final_project

March 5, 2025

[5]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as stats
```

[6]:

```
'''Comment- Import the file provided using pd.read_csv and assogning it to␣
 ↪variable - final_project'''

final_project = pd.read_csv("FEV-data-Excel.xlsx - Auta elektryczne.csv")
```

[179]:

```
# deleting the columns that are not needed for the analysis thereby making the␣
 ↪data more readable.
'''Comment- after importing the file, removed the columns that are not␣
 ↪necessary by commenting them out
            for futher analysis and made a copy of the original data using .
 ↪copy()'''

final_project = final_project[
        ['Car full name', 'Make', 'Model', 'Minimal price (gross) [PLN]',
         'Engine power [KM]','Drive type',
         'Battery capacity [kWh]', 'Range (WLTP) [km]',
         'Maximum speed [kph]','mean - Energy consumption [kWh/100 km]']].copy()
         # 'Maximum torque [Nm]', 'Type of brakes',
         # 'Wheelbase [cm]', 'Length [cm]', 'Width [cm]', 'Height [cm]',
         # 'Minimal empty weight [kg]', 'Permissable gross weight [kg]',
         # 'Maximum load capacity [kg]', 'Number of seats', 'Number of doors',
         # 'Tire size [in]',
         # 'Boot capacity (VDA) [l]',
         # 'Acceleration 0-100 kph [s]', 'Maximum DC charging power [kW]',
```

[181]:

```
# checking the columns for any emply/blank columns
'''Comment- With the help of .isna() we check for any null or NaN values in the␣
 ↪dataset.
            We then combine .isna() wiht .mean() or .sum() to know the total␣
 ↪number of
```

```
          null or NaN values'''

final_project.isna().mean()*100
```

[181]:

```
Car full name                            0.0
Make                                     0.0
Model                                    0.0
Minimal price (gross) [PLN]              0.0
Engine power [KM]                        0.0
Drive type                               0.0
Battery capacity [kWh]                   0.0
Range (WLTP) [km]                        0.0
Maximum speed [kph]                      0.0
mean - Energy consumption [kWh/100 km]   0.0
dtype: float64
```

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

[183]:

```
# a) SOLUTION:

# filtering evs as per the customer requirement
'''
Comment - Here, we filtered the data as per the customers requirement and then␣
 ↪sorted the
             values for Minimal Price (gross) [PLN] in ascending order using␣
 ↪the .sort_values()
'''

filtered_evs = final_project[(final_project["Minimal price (gross) [PLN]"] <=␣
 ↪350000) &\
                (final_project["Range (WLTP) [km]"] >= 400)]\
                .sort_values(by="Minimal price (gross) [PLN]")

filtered_evs
```

[183]:

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

```
22                  Mercedes-Benz EQC  Mercedes-Benz
0              Audi e-tron 55 quattro           Audi

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

    Engine power [KM]   Drive type  Battery capacity [kWh]  Range (WLTP) [km]  \
47                204   2WD (rear)                    58.0                425
20                204  2WD (front)                    64.0                452
18                204  2WD (front)                    64.0                455
15                204  2WD (front)                    64.0                449
48                204   2WD (rear)                    77.0                549
39                285   2WD (rear)                    54.0                430
49                204   2WD (rear)                    77.0                500
40                372          4WD                    75.0                580
41                480          4WD                    75.0                567
8                 286   2WD (rear)                    80.0                460
22                408          4WD                    80.0                414
0                 360          4WD                    95.0                438

    Maximum speed [kph]  mean - Energy consumption [kWh/100 km]
47                  160                                   15.40
20                  167                                   15.70
18                  167                                   15.90
15                  167                                   15.40
48                  160                                   15.90
39                  225                                   18.99
49                  160                                   18.00
40                  233                                   18.99
41                  261                                   18.99
8                   180                                   18.80
22                  180                                   21.85
0                   200                                   24.45
```

