Regression on Household Power Consumption Dataset

Life Cycle of machine learning Project

1 Underwent the problem statement 2 Data collection 3 Data cleaning 4 EDA 5 Preprocessing 6 K-Look Training 7 Cross Validation

Measures taken to improve model accuracy are included

1. Problem Statement

2. Data Collection

a. Importing required packages

```
# Import numpy for array computations, numerical and meaningful indexes
import numpy as np
import numpy as np, np
# Import pandas for data manipulation
import pandas as pd
import pandas as pd, pd
# Import matplotlib for plots
import matplotlib
import matplotlib, mpl
# Import seaborn for more plots
import seaborn as sns
import seaborn, sns
# Import matplotlib.pyplot for plots
import matplotlib.pyplot as plt
import matplotlib.pyplot, plt
# Import numpy.linalg for linear algebra
import numpy.linalg as LA
import numpy.linalg, LA
# Import Counter for counting
from collections import Counter
from collections import Counter, Counter
# Set the width and the height of the plotted
rcParams['figure.figure_size'] = 15, 6
rcParams['figure.figure_size'], 15, 6
# Ignore warnings
import warnings
import warnings, warnings
```

b. reading the dataset

```
household_power_consumption = pd.read_csv("household_power_consumption.txt", sep=";")
```

```
data.head()
```

	Date	Time	Global_active_power	Global_reactive_power	Voltage	Global_intensity	Sub_metering_1	Sub_metering_2	Sub_metering_3
0	16/12/2006	17:24:00	4.216	0.418	234.84	18.400	0.000	1.000	17.000
1	16/12/2006	17:25:00	5.374	0.498	233.29	23.000	0.000	1.000	16.000
2	16/12/2006	17:26:00	5.268	0.492	233.74	23.000	0.000	2.000	17.000
3	16/12/2006	17:27:00	4.054	0.290	235.68	15.800	0.000	1.000	17.000
4	16/12/2006	17:28:00	3.384	0.290	236.39	15.000	0.000	2.000	17.000

3. Data Profiling and Data cleaning

```
data.shape
```

```
(2075259, 9)
```

```
data.isnull().sum(axis=0).sort_values(ascending=False)
```

```
Sub_metering_3         25979
Sub_metering_2         25979
Sub_metering_1         25979
Global_reactive_power  25979
Global_intensity       25979
Voltage                25979
Global_active_power    25979
Time                   25979
Date                   25979
dtype: int64
```

```
data.info()
```

```
<class pandas.core.frame.DataFrame>
RangeIndex: 2075259 entries, 0 to 2075258
Data columns (total 9 columns):
 #   Column                 Dtype  
---  ------                 -----  
 0   Date                   object 
 1   Time                   object 
 2   Global_active_power    float64
 3   Global_reactive_power  float64
 4   Voltage                float64
 5   Global_intensity       float64
 6   Sub_metering_1         float64
 7   Sub_metering_2         float64
 8   Sub_metering_3         float64
dtype: float64
```

```
data.info(),
```

```
<class pandas.core.frame.DataFrame>
RangeIndex: 2075259 entries, 0 to 2075258
Data columns (total 9 columns):
 #   Column                 Dtype  
---  ------                 -----  
 0   Date                   object 
 1   Time                   object 
 2   Global_active_power    float64
 3   Global_reactive_power  float64
 4   Voltage                float64
 5   Global_intensity       float64
 6   Sub_metering_1         float64
 7   Sub_metering_2         float64
 8   Sub_metering_3         float64
dtype: float64,
```

a. separating the date into date month year

```
data['Date'] = pd.to_datetime(data['Date'])
data['year'] = pd.DatetimeIndex(data['Date'])
data['month'] = pd.DatetimeIndex(data['Date'])
data['day'] = pd.DatetimeIndex(data['Date'])
```

```
data.head(1)
```

