.ylabel('Profession')
plt.show()
```

1. **Vehicle Ownership by Age Group**: A bar plot (countplot) is created to show the number of vehicles owned across various age groups. The hue='Make' parameter distinguishes the vehicle makes, allowing for a comparison of vehicle preferences within each age group. This plot helps identify how vehicle ownership varies with age.

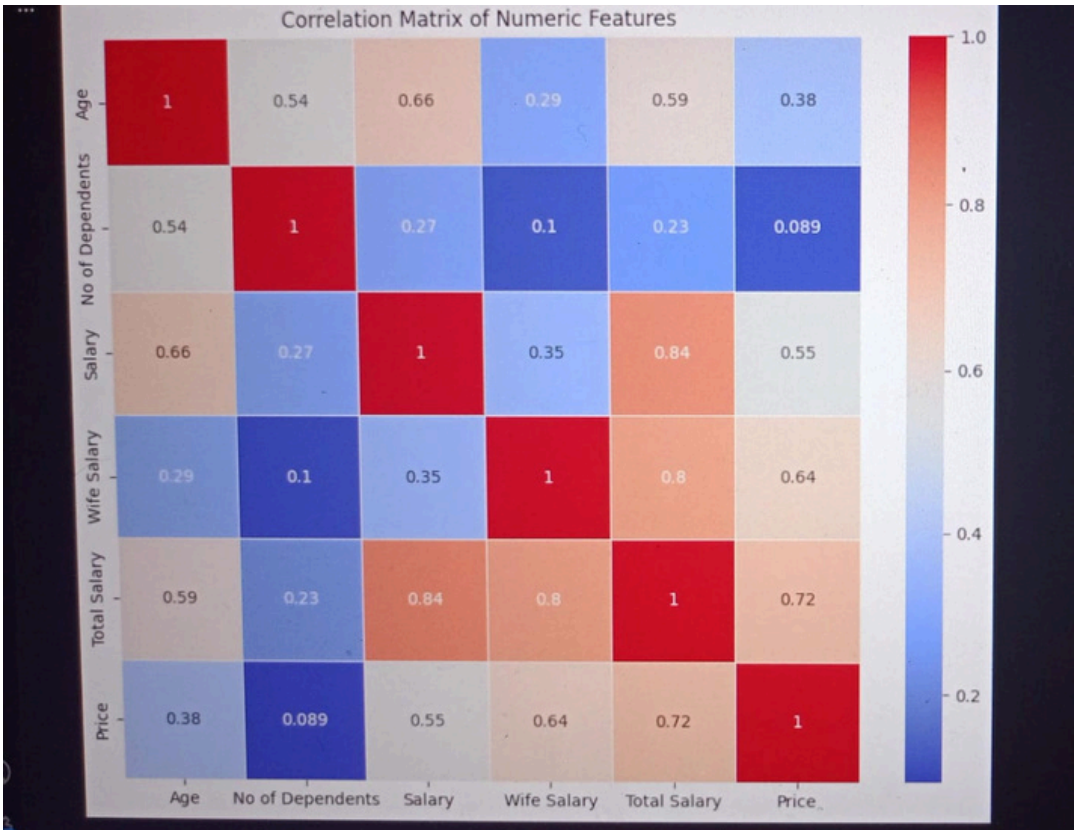
Vehicle Ownership by Salary Range: Another bar plot displays vehicle ownership across different salary ranges. Here, the hue='Make' parameter differentiates the vehicle makes, providing insight into how ownership is distributed across different salary brackets.