```
[185]: # b) SOLUTION:
```

```
# Grouping the filtered data by Make
'''Comment- In this cell, we grouped the above filtered data using Make,␣
 ↪aggregated with .agg()
            took the average of Minimal price (gross) [PLN] using the :mean and␣
 ↪:median for Range (WLTP) [km]'''

grouped_data = filtered_evs.groupby('Make').agg({
               'Minimal price (gross) [PLN]': 'mean',
               'Range (WLTP) [km]': 'mean'
               }).reset_index()

grouped_data
```

[185]:

```
            Make  Minimal price (gross) [PLN]  Range (WLTP) [km]
0           Audi                345700.000000         438.000000
1            BMW                282900.000000         460.000000
2        Hyundai                178400.000000         449.000000
3            Kia                164490.000000         453.500000
4  Mercedes-Benz                334700.000000         414.000000
5          Tesla                230490.000000         525.666667
6     Volkswagen                179423.333333         491.333333
```

[141]:

```
# calculating the average of battery capacity for every make from the customer␣
 ↪requirement data
'''Comment- Calculating the average for the Battery Capacity from the filtered␣
 ↪data
            annd grouping it by Make and sorting the values of Battery Capacity␣
 ↪in
            descending order'''

avg_capacity = filtered_evs.groupby("Make")\
                ["Battery capacity [kWh]"]\
                .mean().round(2).sort_values(ascending = False)
print(avg_capacity)
```

```
Make
Audi                 95.00
BMW                  80.00
Mercedes-Benz        80.00
Volkswagen           70.67
Tesla                68.00
Hyundai              64.00
Kia                  64.00
Name: Battery capacity [kWh], dtype: float64
```

[199]:

```
# c) SOLUTION:
```

```
'''Comment- Merging the two tables (grouped_data and avg_capacity)  to one␣
 ↪using pd.merge
            and renaming the column to Average Battery Capacity using the .
 ↪rename() function'''

merged_data = pd.merge(grouped_data, avg_capacity, on='Make')
merged_data = merged_data.rename(columns={"Battery capacity [kWh]": "Average␣
 ↪Battery capacity [kWh]"})
merged_data
```

```
[199]:             Make  Minimal price (gross) [PLN]  Range (WLTP) [km]  \
       0            Audi                345700.000000         438.000000
       1             BMW                282900.000000         460.000000
       2         Hyundai                178400.000000         449.000000
       3             Kia                164490.000000         453.500000
       4   Mercedes-Benz                334700.000000         414.000000
       5           Tesla                230490.000000         525.666667
       6      Volkswagen                179423.333333         491.333333

