ev-analysis

October 12, 2024

[2]:
```
import pandas as pd
```

[3]:
```
Data = pd.read_csv('EV_dataset.csv')
```

[4]:
```
Data.head()
```

[4]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electric Range	Base MSRP	Legislative District	DOL Vehicle ID	Vehicle Location	Electric Utility	2020 Census Tract
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42	0	NaN	198968248	POINT (-81.80023 24.5545)	NaN	12087972100
1	1G1RD6E45D	Clark	Laughlin	NV	89029	2013	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	38	0	NaN	5204412	POINT (-114.57245 35.16815)	NaN	32003005702
2	JN1AZ0CP8B	Yakima	Yakima	WA	98901	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	73	0	15.0	218972519			
3	1G1FW6S08H	Skagit	Concrete	WA	98237	2017	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	238	0	39.0	186750406			
4	3FA6P0SU1K	Snohomish	Everett	WA	98201	2019	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	26	0	38.0	2006714			

```
2  POINT (-120.50721 46.60448)              PACIFICORP        53077001602
3   POINT (-121.7515 48.53892)  PUGET SOUND ENERGY INC        53057951101
4  POINT (-122.20596 47.97659)  PUGET SOUND ENERGY INC        53061041500
```

[5]:
```
Data.tail()
```

[5]:
```
         VIN (1-10)    County           City State  Postal Code  Model Year  \
112629  7SAYGDEF2N      King         Duvall    WA        98019        2022
112630  1N4BZ1CP7K  San Juan  Friday Harbor    WA        98250        2019
112631  1FMCU0KZ4N      King         Vashon    WA        98070        2022
112632  KNDCD3LD4J      King      Covington    WA        98042        2018
112633  YV4BR0CL8N      King      Covington    WA        98042        2022

          Make    Model                   Electric Vehicle Type  \
112629   TESLA  MODEL Y          Battery Electric Vehicle (BEV)
112630  NISSAN     LEAF          Battery Electric Vehicle (BEV)
112631    FORD   ESCAPE  Plug-in Hybrid Electric Vehicle (PHEV)
112632     KIA     NIRO  Plug-in Hybrid Electric Vehicle (PHEV)
112633   VOLVO     XC90  Plug-in Hybrid Electric Vehicle (PHEV)

        Clean Alternative Fuel Vehicle (CAFV) Eligibility  Electric Range  \
112629  Eligibility unknown as battery range has not b…                0
112630           Clean Alternative Fuel Vehicle Eligible              150
112631           Clean Alternative Fuel Vehicle Eligible               38
112632             Not eligible due to low battery range               26
112633             Not eligible due to low battery range               18

        Base MSRP  Legislative District  DOL Vehicle ID  \
112629          0                  45.0       217955265
112630          0                  40.0       103663227
112631          0                  34.0       193878387
112632          0                  47.0       125039043
112633          0                  47.0       194673692

                  Vehicle Location  \
112629  POINT (-121.98609 47.74068)
112630  POINT (-123.01648 48.53448)
112631   POINT (-122.4573 47.44929)
112632  POINT (-122.09124 47.33778)
112633  POINT (-122.09124 47.33778)

                                      Electric Utility  2020 Census Tract
112629      PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)        53033032401
112630  BONNEVILLE POWER ADMINISTRATION||ORCAS POWER &…        53055960301
112631      PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)        53033027702
112632      PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)        53033032007
112633      PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)        53033032005
```

[6]:
```
Data.isnull().sum()
```

[6]:
```
VIN (1-10)                                             0
County                                                 0
City                                                   0
State                                                  0
Postal Code                                            0
Model Year                                             0
Make                                                   0
Model                                                 20
Electric Vehicle Type                                  0
Clean Alternative Fuel Vehicle (CAFV) Eligibility      0
Electric Range                                         0
Base MSRP                                              0
Legislative District                                 286
DOL Vehicle ID                                         0
Vehicle Location                                      24
Electric Utility                                     443
2020 Census Tract                                      0
dtype: int64
```

[7]:
```
Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 112634 entries, 0 to 112633
Data columns (total 17 columns):
 #   Column                                             Non-Null Count   Dtype
---  ------                                             --------------   -----
 0   VIN (1-10)                                         112634 non-null  object
 1   County                                             112634 non-null  object
 2   City                                               112634 non-null  object
 3   State                                              112634 non-null  object
 4   Postal Code                                        112634 non-null  int64
 5   Model Year                                         112634 non-null  int64
 6   Make                                               112634 non-null  object
 7   Model                                              112614 non-null  object
 8   Electric Vehicle Type                              112634 non-null  object
 9   Clean Alternative Fuel Vehicle (CAFV) Eligibility  112634 non-null  object
 10  Electric Range                                     112634 non-null  int64
 11  Base MSRP                                          112634 non-null  int64
 12  Legislative District                               112348 non-null  float64
 13  DOL Vehicle ID                                     112634 non-null  int64
 14  Vehicle Location                                   112610 non-null  object
 15  Electric Utility                                   112191 non-null  object
 16  2020 Census Tract                                  112634 non-null  int64
dtypes: float64(1), int64(6), object(10)
memory usage: 14.6+ MB
```