A horizontal bar plot shows vehicle ownership by profession, with the hue='Make' parameter highlighting the different vehicle makes. This visualization reveals how vehicle ownership preferences vary among different professional groups.

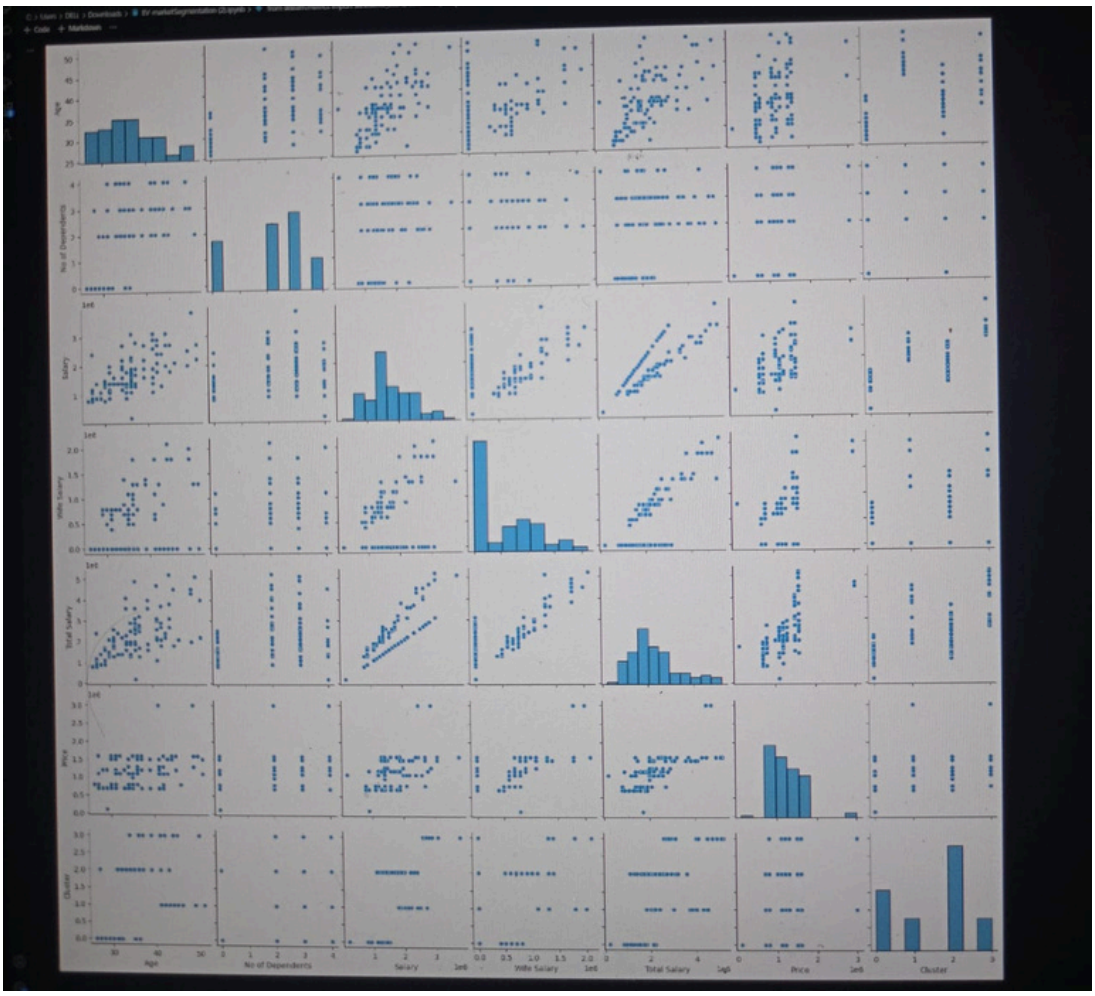


Confusion Matrix

The code creates a heatmap to visualize the correlation matrix of numeric features in the customer_df DataFrame. By selecting only integer and float columns, it calculates the correlation coefficients between these numeric features and displays them in a heatmap. The sns.heatmap function, with annotations and a color map, highlights the strength and direction of these correlations, making it easy to identify patterns and relationships among the numeric features.

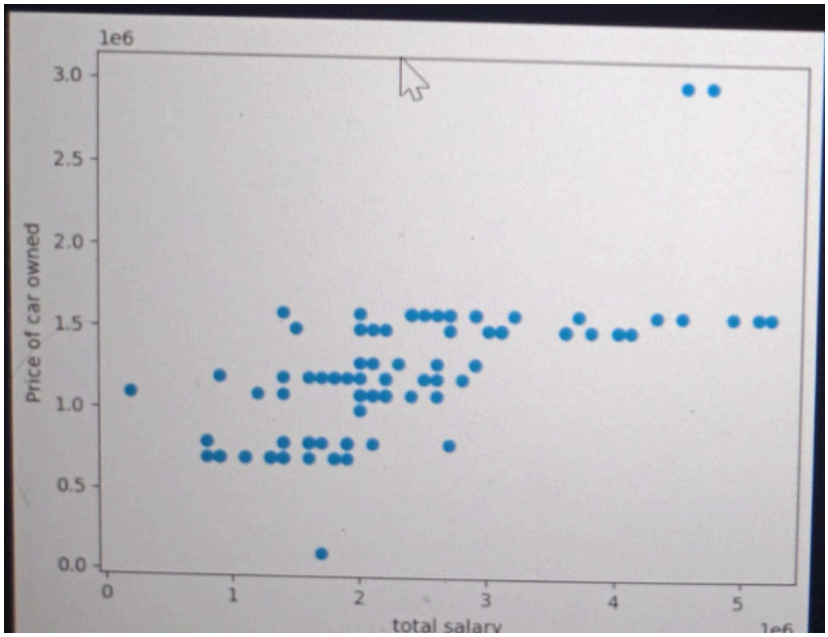


Pair plot



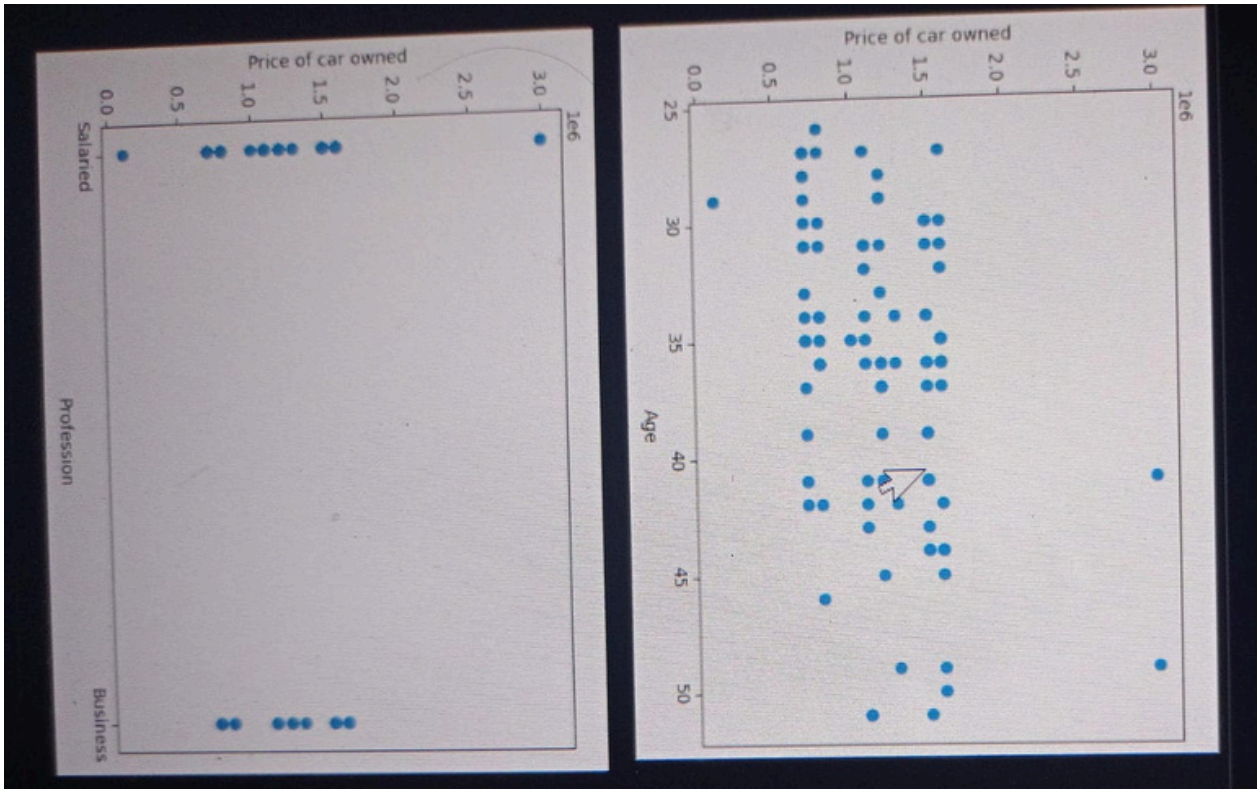