	Date	Time	Global_active_power	Global_reactive_power	Voltage	Global_intensity	Sub_metering_1	Sub_metering_2	Sub_metering_3	year	month	day
0	2006-12-16	17:24:00	4.216	0.418	234.84	18.400	0.000	1.000	17.000	2006	12	16

```
data.dtypes,
```

```
Date                   object
Time                   object
Global_active_power    float64
Global_reactive_power  float64
Voltage                float64
Global_intensity       float64
Sub_metering_1         float64
Sub_metering_2         float64
Sub_metering_3         float64
year                   int64
month                  int64
day                    int64
dtype: object,
```

b. check null values

```
# dataset.isnull() dataset.notnull() dataset.shape dataset.to_numpy()
```

```
Date                   0
Time                   0
Global_active_power    0
Global_reactive_power  0
Voltage                0
Global_intensity       0
Sub_metering_1         0
Sub_metering_2         0
Sub_metering_3         0
year                   0
month                  0
day                    0
dtype: int64
```

c. check all

```
# dataset
```

```
Date                   object
Time                   object
Global_active_power    float64
Global_reactive_power  float64
Voltage                float64
Global_intensity       float64
Sub_metering_1         float64
Sub_metering_2         float64
Sub_metering_3         float64
year                   int64
month                  int64
day                    int64
dtype: object
```

d. check all zero column for uniqueness

```
# dataset.shape(axis=1).value_counts()
```

```
2    2075259
dtype: int64
```

```
# dataset.shape(axis=1).value_counts(ascending=True) dtypes nunique
```

	Date	Time	Global_active_power	Global_reactive_power	Voltage	Global_intensity	Sub_metering_1	Sub_metering_2	Sub_metering_3	year	month	day
dtypes	object	object	float64	float64	float64	float64	float64	float64	float64	int64	int64	int64
nunique	1442	1440	4187	527	2838	222	89	82	32	4	12	31

NOW data = 75 columns

```
# dataset.shape(axis=1).value_counts(ascending=True) dtypes nunique
```

```
2    2075259
dtype: int64
```

```
# dataset.shape(axis=1).value_counts(ascending=False) dtypes nunique
```

```
2    2075259
dtype: int64
```

e. check

```
# dataset
```

```
Date                   object
Time                   object
Global_active_power    float64
Global_reactive_power  float64
Voltage                float64
Global_intensity       float64
Sub_metering_1         float64
Sub_metering_2         float64
Sub_metering_3         float64
year                   int64
month                  int64
day                    int64
dtype: object
```

handle special character in rows

```
# dataset[dataset['Global_active_power'].isin(['?'])].shape
dataset[~dataset.isin(['?'])].shape dropna(axis=0)
# dataset[dataset['Global_active_power'].isin(['?'])].shape
dataset[~dataset.isin(['?'])].shape
# dataset[~dataset.isin(['?'])].shape
dataset.shape
```

```
(2075259, 12)
```

```
# dataset[~dataset.isin(['?'])].shape
```

```
(2075259, 12)
```

```
# dataset[~dataset.isin(['?'])].shape
```

```
(2075259, 12)
```

f. convert datatype into float

```
# dataset.info()
```

```
<class pandas.core.frame.DataFrame>
RangeIndex: 2075259 entries, 0 to 2075258
Data columns (total 12 columns):
 #   Column                 Dtype  
---  ------                 -----  
 0   Date                   object 
 1   Time                   object 
 2   Global_active_power    float64
 3   Global_reactive_power  float64
 4   Voltage                float64
 5   Global_intensity       float64
 6   Sub_metering_1         float64
 7   Sub_metering_2         float64
 8   Sub_metering_3         float64
 9   year                   int64  
 10  month                  int64  
 11  day                    int64  
dtype: float64
```

```
# dataset[~dataset.isin(['?'])].shape dropna(axis=0)
```

```
(2075259, 12)
```

```
# dataset[~dataset.isin(['?'])].shape
```

```
(2075259, 12)
```

```
# dataset[~dataset.isin(['?'])].shape
```

```
(2075259, 12)
```