[8]:
```
# Fill missing values in 'Legislative District' with the mean
Data['Legislative District'].fillna(Data['Legislative District'].mean(),␣
 ↪inplace=True)

# Fill missing values in 'Model', 'Vehicle Location', and 'Electric Utility'␣
 ↪with the mode
Data['Model'].fillna(Data['Model'].mode()[0], inplace=True)
Data['Vehicle Location'].fillna(Data['Vehicle Location'].mode()[0],␣
 ↪inplace=True)
Data['Electric Utility'].fillna(Data['Electric Utility'].mode()[0],␣
 ↪inplace=True)

# Check if all missing values are handled
print(Data.isnull().sum())  # This should show 0 missing values if all are␣
 ↪filled
```

```
VIN (1-10)                                           0
County                                               0
City                                                 0
State                                                0
Postal Code                                          0
Model Year                                           0
Make                                                 0
Model                                                0
Electric Vehicle Type                                0
Clean Alternative Fuel Vehicle (CAFV) Eligibility    0
Electric Range                                       0
Base MSRP                                            0
Legislative District                                 0
DOL Vehicle ID                                       0
Vehicle Location                                     0
Electric Utility                                     0
2020 Census Tract                                    0
dtype: int64
```

[ ]:
```
```

[9]:
```
Data.duplicated().sum()
```

[9]:
```
0
```

1 Univarient Analysis

[10]:
```
import matplotlib.pyplot as plt
import seaborn as sns

# Univariate analysis for numerical columns (non-visual)
print("Summary statistics for numerical columns:")
print(Data.describe())
```

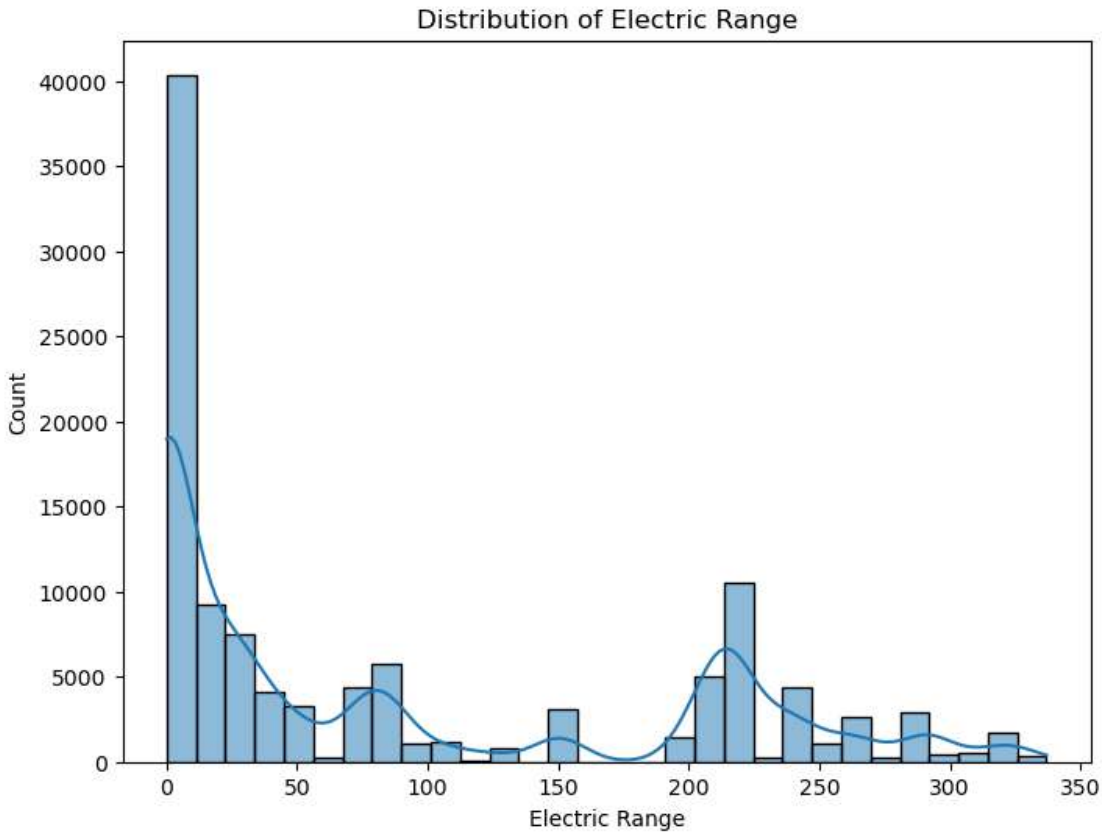
```
Summary statistics for numerical columns:
         Postal Code     Model Year  Electric Range      Base MSRP  \
count  112634.000000  112634.000000   112634.000000  112634.000000
mean    98156.226850    2019.003365       87.812987    1793.439681
std      2648.733064       2.892364      102.334216   10783.753486
min      1730.000000    1997.000000        0.000000       0.000000
25%     98052.000000    2017.000000        0.000000       0.000000
50%     98119.000000    2020.000000       32.000000       0.000000
75%     98370.000000    2022.000000      208.000000       0.000000
max     99701.000000    2023.000000      337.000000  845000.000000

       Legislative District  DOL Vehicle ID  2020 Census Tract
count         112634.000000    1.126340e+05       1.126340e+05
mean              29.805604    1.994567e+08       5.296650e+10
std               14.681869    9.398427e+07       1.699104e+09
min                1.000000    4.777000e+03       1.101001e+09
25%               18.000000    1.484142e+08       5.303301e+10
50%               34.000000    1.923896e+08       5.303303e+10
75%               43.000000    2.191899e+08       5.305307e+10
max               49.000000    4.792548e+08       5.603300e+10
```

[11]:
```
# Univariate analysis for categorical columns (non-visual)
print("\nFrequency of categorical variables:")
print(Data['Make'].value_counts())
```

