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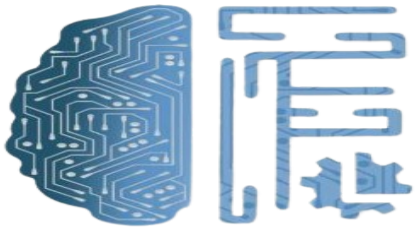
MARKET SEGMENTATION OF ELECTRIC VEHICLES IN INDIA



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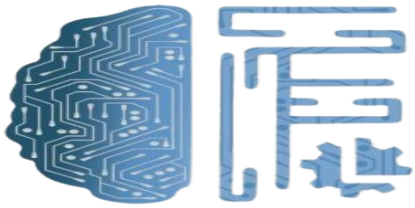
ABSTRACT

Electric vehicles (EVs) are rapidly emerging as a sustainable transportation solution globally, including in India. With the increasing concerns about climate change, air pollution, and energy security, the adoption of electric vehicles is gaining momentum as a viable alternative to traditional internal combustion engine vehicles. In this abstract, we provide an overview of the current landscape of electric vehicles in India, highlighting key trends, challenges, and opportunities.

The Indian government has set ambitious targets to promote electric mobility, aiming to accelerate the adoption of electric vehicles and reduce dependence on fossil fuels. Various policy initiatives, incentives, and subsidies have been introduced to incentivise the production and purchase of electric vehicles, along with the development of charging infrastructure.

Despite the growing interest and government support, the electric vehicle market in India faces several challenges, including high upfront costs, limited charging infrastructure, range anxiety, and consumer awareness. Addressing these challenges requires collaborative efforts from policymakers, industry stakeholders, and other relevant actors.

However, the electric vehicle market in India also presents significant opportunities for innovation, job creation, and environmental sustainability. As technology advances and economies of scale improve, electric vehicles are expected to become more affordable, efficient, and accessible to a wider range of consumers.



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INTRODUCTION

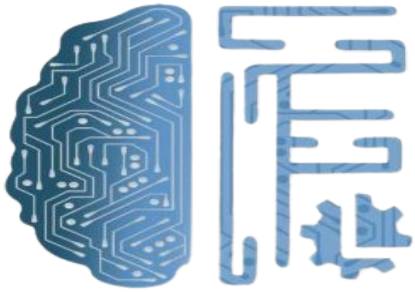
The introduction of electric vehicles (EVs) in India marks a significant transition in the automotive industry, driven by a global push towards sustainable and eco-friendly transportation solutions. EVs offer an alternative to traditional internal combustion engine vehicles, aiming to reduce carbon emissions, dependence on fossil fuels, and environmental pollution.

In recent years, the Indian government has shown a strong commitment to promoting electric mobility through various initiatives and policies. The launch of schemes such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) and the National Electric Mobility Mission Plan (NEMMP) demonstrates the government's efforts to accelerate the adoption of EVs in the country.

One of the key drivers behind the growth of EVs in India is the increasing awareness of environmental issues and the need for cleaner transportation options. With rising concerns over air quality and climate change, there is a growing demand for vehicles that produce fewer emissions and have lower environmental impacts.

The EV market in India has witnessed significant growth in recent years, driven by advancements in battery technology, government incentives, and the entry of new players in the market. Major automakers, both domestic and international, are investing in electric vehicle manufacturing and infrastructure development to cater to the growing demand for EVs.

However, challenges remain, including high upfront costs, limited charging infrastructure, range anxiety, and consumer perceptions regarding EVs' performance and reliability. Addressing these challenges will be crucial for the widespread adoption of electric vehicles in India. Overall, electric vehicles hold immense potential to transform India's transportation landscape, offering cleaner, more sustainable mobility solutions for the future. With continued government support, technological advancements, and increasing consumer acceptance, the electric vehicle market in India is poised for significant growth in the coming years.



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PROBLEM STATEMENT

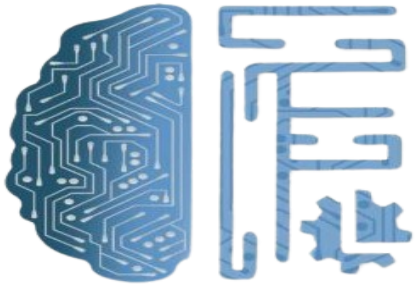
As a part of the team working under an Electric Vehicle Startup, we are tasked with analyzing the Electric Vehicle market in India using segmentation analysis to formulate a feasible strategy for market entry. The startup is currently in the process of deciding the vehicle/customer space in which it will develop its EVs.

To address this challenge, we need to answer the following questions:

1. What type of Electric Vehicle (EV) does the company intend to produce? This includes considerations such as whether the focus will be on electric cars, electric two-wheelers, electric three-wheelers, electric buses, or other specialized electric vehicles.

2. To whom will the company sell its electric vehicles? Understanding the target market segments is crucial for effective market penetration. This involves identifying potential customer segments such as individual consumers, fleet operators, government agencies, commercial enterprises, or specific niche markets.

By conducting a segmentation analysis and answering these key questions, we aim to develop a comprehensive understanding of the Indian Electric Vehicle market landscape. This analysis will enable us to formulate a strategic plan for market entry that targets the segments most likely to adopt and utilize electric vehicles, thereby maximizing the startup's chances of success in the dynamic and rapidly evolving EV industry in India.



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MARKET CHALLENGES

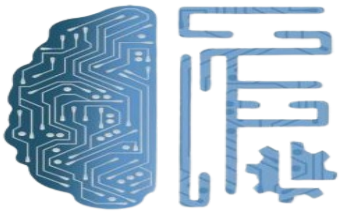
- Consumer Awareness and Education: Many consumers in India lack awareness and understanding of electric vehicles, including their benefits, technology, range, charging infrastructure, and total cost of ownership. Educating consumers about the advantages of EVs and dispelling myths and misconceptions is essential for increasing adoption rates.

- Perceived Range Anxiety: Range anxiety, the fear of running out of battery charge before reaching a destination, is a significant concern among potential EV buyers. Addressing this perception through improved battery technology, expanding charging infrastructure, and providing accurate information about range capabilities is crucial for building consumer confidence.

- Charging Infrastructure: Insufficient charging infrastructure is a major hurdle for EV adoption in India. Establishing a widespread network of fast-charging stations in urban areas, highways, and remote regions is essential for alleviating range anxiety and enabling convenient EV usage.

- Cost Considerations: The upfront cost of electric vehicles, including the price premium compared to conventional vehicles, is a significant barrier for many consumers. Implementing policies and incentives such as subsidies, tax breaks, and incentives for manufacturing and purchasing EVs can help reduce the cost barrier and stimulate demand.

- Technology and Performance: Improving the performance, reliability, and driving experience of electric vehicles is crucial for winning over sceptical consumers. Enhancements in battery technology, vehicle range, charging speed, and overall performance is essential for attracting buyers and competing with traditional internal combustion engine vehicles.



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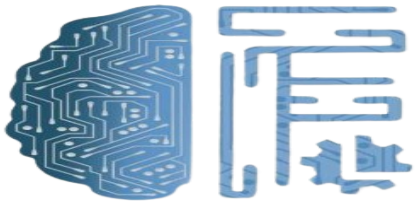
COMPETITIVE LANDSCAPE

- The competitive landscape of the electric vehicle (EV) market in India is dynamic and evolving rapidly, characterized by intense competition among established automakers, emerging startups, and global players seeking to capitalize on the growing demand for sustainable mobility solutions.

- Established automakers such as Tata Motors, Mahindra & Mahindra, and Hyundai have entered the EV space with a range of electric models, leveraging their brand reputation, manufacturing capabilities, and distribution networks to gain market share.

- At the same time, innovative startups like Ola Electric, Ather Energy, and Revolt Motors are disrupting the market with innovative EV offerings, advanced technology, and unique business models, challenging traditional incumbents and driving innovation in the industry.

- International players like Tesla and Nissan are also eyeing the Indian market, bringing global expertise, cutting-edge technology, and premium EV models to cater to discerning consumers and further intensifying competition in the EV segment. Amidst this competitive landscape, companies are focused on product differentiation, pricing strategies, and partnerships to gain a competitive edge, expand market presence, and establish leadership in India's rapidly growing EV market.



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THE SEVERAL DATASETS ARE AS FOLLOWS :

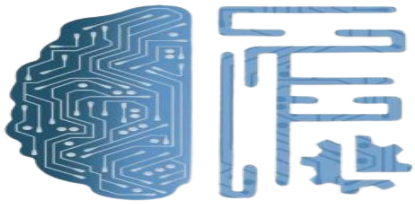
1. This dataset encompasses various brands of electric cars available in India, along with details such as Brand, Model, Accelsec, TopSpeed_KmH, Range_Km, Efficiency_Whkm, Fastcharge_KmH, RapidCharge, PowerTrain, PlugType, BodyStyle, Segment, Seats, PriceEuro,inr.

	Brand	Model	AccelSec	TopSpeed_KmH	Range_Km	Efficiency_WhKm	FastCharge_KmH	RapidCharge	PowerTrain	PlugType	BodyStyle	Segment	S
0	Tesla	Model 3 Long Range Dual Motor	4.6000	233	450	161	940	1	AWD	Type 2 CCS	Sedan	D	
1	Volkswagen	ID.3 Pure	10.0000	160	270	167	250	0	RWD	Type 2 CCS	Hatchback	C	
2	Polestar	2	4.7000	210	400	181	620	1	AWD	Type 2 CCS	Liftback	D	
3	BMW	iX3	6.8000	180	360	206	560	1	RWD	Type 2 CCS	SUV	D	
4	Honda	e	9.5000	145	170	168	190	1	RWD	Type 2 CCS	Hatchback	B	

2. Geographic Distribution of Electric Vehicles in India.

Out[45]:

	Sl. No	State	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)	Passenger Cars (Category M1 as per CMVR)	Buses	Total in state
0	1	Andhra Pradesh	431.0	692.0	4689.0	0	0.0	3680.0	0.0	9492.0
1	2	Assam	463.0	138.0	1006.0	0	117.0	151.0	0.0	1875.0
2	3	Bihar	252.0	430.0	2148.0	6	64.0	271.0	0.0	3171.0
3	4	Chhattisgarh	613.0	382.0	2078.0	58	106.0	997.0	0.0	4234.0
4	5	Delhi	1395.0	251.0	5018.0	0	1.0	12695.0	21.0	19381.0
5	6	Goa	0.0	0.0	0.0	0	0.0	513.0	1.0	514.0
6	7	Gujarat	7182.0	217.0	8476.0	0	4.0	15388.0	0.0	31267.0
7	8	Haryana	3162.0	1504.0	13908.0	113	24.0	4878.0	0.0	23589.0
8	9	Himachal Pradesh	0.0	0.0	0.0	0	0.0	98.0	0.0	98.0
9	10	Jammu & Kashmir	2.0	76.0	152.0	0	0.0	208.0	0.0	438.0
10	11	Jharkhand	75.0	228.0	736.0	9	7.0	655.0	0.0	1710.0
11	12	Karnataka	784.0	1104.0	3252.0	2	0.0	8242.0	2.0	13386.0
12	13	Kerala	432.0	78.0	4961.0	1	0.0	5729.0	1.0	11202.0
13	14	Madhya Pradesh	503.0	378.0	2904.0	8	106.0	2562.0	0.0	6461.0



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14	15	Maharashtra	2630.0	2097.0	10146.0	6	3.0	19129.0	2.0	34013.0
15	16	Manipur	16.0	8.0	11.0	0	5.0	12.0	0.0	52.0
16	17	Meghalaya	0.0	0.0	0.0	0	0.0	6.0	0.0	6.0
17	18	Nagaland	0.0	20.0	3.0	0	0.0	1.0	0.0	24.0
18	19	Odisha	377.0	824.0	2031.0	0	37.0	594.0	0.0	3863.0
19	20	Punjab	698.0	300.0	1968.0	0	5.0	3567.0	0.0	6538.0
20	21	Rajasthan	2036.0	1153.0	8375.0	19	64.0	4116.0	0.0	15763.0
21	22	Tamil Nadu	491.0	863.0	8260.0	0	0.0	7132.0	0.0	16746.0
22	23	Telangana	535.0	711.0	2256.0	2	0.0	5530.0	0.0	9034.0
23	24	Tripura	28.0	9.0	36.0	0	0.0	8.0	0.0	81.0
24	25	Uttar Pradesh	2954.0	2355.0	15199.0	117	139.0	5445.0	0.0	26209.0
25	26	Uttarkhand	423.0	168.0	3239.0	45	38.0	265.0	0.0	4178.0
26	27	West Bengal	1451.0	65.0	10781.0	3	0.0	1840.0	0.0	14140.0
27	28	Andaman & Nicobar islands	0.0	0.0	0.0	0	0.0	82.0	0.0	82.0
28	29	Chandigarh	612.0	18.0	896.0	0	0.0	974.0	0.0	2500.0
29	30	Dadra and Nagar Haveli	4.0	0.0	9.0	0	0.0	803.0	0.0	816.0
30	31	Total	27549.0	14069.0	112538.0	389	720.0	105571.0	27.0	260863.0
31	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

3. This data encompasses the behaviour of Indian consumers when it comes to purchasing electric vehicles.

Out[3]:

	Age	Profession	Marrital Status	Education	No of Dependents	Personal loan	House Loan	Wife Working	Salary	Wife Salary	Total Salary	Make	Price
0	27	Salaried	Single	Post Graduate	0	Yes	No	No	800000	0	800000	i20	800000
1	35	Salaried	Married	Post Graduate	2	Yes	Yes	Yes	1400000	600000	2000000	Ciaz	1000000
2	45	Business	Married	Graduate	4	Yes	Yes	No	1800000	0	1800000	Duster	1200000
3	41	Business	Married	Post Graduate	3	No	No	Yes	1600000	600000	2200000	City	1200000
4	31	Salaried	Married	Post Graduate	2	Yes	No	Yes	1800000	800000	2600000	SUV	1600000

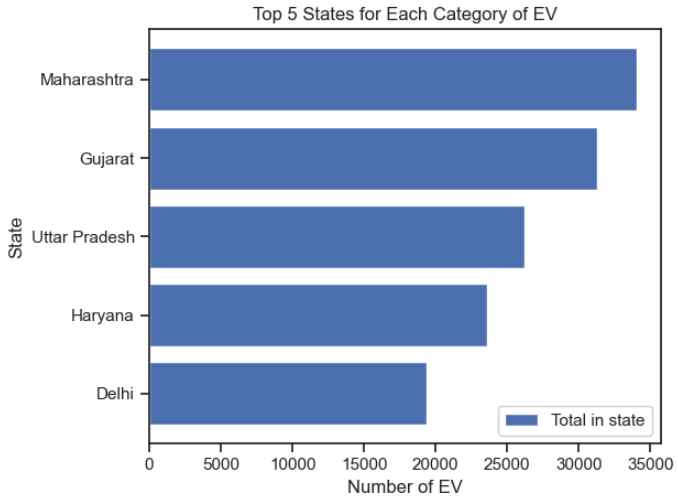
4. This data encompasses the charging station name, address, state, and city in India.

ut[55]:

