

```
In [11]: import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt

In [13]: fev_df=pd.read_csv("FEV-data-Excel.xlsx - Auto elektryczne.csv")
fev_df.head()
```

```
Out[13]:
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	Car full name	Make	Model	Minimal price (gross) [PLN]	Engine power [KM]	Maximum torque [Nm]	Type of brakes	Drive type	Battery capacity [kWh]	Range (WLTP) [km]	Permissible gross weight [kg]	Maximum load capacity [kg]	Number of seats	Number of doors	Tire size [in]	Maximum speed [km/h]	Boot capacity (VDA) [l]	Acceleration 0-100 km/h [s]	Maximum DC charging power [kW]	mean - Energy consumption [kWh/100 km]
0	Audi e-tron 55 quattro	Audi	e-tron 55 quattro	345700	360	664	disc (front + rear)	4WD	95.0	438 ...	3130.0	640.0	5	5	19	200	660.0	5.7	150	24.45
1	Audi e-tron 50 quattro	Audi	e-tron 50 quattro	308400	313	540	disc (front + rear)	4WD	71.0	340 ...	3040.0	670.0	5	5	19	190	660.0	6.8	150	23.80
2	Audi e-tron S quattro	Audi	e-tron S quattro	414900	503	973	disc (front + rear)	4WD	95.0	364 ...	3130.0	585.0	5	5	20	210	660.0	4.5	150	27.55
3	Sportback 50 quattro	Audi	Sportback 50 quattro	319700	313	540	disc (front + rear)	4WD	71.0	346 ...	3040.0	640.0	5	5	19	190	615.0	6.8	150	23.30
4	Sportback 55 quattro	Audi	e-tron Sportback 55 quattro	357000	360	664	disc (front + rear)	4WD	95.0	447 ...	3130.0	670.0	5	5	19	200	615.0	5.7	150	23.85

5 rows × 25 columns

Task 1: A customer has a budget of 350,000 PLN and wants an EV with a minimum range of 400 km.

a) Your task is to filter out EVs that meet these criteria.

```
In [14]: custo_pref = fev_df[(fev_df["Minimal price (gross) [PLN]"] <= 350000) & (fev_df["Range (WLTP) [km]"] >= 400)]
custo_pref
```

```
Out[14]:
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	Car full name	Make	Model	Minimal price (gross) [PLN]	Engine power [KM]	Maximum torque [Nm]	Type of brakes	Drive type	Battery capacity [kWh]	Range (WLTP) [km]	Permissible gross weight [kg]	Maximum load capacity [kg]	Number of seats	Number of doors	Tire size [in]	Maximum speed [km/h]	Boot capacity (VDA) [l]	Acceleration 0-100 km/h [s]	Maximum DC charging power [kW]	mean - Energy consumption [kWh/100 km]
0	Audi e-tron 55 quattro	Audi	e-tron 55 quattro	345700	360	664	disc (front + rear)	4WD	95.0	438 ...	3130.0	640.0	5	5	19	200	660.0	5.7	150	24.45
8	BMW iX3	BMW	iX3	262900	286	400	disc (front + rear)	2WD (rear)	80.0	460 ...	2725.0	540.0	5	5	19	180	510.0	6.8	150	18.80
15	Hyundai Kona electric 64kWh	Hyundai	Kona electric 64kWh	178400	204	395	disc (front + rear)	2WD (front)	64.0	449 ...	2170.0	485.0	5	5	17	167	332.0	7.6	100	15.40
18	Kia e-Niro 64kWh	Kia	e-Niro 64kWh	167990	204	395	disc (front + rear)	2WD (front)	64.0	455 ...	2230.0	493.0	5	5	17	167	451.0	7.8	100	15.90
20	Kia e-Soul 64kWh	Kia	e-Soul 64kWh	160990	204	395	disc (front + rear)	2WD (front)	64.0	452 ...	1682.0	498.0	5	5	17	167	315.0	7.9	100	15.70
22	Mercedes-Benz EQC	Mercedes-Benz	EQC	334700	408	760	disc (front + rear)	4WD	80.0	414 ...	2940.0	445.0	5	5	19	180	500.0	5.1	110	21.85
39	Tesla Model 3 Standard Range Plus	Tesla	Model 3 Standard Range Plus	195490	285	450	disc (front + rear)	2WD (rear)	54.0	430 ...	NaN	NaN	5	5	18	225	425.0	5.6	150	NaN
40	Tesla Model 3 Long Range	Tesla	Model 3 Long Range	235490	372	510	disc (front + rear)	4WD	75.0	580 ...	NaN	NaN	5	5	18	233	425.0	4.4	150	NaN
41	Tesla Model 3 Performance	Tesla	Model 3 Performance	260490	480	639	disc (front + rear)	4WD	75.0	567 ...	NaN	NaN	5	5	20	261	425.0	3.3	150	NaN
47	Volkswagen ID.3 Pro Performance	Volkswagen	ID.3 Pro Performance	155890	204	310	disc (front + rear)	2WD (rear)	58.0	425 ...	2270.0	540.0	5	5	18	160	385.0	7.3	100	15.40
48	Volkswagen ID.3 Pro S	Volkswagen	ID.3 Pro S	179990	204	310	disc (front + rear)	2WD (rear)	77.0	549 ...	2280.0	412.0	5	5	19	160	385.0	7.9	125	15.90
49	Volkswagen ID.4 1st	Volkswagen	ID.4 1st	202390	204	310	disc (front + rear)	2WD (rear)	77.0	500 ...	2660.0	661.0	5	5	20	160	543.0	8.5	125	18.00