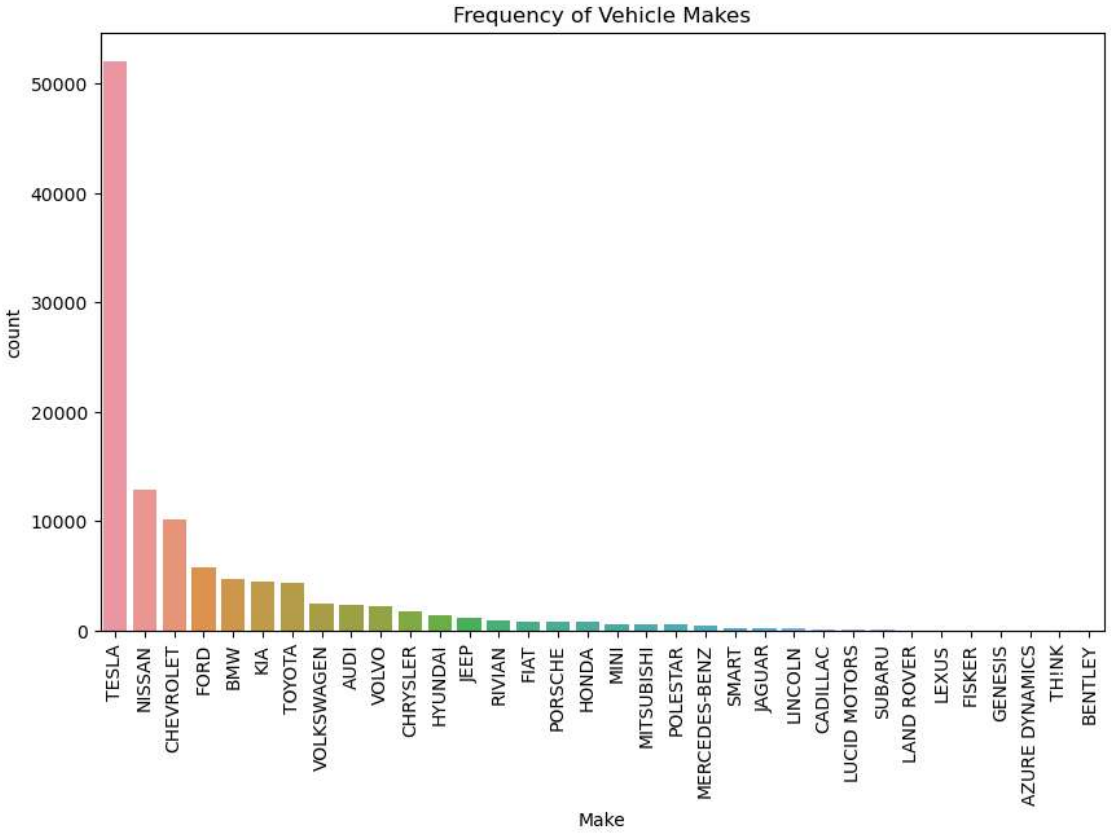
```
Frequency of categorical variables:
TESLA             52078
NISSAN            12880
CHEVROLET         10182
FORD               5819
BMW                4680
KIA                4483
TOYOTA             4405
VOLKSWAGEN         2514
AUDI               2332
VOLVO              2288
CHRYSLER           1794
HYUNDAI            1412
```

```
JEEP                1152
RIVIAN               885
FIAT                 822
PORSCHE              818
HONDA                792
MINI                 632
MITSUBISHI           588
POLESTAR             558
MERCEDES-BENZ        506
SMART                273
JAGUAR               219
LINCOLN              168
CADILLAC             108
LUCID MOTORS          65
SUBARU                59
LAND ROVER            38
LEXUS                 33
FISKER                20
GENESIS               18
AZURE DYNAMICS         7
TH!NK                  3
BENTLEY                3
Name: Make, dtype: int64
```

[12]:
```
# Visual univariate analysis for numerical data - Histogram
plt.figure(figsize=(8, 6))
sns.histplot(Data['Electric Range'], kde=True, bins=30)
plt.title('Distribution of Electric Range')
plt.show()
```



[13]:
```
# Visual univariate analysis for categorical data - Bar plot
plt.figure(figsize=(10, 6))
sns.countplot(data=Data, x='Make', order=Data['Make'].value_counts().index)
plt.title('Frequency of Vehicle Makes')
plt.xticks(rotation=90)
plt.show()
```