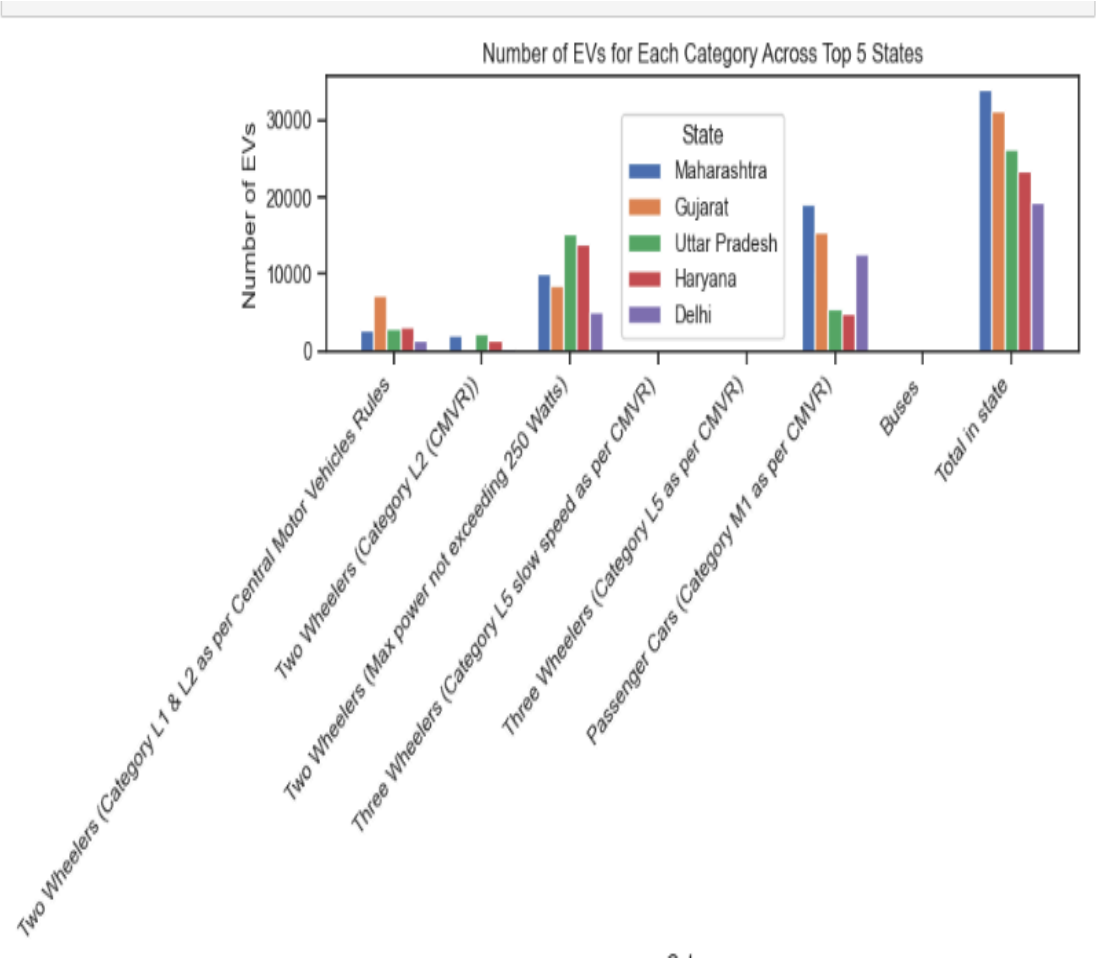
	name	state	city	address	lattitude	longitude	type
0	Neelkanth Star DC Charging Station	Haryana	Gurugram	Neelkanth Star Karnal, NH 44, Gharunda, Kutail...	29.6019	76.9803	12.0
1	Galleria DC Charging Station	Haryana	Gurugram	DLF Phase IV, Sector 28, Gurugram, Haryana 122022	28.4673	77.0818	12.0
2	Highway Xpress (Jaipur-Delhi) DC charging station	Rajasthan	Behror	Jaipur to Delhi Road, Behror Midway, Behror, R...	27.8751	76.2760	12.0
3	Food Carnival DC Charging Station	Uttar Pradesh	Khatauli	Fun and Food Carnival, NH 58, Khatauli Bypass,...	29.3105	77.7218	12.0
4	Food Carnival AC Charging Station	Uttar Pradesh	Khatauli	NH 58, Khatauli Bypass, Bhainsi, Uttar Pradesh...	29.3105	77.7218	12.0

MARKET SEGMENT ANALYSIS

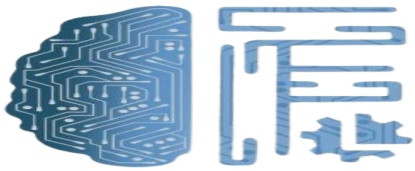
1. GEOGRAPHIC ANALYSIS



The graph above indicates that Maharashtra has recorded the highest number of electric vehicle sales.



- Maharashtra leads in the total number of EV sales, most of the sales are of passenger cars.
- Gujarat has the highest two-wheeler (category L1& L2) EV sales.
- Uttar Pradesh has the highest percentage of sales in Two-wheelers (max power not exceeding 250 watts).



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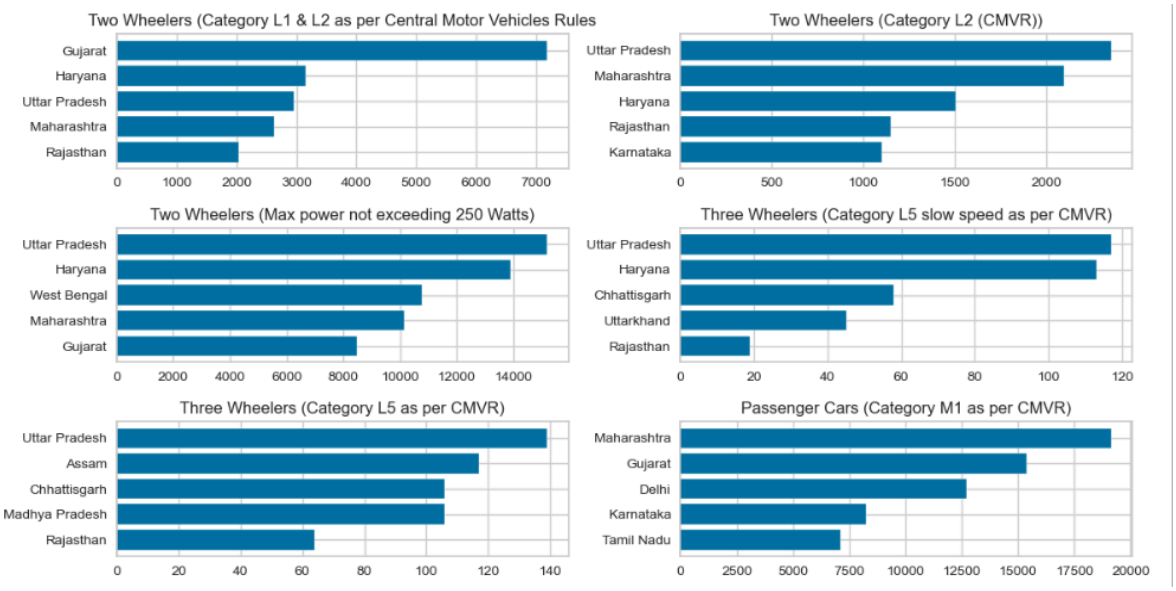

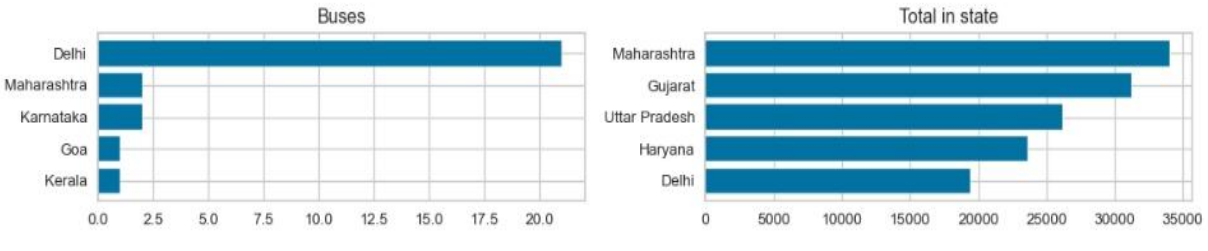

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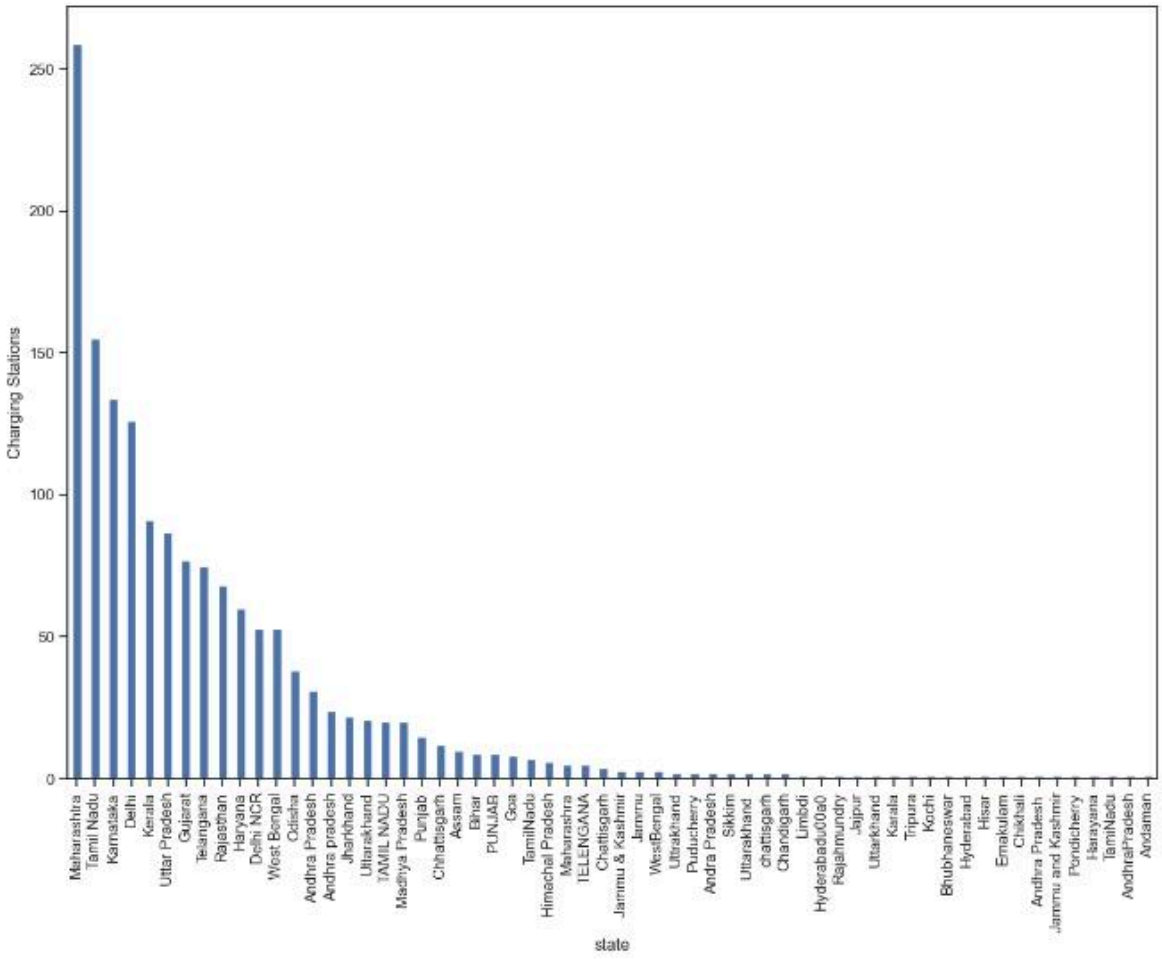
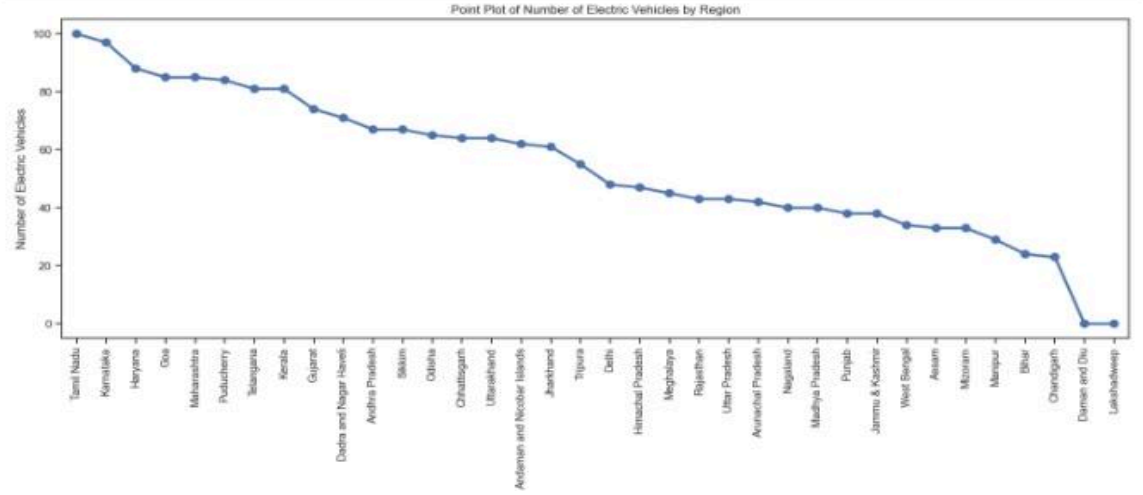
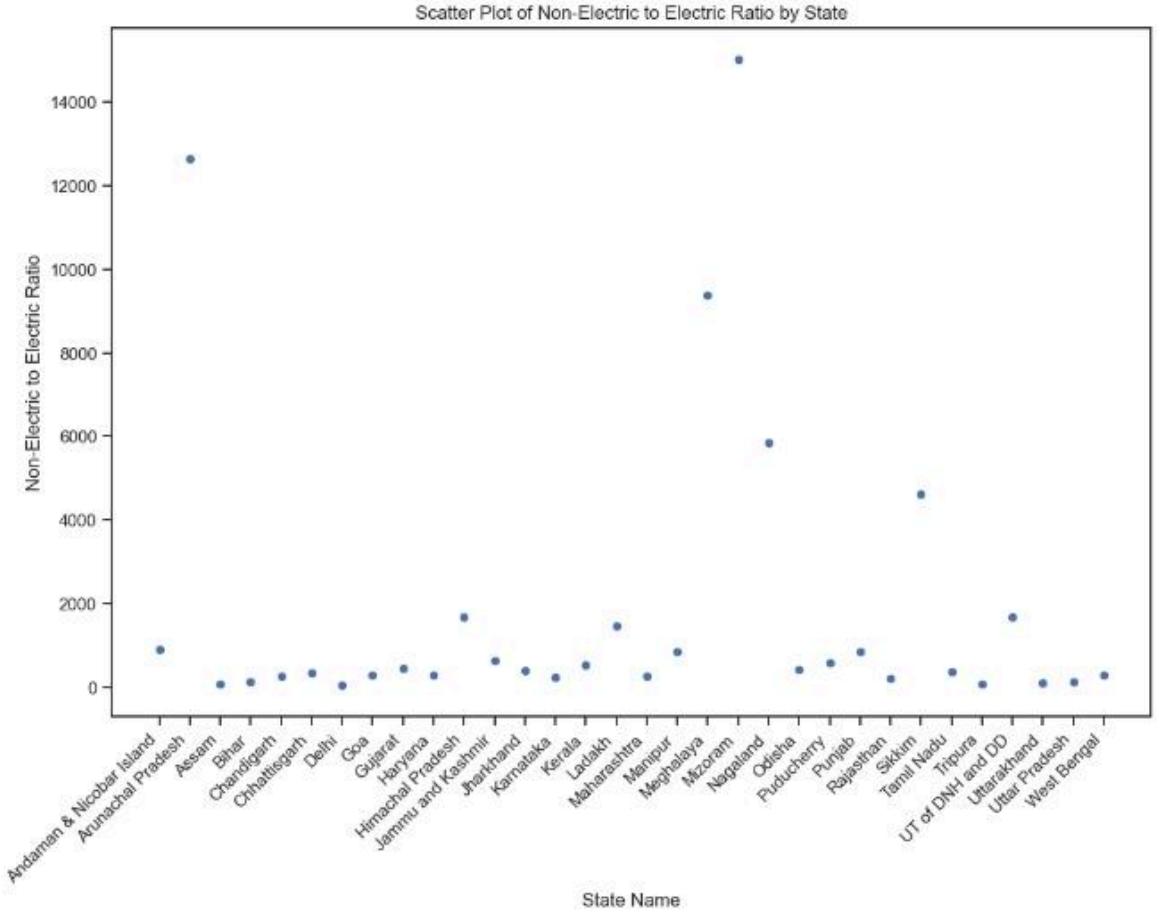
CHARGING STATION ANALYSIS




Point Plot of Number of Electric Vehicles by Region
Number of Electric Vehicles
0
20
40
60
80
100
Tamil Nadu
Karnataka
Haryana
Goa
Maharashtra
Puducherry
Telangana
Kerala
Gujarat
Dadra and Nagar Haveli
Andhra Pradesh
Sikkim
Odisha
Chhattisgarh
Uttarakhand
Andaman and Nicobar Islands
Jharkhand
Tripura
Delhi
Himachal Pradesh
Meghalaya
Rajasthan
Uttar Pradesh
Arunachal Pradesh
Nagaland
Madhya Pradesh
Punjab
Jammu & Kashmir
West Bengal
Assam
Mizoram
Manipur
Bihar
Chandigarh
Daman and Diu
Lakshadweep