Scatter plot

It examine the relationship between customers' Total Salary and the Price of the car they own. By plotting Total Salary on the x-axis and Price on the y-axis, the scatter plot visually displays how car prices vary with changes in total salary. This visualization helps identify any potential trends or correlations between customers' salaries and the prices of their vehicles.



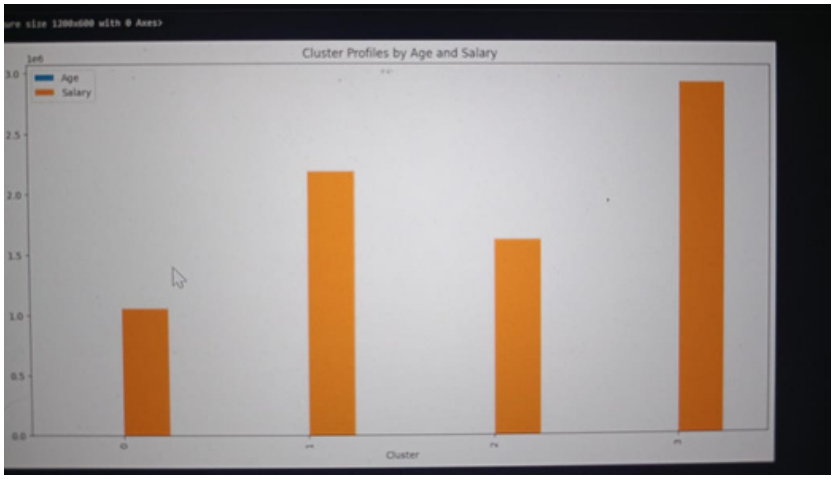
Two scatter plots: one showing the relationship between Age and car Price, and another attempting to relate Profession with car Price. The first plot effectively visualizes how car prices vary with age, while the second plot may be less informative due to Profession being a categorical variable, which is not ideal for scatter plots.