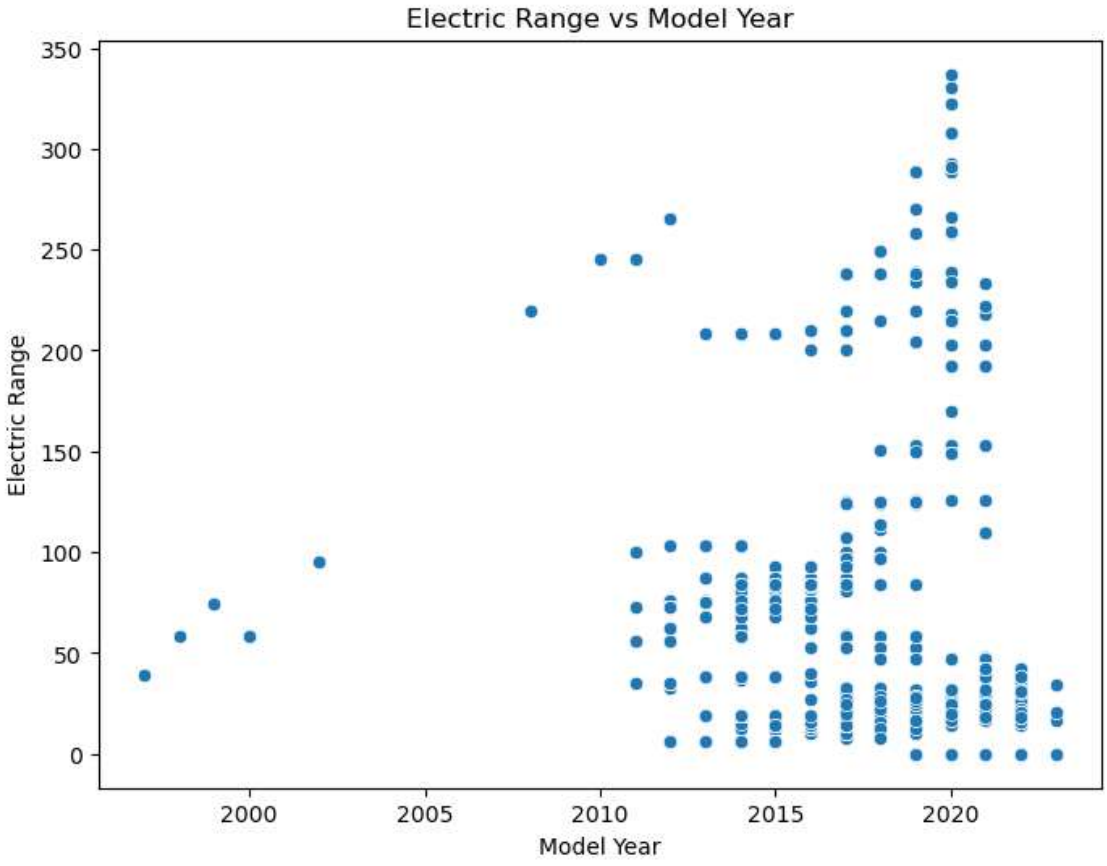
2 Bivarient Analysis

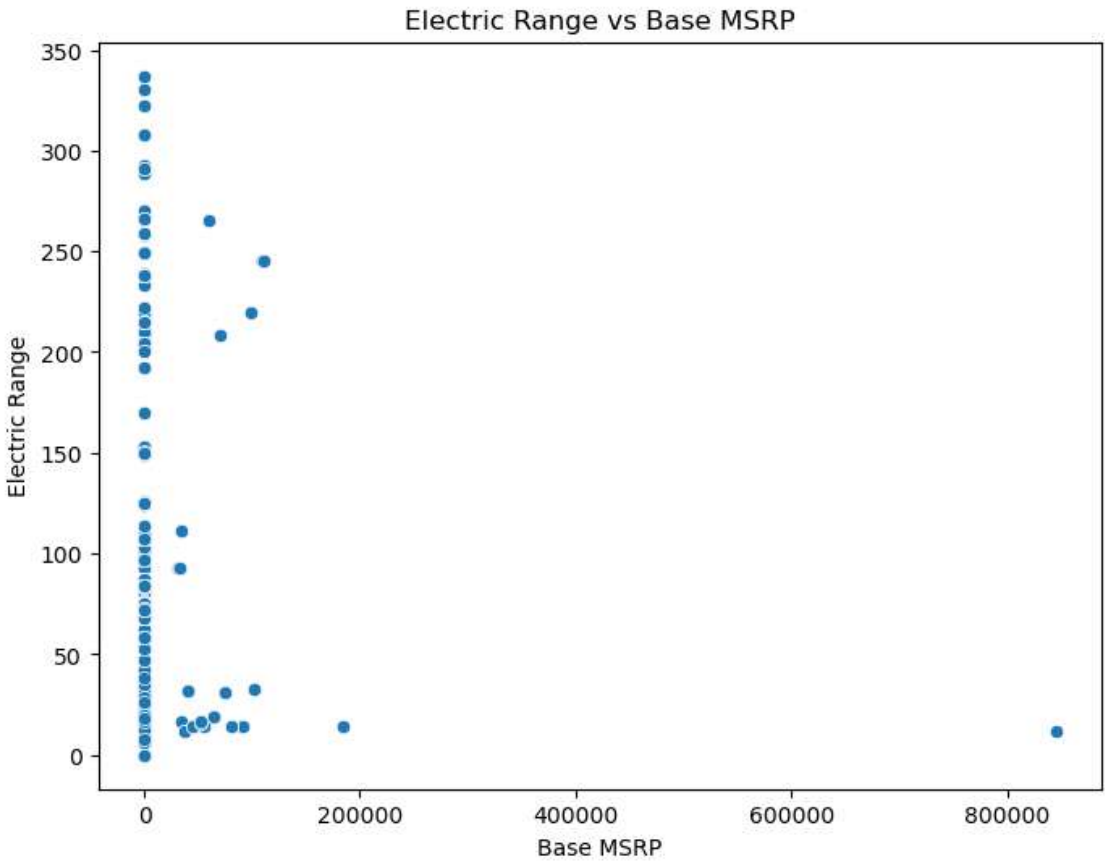
[14]:
```
# Correlation matrix for numerical columns
print(Data.corr())
```

```
                     Postal Code  Model Year  Electric Range  Base MSRP  \
Postal Code             1.000000   -0.004485        0.000385   0.001151
Model Year             -0.004485    1.000000       -0.288433  -0.229130
Electric Range          0.000385   -0.288433        1.000000   0.085025
Base MSRP               0.001151   -0.229130        0.085025   1.000000
Legislative District   -0.049547    0.010427        0.024355   0.012413
DOL Vehicle ID          0.003365   -0.068295        0.009682   0.000504
2020 Census Tract       0.501170    0.000714        0.000722   0.000979

                     Legislative District  DOL Vehicle ID  2020 Census Tract
Postal Code                     -0.049547        0.003365           0.501170
Model Year                       0.010427       -0.068295           0.000714
Electric Range                   0.024355        0.009682           0.000722
Base MSRP                        0.012413        0.000504           0.000979
Legislative District             1.000000       -0.001669          -0.001066
```

```
DOL Vehicle ID                -0.001669        1.000000          0.002754
2020 Census Tract             -0.001066        0.002754          1.000000

C:\Users\sahit\AppData\Local\Temp\ipykernel_888\2347153037.py:2: 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.
  print(Data.corr())
```

