ev-analysis-project

April 3, 2025

[8]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

[183]:
```
data="C:/Users/Himanshu/Downloads/FEV_data_Excel.xlsx"
df=pd.read_excel(data)
df
```

[183]:

	Car full name	Make	\
0	Audi e-tron 55 quattro	Audi	
1	Audi e-tron 50 quattro	Audi	
2	Audi e-tron S quattro	Audi	
3	Audi e-tron Sportback 50 quattro	Audi	
4	Audi e-tron Sportback 55 quattro	Audi	
5	Audi e-tron Sportback S quattro	Audi	
6	BMW i3	BMW	
7	BMW i3s	BMW	
8	BMW iX3	BMW	
9	Citroën ë-C4	Citroën	
10	DS DS3 Crossback e-tense	DS	
11	Honda e	Honda	
12	Honda e Advance	Honda	
13	Hyundai Ioniq electric	Hyundai	
14	Hyundai Kona electric 39.2kWh	Hyundai	
15	Hyundai Kona electric 64kWh	Hyundai	
16	Jaguar I-Pace	Jaguar	
17	Kia e-Niro 39.2kWh	Kia	
18	Kia e-Niro 64kWh	Kia	
19	Kia e-Soul 39.2kWh	Kia	
20	Kia e-Soul 64kWh	Kia	
21	Mazda MX-30	Mazda	
22	Mercedes-Benz EQC	Mercedes-Benz	
23	Mini Cooper SE	Mini	
24	Nissan Leaf	Nissan	
25	Nissan Leaf e+	Nissan	
26	Opel Corsa-e	Opel	

27	Opel Mokka-e	Opel
28	Peugeot e-208	Peugeot
29	Peugeot e-2008	Peugeot
30	Porsche Taycan 4S (Performance)	Porsche
31	Porsche Taycan 4S (Performance Plus)	Porsche
32	Porsche Taycan Turbo	Porsche
33	Porsche Taycan Turbo S	Porsche
34	Renault Zoe R110	Renault
35	Renault Zoe R135	Renault
36	Skoda Citigo-e iV	Skoda
37	Smart fortwo EQ	Smart
38	Smart forfour EQ	Smart
39	Tesla Model 3 Standard Range Plus	Tesla
40	Tesla Model 3 Long Range	Tesla
41	Tesla Model 3 Performance	Tesla
42	Tesla Model S Long Range Plus	Tesla
43	Tesla Model S Performance	Tesla
44	Tesla Model X Long Range Plus	Tesla
45	Tesla Model X Performance	Tesla
46	Volkswagen e-up!	Volkswagen
47	Volkswagen ID.3 Pro Performance	Volkswagen
48	Volkswagen ID.3 Pro S	Volkswagen
49	Volkswagen ID.4 1st	Volkswagen
50	Citroën ë-Spacetourer (M)	Citroën
51	Mercedes-Benz EQV (long)	Mercedes-Benz
52	Nissan e-NV200 evalia	Nissan

	Model	Minimal price (gross) [PLN]	\
0	e-tron 55 quattro	345700	
1	e-tron 50 quattro	308400	
2	e-tron S quattro	414900	
3	e-tron Sportback 50 quattro	319700	
4	e-tron Sportback 55 quattro	357000	
5	e-tron Sportback S quattro	426200	
6	i3	169700	
7	i3s	184200	
8	iX3	282900	
9	ë-C4	125000	
10	DS3 Crossback e-tense	159900	
11	e	152900	
12	e Advance	165900	
13	Ioniq electric	184500	
14	Kona electric 39.2kWh	154400	
15	Kona electric 64kWh	178400	
16	I-Pace	359500	
17	e-Niro 39.2kWh	146990	
18	e-Niro 64kWh	167990	