          Average Battery capacity [kWh]
       0                           95.00
       1                           80.00
       2                           64.00
       3                           64.00
       4                           80.00
       5                           68.00
       6                           70.67
```

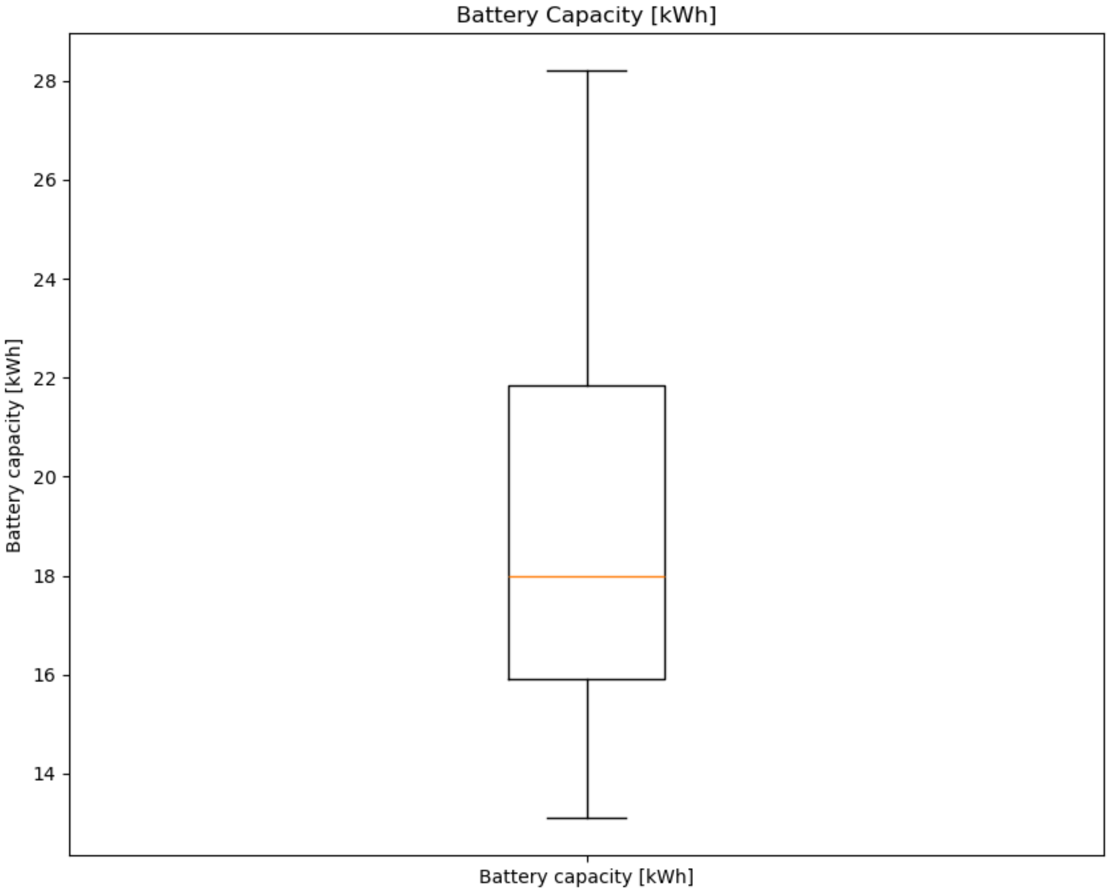
Task 2: You suspect some EVs have unusually high or low energy consumption. Find the outliers in the mean - Energy consumption[kWh/100 k] colum.n

```
[209]: # checking to see if there are any null values remaining in the column
       '''Comment- Filled all the null values in [mean - Energy consumption [kWh/100␣
        ↪km]] column
                   by calculating the average and filled using .fillna()'''

       final_project["mean - Energy consumption [kWh/100 km]"].isna().sum()
```

```
[209]: 0
```

```
[65]: # SOLUTION:

      # plotting a box plot chart to find out the outliers
      '''Comment- To find if there is any outliers for the given column [mean -␣
       ↪Energy consumption [kWh/100 km]]
                  plotted a box plot chart to visualize any outliers. After analyzing␣
       ↪the boxplot, there are no outliers
```

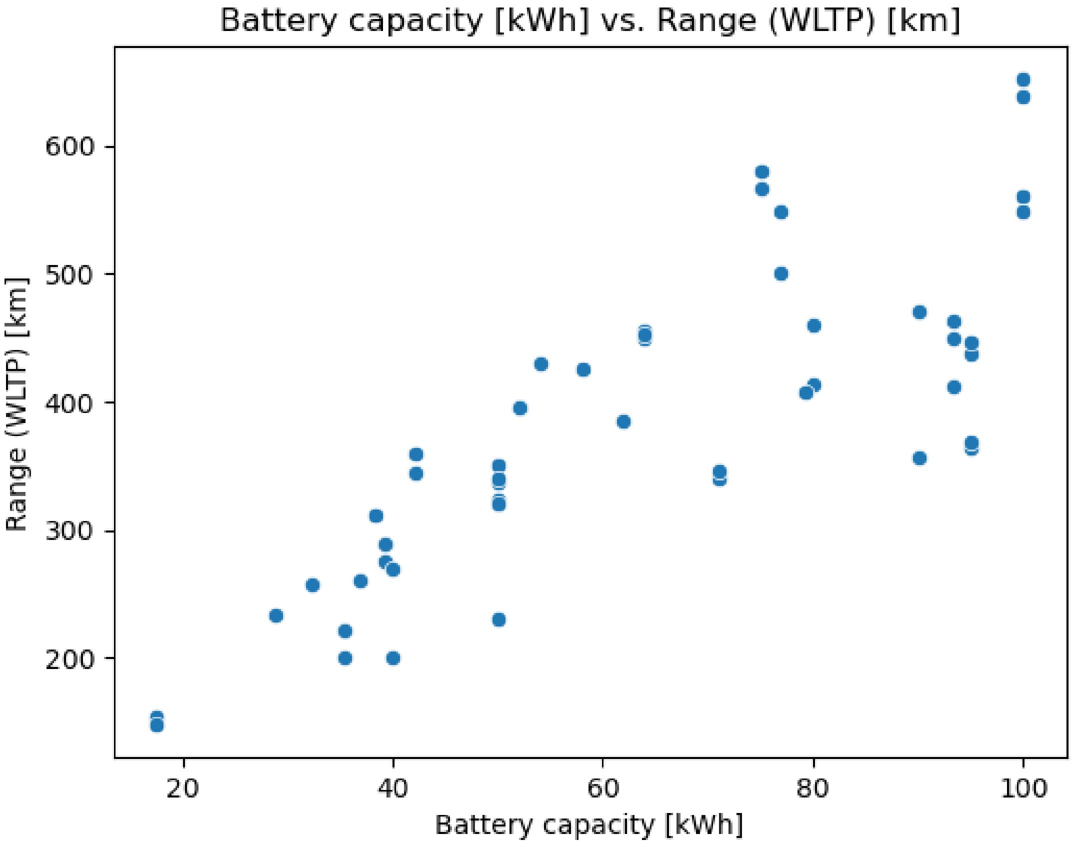
```
            present in the selected data -[mean - Energy consumption [kWh/100␣
↪km]]'''