Scatter Plot of Non-Electric to Electric Ratio by State
Non-Electric to Electric Ratio
0
2000
4000
6000
8000
10000
12000
14000
Andaman & Nicobar Island
Arunachal Pradesh
Assam
Bihar
Chandigarh
Chhattisgarh
Delhi
Goa
Gujarat
Haryana
Himachal Pradesh
Jammu and Kashmir
Jharkhand
Karnataka
Kerala
Ladakh
Maharashtra
Manipur
Meghalaya
Mizoram
Nagaland
Odisha
Puducherry
Punjab
Rajasthan
Sikkim
Tamil Nadu
Tripura
UT of DNH and DD
Uttarakhand
Uttar Pradesh
West Bengal
State Name

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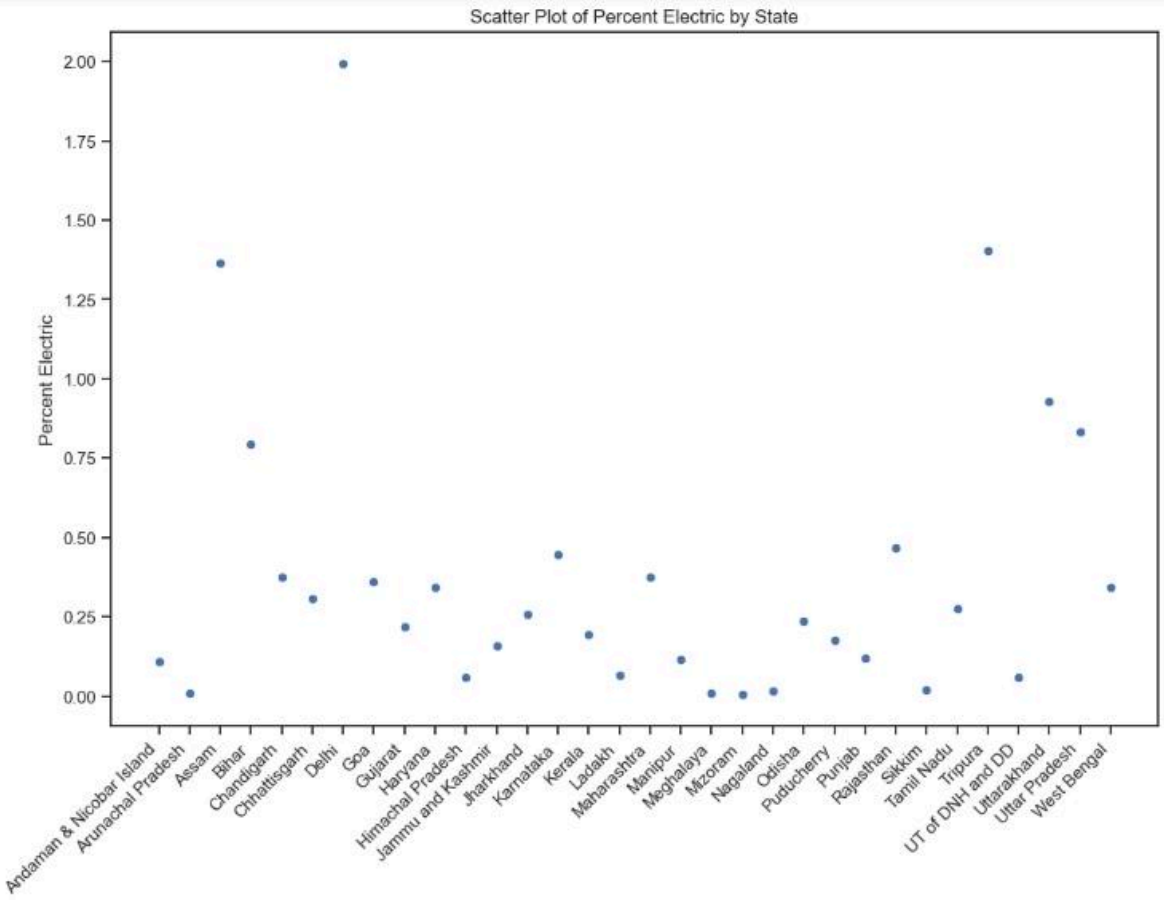

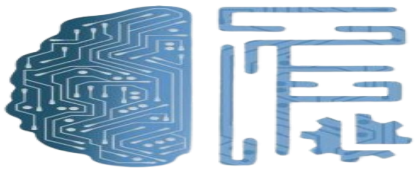

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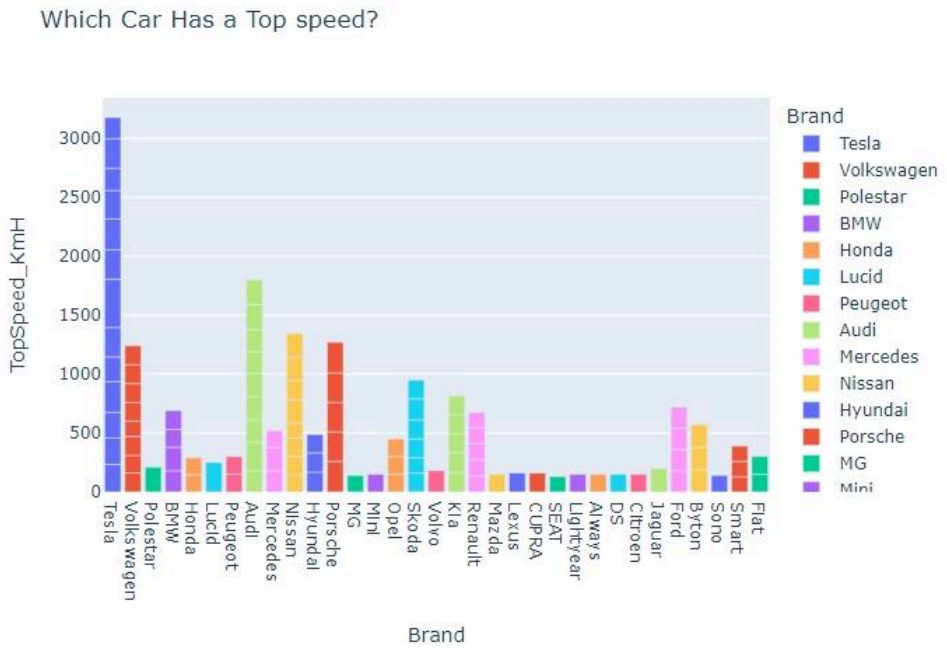
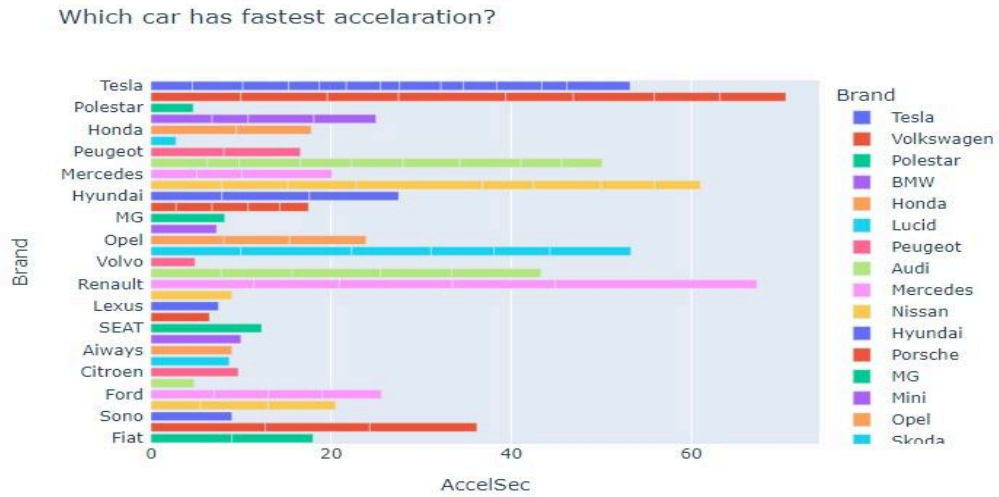
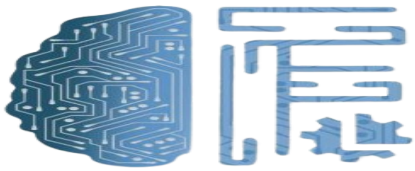
2. BEHAVIOURAL ANALYSIS OF DIFFERENT ELECTRIC VEHICLE BRANDS







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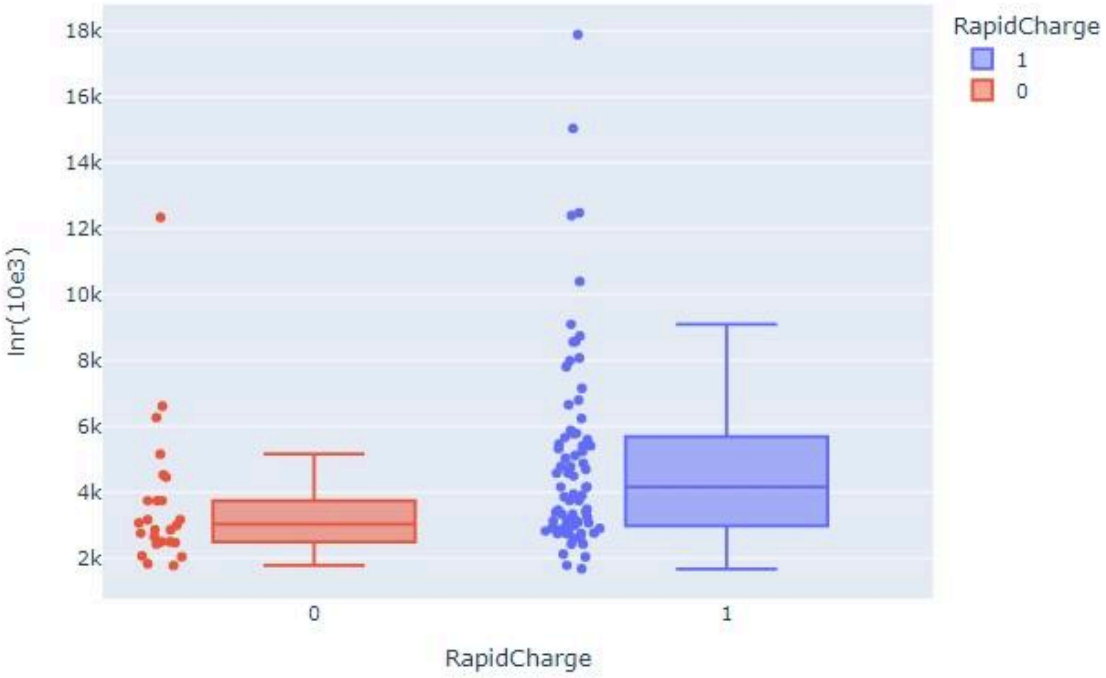
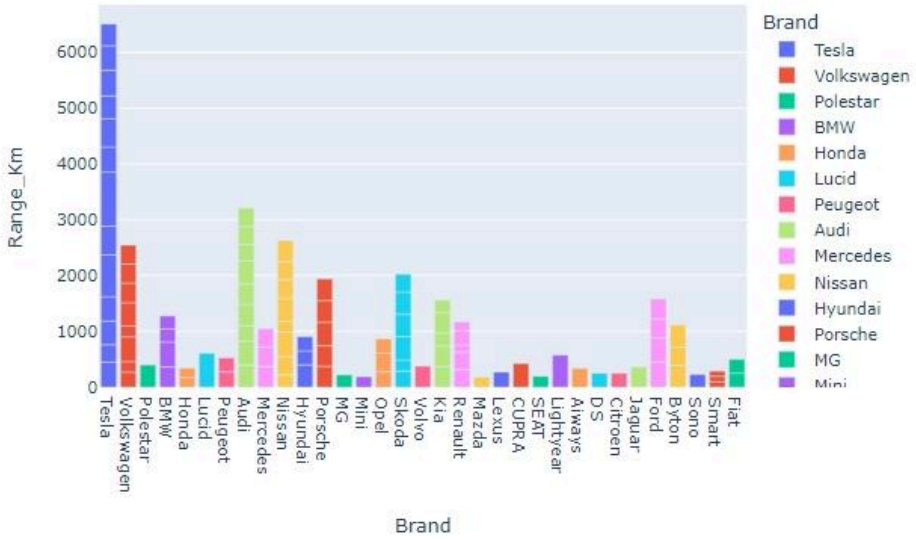


Bar Chart of Brand vs. Range_Km



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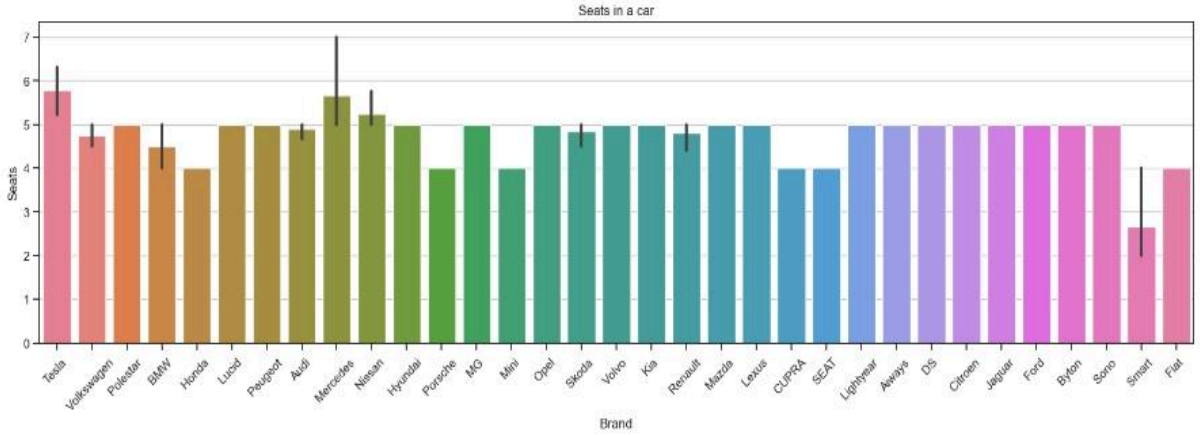

