```
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error
from sklearn.metrics import f1_score
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd
import numpy as np



# Data Load

# load the given data from the url below
energy_data = 'https://raw.githubusercontent.com/timkim0713/electricity-usage-pr
weather_data = 'https://raw.githubusercontent.com/timkim0713/electricity-usage-p
```

PART I: A. ENERGY DATA PROCESSING

- Drop unnecessary data & change the time inteverval to "per day" and add up 48 sub-divided "use [kW]"" data into one day.
- use only 'date & time' & 'use [kW]' columns from energy data.

- Observed Missing Data Found by counting the number of data given per day
- Missing Data Observed at --> **2014-03-09 02:00:00 & 2014-03-09 02:30:00**
- Filled Above '[use kW]' Missing Data for above with linear interpolation

---

- Observed Duplicate Data of Time/Date Label at **2014-11-02 01:00:00, 01:30:00**
- Dropped 2 data at 2014-11-02 01:00:00, 2014-11-02 01:30:00

```
# ENERGY DATA PROCESSING
# Drop unnecessary data & change the time inteverval to "per day" and add up 48

# Read data
df_e = pd.read_csv(energy_data)

# use only 'date & time' & 'use [kW]' columns from energy data.
df_e_filtered =df_e[['Date & Time','use [kW]']]

#Observed Missing Data Found by counting the number of data given per day
#Missing Data --> 2014-03-09 02:00:00, 2014-03-09 02:30:00
#print(df_e_filtered[3218:3221])
```

```
#print(df_e_filtered[3220:3222])

# Add Missing Data
df_e_filtered.loc[3219.5] = '2014-03-09 02:00:00', None
df_e_filtered.loc[3219.6] = '2014-03-09 02:30:00', None
# Sort Index from 0
df_e_filtered = df_e_filtered.sort_index().reset_index(drop=True)
# Used Linear Interpolation to Fill Missing Data we set above (2014-03-09 02:00:
df_e_filtered['use [kW]'].interpolate(method = 'linear', inplace = True)
print("Added Missing Data Value at 2014-03-09 02:00:00, 2014-03-09 02:30:00 usin

# check below
print(df_e_filtered[3220:3222], '\n')


# Rename Date & Time column to date
df_e_filtered['date']=df_e_filtered['Date & Time']


#Observed 2014-11-02 01:00:00, 01:30:00  DUPLICATE DATA!
print("Observed Duplicate Data of Time/Date Label at 2014-11-02 01:00:00, 01:30:

print("Data Size BEFORE duplicate: ",df_e_filtered['date'].size)
df_e_filtered = df_e_filtered.drop_duplicates(subset=['date'])
print("Data Size AFTER duplicate: ",df_e_filtered['date'].size)
print("Dropped 2 data at 2014-11-02 01:00:00, 2014-11-02 01:30:00\n")

# reset index from 0 for dropped indicies
df_e_filtered.reset_index(drop=True, inplace=True)


df_e_filtered['date'] = pd.to_datetime(df_e_filtered['Date & Time'],  format='%Y
# # 48 is the number we use to calculate "per day" from given time interval,
# #thus data results in size of 365 after dividing up the data by 48.
d = {'date': 'first', 'use [kW]': 'sum'}
df_e_processed = df_e_filtered.groupby(df_e_filtered.index // 48).agg(d)

df_e_processed.head()
```

```
Added Missing Data Value at 2014-03-09 02:00:00, 2014-03-09 02:30:00 using Linea
              Date & Time  use [kW]
3220  2014-03-09 02:00:00  0.263443
3221  2014-03-09 02:30:00  0.227414

Observed Duplicate Data of Time/Date Label at 2014-11-02 01:00:00, 01:30:00
Data Size BEFORE duplicate:  17522
Data Size AFTER duplicate:  17520
Dropped 2 data at 2014-11-02 01:00:00, 2014-11-02 01:30:00

/usr/local/lib/python3.7/dist-packages/pandas/core/indexing.py:723: SettingWithC
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stab
```

PART I: B. WEATHER DATA PROCESSING

- Changed time format to match energy data's date/time & changed with unit 's'
- Checked for null data in weather & **Observed 1470 null data in cloudCover **
- Handled above with linear interpolation to fill up the data