g. handling null value with mean

```
# dataset.isnull().sum(axis=0).sort_values(ascending=False)
```

```
Sub_metering_3         25979
Sub_metering_2         25979
Sub_metering_1         25979
Global_reactive_power  25979
Global_intensity       25979
Voltage                25979
Global_active_power    25979
Time                   25979
Date                   25979
year                   0
month                  0
day                    0
dtype: int64
```

```
# dataset[~dataset.isin(['?'])].shape dropna(axis=0).sum(axis=0)
```

```
Date                   object
Time                   object
Global_active_power    float64
Global_reactive_power  float64
Voltage                float64
Global_intensity       float64
Sub_metering_1         float64
Sub_metering_2         float64
Sub_metering_3         float64
year                   int64
month                  int64
day                    int64
dtype: object
```

```
# dataset[~dataset.isin(['?'])].shape dropna(axis=0).sum(axis=0).mean()
```

```
(2075259, 12)
```

```
# dataset
```

```
Date                   object
Time                   object
Global_active_power    float64
Global_reactive_power  float64
Voltage                float64
Global_intensity       float64
Sub_metering_1         float64
Sub_metering_2         float64
Sub_metering_3         float64
year                   int64
month                  int64
day                    int64
dtype: object
```

i. removing unnecessary rows and adding target features

```
# dataset
```

	Date	Time	Global_active_power	Global_reactive_power	Voltage	Global_intensity	Sub_metering_1	Sub_metering_2	Sub_metering_3	year	month	day
0	2006-12-16	17:24:00	4.216	0.418	234.84	18.400	0.000	1.000	17.000	2006	12	16
1	2006-12-16	17:25:00	5.374	0.498	233.29	23.000	0.000	1.000	16.000	2006	12	16
2	2006-12-16	17:26:00	5.268	0.492	233.74	23.000	0.000	2.000	17.000	2006	12	16
3	2006-12-16	17:27:00	4.054	0.290	235.68	15.800	0.000	1.000	17.000	2006	12	16
4	2006-12-16	17:28:00	3.384	0.290	236.39	15.000	0.000	2.000	17.000	2006	12	16

```
# dataset[~dataset.isin(['?'])].shape dropna(axis=0).sum(axis=0).mean().mean()
```

```
(2075259, 12)
```

```
# dataset
```

	Date	Time	Global_active_power	Global_reactive_power	Voltage	Global_intensity	Sub_metering_1	Sub_metering_2	Sub_metering_3	year	month	day
0	2006-12-16	17:24:00	4.216	0.418	234.84	18.400	0.000	1.000	17.000	2006	12	16
1	2006-12-16	17:25:00	5.374	0.498	233.29	23.000	0.000	1.000	16.000	2006	12	16
2	2006-12-16	17:26:00	5.268	0.492	233.74	23.000	0.000	2.000	17.000	2006	12	16
3	2006-12-16	17:27:00	4.054	0.290	235.68	15.800	0.000	1.000	17.000	2006	12	16
4	2006-12-16	17:28:00	3.384	0.290	236.39	15.000	0.000	2.000	17.000	2006	12	16

```
# dataset[~dataset.isin(['?'])].shape dropna(axis=0).sum(axis=0).mean().mean().mean()
```

```
(2075259, 12)
```

```
# dataset
```

	Date	Time	Global_active_power	Global_reactive_power	Voltage	Global_intensity	Sub_metering_1	Sub_metering_2	Sub_metering_3	year	month	day
0	2006-12-16	17:24:00	4.216	0.418	234.84	18.400	0.000	1.000	17.000	2006	12	16
1	2006-12-16	17:25:00	5.374	0.498	233.29	23.000	0.000	1.000	16.000	2006	12	16
2	2006-12-16	17:26:00	5.268	0.492	233.74	23.000	0.000	2.000	17.000	2006	12	16
3	2006-12-16	17:27:00	4.054	0.290	235.68	15.800	0.000	1.000	17.000	2006	12	16
4	2006-12-16	17:28:00	3.384	0.290	236.39	15.000	0.000	2.000	17.000	2006	12	16