[15]:
```
# Scatter plot: Electric Range vs Model Year
plt.figure(figsize=(8, 6))
sns.scatterplot(data=Data, x='Model Year', y='Electric Range')
plt.title('Electric Range vs Model Year')
plt.show()

# Scatter plot: Electric Range vs Base MSRP
plt.figure(figsize=(8, 6))
sns.scatterplot(data=Data, x='Base MSRP', y='Electric Range')
plt.title('Electric Range vs Base MSRP')
plt.show()
```





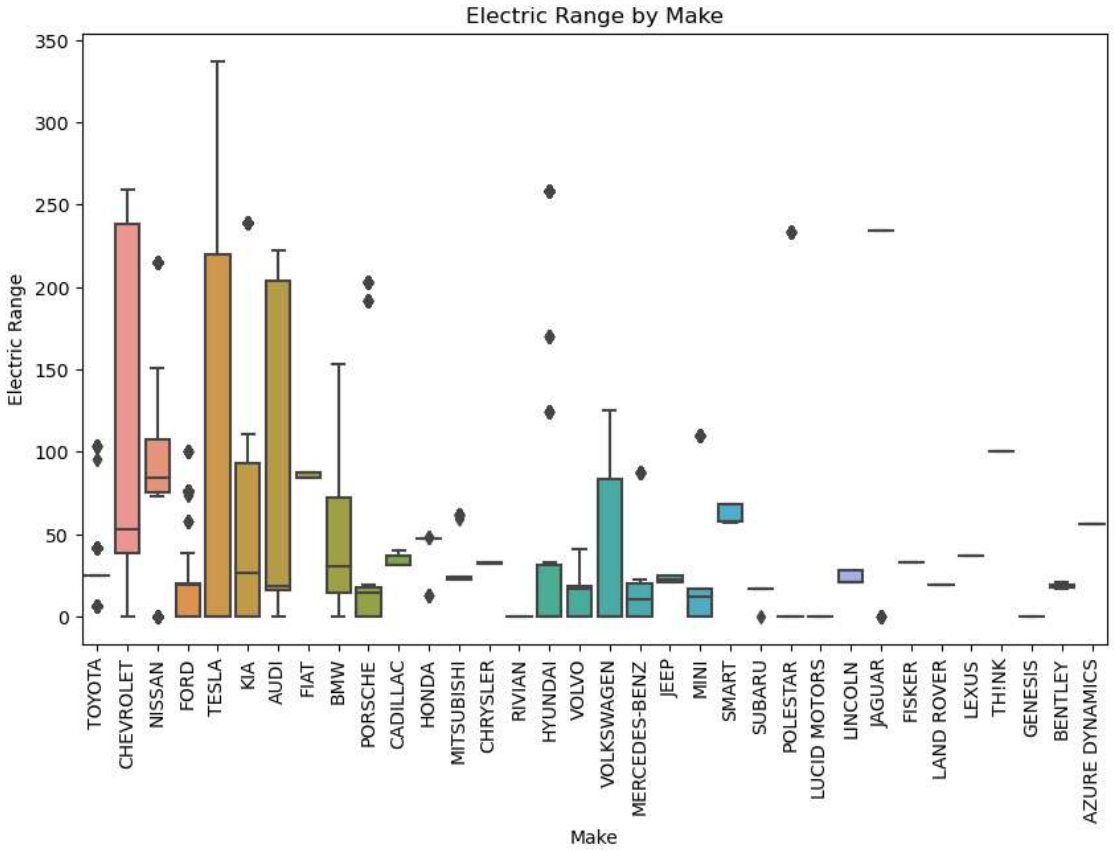
[16]:
```
# Average Electric Range by Make
print(Data.groupby('Make')['Electric Range'].mean())

# Average Base MSRP by Make
print(Data.groupby('Make')['Base MSRP'].mean())
```