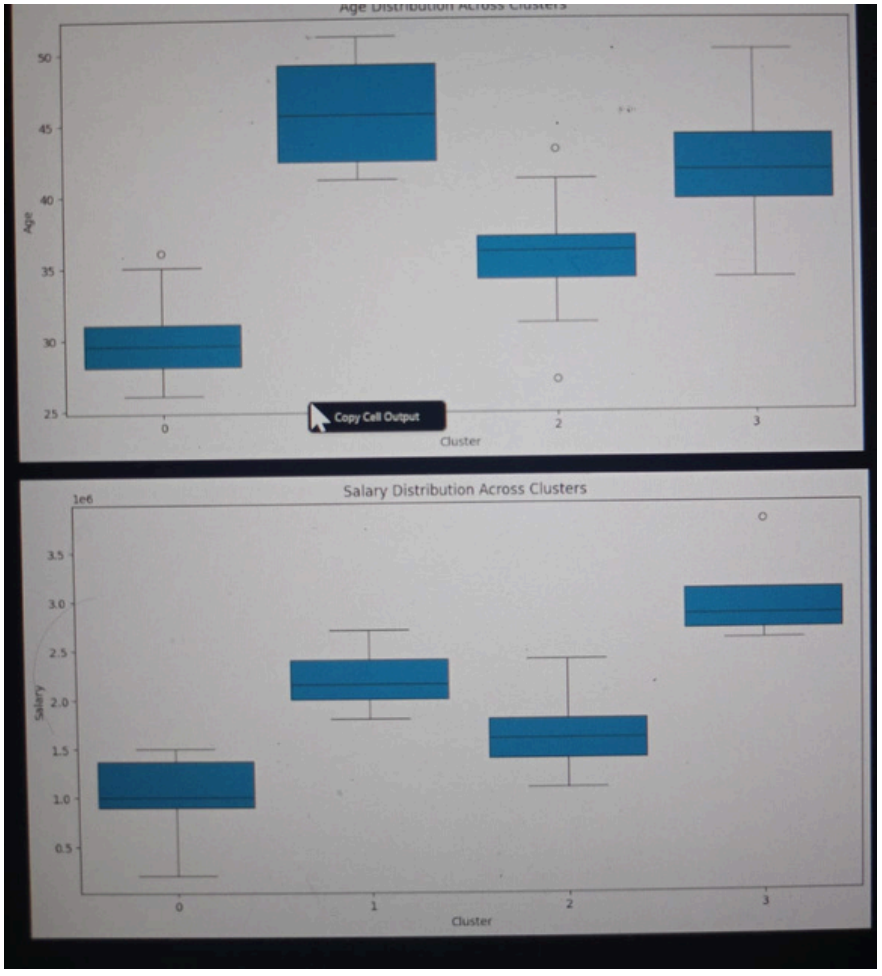
```
plt.xlabel('Age')
plt.ylabel('Price of car owned')
plt.scatter(customer_df['Age'],customer_df['Price'])
plt.show()
plt.xlabel('Profession')
plt.ylabel('Price of car owned')
plt.scatter(customer_df['Profession'],customer_df['Price'])
plt.show()
```



1. **Cluster Profiles by Age and Salary:**
   - A bar plot is created to show the mean values of Age and Salary for each cluster. This helps to compare the average characteristics of each cluster.
2. **Age Distribution Across Clusters:**
   - A boxplot is used to display the distribution of Age within each cluster. It shows the spread and variability of ages in different clusters.
3. **Salary Distribution Across Clusters:**
   - Another boxplot visualizes the distribution of Salary within each cluster, highlighting variations and outliers in salary data across clusters.