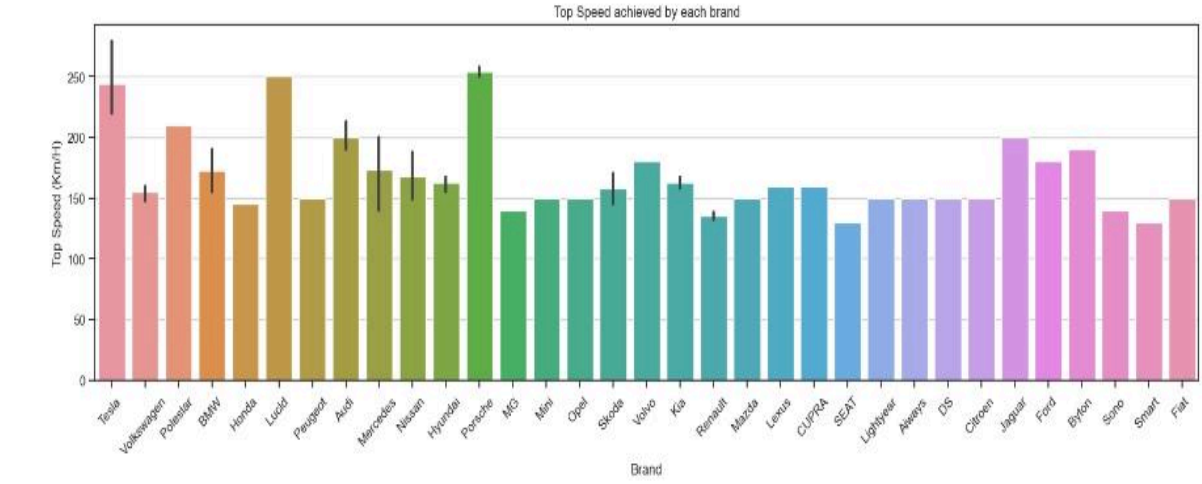

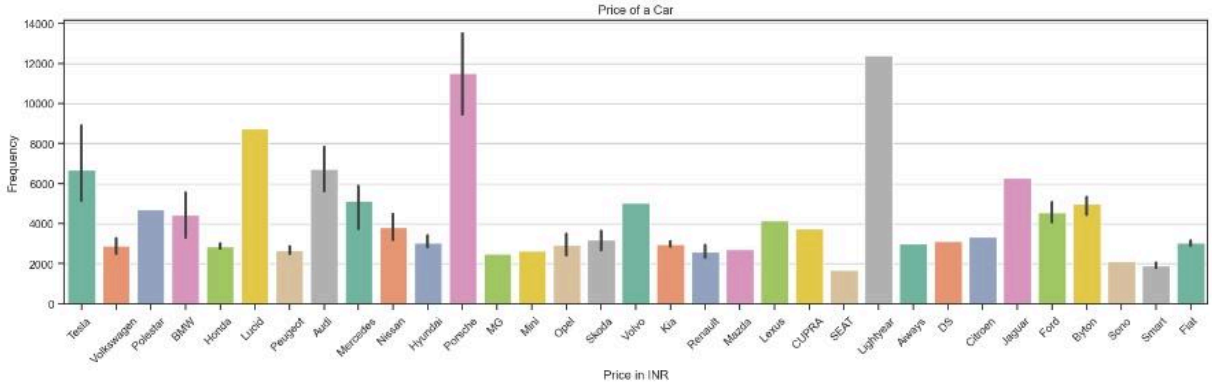

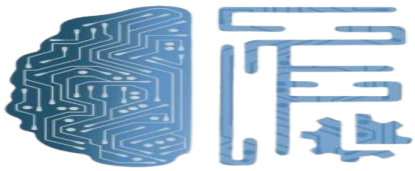

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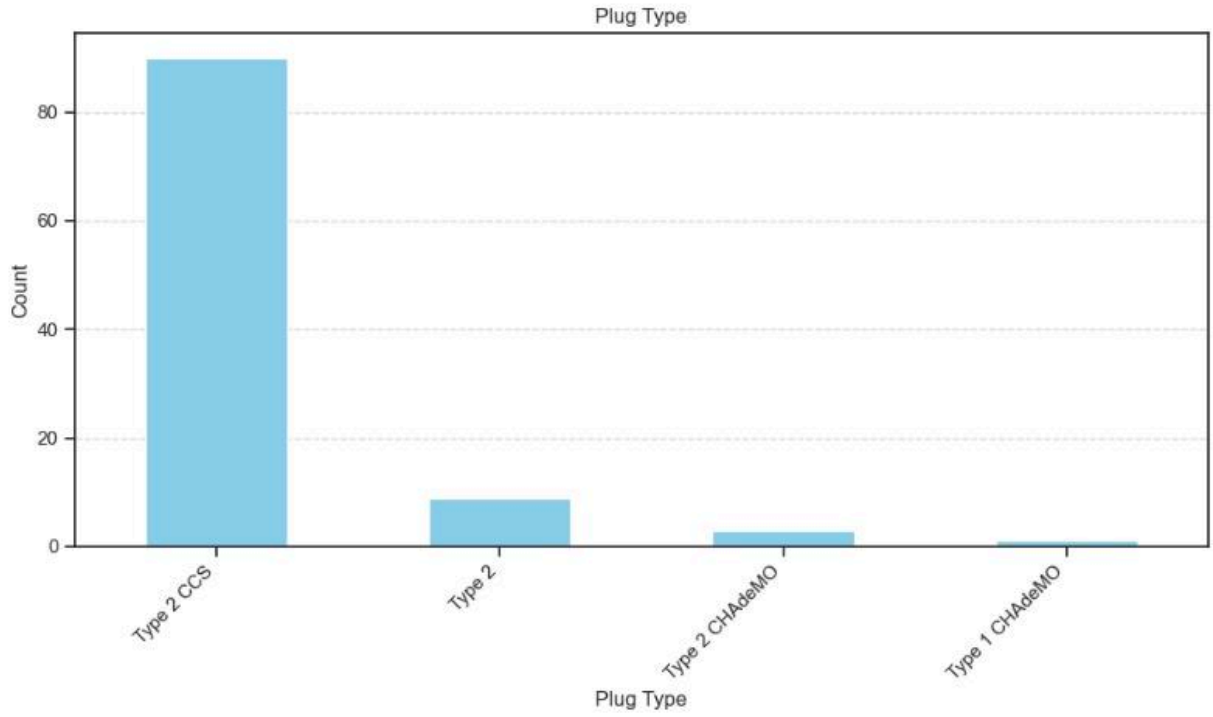
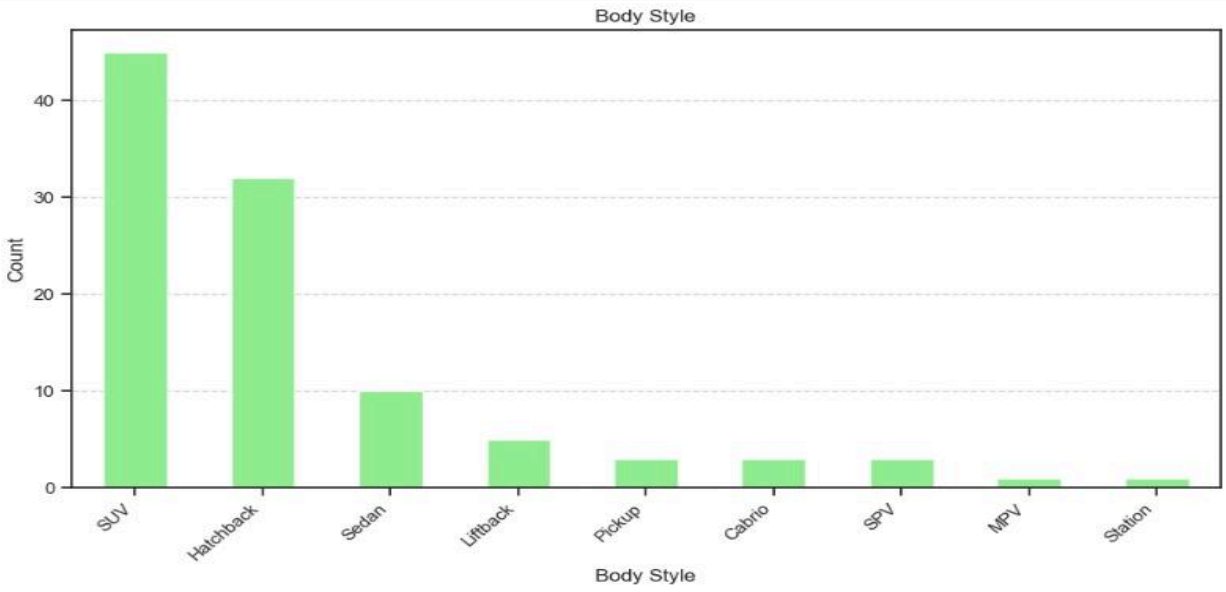
EXPERIMENT WITH YOUR KNOWLEDGE





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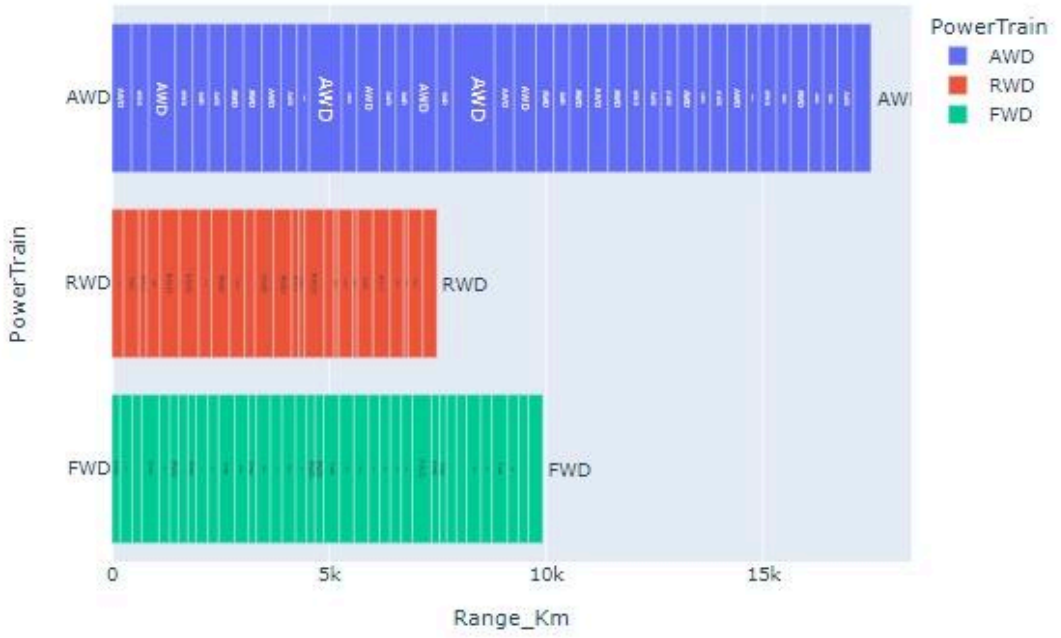
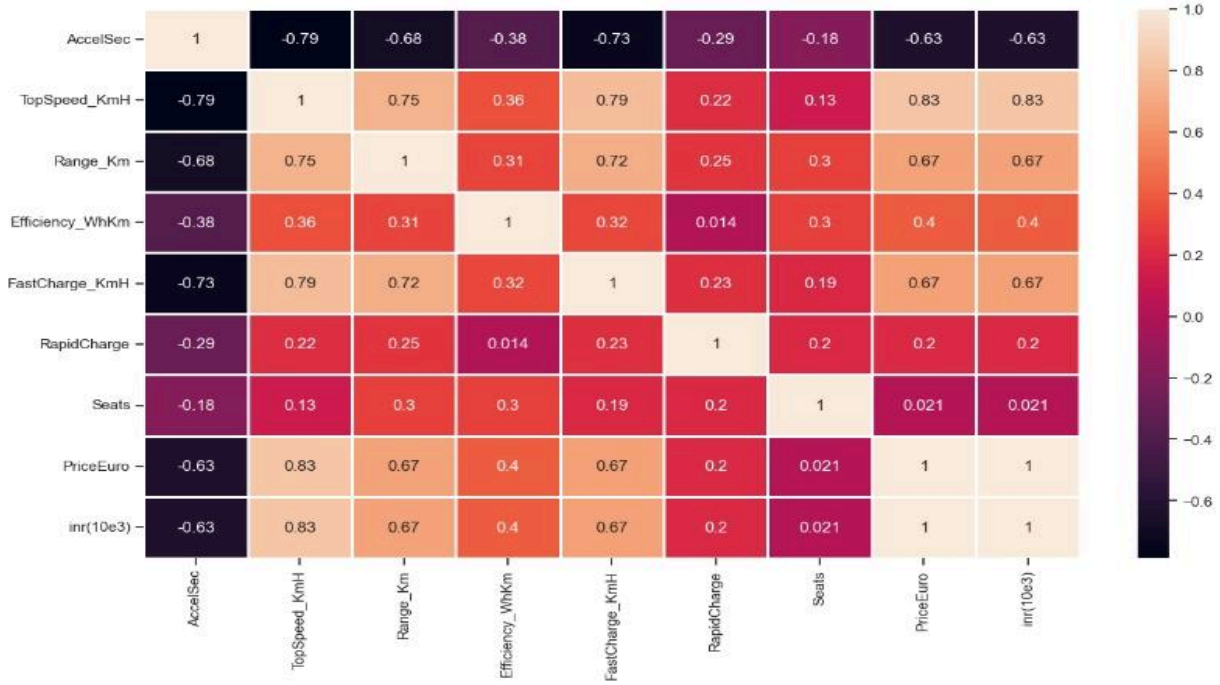
EXPERIMENT WITH YOUR KNOWLEDGE





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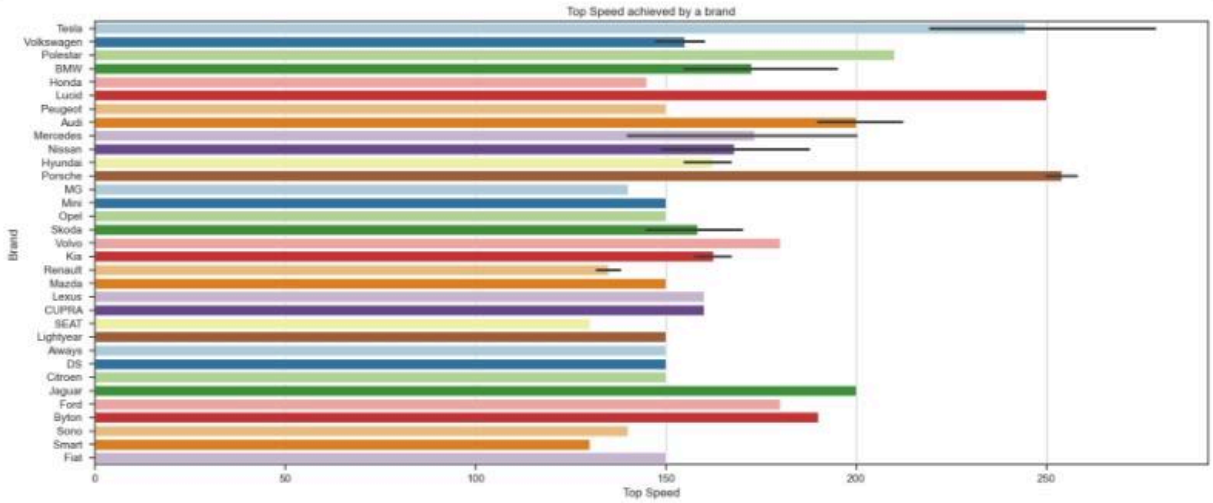