19	e-Soul 39.2kWh	139900
20	e-Soul 64kWh	160990
21	MX-30	142900
22	EQC	334700
23	Cooper SE	139900
24	Leaf	122900
25	Leaf e+	164000
26	Corsa-e	128900
27	Mokka-e	139900
28	e-208	124900
29	e-2008	149400
30	Taycan 4S (Performance)	457000
31	Taycan 4S (Performance Plus)	482283
32	Taycan Turbo	653000
33	Taycan Turbo S	794000
34	Zoe R110	135900
35	Zoe R135	142900
36	Citigo-e iV	82050
37	fortwo EQ	96900
38	forfour EQ	98900
39	Model 3 Standard Range Plus	195490
40	Model 3 Long Range	235490
41	Model 3 Performance	260490
42	Model S Long Range Plus	368990
43	Model S Performance	443990
44	Model X Long Range Plus	407990
45	Model X Performance	482990
46	e-up!	97990
47	ID.3 Pro Performance	155890
48	ID.3 Pro S	179990
49	ID.4 1st	202390
50	ë-Spacetourer (M)	215400
51	EQV (long)	339480
52	e-NV200 evalia	164328

	Engine power [KM]	Maximum torque [Nm]	Type of brakes \
0	360	664	disc (front + rear)
1	313	540	disc (front + rear)
2	503	973	disc (front + rear)
3	313	540	disc (front + rear)
4	360	664	disc (front + rear)
5	503	973	disc (front + rear)
6	170	250	disc (front + rear)
7	184	270	disc (front + rear)
8	286	400	disc (front + rear)
9	136	260	disc (front + rear)
10	136	260	disc (front + rear)

11	136	315	disc (front + rear)
12	154	315	disc (front + rear)
13	136	295	disc (front + rear)
14	136	395	disc (front + rear)
15	204	395	disc (front + rear)
16	400	696	disc (front + rear)
17	136	395	disc (front + rear)
18	204	395	disc (front + rear)
19	136	395	disc (front + rear)
20	204	395	disc (front + rear)
21	145	270	disc (front + rear)
22	408	760	disc (front + rear)
23	184	270	disc (front + rear)
24	150	320	disc (front + rear)
25	217	340	disc (front + rear)
26	136	260	disc (front + rear)
27	136	260	disc (front + rear)
28	136	260	disc (front + rear)
29	136	260	disc (front + rear)
30	435	640	disc (front + rear)
31	490	650	disc (front + rear)
32	625	850	disc (front + rear)
33	625	1050	disc (front + rear)
34	108	225	disc (front + rear)
35	135	245	disc (front + rear)
36	83	212	disc (front) + drum (rear)
37	82	160	disc (front) + drum (rear)
38	82	160	disc (front) + drum (rear)
39	285	450	disc (front + rear)
40	372	510	disc (front + rear)
41	480	639	disc (front + rear)
42	525	755	disc (front + rear)
43	772	1140	disc (front + rear)
44	525	755	disc (front + rear)
45	772	1140	disc (front + rear)
46	83	210	disc (front) + drum (rear)
47	204	310	disc (front) + drum (rear)
48	204	310	disc (front) + drum (rear)
49	204	310	disc (front) + drum (rear)
50	136	260	disc (front + rear)
51	204	362	NaN
52	109	254	disc (front + rear)

	Drive type	Battery capacity [kWh]	Range (WLTP) [km]	…	\
0	4WD	95.0	438	…	
1	4WD	71.0	340	…	
2	4WD	95.0	364	…	