---

- Mapped the time interval into one day, using average for all the numerical data, mode for string values.
- The interval is divided into 24 to change into one day interval.

```
# WEATHER DATA PROCESSING
df_w = pd.read_csv(weather_data)
# format given time to match energy date/time & change unit
df_w['date'] = pd.to_datetime(df_w['time'],unit='s')

# check for null data in weather, observe 1470 null in cloudCover
print(df_w.isnull().sum())
print("Observed 1470 null cloudCover data rows.\n------------------------------
print("Handling the null data with linear interpolation")
# Using linear regression interpolation to fill the empty data.
df_w['cloudCover'].interpolate(method = 'linear', inplace = True)
print(df_w.isnull().sum())
print("Done.")

# Mapping of average of "per day" interval with average for the all the numerica
# & time is set into day interval (chosen with first index every 24 data).
d = {'date': 'first', 'temperature':'mean', 'icon':lambda x:x.value_counts().ind
     'summary':lambda x:x.value_counts().index[0], 'pressure':'mean', 'windSpeed
     'precipProbability':'mean'}


df_w_processed = df_w.groupby(df_w.index // 24).agg(d)
```

```
df_w_processed.head()
```

```
temperature             0
icon                    0
humidity                0
visibility              0
summary                 0
pressure                0
windSpeed               0
cloudCover           1470
time                    0
windBearing             0
precipIntensity         0
dewPoint                0
precipProbability       0
date                    0
dtype: int64
Observed 1470 null cloudCover data rows.
------------------------------------------------
Handling the null data with linear interpolation
temperature          0
icon                 0
humidity             0
visibility           0
summary              0
pressure             0
windSpeed            0
cloudCover           0
time                 0
windBearing          0
precipIntensity      0
dewPoint             0
precipProbability    0
date                 0
dtype: int64
Done.
```

	date	temperature	icon	humidity	visibility	summary	pressure	windSpeed
0	2014-01-01	20.110833	clear-night	0.556667	9.970000	Clear	1025.395000	6.820417
1	2014-01-02	16.382500	snow	0.784583	3.834583	Light Snow	1023.465833	7.433750
2	2014-01-03	6.256667	snow	0.680833	4.509167	Light Snow	1014.428750	12.828333
	2014-		clear-					

PART I: C. Merge Energy Data into Weather Data

- Checked the shape of merged data: 365x14

```
# Merge Energy Data into Weather Data

# Merge Energy into Weather
df = df_w_processed.merge(df_e_processed)
# df = pd.concat([df_w_processed, df_e_processed] )

# reorder columns
columns_titles = ['date', 'use [kW]', 'temperature', 'icon', 'summary', 'visibil
merged_df = df.reindex(columns=columns_titles)
print("Size of Data: ",merged_df.shape)
merged_df.head()
```

```
Size of Data:  (365, 14)
```

	date	use [kW]	temperature	icon	summary	visibility	humidity	pressure	w
0	2014-01-01	65.013592	20.110833	clear-night	Clear	9.970000	0.556667	1025.395000	
1	2014-01-02	32.305336	16.382500	snow	Light Snow	3.834583	0.784583	1023.465833	
2	2014-01-03	31.164468	6.256667	snow	Light Snow	4.509167	0.680833	1014.428750	

PART II: Training/Test Dataset

Goal is on predicting each day of December, so Jan - Nov data are split into training/test dataset with 8:2 ratio.