plt.figure(figsize=(10, 8))
plt.boxplot(final_project['mean - Energy consumption [kWh/100 km]'])
plt.title('Battery Capacity [kWh]')
plt.ylabel('Battery capacity [kWh]')
plt.xticks([1], ['Battery capacity [kWh]'])
plt.show()

# no visible outliers can be seen in the chart
```



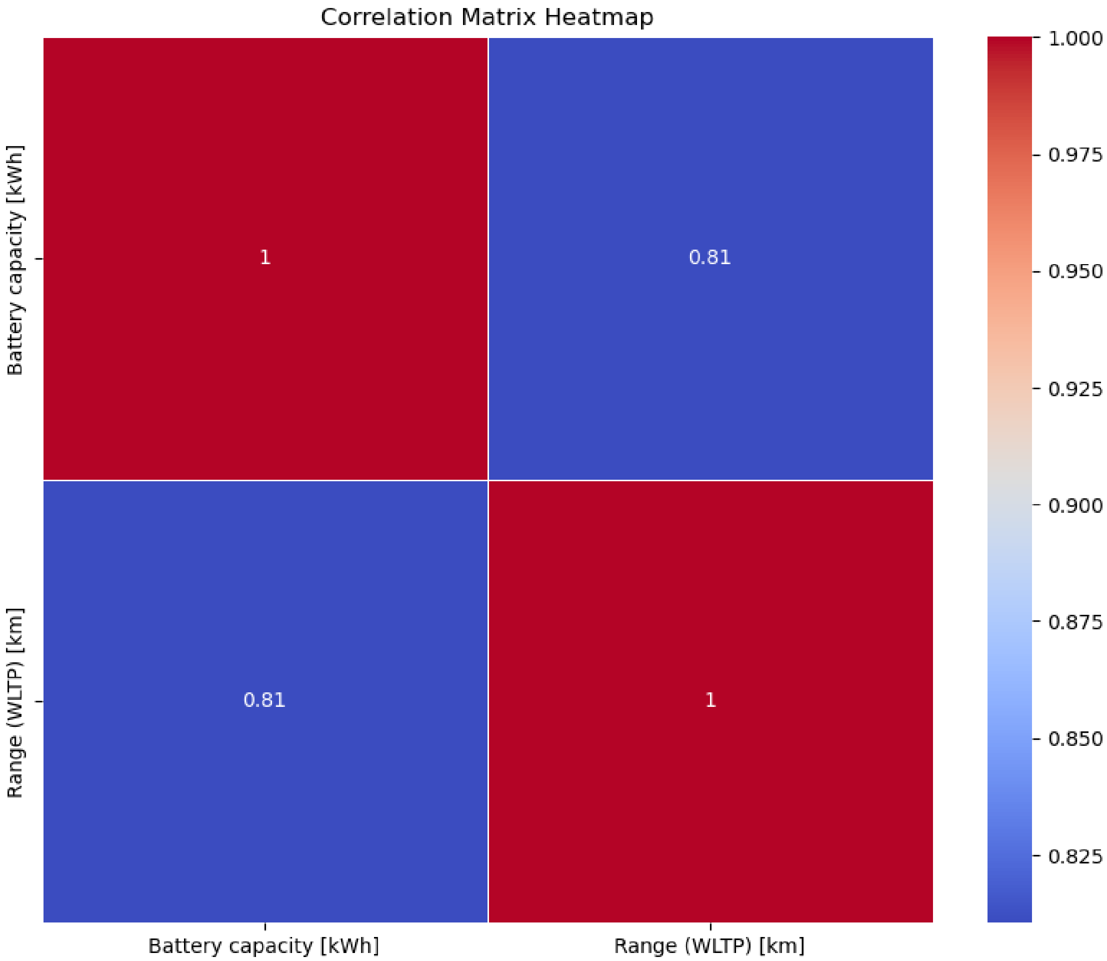
Task 3: Your manager wants to know if there's a strong relationship between battery capacity and range.

[163]:
```
# SOLUTION:

# check to see  if there's any relationship between Battery capacity and Range
# plotting a scatter chart
```

```
'''Comment- To find out any relationship between Battery capacity and Range, we␣
 ↪calculate
            the correlation between the two using .corr() and by plotting␣
 ↪Scatter plot and
            Heatmap. These two charts can help us identify any relationships by␣
 ↪visualizing.

Insights:   After analzying the correlation, scatter plot and heatmap, we␣
 ↪conclude that there
            is a strong positive relation ship between Battery Capacity and␣
 ↪Range. Meaning the higher
            the battery capacity the higher the range of the EV'''

sns.scatterplot(data=final_project, x='Battery capacity [kWh]', y='Range (WLTP)␣
 ↪[km]')
plt.title('Battery capacity [kWh] vs. Range (WLTP) [km]')
plt.show()

# plotting a heatmap chart

columns_correl = final_project[['Battery capacity [kWh]', 'Range (WLTP) [km]']]


correlation_matrix= columns_correl.corr()

print(correlation_matrix)

plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', linewidths=0.5)
plt.title('Correlation Matrix Heatmap')
plt.show()
```



```
                        Battery capacity [kWh]  Range (WLTP) [km]
Battery capacity [kWh]                1.000000           0.810439
Range (WLTP) [km]                     0.810439           1.000000
```



Task 4:Build an EV recommendation class. The class should allow users to input their

budget, desired range, and battery capacity. The class should then return the top three EVs matching their criteria.

[321]:

```
# SOLUTION:

# creating a class to get recommendations from customers input
'''Comment- Creating a Class & function named Car_recommender and␣
 ↪get_recommendations.
            Setting up the creteria under the get_recommendation function as␣
 ↪per the user input
            then lastly calling the function to get user input'''

class Car_recommender:
    def __init__(self, data_file):
        self.df = pd.read_csv("FEV-data-Excel.xlsx - Auta elektryczne.csv")
    def get_recommendations(self, budget, desired_range, battery_capacity):

        filtered_df = self.df[
            (self.df['Minimal price (gross) [PLN]'] <= budget) &
            (self.df['Range (WLTP) [km]'] >= desired_range) &
            (self.df['Battery capacity [kWh]'] >= battery_capacity)
             ]

        sorted_df = filtered_df.sort_values(
            by=['Minimal price (gross) [PLN]', 'Range (WLTP) [km]'],
            ascending=[True, False]
        ).head(3)
        return sorted_df[['Make', 'Car full name', 'Minimal price (gross)␣
 ↪[PLN]',\
                          'Range (WLTP) [km]', 'Battery capacity [kWh]']]


data_file = 'FEV-data-Excel.xlsx - Auta elektryczne.csv'
recommender = Car_recommender(data_file)