3	4WD	71.0	346	…
4	4WD	95.0	447	…
5	4WD	95.0	369	…
6	2WD (rear)	42.2	359	…
7	2WD (rear)	42.2	345	…
8	2WD (rear)	80.0	460	…
9	2WD (front)	50.0	350	…
10	2WD (front)	50.0	320	…
11	2WD (rear)	35.5	222	…
12	2WD (rear)	35.5	222	…
13	2WD (front)	38.3	311	…
14	2WD (front)	39.2	289	…
15	2WD (front)	64.0	449	…
16	4WD	90.0	470	…
17	2WD (front)	39.2	289	…
18	2WD (front)	64.0	455	…
19	2WD (front)	39.2	276	…
20	2WD (front)	64.0	452	…
21	2WD (front)	35.5	200	…
22	4WD	80.0	414	…
23	2WD (front)	28.9	234	…
24	2WD (front)	40.0	270	…
25	2WD (front)	62.0	385	…
26	2WD (front)	50.0	337	…
27	2WD (front)	50.0	324	…
28	2WD (front)	50.0	340	…
29	2WD (front)	50.0	320	…
30	4WD	79.2	407	…
31	4WD	93.4	463	…
32	4WD	93.4	450	…
33	4WD	93.4	412	…
34	2WD (front)	52.0	395	…
35	2WD (front)	52.0	395	…
36	2WD (front)	36.8	260	…
37	2WD (rear)	17.6	154	…
38	2WD (rear)	17.6	148	…
39	2WD (rear)	54.0	430	…
40	4WD	75.0	580	…
41	4WD	75.0	567	…
42	4WD	100.0	652	…
43	4WD	100.0	639	…
44	4WD	100.0	561	…
45	4WD	100.0	548	…
46	2WD (front)	32.3	258	…
47	2WD (rear)	58.0	425	…
48	2WD (rear)	77.0	549	…
49	2WD (rear)	77.0	500	…

50	2WD (front)	50.0	230	…
51	2WD (front)	90.0	356	…
52	2WD (front)	40.0	200	…

	Permissable gross weight [kg]	Maximum load capacity [kg]	\
0	3130.0	640.0	
1	3040.0	670.0	
2	3130.0	565.0	
3	3040.0	640.0	
4	3130.0	670.0	
5	3130.0	565.0	
6	1730.0	440.0	
7	1730.0	440.0	
8	2725.0	540.0	
9	2000.0	459.0	
10	1975.0	450.0	
11	1855.0	342.0	
12	1870.0	350.0	
13	1970.0	518.0	
14	2020.0	485.0	
15	2170.0	485.0	
16	2670.0	537.0	
17	2080.0	488.0	
18	2230.0	493.0	
19	1682.0	490.0	
20	1682.0	498.0	
21	2119.0	474.0	
22	2940.0	445.0	
23	1770.0	480.0	
24	1995.0	450.0	
25	2140.0	435.0	
26	1916.0	367.0	
27	2015.0	417.0	
28	1918.0	463.0	
29	NaN	NaN	
30	2880.0	740.0	
31	2880.0	660.0	
32	2880.0	575.0	
33	2870.0	575.0	
34	1988.0	425.0	
35	1988.0	486.0	
36	1530.0	367.0	
37	1310.0	290.0	
38	1570.0	445.0	
39	NaN	NaN	
40	NaN	NaN	
41	NaN	NaN	

42	NaN	NaN
43	NaN	NaN
44	NaN	NaN
45	NaN	NaN
46	1530.0	370.0
47	2270.0	540.0
48	2280.0	412.0
49	2660.0	661.0
50	2810.0	1056.0
51	3500.0	865.0
52	2250.0	658.0

	Number of seats	Number of doors	Tire size [in]	Maximum speed [kph]	\
0	5	5	19	200	
1	5	5	19	190	
2	5	5	20	210	
3	5	5	19	190	
4	5	5	19	200	
5	5	5	20	210	
6	4	5	19	160	
7	4	5	20	160	
8	5	5	19	180	
9	5	5	16	150	
10	5	5	17	150	
11	5	5	16	145	
12	5	5	17	145	
13	5	5	16	165	
14	5	5	17	155	
15	5	5	17	167	
16	5	5	20	200	
17	5	5	17	155	
18	5	5	17	167	
19	5	5	17	157	
20	5	5	17	167	
21	5	5	18	140	
22	5	5	19	180	
23	4	3	16	150	
24	5	5	16	144	
25	5	5	17	157	
26	5	5	16	150	
27	5	5	16	150	
28	5	5	16	150	
29	5	5	16	150	
30	4	4	19	250	
31	4	4	19	250	
32	4	4	20	260	
33	4	4	21	260	

34	5	5	15	135
35	5	5	16	140
36	4	5	14	130
37	2	3	15	130
38	4	5	15	130
39	5	5	18	225
40	5	5	18	233
41	5	5	20	261
42	5	5	19	250
43	5	5	21	261
44	7	5	20	250
45	7	5	20	261
46	4	5	14	130
47	5	5	18	160
48	5	5	19	160
49	5	5	20	160
50	8	5	16	130
51	6	5	17	160
52	5	5	15	123