12 rows × 25 columns

b) Group them by the manufacturer (Make).

```
In [174]: custo_pref = fev_df[(fev_df["Minimal price (gross) [PLN]"] <= 350000) & (fev_df["Range (WLTP) [km]"] >= 400)]
manufacturers_groups = custo_pref.groupby('Make')
for make, group in manufacturers_groups:
    print(f'Manufacturer: {make}')
    print(group)
```

Manufacturer: Audi

```
Car full name      Make      Model \
0 Audi e-tron 55 quattro Audi  e-tron 55 quattro
Minimal price (gross) [PLN]  Engine power [KM]  Maximum torque [Nm] \
0      345700      360      664
Type of brakes Drive type Battery capacity [kWh]_x \
0 disc (front + rear)      4WD      95.0
Range (WLTP) [km] ... Number of doors Tire size [in] \
0      438 ...      5      19
Maximum speed [km/h] Boot capacity [VDA] [l] Acceleration 0-100 km/h [s] \
0      200      660.0      5.7
Maximum DC charging power [kW] mean - Energy consumption [kWh/100 km] \
0      150      24.45
avg_bat_cap Battery capacity [kWh]_y Battery capacity [kWh]
0      95.0      95.0      95.0

[1 rows x 28 columns]
Manufacturer: BMW
Car full name      Make      Model Minimal price (gross) [PLN]  Engine power [KM] \
8 BMW iX3 BMW iX3      262900
Maximum torque [Nm] Type of brakes Drive type \
8      400 disc (front + rear) 2WD (rear)
Battery capacity [kWh]_x Range (WLTP) [km] ... Number of doors \
8      80.0      460 ...      5
Tire size [in] Maximum speed [km/h] Boot capacity [VDA] [l] \
8      19      180      510.0
Acceleration 0-100 km/h [s] Maximum DC charging power [kW] \
8      6.8      150
mean - Energy consumption [kWh/100 km] avg_bat_cap \
8      18.8      NaN
Battery capacity [kWh]_y Battery capacity [kWh]
8      80.0      80.0      80.0

[1 rows x 28 columns]
Manufacturer: Hyundai
Car full name      Make      Model \
15 Hyundai Kona electric 64kWh Hyundai Kona electric 64kWh
Minimal price (gross) [PLN]  Engine power [KM]  Maximum torque [Nm] \
15      178400      204      395
Type of brakes Drive type Battery capacity [kWh]_x \
15 disc (front + rear) 2WD (front)      64.0
Range (WLTP) [km] ... Number of doors Tire size [in] \
15      449 ...      5      17
Maximum speed [km/h] Boot capacity [VDA] [l] Acceleration 0-100 km/h [s] \
15      167      332.0      7.6
Maximum DC charging power [kW] mean - Energy consumption [kWh/100 km] \
15      100      15.4
avg_bat_cap Battery capacity [kWh]_y Battery capacity [kWh]
15      NaN      64.0      64.0

[1 rows x 28 columns]
Manufacturer: Kia
Car full name      Make      Model Minimal price (gross) [PLN] \
18 Kia e-Niro 64kWh Kia e-Niro 64kWh      167990
20 Kia e-Soul 64kWh Kia e-Soul 64kWh      160990
Engine power [KM] Maximum torque [Nm] Type of brakes Drive type \
18      204      395 disc (front + rear) 2WD (front)
20      204      395 disc (front + rear) 2WD (front)
Battery capacity [kWh]_x Range (WLTP) [km] ... Number of doors \
18      64.0      455 ...      5
20      64.0      452 ...      5
Tire size [in] Maximum speed [km/h] Boot capacity [VDA] [l] \
18      17      167      451.0
20      17      167      315.0
Acceleration 0-100 km/h [s] Maximum DC charging power [kW] \
18      7.8      100
20      7.9      100
mean - Energy consumption [kWh/100 km] avg_bat_cap \
18      15.9      NaN
20      15.7      NaN
Battery capacity [kWh]_y Battery capacity [kWh]
18      64.0      64.0
20      64.0      64.0

[2 rows x 28 columns]
Manufacturer: Mercedes-Benz