These plots provide insights into the characteristics and variations within customer segments.

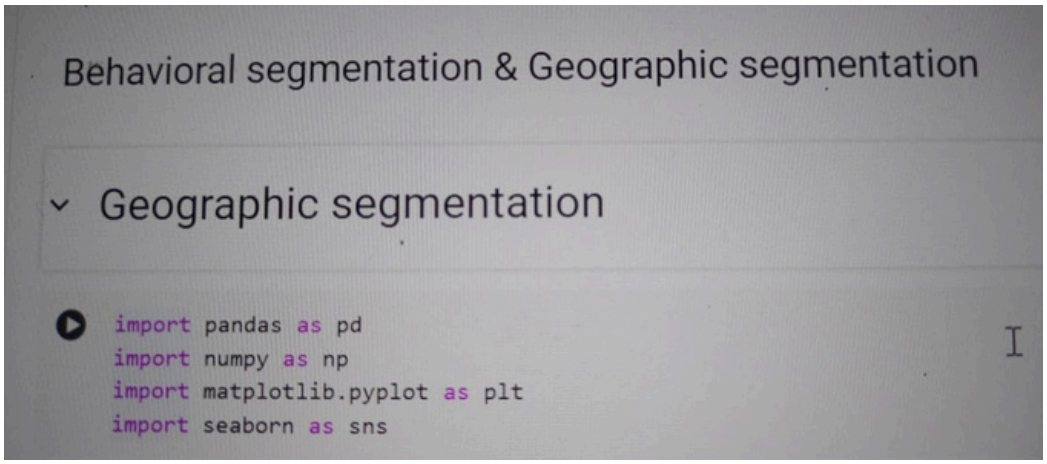




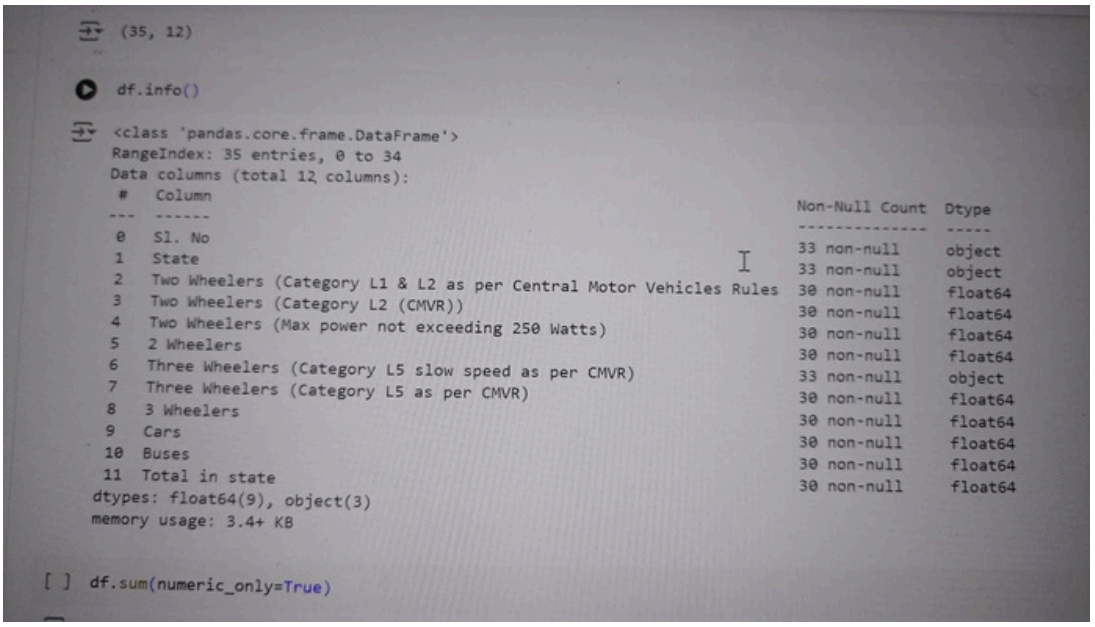
2.Geographic segmentation

Dataset link

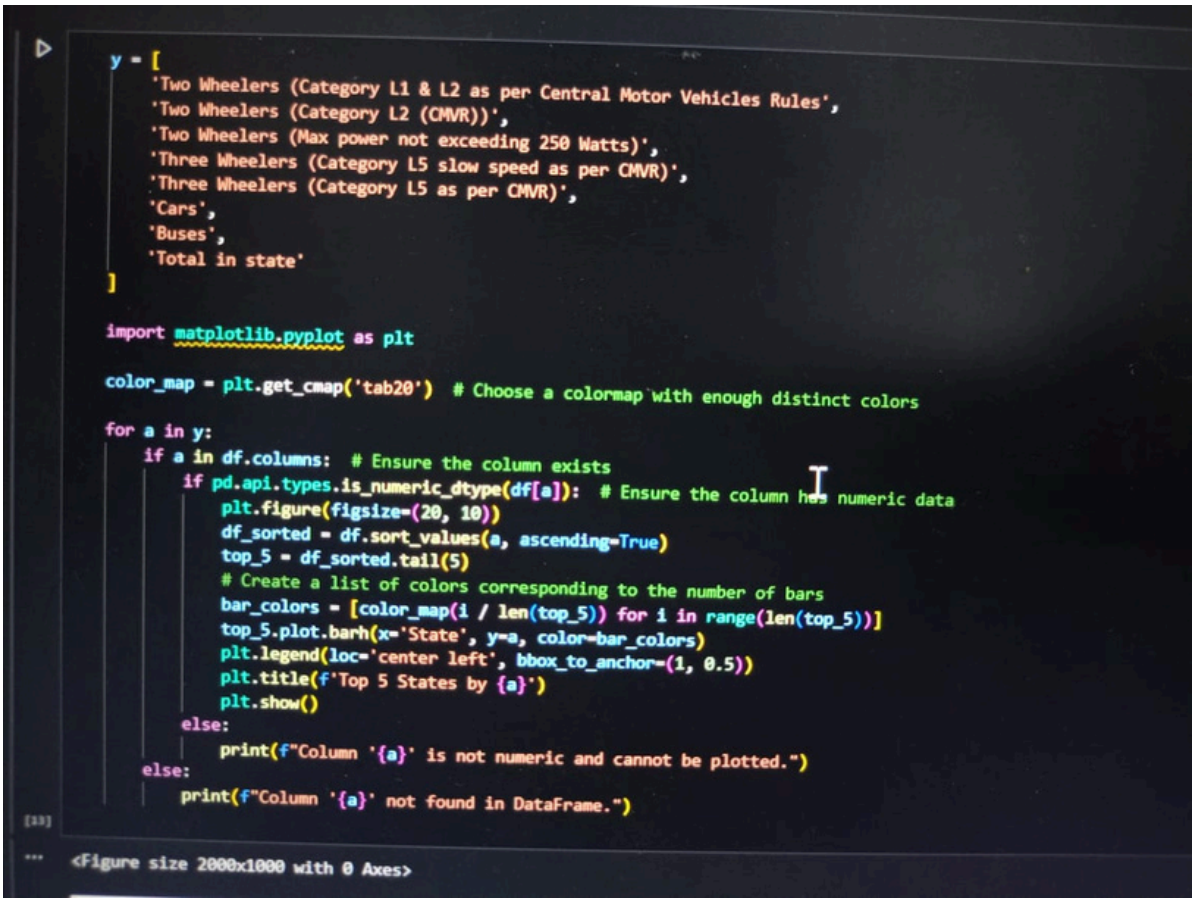
https://github.com/RaniaBZ/Feynn_labs_Market-Segmentation/blob/main/EV%20States.csv



The DataFrame contains 35 entries and 12 columns, detailing vehicle registrations across various categories and states. It includes columns for vehicle types such as two-wheelers, three-wheelers, cars, and buses, as well as a total count of vehicles in each state. Some columns have missing values: Sl. No and State each have 2 missing entries, while several vehicle-related columns have 5 missing values each. The data types include numerical (float64) for vehicle counts and categorical (object) for state names and some vehicle categories.