	Boot capacity (VDA) [l]	Acceleration 0-100 kph [s]	\
0	660.0	5.7	
1	660.0	6.8	
2	660.0	4.5	
3	615.0	6.8	
4	615.0	5.7	
5	615.0	4.5	
6	260.0	8.1	
7	260.0	6.9	
8	510.0	6.8	
9	380.0	9.5	
10	350.0	8.7	
11	171.0	9.0	
12	171.0	8.3	
13	357.0	9.9	
14	332.0	9.7	
15	332.0	7.6	
16	656.0	4.8	
17	451.0	9.8	
18	451.0	7.8	
19	315.0	9.9	
20	315.0	7.9	
21	350.0	9.7	
22	500.0	5.1	
23	211.0	7.3	
24	435.0	7.9	
25	435.0	6.9	

26	267.0	8.1
27	310.0	9.0
28	311.0	8.1
29	434.0	NaN
30	488.0	4.0
31	488.0	4.0
32	447.0	3.2
33	447.0	2.8
34	338.0	11.4
35	338.0	9.5
36	250.0	12.3
37	185.0	11.6
38	260.0	12.7
39	425.0	5.6
40	425.0	4.4
41	425.0	3.3
42	745.0	3.8
43	745.0	2.5
44	857.0	4.6
45	857.0	2.8
46	250.0	11.9
47	385.0	7.3
48	385.0	7.9
49	543.0	8.5
50	603.0	13.1
51	NaN	NaN
52	870.0	NaN

	Maximum DC charging power [kW]	mean - Energy consumption [kWh/100 km]
0	150	24.45
1	150	23.80
2	150	27.55
3	150	23.30
4	150	23.85
5	150	27.20
6	50	13.10
7	50	14.30
8	150	18.80
9	100	NaN
10	100	15.60
11	100	17.20
12	100	17.50
13	100	13.80
14	100	15.00
15	100	15.40
16	100	21.20
17	100	15.30

18	100	15.90
19	100	15.60
20	100	15.70
21	37	14.50
22	110	21.85
23	50	16.75
24	50	18.50
25	100	17.10
26	100	16.65
27	100	17.60
28	100	16.40
29	100	NaN
30	225	23.40
31	270	24.10
32	270	24.85
33	270	25.10
34	50	16.50
35	50	16.50
36	40	15.45
37	22	16.35
38	22	17.00
39	150	NaN
40	150	NaN
41	150	NaN
42	150	NaN
43	150	NaN
44	150	NaN
45	150	NaN
46	40	14.00
47	100	15.40
48	125	15.90
49	125	18.00
50	100	25.20
51	110	28.20
52	50	25.90

[53 rows x 25 columns]

0.1 TASK_1: A customer has a budget of 350,000 PLN and wants an EV with a minimum range of 400km.

0.1.1 A) To filter out EVs that meet these criteria.

[28]:
```
filtered_EVs=df[(df["Minimal Price (gross) [PLN"]<=350000) & (df["Range (WLTP)␣
↪[km]"] >= 400)]
filtered_EVs
```

[28]:

	Car full name	Make	\
0	Audi e-tron 55 quattro	Audi	
8	BMW iX3	BMW	
15	Hyundai Kona electric 64kWh	Hyundai	
18	Kia e-Niro 64kWh	Kia	
20	Kia e-Soul 64kWh	Kia	
22	Mercedes-Benz EQC	Mercedes-Benz	
39	Tesla Model 3 Standard Range Plus	Tesla	
40	Tesla Model 3 Long Range	Tesla	
41	Tesla Model 3 Performance	Tesla	
47	Volkswagen ID.3 Pro Performance	Volkswagen	
48	Volkswagen ID.3 Pro S	Volkswagen	
49	Volkswagen ID.4 1st	Volkswagen	