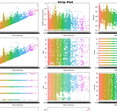
4. Statistical Analysis

4.1 Numerical and categorical features:

```
# dataset.describe(include=['O']).T
# dataset.describe(include=['O']).T dtypes nunique
```

```
Date                   object
Time                   object
dtype: object
```

```
```



4.4 Multivariant Analysis

```
In [108]: df.corr()
```

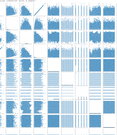
	Hotel_price_per	Hotel_stars_per	Voltage	Hotel_internet_	city	month	year	hour	minute	Total_ticketing_
Hotel_price_per	1.000000	0.249011	-0.007419	-0.008266	-0.010174	-0.000473	-0.010000	-0.000000	-0.000000	-0.000000
Hotel_stars_per	0.249011	1.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000
Voltage	-0.007419	-0.000000	1.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000
Hotel_internet_	-0.008266	-0.000000	-0.000000	1.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000
city	-0.010174	-0.000000	-0.000000	-0.000000	1.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000
month	-0.000473	-0.000000	-0.000000	-0.000000	-0.000000	1.000000	-0.000000	-0.000000	-0.000000	-0.000000
year	-0.010000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	1.000000	-0.000000	-0.000000	-0.000000
hour	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	1.000000	-0.000000	-0.000000
minute	0.007174	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	1.000000	-0.000000
Total_ticketing_	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	1.000000

Pair Plot

```
In [109]: sns.pairplot(df)
Out[109]: <seaborn.axisgrid.PairGrid at 0x1a1a1a1a>
```

Heat Map

```
In [110]: plt.figure(figsize=(20,20))
sns.heatmap(df.corr(),annot=True)
Out[110]: <matplotlib.axes._subplots.AxesSubplot>, <matrix>
```



5. Graph Analysis [Visualization]

Q. HOur for peak power consumption?

```
In [111]: df.groupby('hour').sum()
Out[111]: <DataFrame_hour_>
```

Q month having least power consumption

```
In [112]: df.groupby('month').sum()
Out[112]: <DataFrame_month_>
```

Q year vs consumption trend.

```
In [113]: df.groupby('year').sum()
Out[113]: <DataFrame_year_>
```

Variance Inflation Factor (VIF)

```
In [114]: df.head()
```

	Hotel_price_per	Hotel_stars_per	Voltage	Hotel_internet_	city	month	year	hour	minute	Total_ticketing_
1347718	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1348968	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1349148	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1349151	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1349179	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0

Preprocessing [handling Outliers]

```
In [115]: df.describe()
Out[115]: <DataFrame_Hotel_price_per_Hotel_stars_per_Voltage_Hotel_internet__city_month_year_hour_minute_Total_ticketing_>
```

	Hotel_price_per	Hotel_stars_per	Voltage	Hotel_internet_	city	month	year	hour	minute	Total_ticketing_
count	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
mean	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
std	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
min	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
25%	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
50%	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
75%	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
max	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0

```
In [116]: df.shape
Out[116]: <tuple>
```

```
In [117]: df.dtypes
Out[117]: <series_object_>
```

	Hotel_price_per	Hotel_stars_per	Voltage	Hotel_internet_	city	month	year	hour	minute	Total_ticketing_
1347718	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1348968	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1349148	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1349151	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1349179	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0

```
In [118]: df.dtypes
Out[118]: <series_object_>
```

```
In [119]: df.head()
```