# Example user inputs
budget = int(input("Enter your Budget"))
desired_range = int(input("Enter your Desired range"))
battery_capacity = int(input("Enter Battery Capacity"))

# Get the recommendations
recommendations = recommender.get_recommendations(budget, desired_range,␣
 ↪battery_capacity)
recommendations
```

```
Enter your Budget 350000
Enter your Desired range 400
Enter Battery Capacity 70
```

```
[321]:          Make             Car full name  Minimal price (gross) [PLN]  \
       48  Volkswagen     Volkswagen ID.3 Pro S                       179990
       49  Volkswagen       Volkswagen ID.4 1st                       202390
       40       Tesla  Tesla Model 3 Long Range                       235490

           Range (WLTP) [km]  Battery capacity [kWh]
       48                549                    77.0
       49                500                    77.0
       40                580                    75.0
```

Task 5: Inferential Statistics – Hypothesis Testing: Test whether there is a significant difference in the average Engine power[K] of vehicles manufactured by two leading manufacturers i.e. Tesla and Audi. What insights can you draw from the test results ? Recommendations and Conclusion: Provide actionable insights based on your analysi s. (Conduct a two sample t-test using ttest_ind from scipy.stats module)

[151]:

```
# Hypothesis testing for two makes to check for significant differences
'''Comment- In this cell we test the hypothesis to check whether there is a␣
 ↪significant
            difference in the average Engine power [KM] of vehicles␣
 ↪manufactured by two leading
            manufacturers i.e. Tesla and Audi. First filter the Make to Audi␣
 ↪and Tesla and show
            their ngine power [KM], then print the ouput'''
audi_make = final_project[final_project["Make"] == "Audi"]["Engine power [KM]"]
tesla_make = final_project[final_project["Make"] == "Tesla"]["Engine power␣
 ↪[KM]"]

print(f"Audi data:\n{audi_make}")
print(f"Tesla data:\n{tesla_make}")
```

```
Audi data:
0    360
1    313
2    503
3    313
4    360
5    503
Name: Engine power [KM], dtype: int64
Tesla data:
39    285
40    372
41    480
42    525
43    772
44    525
45    772
Name: Engine power [KM], dtype: int64
```

[317]:

```
# Calculating the p-value using the ttest_ind
'''Comment- We now draw conclusion on wether we accpect or reject the null␣
 ↪hypothesis.
            First calculate the p-value using scipy.stats and ttest_ind and set␣
 ↪the significance value
            to 0.05(common significance threshold). Then set up an If condition␣
 ↪that compares the calculated
            p-value to the significance value and gives the output.

Analysis & Insights:
```

```
            Since the p-value(0.106841) is greater than the significance␣
 ↪value(0.05), we do not have
            strong statistical evidence to claim that there is a significant␣
 ↪difference between the
            means of two groups i.e., Average Engine Power [KM] of Audi & Telsa.
 ↪ The Average engine power of the
            vehicles produced by two makes is similar.
            --Therefore we reject the null hypothesis--

'''

t,p_value = stats.ttest_ind(a=audi_make , b= tesla_make, equal_var = False)

print("\t**Two sample t-test using 'ttest_ind from scipy.stats'**")
print("\t\t\tT-stat:", t.round(6))
print(f"\t\t\tP-value: {p_value.round(6)}")

if p_value > 0.05:
    print(" \t\tWe fail to reject the Ho(Null) hypotheses.")
else:
    print("\t\tWe are accepting the null hypothesis")
```

```
        **Two sample t-test using 'ttest_ind from scipy.stats'**
                        T-stat: -1.793995
                        P-value: 0.106841
                We fail to reject the Ho(Null) hypotheses.
```

[ ]:

```
''' Video Explanation link
    https://drive.google.com/file/d/1F_99P9XwFW4CAp4EDz5MrdUwFcRtkirf/view?
 ↪usp=sharing '''
```