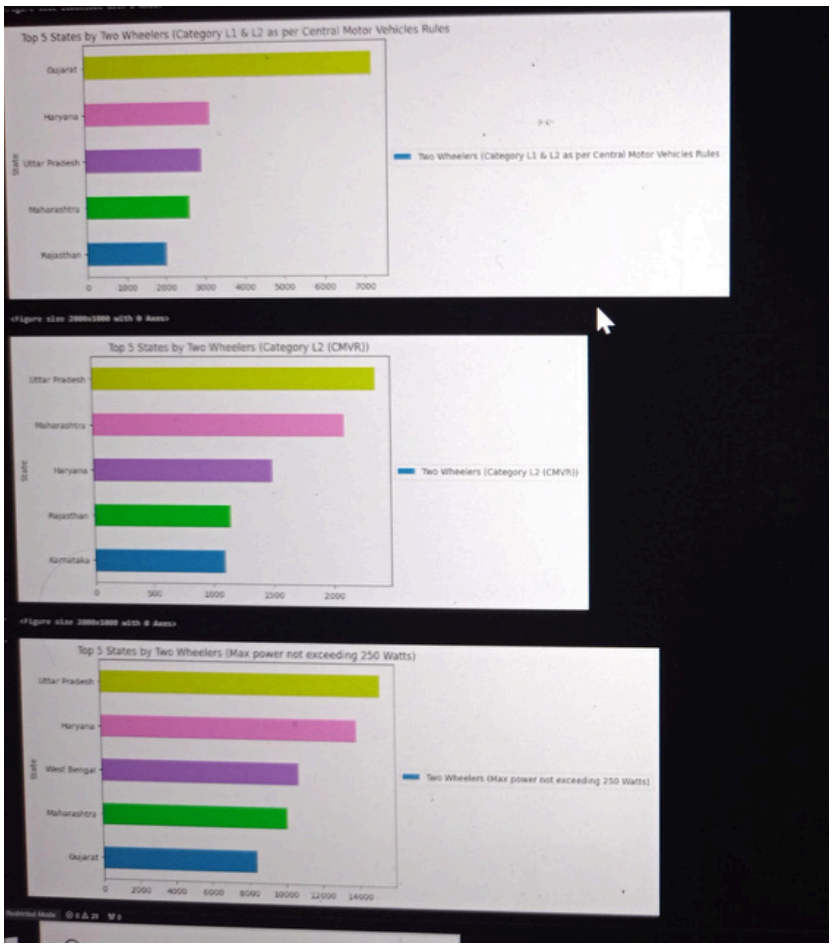
The code creates horizontal bar plots to visualize the top 5 states by vehicle category, using a color map for distinct bar colors. It iterates through a list of vehicle categories, checks if each column exists and contains numeric data, then sorts the DataFrame by each category to select the top 5 states. These states are plotted with horizontal bars, displaying the number of vehicles for each category. The plots include legends and titles for clarity, and handle cases where columns are missing or non-numeric.

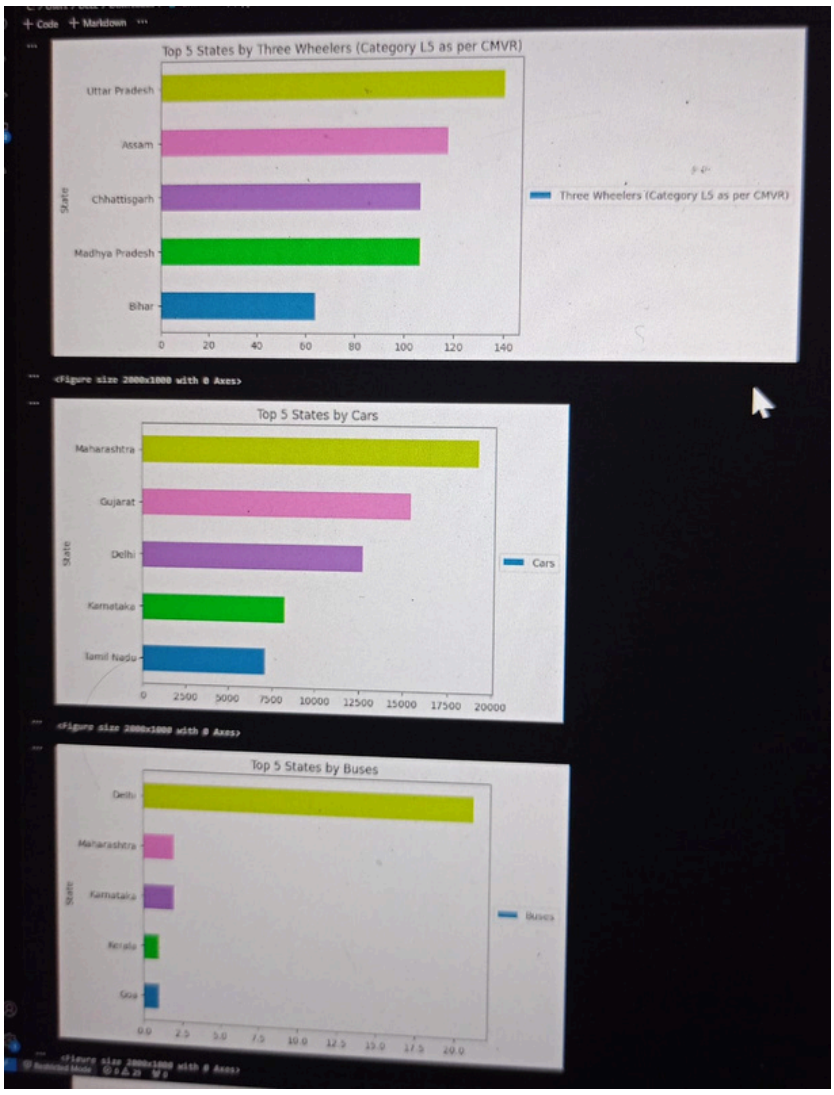


```
y = [
    'Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules',
    'Two Wheelers (Category L2 (CMVR))',
    'Two Wheelers (Max power not exceeding 250 Watts)',
    'Three Wheelers (Category L5 slow speed as per CMVR)',
    'Three Wheelers (Category L5 as per CMVR)',
    'Cars',
    'Buses',
    'Total in state'
]

import matplotlib.pyplot as plt

color_map = plt.get_cmap('tab20')  # Choose a colormap with enough distinct colors

for a in y:
    if a in df.columns:  # Ensure the column exists
        if pd.api.types.is_numeric_dtype(df[a]):  # Ensure the column has numeric data
            plt.figure(figsize=(20, 10))
            df_sorted = df.sort_values(a, ascending=True)
            top_5 = df_sorted.tail(5)
            # Create a list of colors corresponding to the number of bars
            bar_colors = [color_map(i / len(top_5)) for i in range(len(top_5))]
            top_5.plot.barh(x='State', y=a, color=bar_colors)
            plt.legend(loc='center left', bbox_to_anchor=(1, 0.5))
            plt.title(f'Top 5 States by {a}')
            plt.show()
        else:
            print(f"Column '{a}' is not numeric and cannot be plotted.")