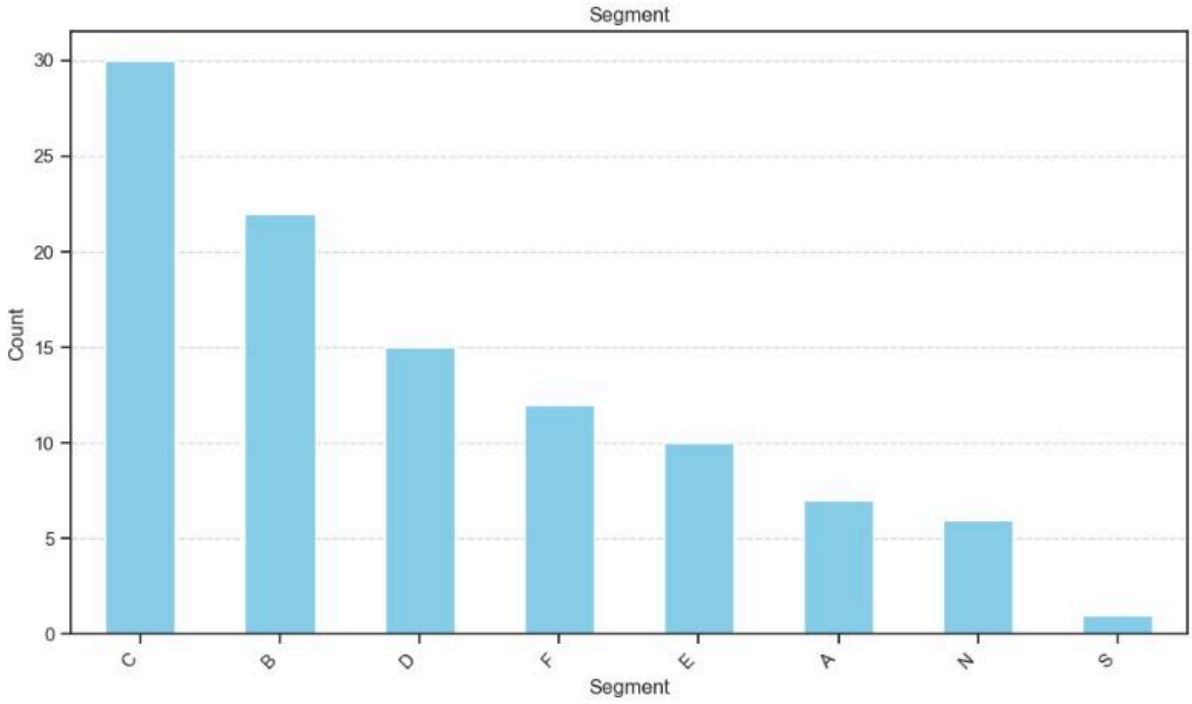

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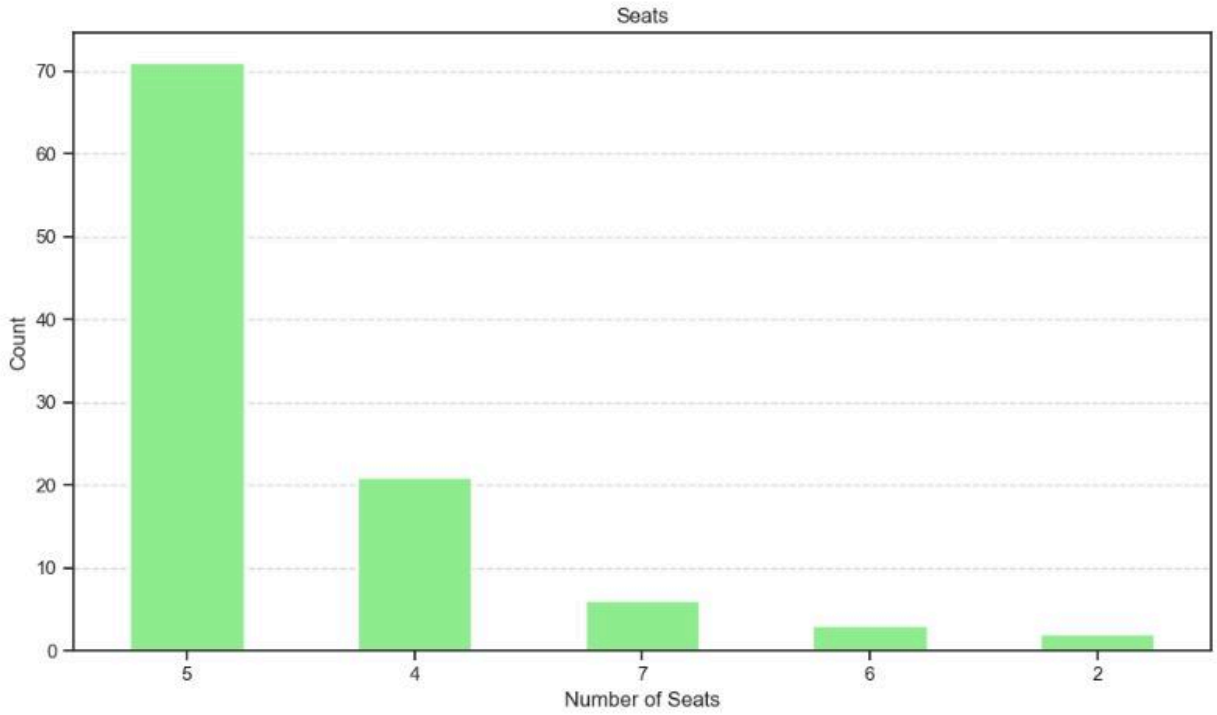
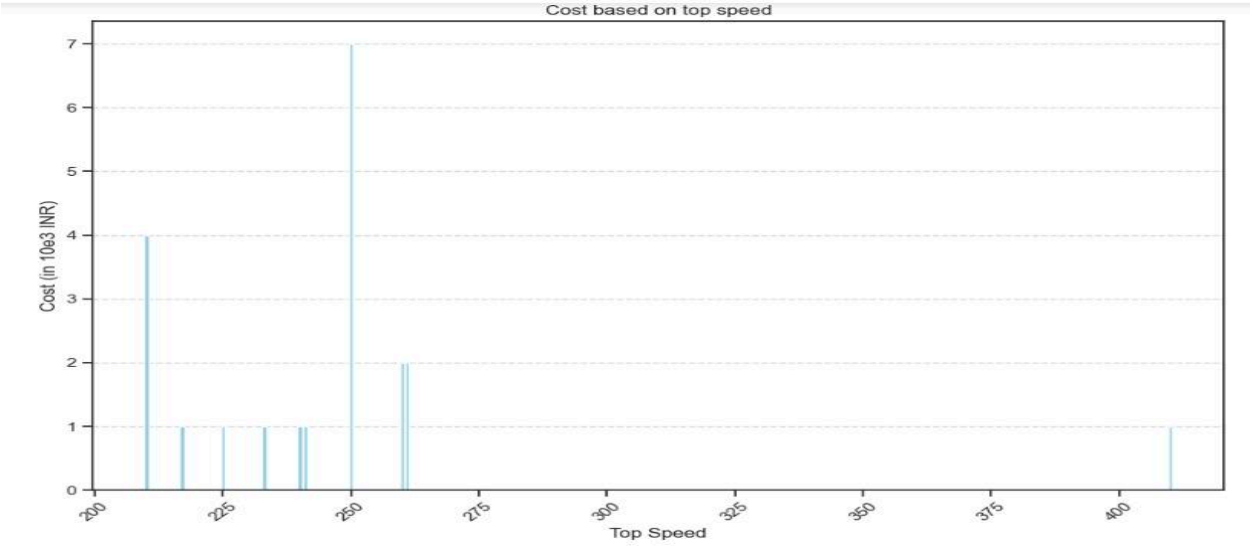
EXPERIMENT WITH YOUR KNOWLEDGE





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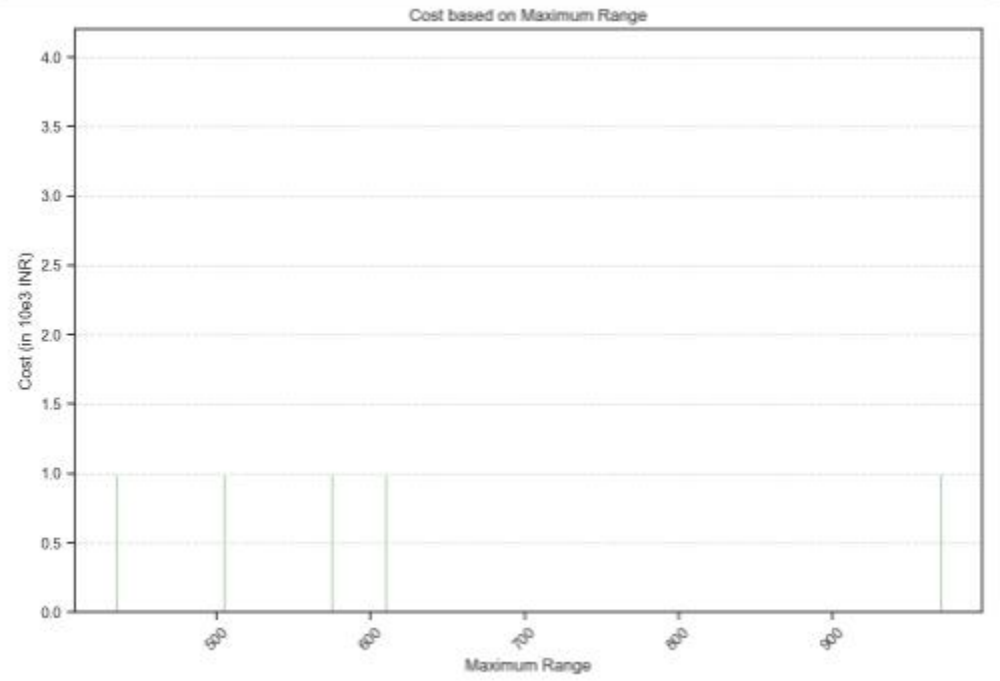
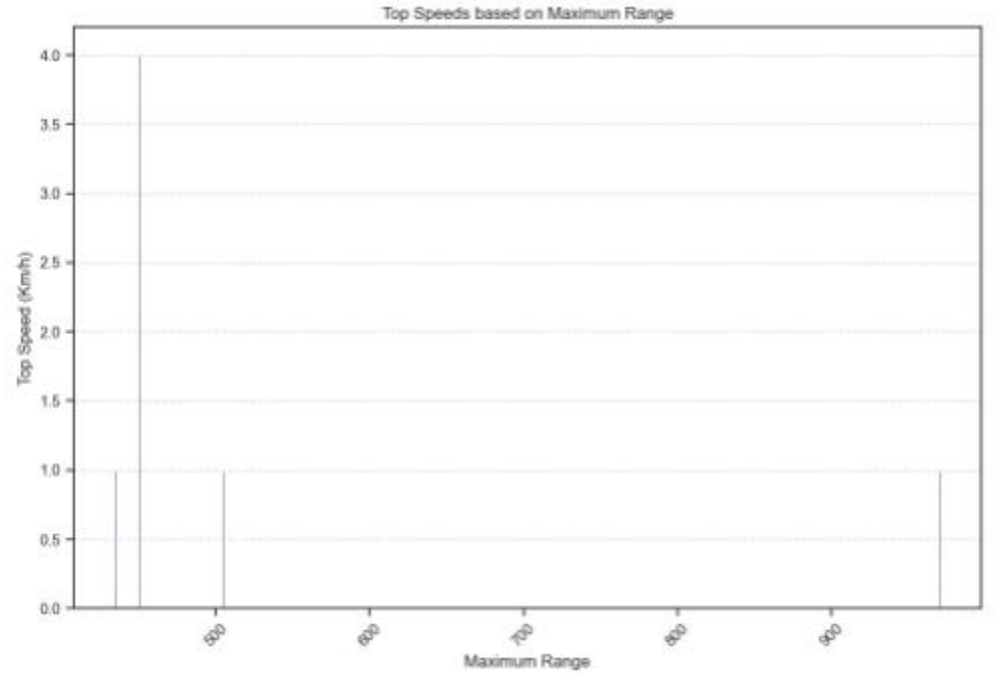
EXPERIMENT WITH YOUR KNOWLEDGE





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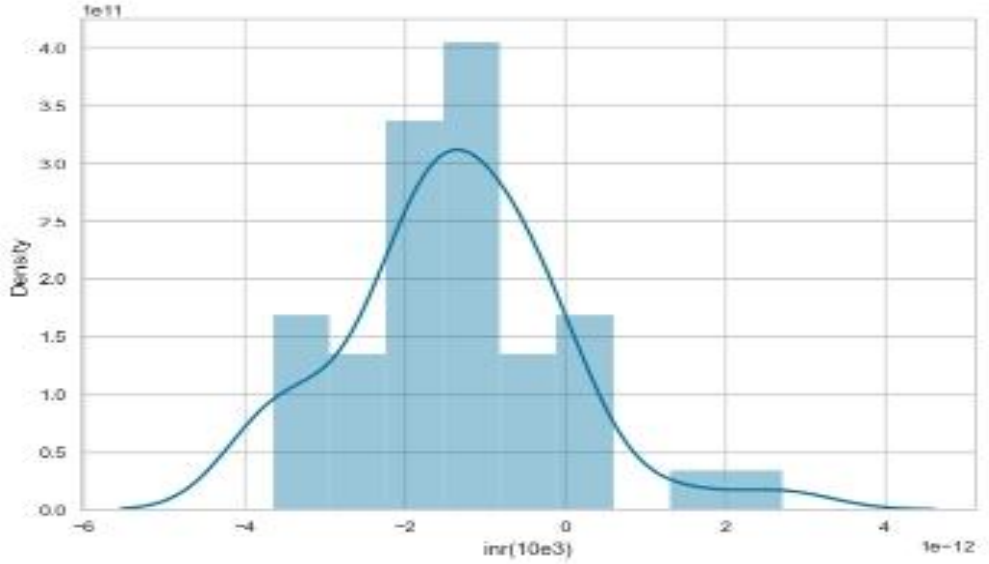
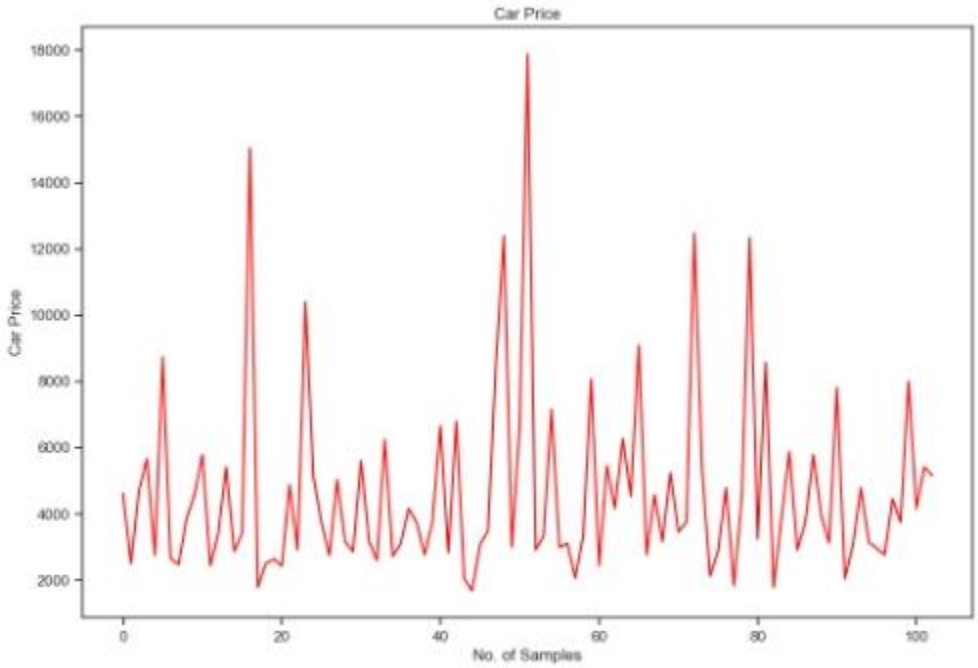
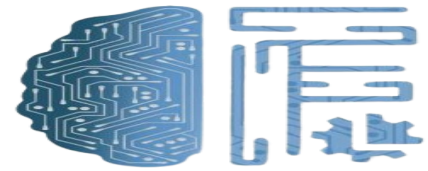
EXPERIMENT WITH YOUR KNOWLEDGE