	Hotel_price_per	Hotel_stars_per	Voltage	Hotel_internet_	city	month	year	hour	minute	Total_ticketing_
1347718	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1348968	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1349148	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1349151	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0
1349179	0.00	0.00	240.47	1.0	0	2020	12	0	0	1.0

```
In [120]: pip install Yellowbrick
Collecting Yellowbrick...
  Downloading Yellowbrick-1.3.post1-py2.7-any.whl (271 KB)
     |********************************| 271 KB 1.1MB/s
Requirement already satisfied: 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212.0,!=3.212.1,!=3.212.2,!=3.212.3,!=3.212.4,!=3.213.0,!=3.213.1,!=3.213.2,!=3.213.3,!=3.213.4,!=3.214.0,!=3.214.1,!=3.214.2,!=3.214.3,!=3.214.4,!=3.215.0,!=3.215.1,!=3.215.2,!=3.215.3,!=3.215.4,!=3.216.0,!=3.216.1,!=3.216.2,!=3.216.3,!=3.216.4,!=3.217.0,!=3.217.1,!=3.217.2,!=3.217.3,!=3.217.4,!=3.218.0,!=3.218.1,!=3.218.2,!=3.218.3,!=3.218.4,!=3.219.0,!=3.219.1,!=3.219.2,!=3.219.3,!=3.219.4,!=3.220.0,!=3.220.1,!=3.220.2,!=3.220.3,!=3.220.4,!=3.221.0,!=3.221.1,!=3.221.2,!=3.221.3,!=3.221.4,!=3.222.0,!=3.222.1,!=3.222.2,!=3.222.3,!=3.222.4,!=3.223.0,!=3.223.1,!=3.223.2,!=3.223.3,!=3.223.4,!=3.224.0,!=3.224.1,!=3.224.2,!=3.224.3,!=3.224.4,!=3.225.0,!=3.225.1,!=3.225.2,!=3.225.3,!=3.225.4,!=3.226.0,!=3.226.1,!=3.226.2,!=3.226.3,!=3.226.4,!=3.227.0,!=3.227.1,!=3.227.2,!=3.227.3,!=3.227.4,!=3.228.0,!=3.228.1,!=3.228.2,!=3.228.3,!=3.228.4,!=3.229.0,!=3.229.1,!=3.229.2,!=3.229.3,!=3.229.4,!=3.230.0,!=3.230.1,!=3.230.2,!=3.230.3,!=3.230.4,!=3.231.0,!=3.231.1,!=3.231.2,!=3.231.3,!=3.231.4,!=3.232.0,!=3.232.1,!=3.232.2,!=3.232.3,!=3.232.4,!=3.233.0,!=3.233.1,!=3.233.2,!=3.233.3,!=3.233.4,!=3.234.0,!=3.234.1,!=3.234.2,!=3.234.3,!=3.234.4,!=3.235.0,!=3.235.1,!=3.235.2,!=3.235.3,!=3.235.4,!=3.236.0,!=3.236.1,!=3.236.2,!=3.236.3,!=3.236.4,!=3.237.0,!=3.237.1,!=3.237.2,!=3.237.3,!=3.237.4,!=3.238.0,!=3.238.1,!=3.238.2,!=3.238.3,!=3.238.4,!=3.239.0,!=3.239.1,!=3.239.2,!=3.239.3,!=3.239.4,!=3.240.0,!=3.240.1,!=3.240.2,!=3.240.3,!=3.240.4,!=3.241.0,!=3.241.1,!=3.241.2,!=3.241.3,!=3.241.4,!=3.242.0,!=3.242.1,!=3.242.2,!=3.242.3,!=3.242.4,!=3.243.0,!=3.243.1,!=3.243.2,!=3.243.3,!=3.243.4,!=3.244.0,!=3.244.1,!=3.244.2,!=3.244.3,!=3.244.4,!=3.245.0,!=3.245.1,!=3.245.2,!=3.245.3,!=3.245.4,!=3.246.0,!=3.246.1,!=3.246.2,!=3.246.3,!=3.246.4,!=3.247.0,!