    else:
        print(f"Column '{a}' not found in DataFrame.")
```

```
<Figure size 2000x1000 with 0 Axes>
```

Below shows the visualization on different types of vehicles from different states, it states the top 5 states

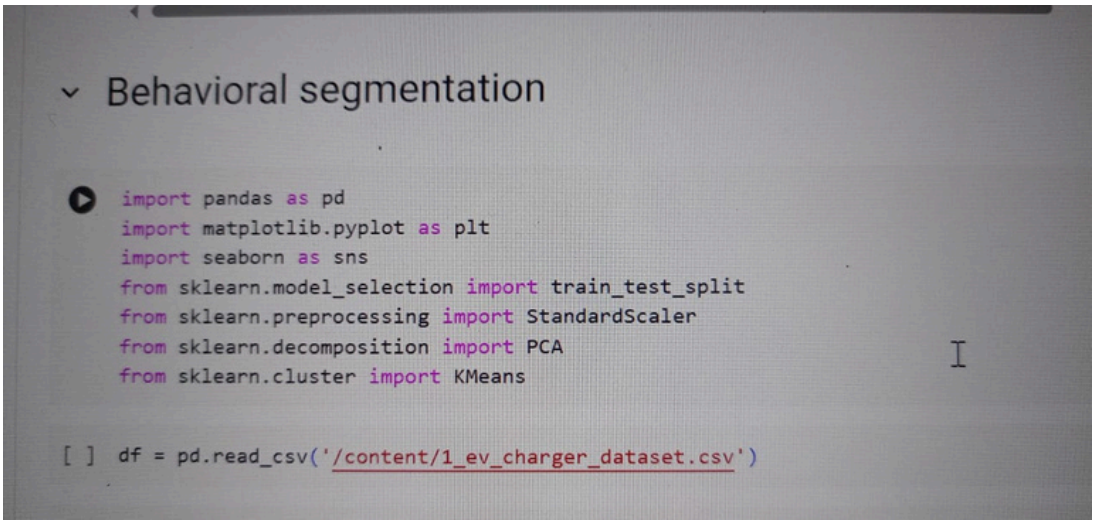

Top 5 States by Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules)
Gujarat
Haryana
Uttar Pradesh
Maharashtra
Rajasthan
State
0
1000
2000
3000
4000
5000
6000
7000
Two Wheelers (Category L1 & L2 as per Central Motor Vehicles Rules)
<Figure size 2000x1000 with 0 Axes>
Top 5 States by Two Wheelers (Category L2 (CMVR))
Uttar Pradesh
Maharashtra
Haryana
Rajasthan
Karnataka
State
0
500
1000
1500
2000
Two Wheelers (Category L2 (CMVR))
<Figure size 2000x1000 with 0 Axes>
Top 5 States by Two Wheelers (Max power not exceeding 250 Watts)
Uttar Pradesh
Haryana
West Bengal
Maharashtra
Gujarat
State
0
2000
4000
6000
8000
10000
12000
14000
Two Wheelers (Max power not exceeding 250 Watts)


+ Code
+ Markdown
Top 5 States by Three Wheelers (Category L5 as per CMVR)
Uttar Pradesh
Assam
Chhattisgarh
Madhya Pradesh
Bihar
State
0
20
40
60
80
100
120
140
Three Wheelers (Category L5 as per CMVR)
<Figure size 2000x1000 with 0 Axes>
Top 5 States by Cars
Maharashtra
Gujarat
Delhi
Karnataka
Tamil Nadu
State
0
2500
5000
7500
10000
12500
15000