	Model	Minimal price (gross) [PLN]	\
0	e-tron 55 quattro	345700	
8	iX3	282900	
15	Kona electric 64kWh	178400	
18	e-Niro 64kWh	167990	
20	e-Soul 64kWh	160990	
22	EQC	334700	
39	Model 3 Standard Range Plus	195490	
40	Model 3 Long Range	235490	
41	Model 3 Performance	260490	
47	ID.3 Pro Performance	155890	
48	ID.3 Pro S	179990	
49	ID.4 1st	202390	

	Engine power [KM]	Maximum torque [Nm]	Type of brakes	\
0	360	664	disc (front + rear)	
8	286	400	disc (front + rear)	
15	204	395	disc (front + rear)	
18	204	395	disc (front + rear)	
20	204	395	disc (front + rear)	
22	408	760	disc (front + rear)	
39	285	450	disc (front + rear)	
40	372	510	disc (front + rear)	
41	480	639	disc (front + rear)	
47	204	310	disc (front) + drum (rear)	
48	204	310	disc (front) + drum (rear)	
49	204	310	disc (front) + drum (rear)	

	Drive type	Battery capacity [kWh]	Range (WLTP) [km]	…	\
0	4WD	95.0	438	…	
8	2WD (rear)	80.0	460	…	
15	2WD (front)	64.0	449	…	
18	2WD (front)	64.0	455	…	

```
20  2WD (front)                   64.0                452  …
22          4WD                   80.0                414  …
39   2WD (rear)                   54.0                430  …
40          4WD                   75.0                580  …
41          4WD                   75.0                567  …
47   2WD (rear)                   58.0                425  …
48   2WD (rear)                   77.0                549  …
49   2WD (rear)                   77.0                500  …

    Permissable gross weight [kg]  Maximum load capacity [kg]  \
0                          3130.0                       640.0
8                          2725.0                       540.0
15                         2170.0                       485.0
18                         2230.0                       493.0
20                         1682.0                       498.0
22                         2940.0                       445.0
39                            NaN                         NaN
40                            NaN                         NaN
41                            NaN                         NaN
47                         2270.0                       540.0
48                         2280.0                       412.0
49                         2660.0                       661.0

    Number of seats  Number of doors  Tire size [in]  Maximum speed [kph]  \
0                 5                5              19                  200
8                 5                5              19                  180
15                5                5              17                  167
18                5                5              17                  167
20                5                5              17                  167
22                5                5              19                  180
39                5                5              18                  225
40                5                5              18                  233
41                5                5              20                  261
47                5                5              18                  160
48                5                5              19                  160
49                5                5              20                  160

    Boot capacity (VDA) [l]  Acceleration 0-100 kph [s]  \
0                     660.0                         5.7
8                     510.0                         6.8
15                    332.0                         7.6
18                    451.0                         7.8
20                    315.0                         7.9
22                    500.0                         5.1
39                    425.0                         5.6
40                    425.0                         4.4
41                    425.0                         3.3
```

```
47                    385.0                          7.3
48                    385.0                          7.9
49                    543.0                          8.5

    Maximum DC charging power [kW]  mean - Energy consumption [kWh/100 km]
0                              150                                    24.45
8                              150                                    18.80
15                             100                                    15.40
18                             100                                    15.90
20                             100                                    15.70
22                             110                                    21.85
39                             150                                      NaN
40                             150                                      NaN
41                             150                                      NaN
47                             100                                    15.40
48                             125                                    15.90
49                             125                                    18.00

[12 rows x 25 columns]
```

0.1.2 TASK_1(B): Group them by the manufacturer(make).

[32]:
```
# Using groupby(), size() and reset_index() together for grouping manufacturer␣
↪along with each EVs count.
grouped_EVs=filtered_EVs.groupby("Make").size().reset_index(name="Count")
grouped_EVs
```

[32]:
```
            Make  Count
0           Audi      1
1            BMW      1
2        Hyundai      1
3            Kia      2
4  Mercedes-Benz      1
5          Tesla      3
6     Volkswagen      3
```

0.1.3 TASK_1(C): Calculate the average battery capacity for each manufacturer.

[83]:
```
# Using mean() for calculating the average battery capacity.
avg_battery_capacity = (filtered_EVs.groupby("Make")["Battery capacity [kWh]"].
↪mean().round(2))
avg_battery_capacity
```