- Jan - Nov Training/Test Score: 0.2666596060081261
- Model Score on December: -0.5972748944608137
- Root Mean Squared Error on December Evaluation: 8.968926005862448
- Exported CSV with 2 columns: date, predicted use [kW]

```
# Goal is on predicting each day of December, so split Jan - Nov data are split
# 0 - 333 is Jan - Nov, otherwise December
X = merged_df.drop("icon",axis=1)
X = X.drop("summary", axis=1)
X = X.drop("date",axis=1)
X = X.drop("use [kW]",axis=1)

X= X[:334]
y = merged_df['use [kW]'][:334]
```

```
december_original_df = merged_df[334:]

december_df = merged_df[334:]
december_df = december_df.drop('icon', axis=1)
december_df = december_df.drop("summary", axis=1)
december_df = december_df.drop("date",axis=1)
december_df = december_df.drop("use [kW]",axis=1)

# # Splitting the data into training and testing data
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, randc

# drop use [kW] column in test dataset
# test = test.drop('use [kW]', 1)
```

PART III: Linear Regression - Predicting Energy Usage

How well/badly does the model work? (Evaluate the correctness of your predictions based on the original “use [kW]” column). Calculate the Root mean squared error of your model.

```
model = LinearRegression().fit(X_train, y_train)
print("Jan - Nov Training/Test Score: ", model.score(X_train, y_train))

december_predicted_use_kw = model.predict(december_df)
print("Model Score on December: ",model.score(december_df, december_original_df[
#
print("Root Mean Squared Error on December Evaluation: ", mean_squared_error(dec


# Exporting CSV Data Date, use [kW]
data = {'date': december_original_df['date'].dt.strftime('%Y-%m-%d'),
        'predicted use [kW]': december_predicted_use_kw,
        # 'actual use [kW]': december_original_df['use [kW]'].to_numpy()
        }
csv_df = pd.DataFrame(data, columns= ['date', 'predicted use [kW]'])#'actual use
# print(csv_df)
csv_df.to_csv(r'./cse351_hw2_kim_daekyung_110887867_linear_regression.csv',index
print("Exported CSV with 2 columns: date, predicted use [kW]")
```

```
Jan - Nov Training/Test Score:  0.2666596060081261
Model Score on December:  -0.5972748944608137
Root Mean Squared Error on December Evaluation:  8.968926005862448
Exported CSV with 2 columns: date, predicted use [kW]
```

PART IV. Logistic Regression - Temperature classification

- Divided up Jan-Nov / Dec
- Ran Logistic Regression on temperature data (1: >=35, 0:< 35)
- Score below in the output

- Jan - Nov Training/Test Score for temperature: 0.9700374531835206
- Model Score on December Temperature: 0.6129032258064516
- F1 Score of December Temperature Prediction: 0.6666666666666667

```
# temp >= 35 high, <35 is low

# december_original_df.drop('temperature', axis=1)
# clf = LogisticRegression(random_state=0).fit()
THRESHOLD = 35

temperature_df =merged_df.drop('icon',axis=1).drop('summary',axis=1).drop('date'
temperature_december_df = temperature_df[334:]
temperature_df = temperature_df[:334]
temperature_df['temperature'] = (temperature_df['temperature'] >= THRESHOLD).ast


temperature_only_df = temperature_df['temperature'][:334]
temperature_df = temperature_df.drop('temperature',axis=1)[:334]
X= temperature_df
y =temperature_only_df
# # Splitting the data into training and testing data
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, randc

temperature_model = LogisticRegression().fit(X_train, y_train)
print("Jan - Nov Training/Test Score for temperature: ", temperature_model.score


# December Temperature Data for Prediction
december_temperature_df = merged_df.drop('icon',axis=1).drop('summary',axis=1)[3
december_temperature_with_date_df = december_temperature_df
december_temperature_df = december_temperature_with_date_df.drop('date',axis=1)
december_temperature_original_df = (december_temperature_df['temperature']>= THR
december_temperature_df = december_temperature_df.drop('temperature',axis=1)

december_predicted_temperature = temperature_model.predict(december_temperature_

print("Model Score on December Temperature: ",temperature_model.score(december_t
print("F1 Score of December Temperature Prediction: ", f1_score(december_tempera
```

```
Jan - Nov Training/Test Score for temperature:  0.9700374531835206
```

```
Model Score on December Temperature:  0.6129032258064516
F1 Score of December Temperature Prediction:  0.6666666666666667
/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:818: Co
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regressio
  extra_warning_msg=_LOGISTIC_SOLVER_CONVERGENCE_MSG,
```

```
# CSV Export
data = {'date': december_temperature_with_date_df['date'].dt.strftime('%Y-%m-%d'
        'predicted classification': december_predicted_temperature
        #'actual classification': december_temperature_original_df
        }
csv_df = pd.DataFrame(data, columns= ['date', 'predicted classification'])#'actu
# print(csv_df)
csv_df.to_csv(r'./cse351_hw2_kim_daekyung_110887867_logistic_regression.csv',ind
print("Exported CSV with 2 columns: date, predicted classification")
```

```
Exported CSV with 2 columns: date, predicted classification
```