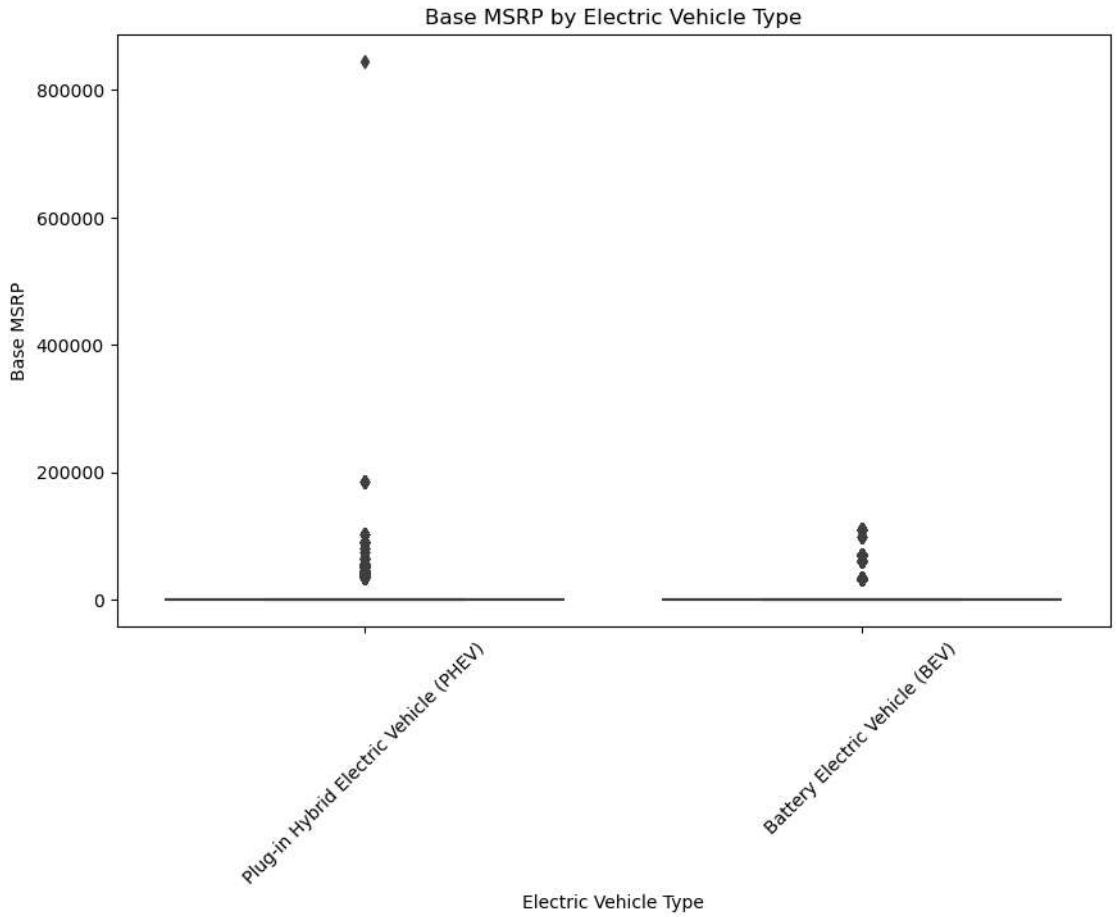
```
Make
AUDI                62.876930
AZURE DYNAMICS      56.000000
BENTLEY             18.666667
BMW                 46.657479
CADILLAC            35.537037
CHEVROLET          109.766549
CHRYSLER            32.361204
FIAT                85.624088
FISKER              33.000000
FORD                16.848084
GENESIS              0.000000
HONDA               46.618687
HYUNDAI             48.228754
```

```
JAGUAR            207.287671
JEEP               22.707465
KIA                67.631943
LAND ROVER         19.000000
LEXUS              37.000000
LINCOLN            23.083333
LUCID MOTORS        0.000000
MERCEDES-BENZ      22.055336
MINI               26.604430
MITSUBISHI         26.746599
NISSAN             89.326941
POLESTAR           40.921147
PORSCHE            54.090465
RIVIAN              0.000000
SMART              62.282051
SUBARU             16.711864
TESLA             118.162756
TH!NK             100.000000
TOYOTA             26.044268
VOLKSWAGEN         43.762530
VOLVO              14.448864
Name: Electric Range, dtype: float64
Make
AUDI                    0.000000
AZURE DYNAMICS          0.000000
BENTLEY                 0.000000
BMW                  5545.128205
CADILLAC            11125.185185
CHEVROLET               0.000000
CHRYSLER             2652.957079
FIAT                    0.000000
FISKER             102000.000000
FORD                    0.000000
GENESIS                 0.000000
HONDA                   0.000000
HYUNDAI                 0.000000
JAGUAR                  0.000000
JEEP                    0.000000
KIA                  4642.371180
LAND ROVER              0.000000
LEXUS                   0.000000
LINCOLN                 0.000000
LUCID MOTORS            0.000000
MERCEDES-BENZ           0.000000
MINI                 8750.000000
MITSUBISHI              0.000000
NISSAN                  0.000000
POLESTAR                0.000000
```

```
PORSCHE              5621.882641
RIVIAN                  0.000000
SMART                   0.000000
SUBARU              34401.864407
TESLA                2272.908906
TH!NK                   0.000000
TOYOTA                  0.000000
VOLKSWAGEN              0.000000
VOLVO                7303.955420
Name: Base MSRP, dtype: float64
```

[17]:
```python
# Box plot: Electric Range by Make
plt.figure(figsize=(10, 6))
sns.boxplot(data=Data, x='Make', y='Electric Range')
plt.title('Electric Range by Make')
plt.xticks(rotation=90)
plt.show()

# Box plot: Base MSRP by Electric Vehicle Type
#cate vs numeri
plt.figure(figsize=(10, 6))
sns.boxplot(data=Data, x='Electric Vehicle Type', y='Base MSRP')
plt.title('Base MSRP by Electric Vehicle Type')
plt.xticks(rotation=45)
plt.show()
```


Electric Range by Make
Electric Range
350
300
250
200
150
100
50
0
TOYOTA
CHEVROLET
NISSAN
FORD
TESLA
KIA
AUDI
FIAT
BMW
PORSCHE
CADILLAC
HONDA
MITSUBISHI
CHRYSLER
RIVIAN
HYUNDAI
VOLVO
VOLKSWAGEN
MERCEDES-BENZ
JEEP
MINI
SMART
SUBARU
POLESTAR
LUCID MOTORS
LINCOLN
JAGUAR
FISKER
LAND ROVER
LEXUS
THINK
GENESIS
BENTLEY
AZURE DYNAMICS
Make