17500
20000
Cars
<Figure size 2000x1000 with 0 Axes>
Top 5 States by Buses
Delhi
Maharashtra
Karnataka
Kerala
Goa
State
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Buses
<Figure size 2000x1000 with 0 Axes>

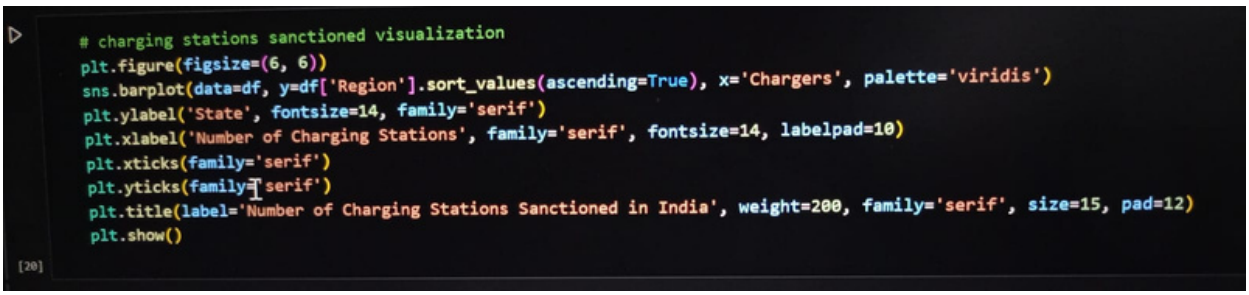
3. Behavioral segmentation

Dataset link:

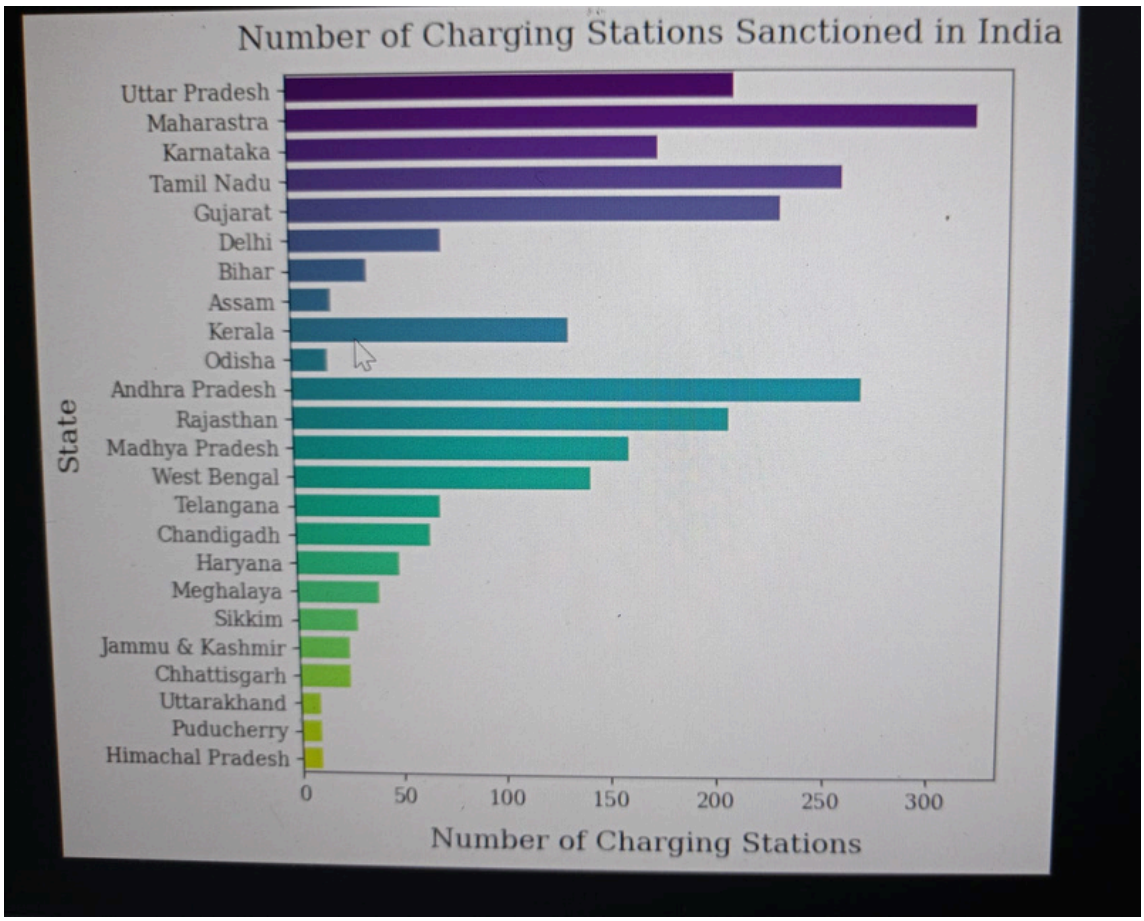
https://github.com/RaniaBZ/Feynn_labs_Market-Segmentation/blob/main/1_ev_charger_dataset.csv



The code creates a bar plot to visualize the number of charging stations across various states. It uses Seaborn's barplot to display the number of chargers on the x-axis and states on the y-axis, sorted in ascending order. The plot is styled with the 'viridis' color palette, and customizes labels, tick fonts, and the title using serif fonts and specific sizes. This visualization helps to easily compare the number of charging stations sanctioned in different states in India.



Number of Charging stations sanctioned in India



Link to Datasets

Data set1 link:

https://github.com/RaniaBZ/Feynn_labs_Market-Segmentation/blob/main/customer_dataset.csv

Data set2 link:

https://github.com/RaniaBZ/Feynn_labs_Market-Segmentation/blob/main/1_ev_charger_dataset.csv

Data set3 link:

https://github.com/RaniaBZ/Feynn_labs_Market-Segmentation/blob/main/EV%20States.csv