Car full name      Make      Model Minimal price (gross) [PLN] \
22 Mercedes-Benz EQC Mercedes-Benz EQC      334700
Engine power [KM] Maximum torque [Nm] Type of brakes Drive type \
22      408      760 disc (front + rear) 4WD
Battery capacity [kWh]_x Range (WLTP) [km] ... Number of doors \
22      80.0      414 ...      5
Tire size [in] Maximum speed [km/h] Boot capacity [VDA] [l] \
22      19      180      500.0
Acceleration 0-100 km/h [s] Maximum DC charging power [kW] \
22      5.1      110
mean - Energy consumption [kWh/100 km] avg_bat_cap \
22      21.85      NaN
Battery capacity [kWh]_y Battery capacity [kWh]
22      80.0      80.0

[1 rows x 28 columns]
Manufacturer: Tesla
Car full name      Make      Model \
39 Tesla Model 3 Standard Range Plus Tesla Model 3 Standard Range Plus
40 Tesla Model 3 Long Range Tesla Model 3 Long Range
41 Tesla Model 3 Performance Tesla Model 3 Performance
Minimal price (gross) [PLN]  Engine power [KM]  Maximum torque [Nm] \
39      195490      285      450
40      235490      372      510
41      260490      480      639
Type of brakes Drive type Battery capacity [kWh]_x \
39 disc (front + rear) 2WD (rear)      54.0
40 disc (front + rear) 2WD      75.0
41 disc (front + rear) 4WD      75.0
Range (WLTP) [km] ... Number of doors Tire size [in] \
39      430 ...      5      18
40      430 ...      5      18
41      567 ...      5      20
Maximum speed [km/h] Boot capacity [VDA] [l] Acceleration 0-100 km/h [s] \
39      225      425.0      5.6
40      233      425.0      4.4
41      261      425.0      3.3
Maximum DC charging power [kW] mean - Energy consumption [kWh/100 km] \
39      150      15.4
40      150      15.9
41      150      18.0
avg_bat_cap Battery capacity [kWh]_y Battery capacity [kWh]
39      100.0      68.0      68.0
40      100.0      68.0      68.0
41      100.0      68.0      68.0

[3 rows x 28 columns]
Manufacturer: Volkswagen
Car full name      Make      Model \
47 Volkswagen ID.3 Pro Performance Volkswagen ID.3 Pro Performance
48 Volkswagen ID.3 Pro S Volkswagen ID.3 Pro S
49 Volkswagen ID.4 1st Volkswagen ID.4 1st
Minimal price (gross) [PLN]  Engine power [KM]  Maximum torque [Nm] \
47      155890      204      310
48      179990      204      310
49      202390      204      310
Type of brakes Drive type Battery capacity [kWh]_x \
47 disc (front) + drum (rear) 2WD (rear)      58.0
48 disc (front) + drum (rear) 2WD (rear)      77.0
49 disc (front) + drum (rear) 2WD (rear)      77.0
Range (WLTP) [km] ... Number of doors Tire size [in] \
47      425 ...      5      18
48      549 ...      5      19
49      509 ...      5      20
Maximum speed [km/h] Boot capacity [VDA] [l] Acceleration 0-100 km/h [s] \
47      160      385.0      7.3
48      160      385.0      7.9
49      160      543.0      8.5
Maximum DC charging power [kW] mean - Energy consumption [kWh/100 km] \
47      100      15.4
48      125      15.9
49      125      18.0
avg_bat_cap Battery capacity [kWh]_y Battery capacity [kWh]
47      NaN      70.666667      70.666667
48      NaN      70.666667      70.666667
49      NaN      70.666667      70.666667

[3 rows x 28 columns]
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c) Calculate the average battery capacity for each manufacturer.

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In [168]: average_battery_capacity = custo_pref.groupby('Make')['Battery capacity [kWh]'].mean()
average_battery_capacity
```