MULTIVARIATE ANALYSIS







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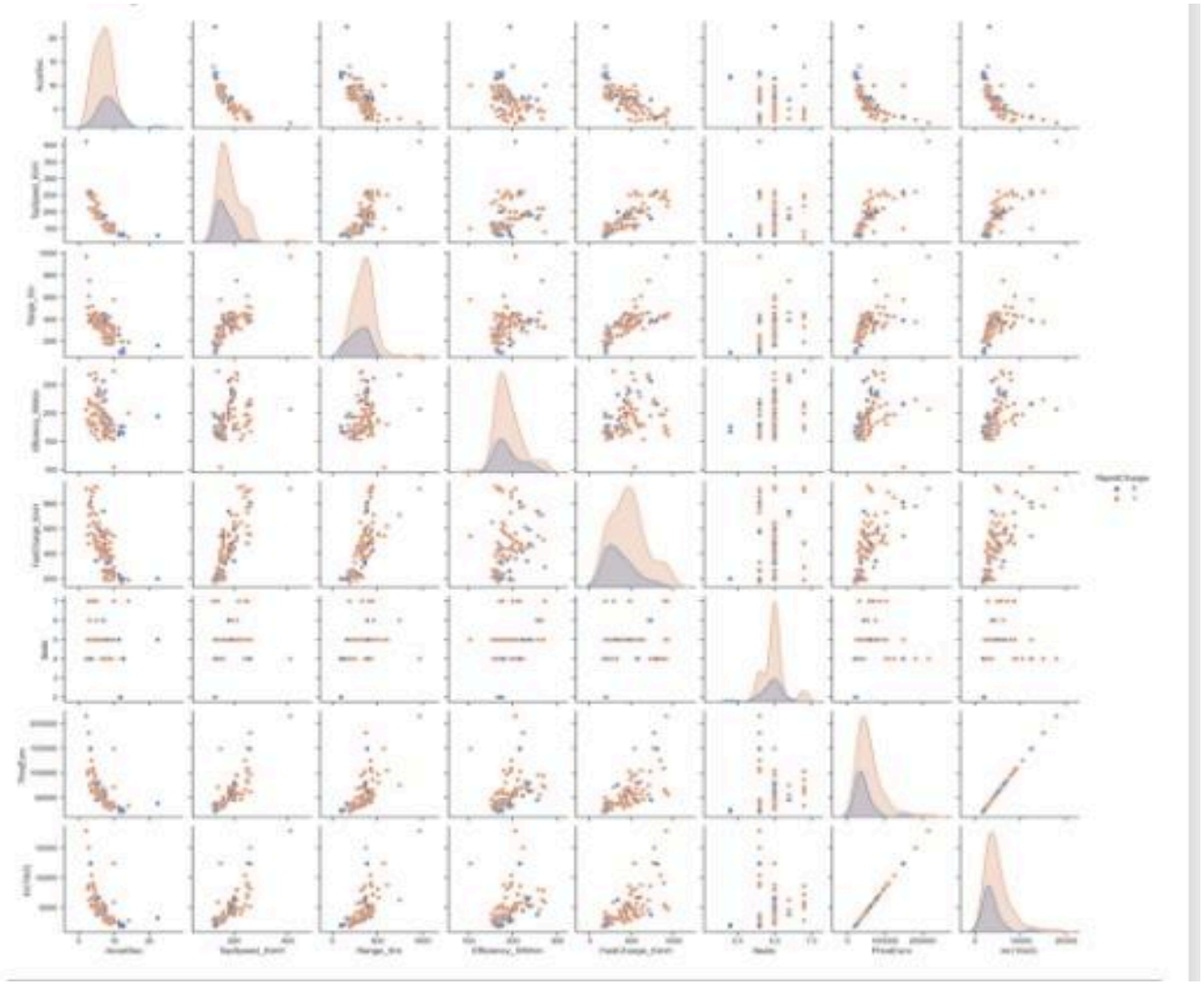
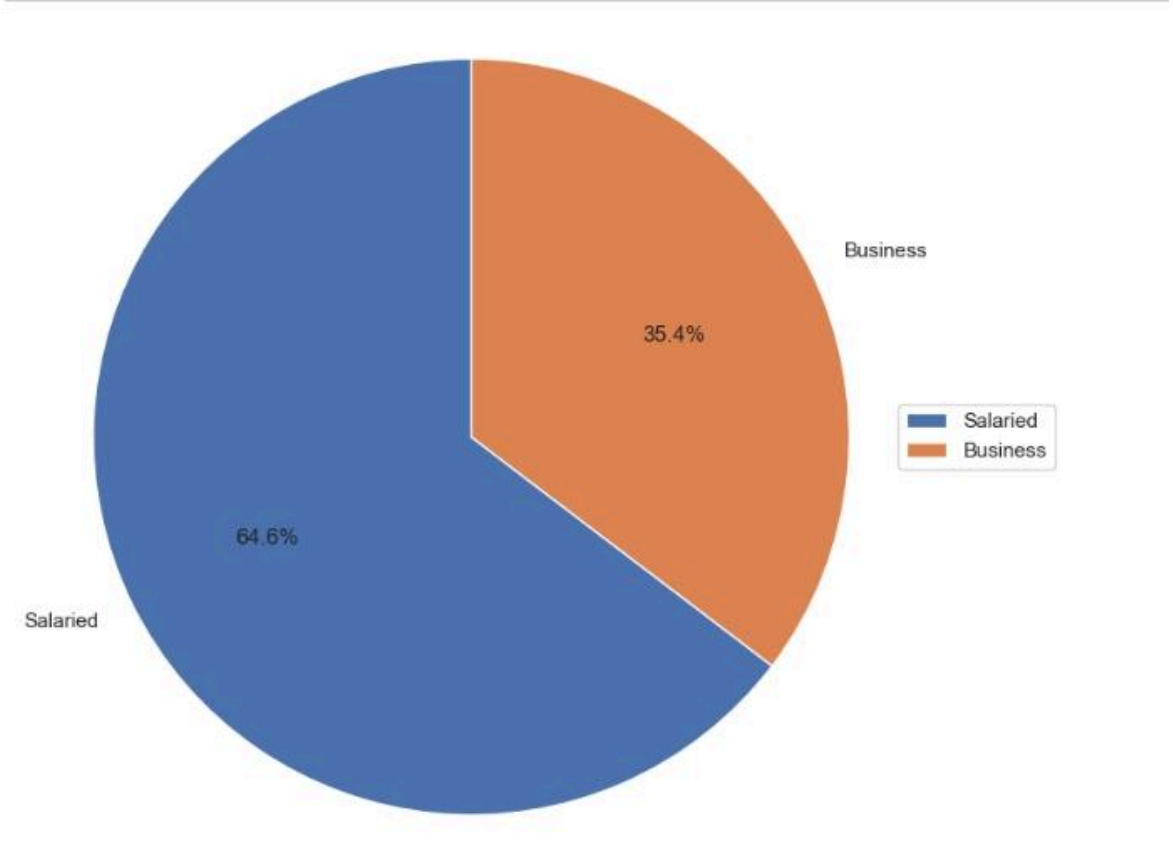
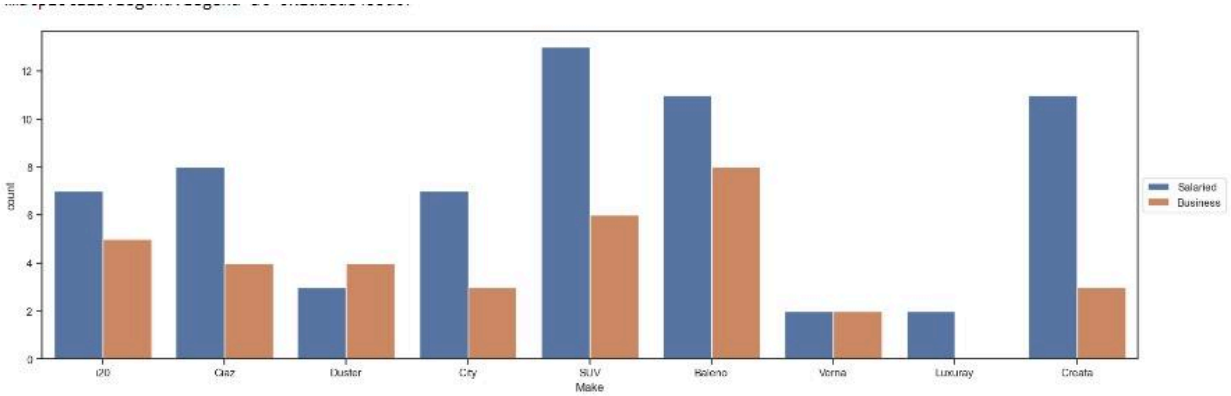


3. DEMOGRAPHIC ANALYSIS





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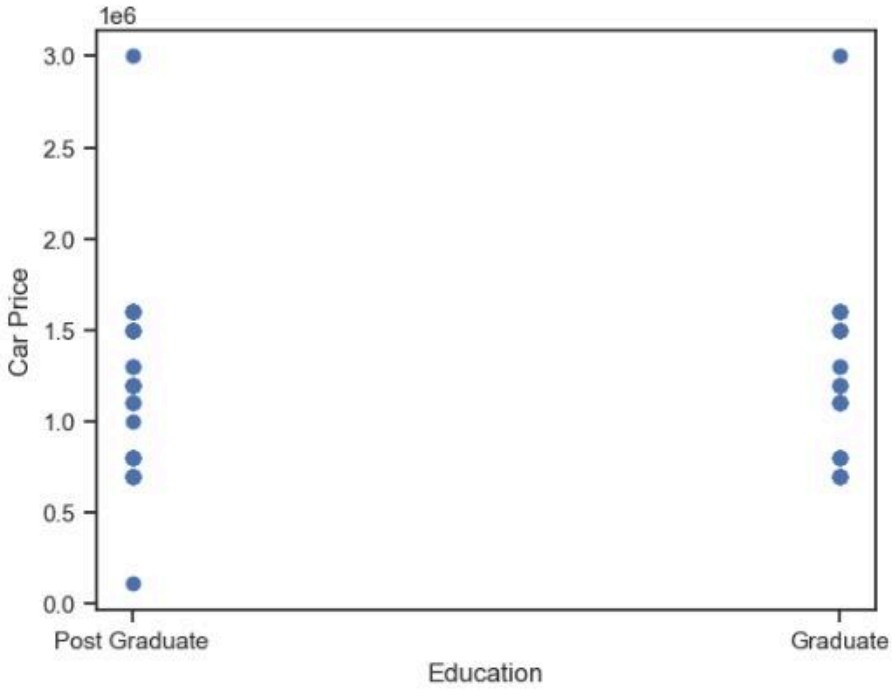
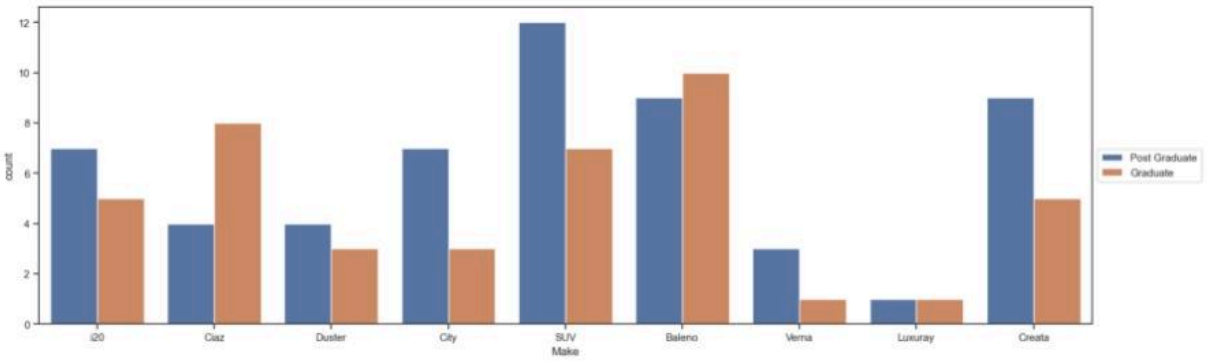
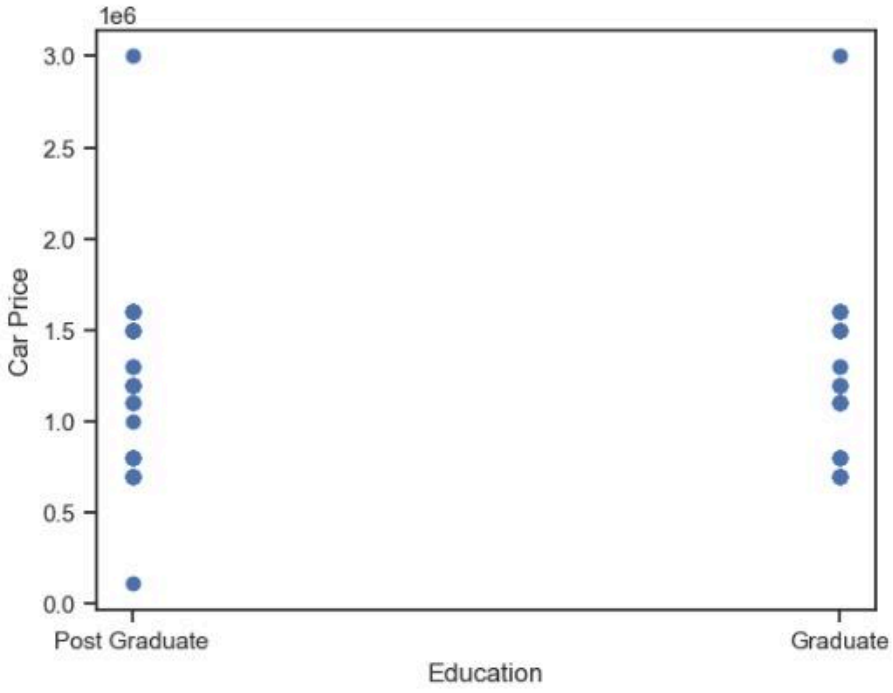
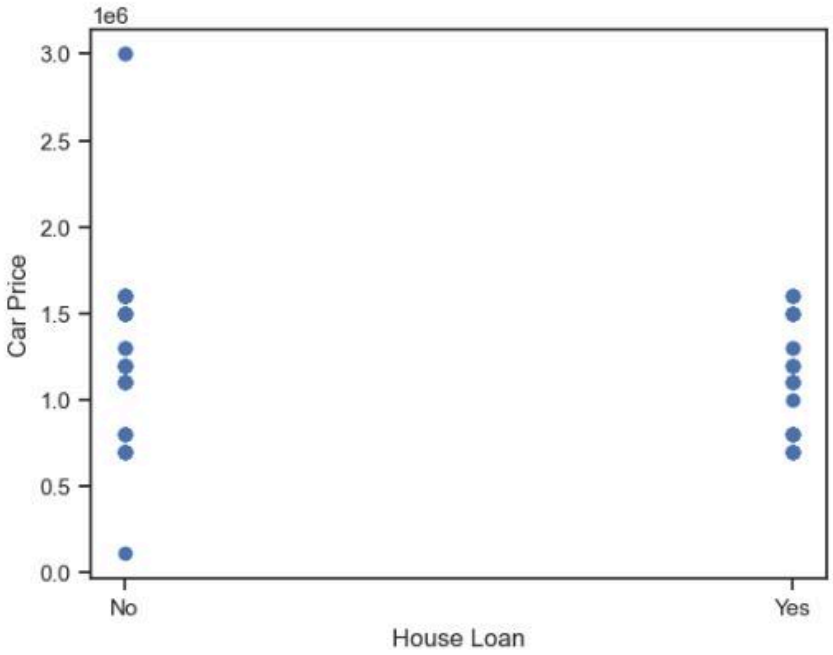





1e6
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Car Price
Post Graduate
Graduate
Education


1e6
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Car Price
No
Yes
House Loan

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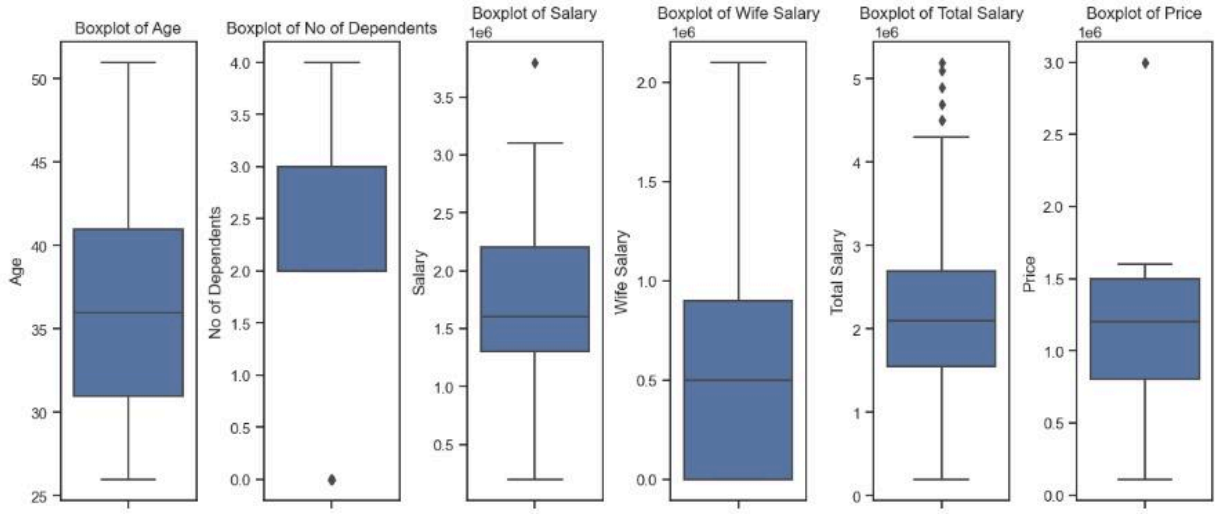
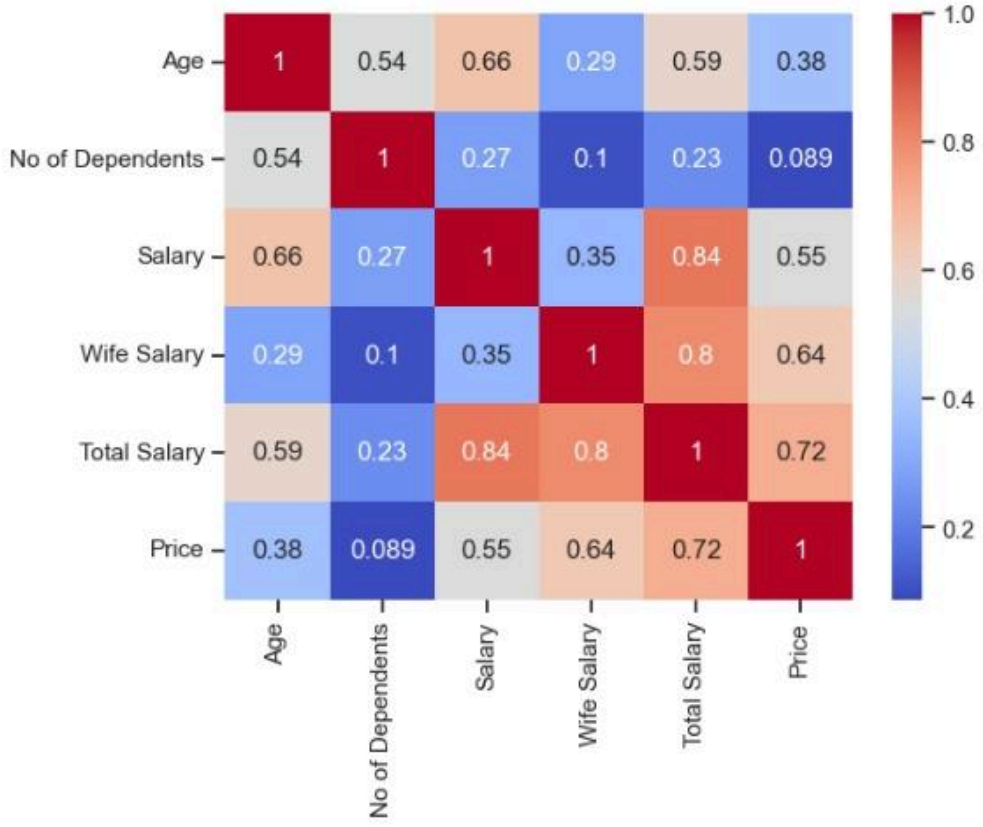
EXPERIMENT WITH YOUR KNOWLEDGE