[83]:
```
Make
Audi             95.00
BMW              80.00
```

```
Hyundai          64.00
Kia              64.00
Mercedes-Benz    80.00
Tesla            68.00
Volkswagen       70.67
Name: Battery capacity [kWh], dtype: float64
```

1 INSIGHTS:

1. In comparison, Hyundai, Tesla and Volkswagen EVs have good battery capacity and there Minimal price is also cheaper. So they can be affordable in customers budget.
2. Audi, BMW and Mercedes-Benz EVs does provide much better battery capacity than the others but they exceed the budget.
3. Manufacturers can make EVs that can have longer-ranges or good battery capacity in affordable prices.

1.1 TASK_2:You suspect some EVs have unusually high or low energy consumption. Find the outliers in the mean.

[98]:
```
# We have mean energy consumption column from which we can get standard␣
 ↪deviation.
std_mean_energy=df["mean - Energy consumption [kWh/100 km]"].std()

# Using Z-score metthod to detect outliers in energy consumption.
df["Z_score"]=df["mean - Energy consumption [kWh/100 km]"]/std_mean_energy
outliers=df[df["Z_score"] > 3] # consider values with a z-score greater than 3␣
 ↪as outliers

# Rounding the Z-scores to 2 decimal places
outliers_EVs=outliers[["Car full name", "Z_score", "mean - Energy consumption␣
 ↪[kWh/100 km]"]].copy()
outliers_EVs["Z_score"]=outliers_EVs["Z_score"].round(2)
outliers_EVs
```

[98]:

	Car full name	Z_score	\
0	Audi e-tron 55 quattro	5.53	
1	Audi e-tron 50 quattro	5.39	
2	Audi e-tron S quattro	6.24	
3	Audi e-tron Sportback 50 quattro	5.27	
4	Audi e-tron Sportback 55 quattro	5.40	
5	Audi e-tron Sportback S quattro	6.16	
7	BMW i3s	3.24	
8	BMW iX3	4.26	
10	DS DS3 Crossback e-tense	3.53	
11	Honda e	3.89	
12	Honda e Advance	3.96	

13	Hyundai Ioniq electric	3.12
14	Hyundai Kona electric 39.2kWh	3.40
15	Hyundai Kona electric 64kWh	3.49
16	Jaguar I-Pace	4.80
17	Kia e-Niro 39.2kWh	3.46
18	Kia e-Niro 64kWh	3.60
19	Kia e-Soul 39.2kWh	3.53
20	Kia e-Soul 64kWh	3.55
21	Mazda MX-30	3.28
22	Mercedes-Benz EQC	4.95
23	Mini Cooper SE	3.79
24	Nissan Leaf	4.19
25	Nissan Leaf e+	3.87
26	Opel Corsa-e	3.77
27	Opel Mokka-e	3.98
28	Peugeot e-208	3.71
30	Porsche Taycan 4S (Performance)	5.30
31	Porsche Taycan 4S (Performance Plus)	5.45
32	Porsche Taycan Turbo	5.62
33	Porsche Taycan Turbo S	5.68
34	Renault Zoe R110	3.73
35	Renault Zoe R135	3.73
36	Skoda Citigo-e iV	3.50
37	Smart fortwo EQ	3.70
38	Smart forfour EQ	3.85
46	Volkswagen e-up!	3.17
47	Volkswagen ID.3 Pro Performance	3.49
48	Volkswagen ID.3 Pro S	3.60
49	Volkswagen ID.4 1st	4.07
50	Citroën ë-Spacetourer (M)	5.70
51	Mercedes-Benz EQV (long)	6.38
52	Nissan e-NV200 evalia	5.86

	mean - Energy consumption [kWh/100 km]
0	24.45
1	23.80
2	27.55
3	23.30
4	23.85
5	27.20
7	14.30
8	18.80
10	15.60
11	17.20
12	17.50
13	13.80
14	15.00