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Out[168]:
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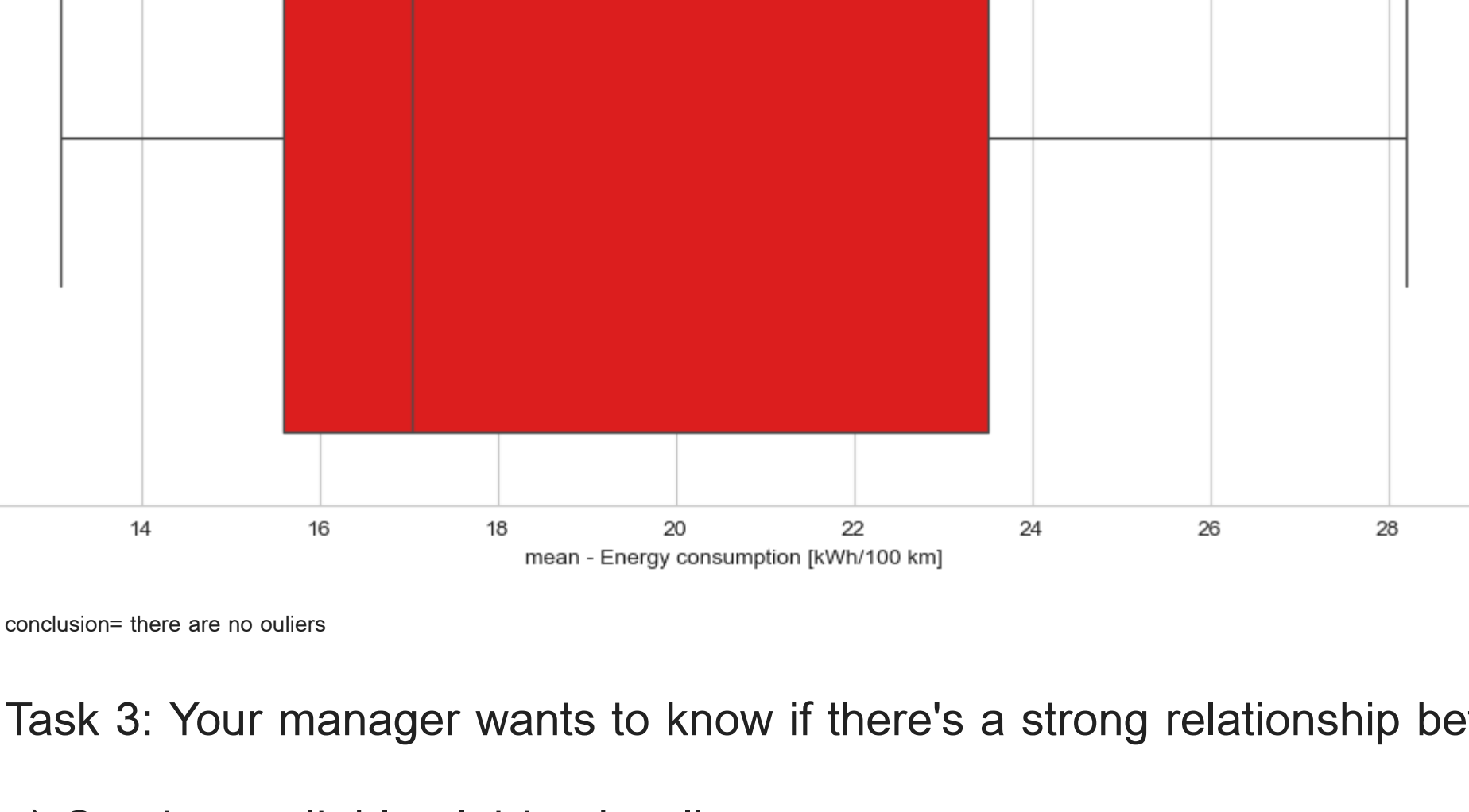
Make	average_battery_capacity
Audi	95.000000
BMW	80.000000
Hyundai	64.000000
Kia	64.000000
Mercedes-Benz	80.000000
Tesla	68.000000
Volkswagen	70.666667

Name: Battery capacity [kWh], dtype: float64

Task 2: You suspect some EVs have unusually high or low energy consumption.

"Find the outliers in the mean - Energy consumption [kWh/100 km] column."

```
In [19]: plt.figure(figsize=(12, 6))
sns.set_style("whitegrid")
sns.set_palette("muted")
sns.boxplot(x='mean - Energy consumption [kWh/100 km]', data=fev_df, showfliers=True, color='red')
plt.title("Box Plot of mean - Energy consumption [kWh/100 km] with Outliers")
plt.show()
```



conclusion: there are no outliers

Task 3: Your manager wants to know if there's a strong relationship between battery capacity and range.

a) Create a suitable plot to visualize.

```
In [131]: >=fev_df[["Battery capacity [kWh]", "Range (WLTP) [km]", "Minimal price (gross) [PLN]", "Engine power [KM]", "Maximum torque [Nm]"]].corr()
sns.heatmap(x=sns.cmap("coolwarm"))
plt.show()
```