PART V: Energy Usage Data Analysis (Data Processing)

```
df_e = pd.read_csv(energy_data)

# Add Missing Data
df_e.loc[3219.5] = '2014-03-09 02:00:00', None ,None ,None ,None ,None ,None ,No
df_e.loc[3219.6] = '2014-03-09 02:30:00', None ,None ,None ,None ,None ,None ,No
# Sort Index from 0
df_e = df_e.sort_index().reset_index(drop=True)
# Used Linear Interpolation to Fill Missing Data we set above (2014-03-09 02:00:
df_e.interpolate(method = 'linear', inplace = True)
print("Added Missing Data Value at 2014-03-09 02:00:00, 2014-03-09 02:30:00 usin

#Observed 2014-11-02 01:00:00, 01:30:00  DUPLICATE DATA!
print("Observed Duplicate Data of Time/Date Label at 2014-11-02 01:00:00, 01:30:
df_e = df_e.drop_duplicates(subset=['Date & Time'])
print("Handled Data Processing mentioned above.")
```

```
Added Missing Data Value at 2014-03-09 02:00:00, 2014-03-09 02:30:00 using Linea
Observed Duplicate Data of Time/Date Label at 2014-11-02 01:00:00, 01:30:00
Handled Data Processing mentioned above.
```

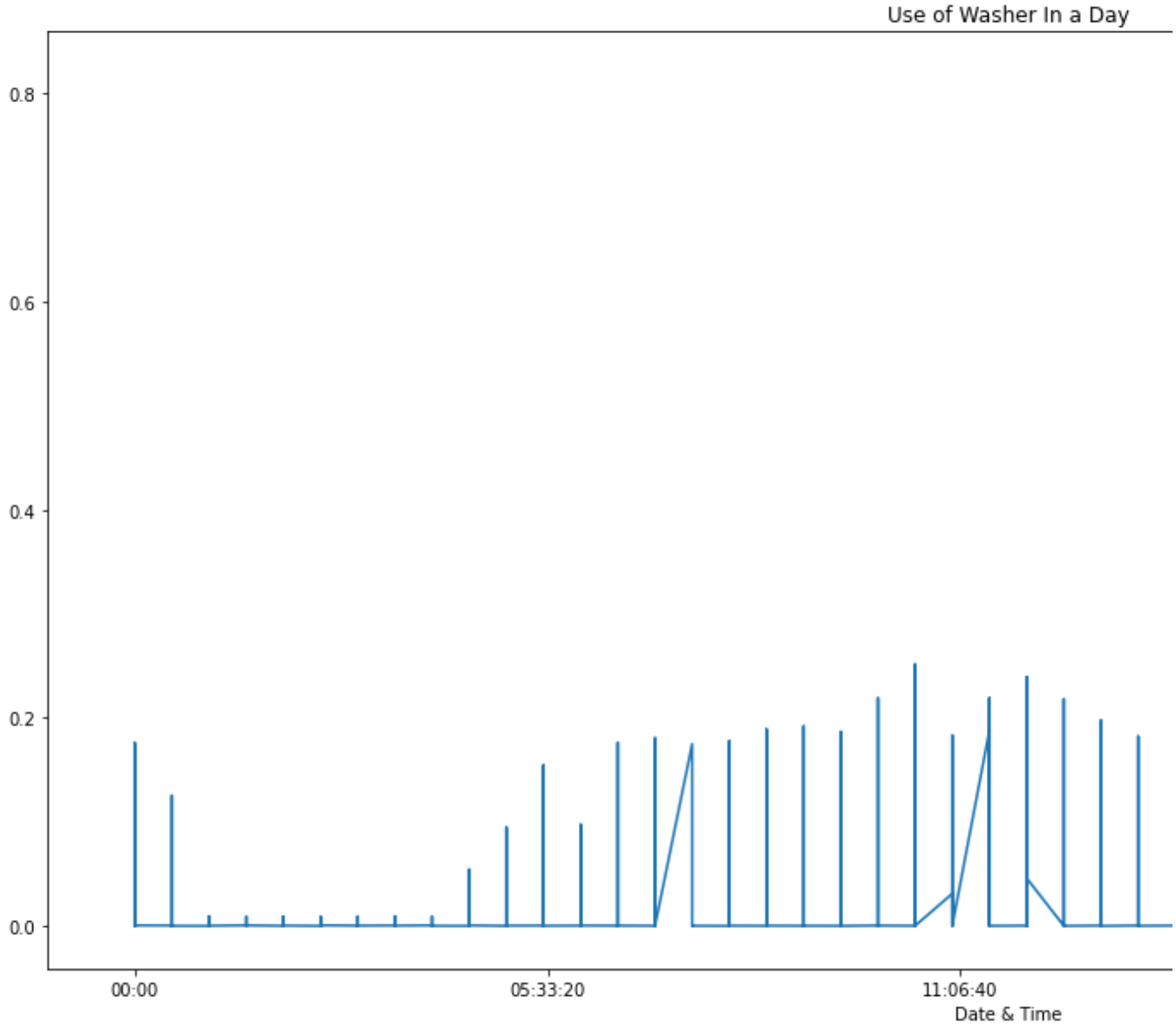
PART V. A: Is the washer being used only during the day?