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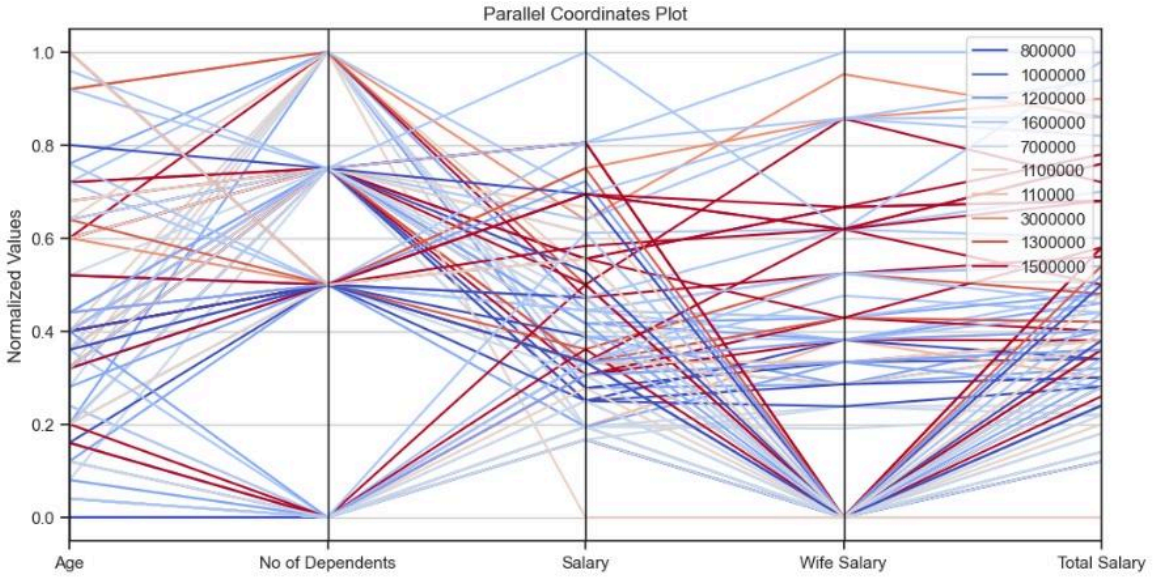
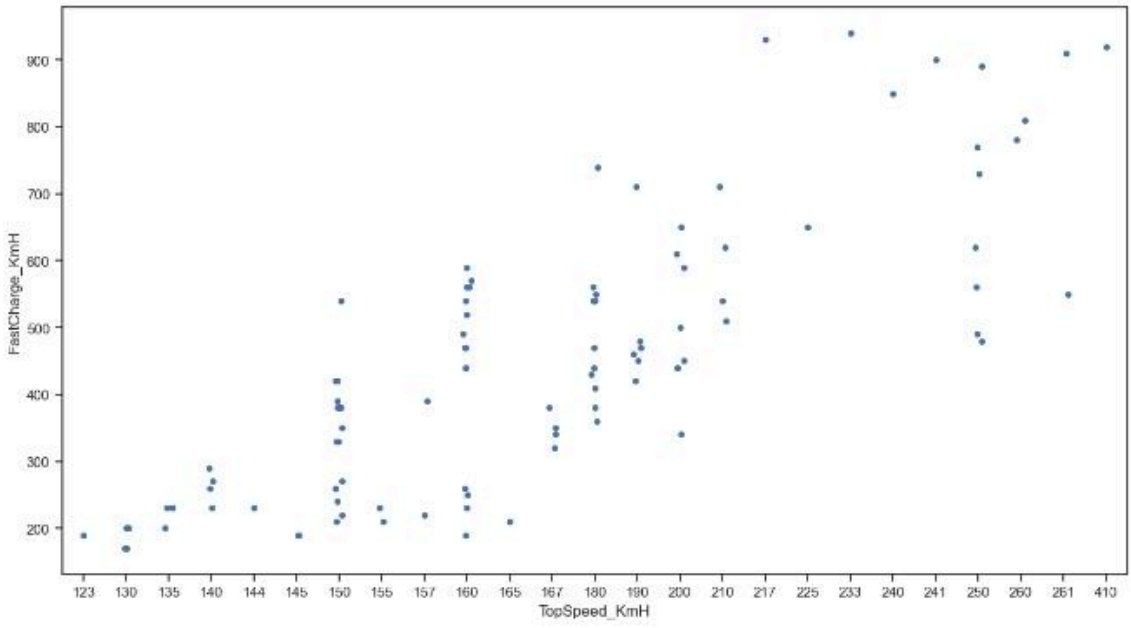
EXPERIMENT WITH YOUR KNOWLEDGE



CLUSTERING OF DIFFERENT ELECTRIC VEHICLE BRANDS



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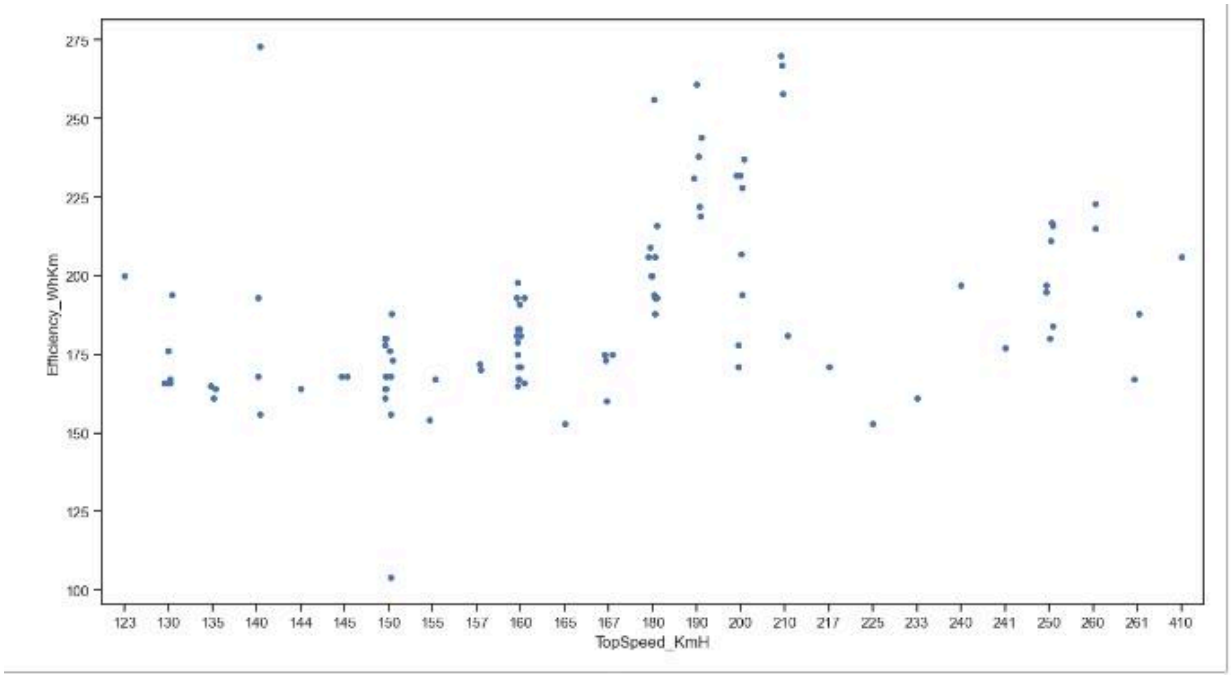
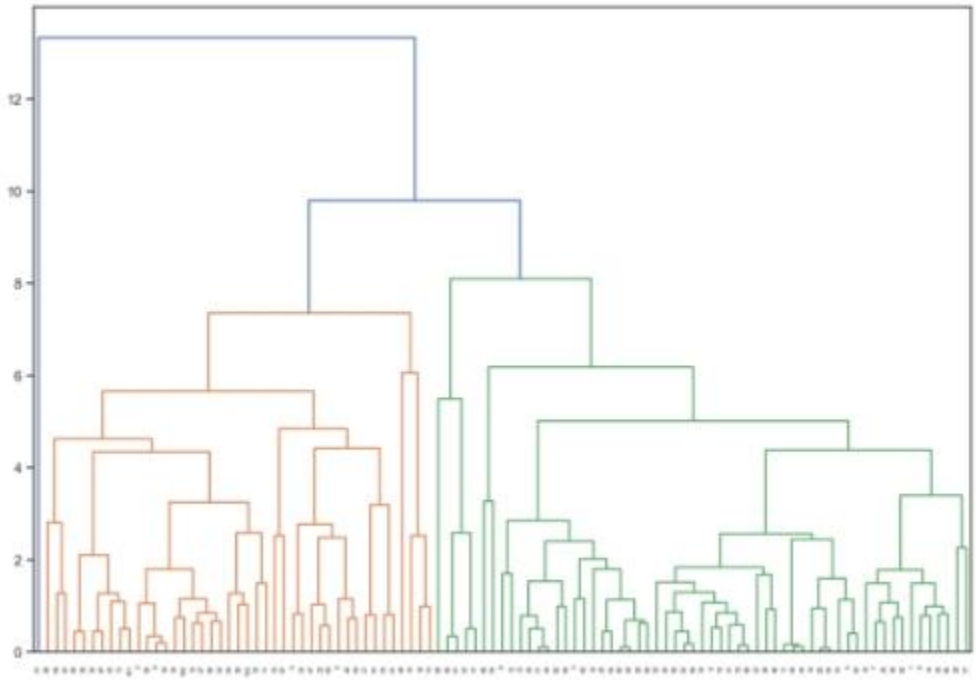
EXPERIMENT WITH YOUR KNOWLEDGE





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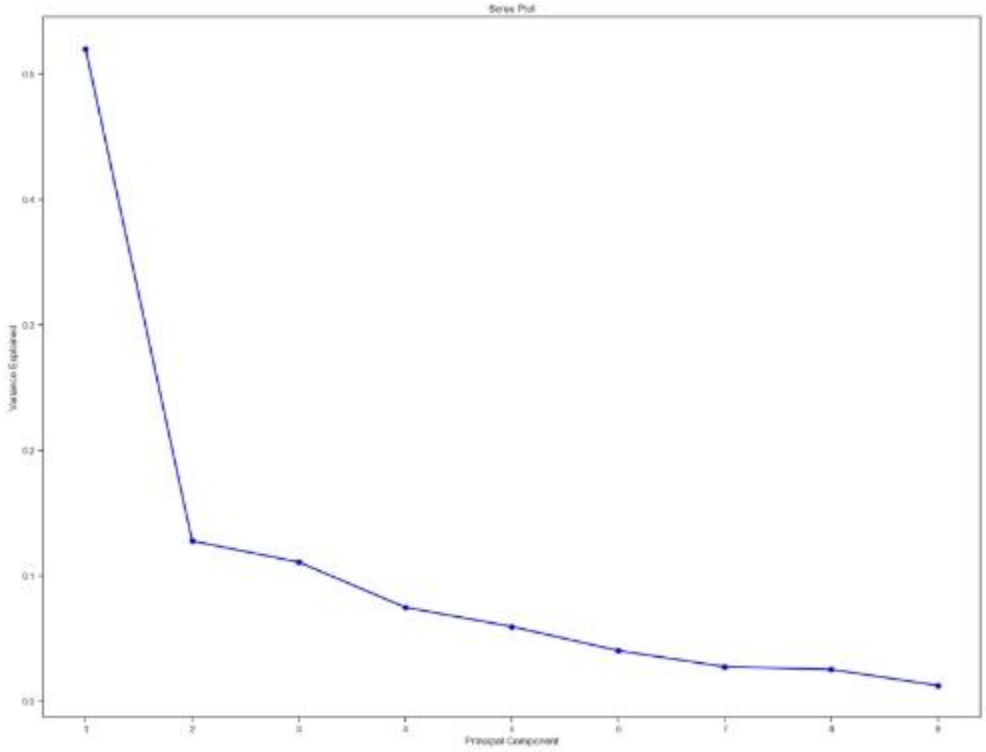
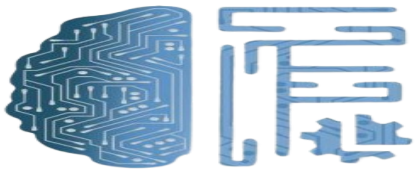
EXPERIMENT WITH YOUR KNOWLEDGE





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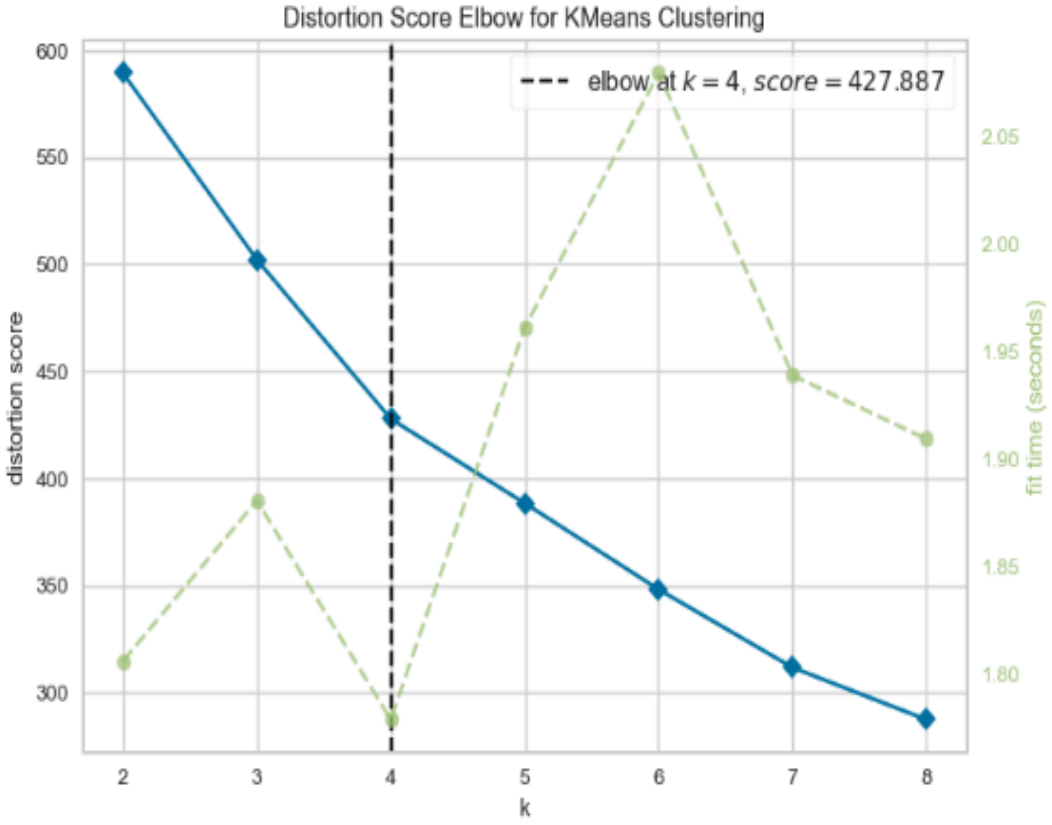
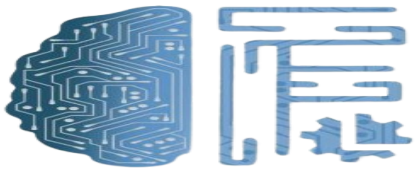
EXPERIMENT WITH YOUR KNOWLEDGE