[18]:
```
# Cross-tabulation for Electric Vehicle Type and CAFV Eligibility
cross_tab = pd.crosstab(Data['Electric Vehicle Type'], Data['Clean Alternative␣
 ↪Fuel Vehicle (CAFV) Eligibility'])
print(cross_tab)
```

```
Clean Alternative Fuel Vehicle (CAFV) Eligibility  Clean Alternative Fuel
Vehicle Eligible  \
Electric Vehicle Type
Battery Electric Vehicle (BEV)
46799
Plug-in Hybrid Electric Vehicle (PHEV)
11840

Clean Alternative Fuel Vehicle (CAFV) Eligibility  Eligibility unknown as
battery range has not been researched  \
Electric Vehicle Type
Battery Electric Vehicle (BEV)
39236
Plug-in Hybrid Electric Vehicle (PHEV)
```

```
0

Clean Alternative Fuel Vehicle (CAFV) Eligibility  Not eligible due to low
battery range
Electric Vehicle Type
Battery Electric Vehicle (BEV)
9
Plug-in Hybrid Electric Vehicle (PHEV)
14750
```

3 Plotly Express

[19]:
```
! pip install plotly
```

```
Requirement already satisfied: plotly in c:\users\sahit\anaconda3\lib\site-
packages (5.9.0)
Requirement already satisfied: tenacity>=6.2.0 in
c:\users\sahit\anaconda3\lib\site-packages (from plotly) (8.0.1)
WARNING: Ignoring invalid distribution -ensorflow-intel
(c:\users\sahit\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf
(c:\users\sahit\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -ensorflow-intel
(c:\users\sahit\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf
(c:\users\sahit\anaconda3\lib\site-packages)

[notice] A new release of pip is available: 24.0 -> 24.2
[notice] To update, run: python.exe -m pip install --upgrade pip
```

[20]:
```
import pandas as pd
nyc = pd.read_csv('EV_dataset.csv')
```

[21]:
```
import plotly.express as px
```

[22]:
```
px.scatter(nyc, x='Model Year', y='Electric Range')
#fig.sh
```

[23]:
```
px.box(nyc, x='Electric Vehicle Type', y='Base MSRP')
```

[24]:
```
px.pie(nyc, names='Make', values='Base MSRP')
```

[25]:
```
# Group by 'Postal Code' and calculate the average 'Base MSRP'
grouped_df = nyc.groupby('Postal Code', as_index=False)['Base MSRP'].mean()
grouped_df.head()
```

[25]:

	Postal Code	Base MSRP
0	1730	0.0
1	1731	0.0
2	1824	0.0
3	2842	0.0
4	3804	0.0

[26]:
```
fig = px.choropleth(data_frame=grouped_df,
                    locations='Postal Code',
                    color='Base MSRP',
                    locationmode='USA-states',
                    title='Choropleth Map of Average Base MSRP by Postal Code')
fig.show()
```

[27]:
```
#grouped_df = nyc.groupby(['Postal Code', 'Model Year'], as_index=False)['Base␣
 ↪MSRP'].mean()

# Create the animated Choropleth plot with 'Model Year'
fig = px.choropleth(nyc,
                    locations='Postal Code',
                    color='Base MSRP',
                    locationmode='USA-states',
                    animation_frame='Model Year',
                    title='Animated Choropleth Map of Average Base MSRP by␣
 ↪Postal Code Over Years')
fig.show()
```

[ ]:
```

```

[28]:
```
!pip install bar-chart-race
```

```
Requirement already satisfied: bar-chart-race in
c:\users\sahit\anaconda3\lib\site-packages (0.1.0)
Requirement already satisfied: pandas>=0.24 in
c:\users\sahit\anaconda3\lib\site-packages (from bar-chart-race) (1.5.3)
Requirement already satisfied: matplotlib>=3.1 in
c:\users\sahit\anaconda3\lib\site-packages (from bar-chart-race) (3.7.0)
Requirement already satisfied: contourpy>=1.0.1 in
c:\users\sahit\anaconda3\lib\site-packages (from matplotlib>=3.1->bar-chart-
race) (1.0.5)
Requirement already satisfied: cycler>=0.10 in
c:\users\sahit\anaconda3\lib\site-packages (from matplotlib>=3.1->bar-chart-
race) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in
c:\users\sahit\anaconda3\lib\site-packages (from matplotlib>=3.1->bar-chart-
race) (4.25.0)
Requirement already satisfied: kiwisolver>=1.0.1 in
```

```
c:\users\sahit\anaconda3\lib\site-packages (from matplotlib>=3.1->bar-chart-
race) (1.4.4)
Requirement already satisfied: numpy>=1.20 in c:\users\sahit\anaconda3\lib\site-
packages (from matplotlib>=3.1->bar-chart-race) (1.26.4)
Requirement already satisfied: packaging>=20.0 in
c:\users\sahit\anaconda3\lib\site-packages (from matplotlib>=3.1->bar-chart-
race) (22.0)
Requirement already satisfied: pillow>=6.2.0 in
c:\users\sahit\anaconda3\lib\site-packages (from matplotlib>=3.1->bar-chart-
race) (10.2.0)
Requirement already satisfied: pyparsing>=2.3.1 in
c:\users\sahit\anaconda3\lib\site-packages (from matplotlib>=3.1->bar-chart-
race) (3.0.9)
Requirement already satisfied: python-dateutil>=2.7 in
c:\users\sahit\anaconda3\lib\site-packages (from matplotlib>=3.1->bar-chart-
race) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in
c:\users\sahit\anaconda3\lib\site-packages (from pandas>=0.24->bar-chart-race)
(2022.7)
Requirement already satisfied: six>=1.5 in c:\users\sahit\anaconda3\lib\site-
packages (from python-dateutil>=2.7->matplotlib>=3.1->bar-chart-race) (1.16.0)

WARNING: Ignoring invalid distribution -ensorflow-intel
(c:\users\sahit\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf
(c:\users\sahit\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -ensorflow-intel
(c:\users\sahit\anaconda3\lib\site-packages)
WARNING: Ignoring invalid distribution -rotobuf
(c:\users\sahit\anaconda3\lib\site-packages)

[notice] A new release of pip is available: 24.0 -> 24.2
[notice] To update, run: python.exe -m pip install --upgrade pip
```