15	15.40
16	21.20
17	15.30
18	15.90
19	15.60
20	15.70
21	14.50
22	21.85
23	16.75
24	18.50
25	17.10
26	16.65
27	17.60
28	16.40
30	23.40
31	24.10
32	24.85
33	25.10
34	16.50
35	16.50
36	15.45
37	16.35
38	17.00
46	14.00
47	15.40
48	15.90
49	18.00
50	25.20
51	28.20
52	25.90

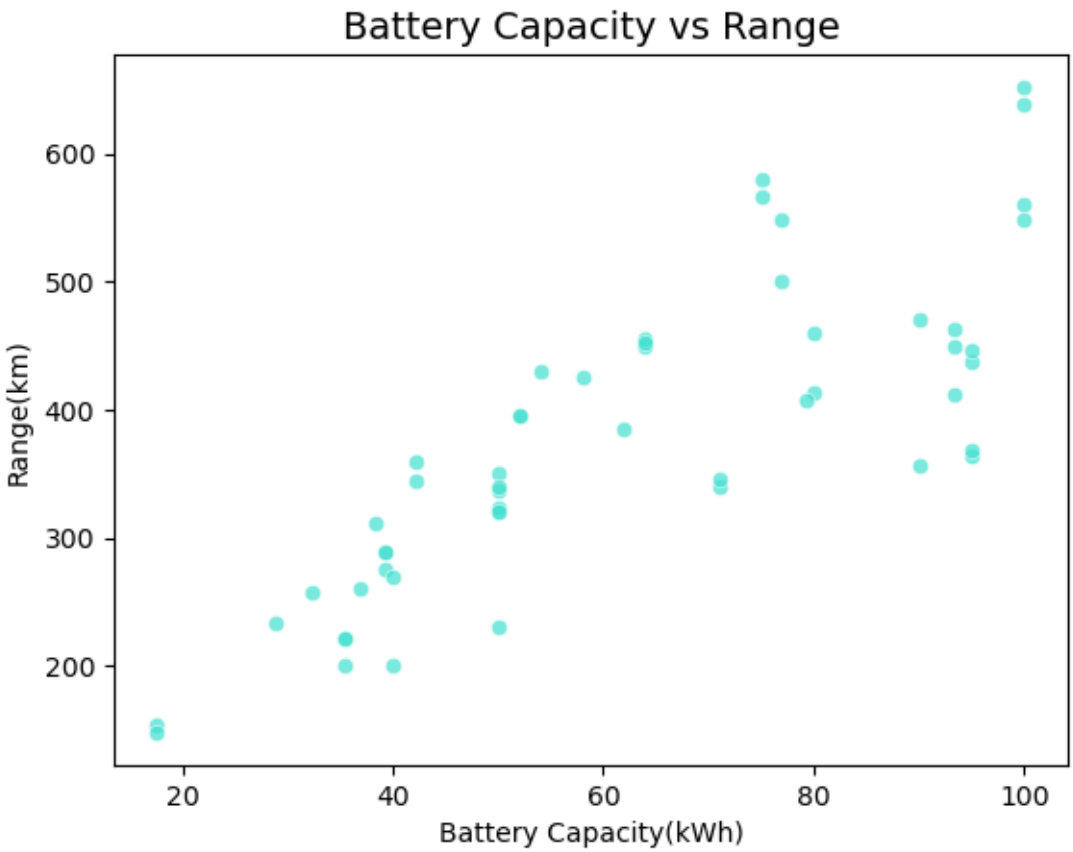
In this task, I have taken help from ChatGPT to generate codes that helps me in creating the table. Z-score lower than 3 is not showing in this table. ## INSIGHTS: 1. Z-score greater than 3 indicates that these EVs consume high energy because maybe they have powerful motors that consume high-performances. 2. Z-score lower than 3 indicates that the EVs consume low energy because of their lightweight design that consumes low energy and maybe energy efficient.