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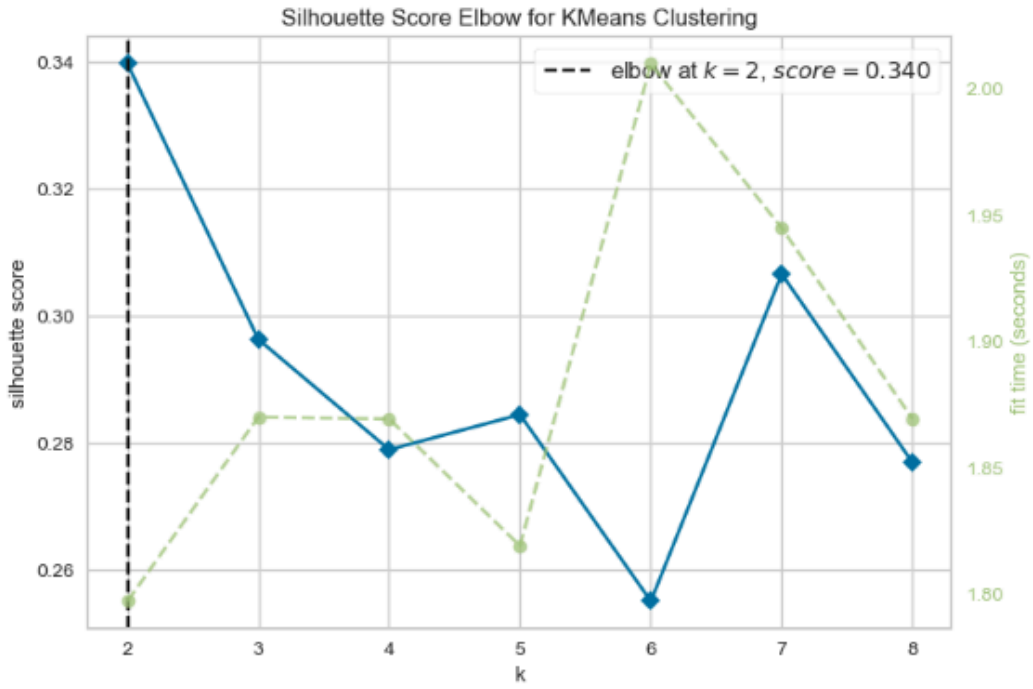
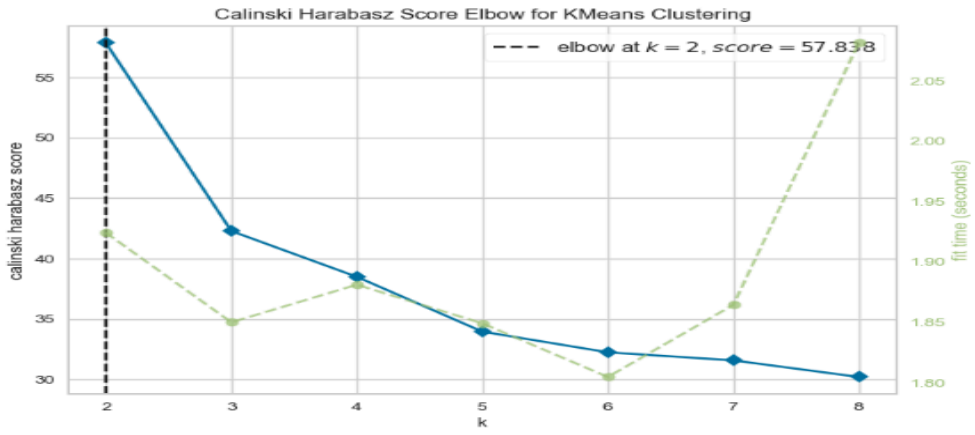
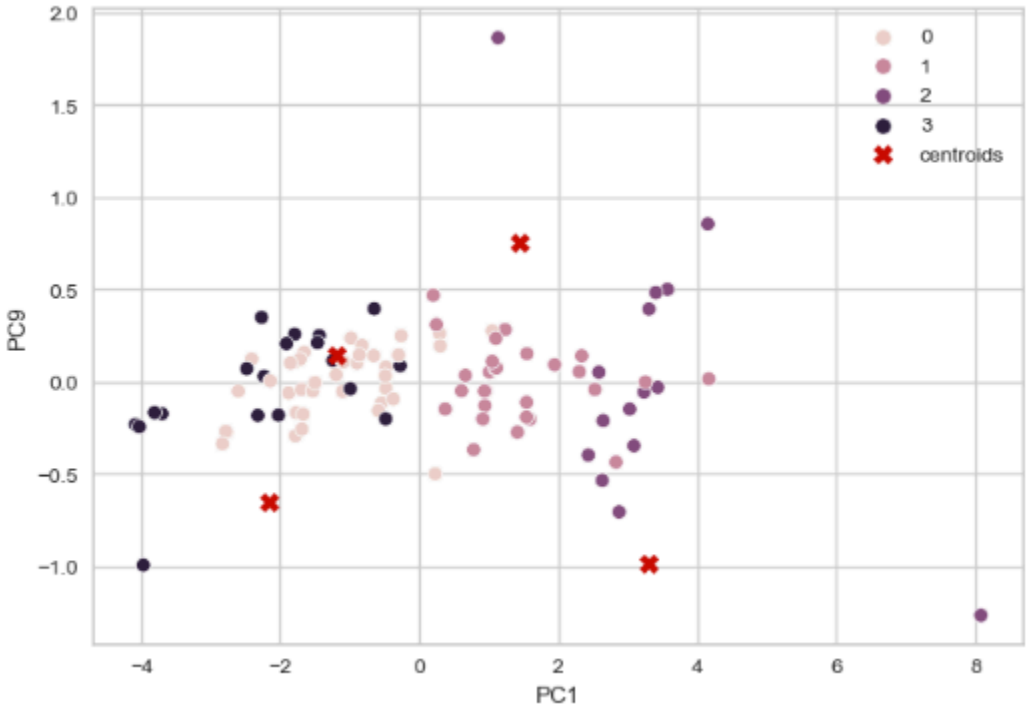
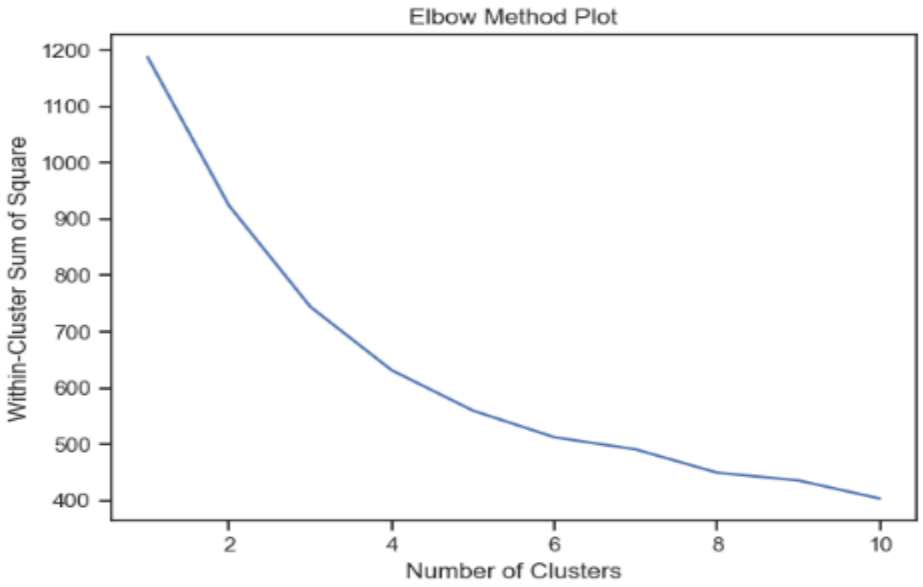
EXPERIMENT WITH YOUR KNOWLEDGE

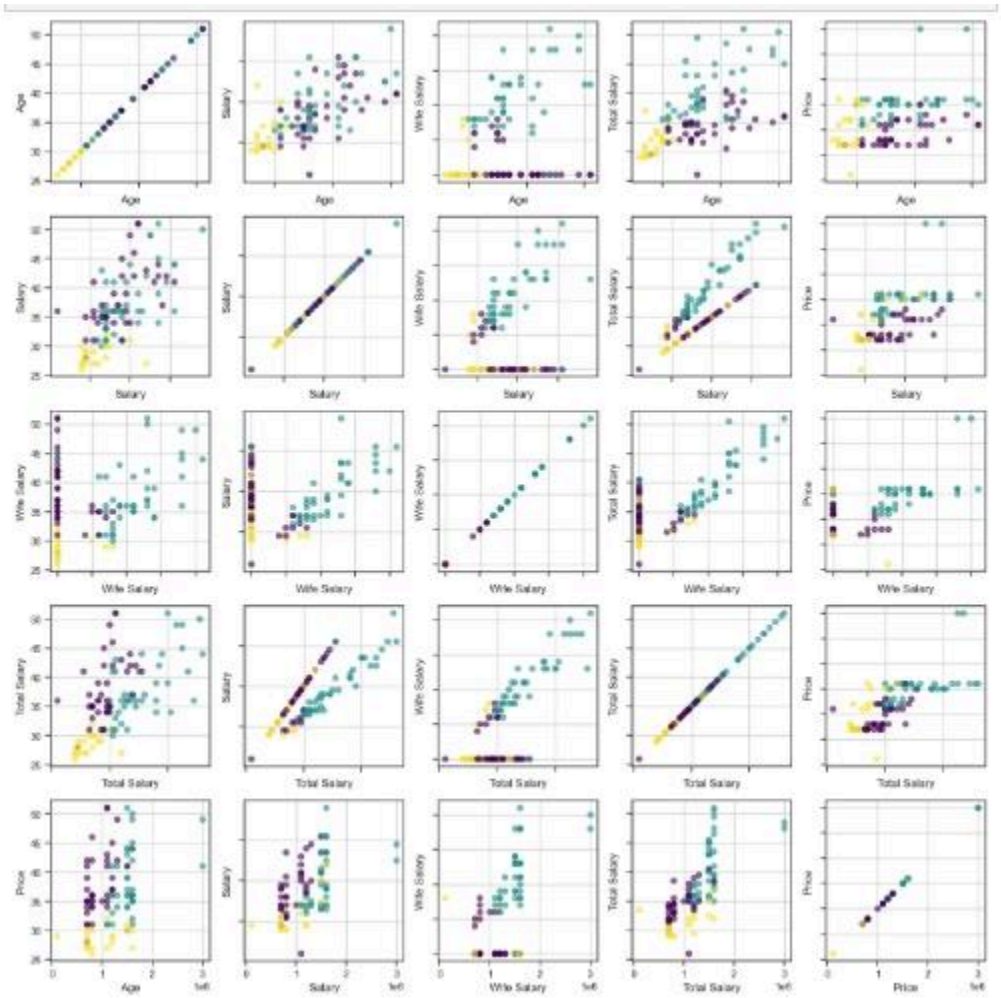






FOR DEMOGRAPHIC




Age
Salary
Wife Salary
Total Salary
Price
1e6

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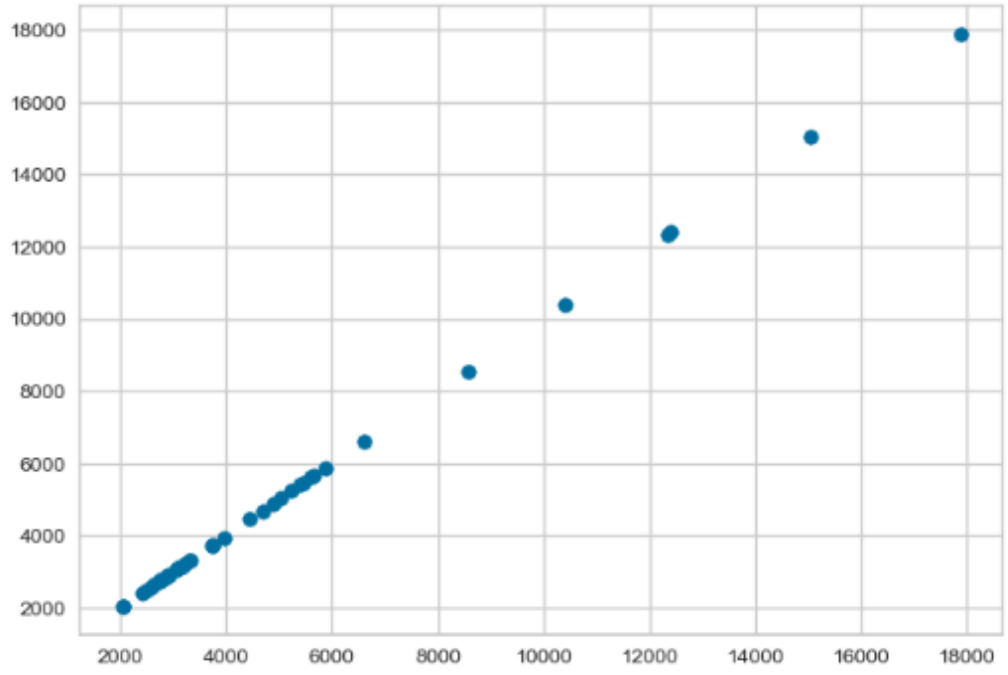
EXPERIMENT WITH YOUR KNOWLEDGE

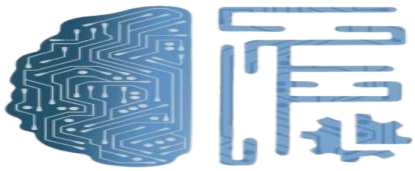
REGRESSION



In [141]:
```
cdf=pd.DataFrame(lm.coef_, X.columns, columns=['Coeff'])
cdf
```

Out[141]:

	Coeff
PC1	1101.5872
PC2	-741.2090
PC3	208.5362
PC4	508.3225
Pc5	122.3533
PC6	1579.0069
PC7	333.6115
PC8	-1079.9951
PC9	1461.7227



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EXPERIMENT WITH YOUR KNOWLEDGE

In [142]:
```
predictions=lm.predict(X_test)
predictions
```

Out[142]:
```
array([ 3744.    ,  2496.    ,  5233.28  ,  3243.7184,  3064.8384,
        5459.584 ,  2903.68  ,  3328.    ,  3952.    ,  2594.5088,
        2654.08  ,  3744.    ,  2041.2288, 15040.9792,  6609.824 ,
        3170.336 ,  4451.2   ,  2866.9888,  3744.    , 17888.    ,
        4877.184 ,  5660.928 ,  5876.4992,  2062.528 , 12396.8   ,
        8565.024 , 12338.6432,  3328.    ,  4695.808 ,  5408.    ,
        3064.8384,  3120.    ,  2826.3872, 10400.    ,  2745.6   ,
        2912.    ,  3153.28  ,  5028.3584,  2424.9472,  2766.0672,
        5604.1856,  3098.1184])
```

In [143]:
```
y_test
```

Out[143]:
```
37    3744.0000
1     2496.0000
69    5233.2800
80    3243.7184
92    3064.8384
61    5459.5840
85    2903.6800
53    3328.0000
88    3952.0000
32    2594.5088
6     2654.0800
71    3744.0000
43    2041.2288
16   15040.9792
50    6609.8240
31    3170.3360
97    4451.2000
14    2866.9888
25    3744.0000
51   17888.0000
21    4877.1840
3     5660.9280
84    5876.4992
57    2062.5280
48   12396.8000
47    8565.0240
79   12338.6432
58    3328.0000
2     4695.8080
13    5408.0000
45    3064.8384
89    3120.0000
41    2826.3872
23   10400.0000
26    2745.6000
22    2912.0000
94    3153.2800
27    5028.3584
20    2424.9472
66    2766.0672
30    5604.1856
35    3098.1184
Name: inr(10e3), dtype: float64
```