- Graph indicates that the washer is more used in the daytime than nighttime. (Peaking at 14:00-16:00). And we can see that there is little use midnight to the morning, and moderate

```
df_e_washer = df_e[['Washer [kW]', 'Date & Time']]
df_e_washer['Date & Time'] =  pd.to_datetime(df_e_washer['Date & Time']).dt.time
df_e_washer.set_index('Date & Time').plot(figsize=(20, 10), title="Use of Washer
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3: SettingWithCopyW
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
  This is separate from the ipykernel package so we can avoid doing imports until
<matplotlib.axes._subplots.AxesSubplot at 0x7f8f277fb050>
```



PART V. B: During which month is the AC used most?

- Graph indicates below that the summmer season, (June - Oct), the AC was most used. We can observe no usage of AC in the winter season (Nov - Feb).

```
df_e_ac = df_e[['AC [kW]', 'Date & Time']]
df_e_ac['Date & Time'] =  pd.to_datetime(df_e_ac['Date & Time']).dt.month
df_e_ac.set_index('Date & Time').plot(figsize=(20, 10), title="Use of AC In a Ye
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3: SettingWithCopyW
A value is trying to be set on a copy of a slice from a DataFrame.
```

Part V. C: Use of Dining Room (R) [kW] In a Day

- We can conclude that use of Dining Room in a day is high at lunch around (11:00 - 1:00) time & at dinner time around (17:00 - 19:00). This can be observed by comparing the visualized data to the other times in a day below. We can also observe no use of dining room at late midnight (1:00 AM) to early morning (4:00 AM).

```
df_e_ac = df_e[['Dining room (R) [kW]', 'Date & Time']]
df_e_ac['Date & Time'] =  pd.to_datetime(df_e_ac['Date & Time']).dt.time
df_e_ac.set_index('Date & Time').plot(figsize=(20, 10), title="Use of Dining Roo
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: SettingWithCopyW
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stab
```