=3.247.1,!=3.247.2,!=3.247.3,!=3.247.4,!=3.248.0,!=3.248.1,!=3.248.2,!=3.248.3,!=3.248.4,!=3.249.0,!=3.249.1,!=3.249.2,!=3.249.3,!=3.249.4,!=3.250.0,!=3.250.1,!=3.250.2,!=3.250.3,!=3.250.4,!=3.251.0,!=3.251.1,!=3.251.2,!=3.251.3,!=3.251.4,!=3.252.0,!=3.252.1,!=3.252.2,!=3.252.3,!=3.252.4,!=3.253.0,!=3.253.1,!=3.253.2,!=3.253.3,!=3.253.4,!=3.254.0,!=3.254.1,!=3.254.2,!=3.254.3,!=3.254.4,!=3.255.0,!=3.255.1,!=3.255.2,!=3.255.3,!=3.255.4,!=3.256.0,!=3.256.1,!=3.256.2,!=3.256.3,!=3.256.4,!=3.257.0,!=3.257.1,!=3.257.2,!=3.257.3,!=3.257.4,!=3.258.0,!=3.258.1,!=3.258.2,!=3.258.3,!=3.258.4,!=3.259.0,!=3.259.1,!=3.259.2,!=3.259.3,!=3.259.4,!=3.260.0,!=3.260.1,!=3.260.2,!=3.260.3,!=3.260.4,!=3.261.0,!=3.261.1,!=3.261.2,!=3.261.3,!=3.261.4,!=3.262.0,!=3.262.1,!=3.262.2,!=3.262.3,!=3.262.4,!=3.263.0,!=3.263.1,!=3.263.2,!=3.263.3,!=3.263.4,!=3.264.0,!=3.264.1,!=3.264.2,!=3.264.3,!=3.264.4,!=3.265.0,!=3.265.1,!=3.265.2,!=3.265.3,!=3.265.4,!=3.266.0,!=3.266.1,!=3.266.2,!=3.266.3,!=3.266.4,!=3.267.0,!=3.267.1,!=3.267.2,!=3.267.3,!=3.267.4,!=3.268.0,!=3.268.1,!=3.268.2,!=3.268.3,!=3.268.4,!=3.269.0,!=3.269.1,!=3.269.2,!=3.269.3,!=3.269.4,!=3.270.0,!=3.270.1,!=3.270.2,!=3.270.3,!=3.270.4,!=3.271.0,!=3.271.1,!=3.271.2,!=3.271.3,!=3.271.4,!=3.272.0,!=3.272.1,!=3.272.2,!=3.272.3,!=3.272.4,!=3.273.0,!=3.273.1,!=3.273.2,!=3.273.3,!=3.273.4,!=3.274.0,!=3.274.1,!=3.274.2,!=3.274.3,!=3.274.4,!=3.275.0,!=3.275.1,!=3.275.2,!=3.275.3,!=3.275.4,!=3.276.0,!=3.276.1,!=3.276.2,!=3.276.3,!=3.276.4,!=3.277.0,!=3.277.1,!=3.277.2,!=3.277.3,!=3.277.4,!=3.278.0,!=3.278.1,!=3.278.2,!=3.278.3,!=3.278.4,!=3.279.0,!=3.279.1,!=3.279.2,!=3.279.3,!=3.279.4,!=3.280.0,!=3.280.1,!=3.280.2,!=3.280.3,!=3.280.4,!=3.281.0,!=3.281.1,!=3.281.2,!=3.281.3,!=3.281.4,!=3.282.0,!=3.282.1,!=3.282.2,!=3.282.3,!=3.282.4,!=3.283.0,!=3.283.1,!=3.283.2,!=3.283.3,!=3.283.4,!=3.284.0,!=3.284.1,!=3.284.2,!=3.284.3,!=3.284.4,!=3.285.0,!=3.285.1,!=3.285.2,!=3.285.3,!=3.285.4,!=3.286.0,!=3.286.1,!=3.286.2,!=3.286.3,!=3.286.4,!=3.287.0,!=3.287.1,!=3.287.2,!=3.287.3,!=3.287.4,!=3.288.0,!=3.288.1,!=3.288.2,!=3.288.3,!=3.288.4,!=3.289.0,!=3.289.1,!=3.289.2,!=3.289.3,!=3.289.4,!=3.290.0,!=3.290.1,!=3.290.2,!=3.290.3,!=3.290.4,!=3.291.0,!=3.291.1,!=3.291.2,!=3.291.3,!=3.291.4,!=3.292.0,!=3.292.1,!=3.292.2,!=3.292.3,!=3.292.4,!=3.293.0,!=3.293.1,!=3.293.2,!=3.293.3,!=3.293.4,!=3.294.0,!=3.294.1,!=3.294.2,!=3.294.3,!=3.294.4,!=3.295.0,!=3.
```