1.2 TASK_3: Your manager wants to know if there's a strong relationship between battery capacity and range.

[185]:
```
# Creating a scatter plot to visualize the relationship between battery␣
 ↪capacity and range.

sns.scatterplot(data=df,x="Battery capacity [kWh]",y="Range (WLTP)␣
 ↪[km]",alpha=0.7,color="turquoise")
plt.title("Battery Capacity vs Range",fontsize=14)
```

```
plt.xlabel("Battery Capacity(kWh)",fontsize=10)
plt.ylabel("Range(km)",fontsize=10)
plt.show()
```



As shown in the Scatter plot, the Range is increasing and along with it Battery capacity is also tend to increase.

2 INSIGHTS:

1. In the scatter plot it shows positive correlation between battery capacity and range.
2. However, some EVs with same battery capacity may have different ranges due to efficiency and same goes with range.

2.1 TASK_4: Build an EV recommendation class.

[189]:
```
# Creating a class to recommend EVs based on budget, range, and battery␣
↪capacity.

class EVRecommendation:
    def __init__(self, df):
```

```
        self.df = df

    def recommend(self):
        try:
            budget = float(input("Enter your budget (PLN): "))
            min_range = float(input("Enter the minimum range (km): "))
            min_battery = float(input("Enter the minimum battery capacity (kWh):
 ↪ "))

            recommendations = self.df[(self.df["Minimal price (gross) [PLN]"]␣
 ↪<= budget) &
                                      (self.df["Range (WLTP) [km]"] >=␣
 ↪min_range) &
                                      (self.df["Battery capacity [kWh]"] >=␣
 ↪min_battery)]

            if recommendations.empty:
                print("No EVs match your criteria.")
            else:
                print("Recommended EVs based on your input:")
                print(recommendations[["Make", "Model", "Minimal price (gross)␣
 ↪[PLN]", "Range (WLTP) [km]", "Battery capacity [kWh]"]].head(3))
        except ValueError:
            print("Invalid input! Please enter numerical values.")

# Example usage
ev_rec = EVRecommendation(df)
ev_rec.recommend()
```

```
Enter your budget (PLN):  200000
Enter the minimum range (km):  350
Enter the minimum battery capacity (kWh):  60
```

```
Recommended EVs based on your input:
       Make                Model  Minimal price (gross) [PLN]  \
15  Hyundai  Kona electric 64kWh                       178400
18      Kia         e-Niro 64kWh                       167990
20      Kia         e-Soul 64kWh                       160990

    Range (WLTP) [km]  Battery capacity [kWh]
15                449                    64.0
18                455                    64.0
20                452                    64.0
```

By taking help of ChatGPT, I generate some codes to exceute in the script.

3 Insight On This:

1. We can sort the criteria by best match, prioritize budget within range or we can allow an optional preference for speed, seats or cargo spaces.

3.1 TASK_5: Inferential Statistics - Hypothesis Testing.

[174]:
```
import scipy.stats as stats

# Filtering data for Tesla and Audi
tesla_engine=dataframe[dataframe["Make"] == "Tesla"]["Engine power [KM]"]
audi_engine=dataframe[dataframe["Make"] == "Audi"]["Engine power [KM]"]

# Performing two-sample t-test to compare engine power of Tesla and Audi.
t_stat, p_value=stats.ttest_ind(tesla_engine,audi_engine,equal_var=False)
print(f"T-test results: t-statistic = {t_stat:.3f}, p-value={p_value:>3f}")

# Interpretation
alpha = 0.05
if p_value < alpha:
    print("Reject the null hypothesis: there is a significant difference in␣
 ↪engine power between Audi and Tesla.")

else:
    print("Fail to reject the null hypothesis: No significant difference in␣
 ↪engine power between Audi and Tesla.")
```

```
T-test results: t-statistic = 1.794, p-value=0.106841
Fail to reject the null hypothesis: No significant difference in engine power
between Audi and Tesla.
```

4 INSIGHTS:

1. No significant difference, meaning any observed difference could be due to some random variations in both the engine power(Tesla and Audi).
2. Both Audi and Tesla brands should focus on their range, battery capacity and price to make budget friendly EVs for customers.

5 Video Link:

https://drive.google.com/file/d/1An6rmPeNebQAiNNqYDCcqxofutXwcjH7/view?usp=sharing

[ ]:
```

```