[29]:
```
import bar_chart_race as bcr
```

[49]:
```
make_year_counts = df.groupby(["Make", "Model Year"])

make_year_counts.head()
```

[49]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	\
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	
1	1G1RD6E45D	Clark	Laughlin	NV	89029	2013	
2	JN1AZ0CP8B	Yakima	Yakima	WA	98901	2011	
3	1G1FW6S08H	Skagit	Concrete	WA	98237	2017	
4	3FA6P0SU1K	Snohomish	Everett	WA	98201	2019	
…	…	…	…	…	…	…	
95445	537LS7D49C	Kitsap	Bremerton	WA	98312	2012	

```
98746   1FT6W1EV4P   Kittitas  Ellensburg    WA        98926        2023
99680   JT3GS10V32       King   Sammamish    WA        98075        2002
110308  1FTZR0812X     Pierce      Graham    WA        98338        1999
112267  1FTVW1EL4P   Kittitas  Ellensburg    WA        98926        2023

                Make                     Model  \
0              TOYOTA                RAV4 PRIME
1           CHEVROLET                      VOLT
2              NISSAN                      LEAF
3           CHEVROLET                   BOLT EV
4                FORD                    FUSION
…                 …                         …
95445   AZURE DYNAMICS  TRANSIT CONNECT ELECTRIC
98746            FORD                      F-150
99680          TOYOTA                       RAV4
110308           FORD                     RANGER
112267           FORD                      F-150

                        Electric Vehicle Type  \
0       Plug-in Hybrid Electric Vehicle (PHEV)
1       Plug-in Hybrid Electric Vehicle (PHEV)
2               Battery Electric Vehicle (BEV)
3               Battery Electric Vehicle (BEV)
4       Plug-in Hybrid Electric Vehicle (PHEV)
…                                         …
95445           Battery Electric Vehicle (BEV)
98746           Battery Electric Vehicle (BEV)
99680           Battery Electric Vehicle (BEV)
110308          Battery Electric Vehicle (BEV)
112267          Battery Electric Vehicle (BEV)

        Clean Alternative Fuel Vehicle (CAFV) Eligibility  Electric Range  \
0                 Clean Alternative Fuel Vehicle Eligible              42
1                 Clean Alternative Fuel Vehicle Eligible              38
2                 Clean Alternative Fuel Vehicle Eligible              73
3                 Clean Alternative Fuel Vehicle Eligible             238
4                   Not eligible due to low battery range              26
…                                                     …             …
95445             Clean Alternative Fuel Vehicle Eligible              56
98746   Eligibility unknown as battery range has not b…               0
99680             Clean Alternative Fuel Vehicle Eligible              95
110308            Clean Alternative Fuel Vehicle Eligible              74
112267  Eligibility unknown as battery range has not b…               0

        Base MSRP  Legislative District  DOL Vehicle ID  \
0               0                   NaN       198968248
1               0                   NaN         5204412
```

```
2               0                  15.0       218972519
3               0                  39.0       186750406
4               0                  38.0         2006714
…             …                    …            …
95445           0                  35.0       347393252
98746           0                  13.0       225794614
99680           0                  41.0       175935672
110308          0                   2.0       215121742
112267          0                  13.0       221472548

                    Vehicle Location  \
0          POINT (-81.80023 24.5545)
1        POINT (-114.57245 35.16815)
2        POINT (-120.50721 46.60448)
3         POINT (-121.7515 48.53892)
4        POINT (-122.20596 47.97659)
…                                …
95445    POINT (-122.66122 47.56573)
98746    POINT (-120.54872 46.99703)
99680    POINT (-122.03539 47.61344)
110308   POINT (-122.29477 47.05703)
112267   POINT (-120.54872 46.99703)

                                        Electric Utility  2020 Census Tract
0                                                    NaN        12087972100
1                                                    NaN        32003005702
2                                              PACIFICORP        53077001602
3                                  PUGET SOUND ENERGY INC        53057951101
4                                  PUGET SOUND ENERGY INC        53061041500
…                                                      …                …
95445                              PUGET SOUND ENERGY INC        53035080900
98746   BONNEVILLE POWER ADMINISTRATION||PUD NO 1 OF K…        53037975300
99680       PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)        53033032207
110308  BONNEVILLE POWER ADMINISTRATION||CITY OF TACOM…        53053073116
112267  BONNEVILLE POWER ADMINISTRATION||PUD NO 1 OF K…        53037975300

[1003 rows x 17 columns]
```

[58]:
```python
# Group by 'Make' and 'Model Year', then count occurrences
make_year_counts = df.groupby(["Make", "Model Year"]).size().
  ↪reset_index(name='Count')

# Display the first few rows
print(make_year_counts.head())
```

```
   Make  Model Year  Count
0  AUDI        2016    214
```

```
1  AUDI         2017    187
2  AUDI         2018    174
3  AUDI         2019    392
4  AUDI         2020    224
```

[59]:
```python
import plotly.express as px

# Create a bar chart
fig = px.bar(
    make_year_counts,
    x='Count',
    y='Make',
    color='Make',
    animation_frame='Model Year',
    range_x=[0, make_year_counts['Count'].max() + 10],
    title='Sales of Electric Vehicles by Make and Year',
    labels={'Count': "Number of EVs"},
    orientation='h'
)

# Update layout
fig.update_layout(
    xaxis_title='Count of EVs',
    yaxis_title='EV Make',
    title_font=dict(size=20),
    showlegend=False
)

# Show the figure
fig.show()
```

[ ]:
```python

```