Part V. D: Use of Garage Outlets [kW] In a Day

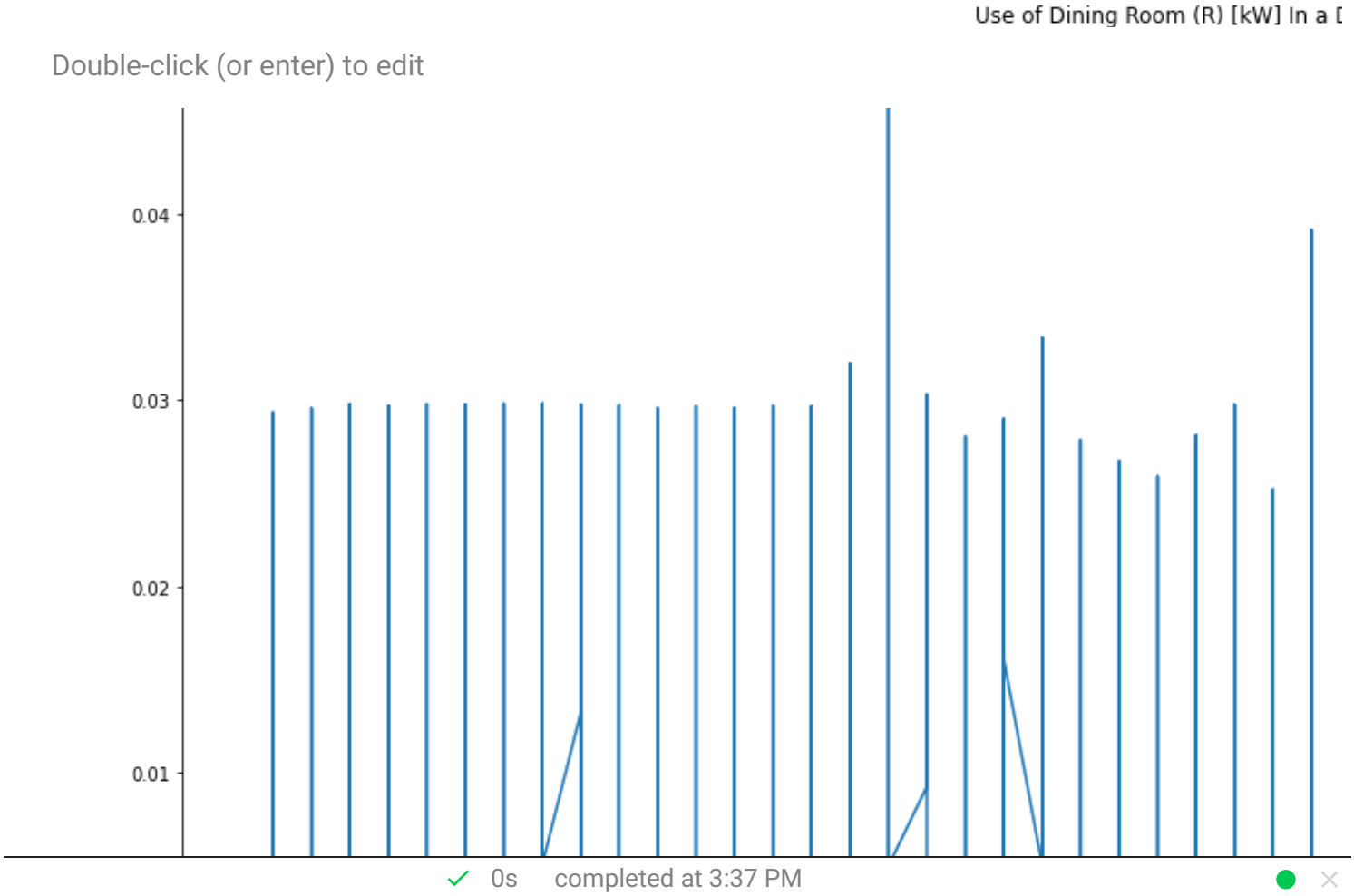
- We can conclude that Use of Garage Outlets in a day is high at times in the morning (8:00 - 9:00) and afternoon (16:00 - 18:00) when most people leave their houses and return from work. This can be observed compared to the other times in a day in the graph below.

```
df_e_go = df_e[['Garage outlets [kW]', 'Date & Time']]
df_e_go['Date & Time'] =  pd.to_datetime(df_e_go['Date & Time']).dt.time
df_e_go.set_index('Date & Time').plot(figsize=(20, 10), title="Use of Dining Roo
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: SettingWithCopyW
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stab

<matplotlib.axes._subplots.AxesSubplot at 0x7f8f38730a10>
```



Double-click (or enter) to edit

✓ 0s completed at 3:37 PM