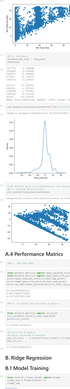
A.2 Prediction1

```
cbg_predictpossum(n_predict=3,n_lag=
                  TRUE,
                  FALSE)
```

```
##  [1] "Predicted 1 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000
```

A.3 Assumption

```
par(mfrow=c(2,2))
plot.ts(cbg$cbg_residuals,main="Plot of cbg residuals")
qqnorm(cbg$cbg_residuals, cex=1.5,pch=19,col="blue")
qqline(cbg$cbg_residuals,col="red",lwd=2)
acf(cbg$cbg_residuals,lwd=2,ylim=c(-1,1))
```




```
cbg$Ljung_Box_test
```

```
##  [1] "Ljung-Box test"
##  [2] "data:  cbg$cbg_residuals"
##  [3] "Q = 1.1e-04, df = 1, p-value = 0.9917"
```

```
cbg$Jarque_Bera_test
```

```
##  [1] "Jarque Bera Test"
##  [2] "data:  cbg$cbg_residuals"
##  [3] "X-squared = 1.2, df = 2, p-value = 0.5488"
```

```
cbg$Shapiro_Wilk_test
```

```
##  [1] "Shapiro-Wilk normality test"
##  [2] "data:  cbg$cbg_residuals"
##  [3] "W = 0.9996, p-value = 0.9000"
```

```
cbg$Ljung_Box_test$p.value[1]
```

```
## [1] 0.9917
```

```
cbg$Jarque_Bera_test$p.value
```

```
## [1] 0.5488
```

```
cbg$Shapiro_Wilk_test$p.value
```

```
## [1] 0.9000
```

```
par(mfrow=c(2,2))
plot.ts(cbg$cbg_residuals,main="Plot of cbg residuals")
qqnorm(cbg$cbg_residuals, cex=1.5,pch=19,col="blue")
qqline(cbg$cbg_residuals,col="red",lwd=2)
acf(cbg$cbg_residuals,lwd=2,ylim=c(-1,1))
```

A.4 Performance Matrics

```
cbg$cbg_perf_mat
```

```
##  [1] "Error Measures:"
##  [2] "  mnum.error mnum.rmse mnum.mpe mnum.mape"
##  [3] "1  0.0000000  0.0000000 0.0000000 0.0000000"
```

```
cbg$cbg_perf_mat[2,2]
```

```
## [1] 0.0000000
```

```
cbg$cbg_perf_mat[2,4]
```

```
## [1] 0.0000000
```

```
cbg$cbg_perf_mat[2,3]
```

```
## [1] 0.0000000
```

```
cbg$cbg_perf_mat[2,1]
```

```
## [1] 0.0000000
```

B. Ridge Regression

B.1 Model Training

```
cbg$cbg_ridge_model_lambda$ridge_model$lambda
```

```
##  [1] 0.01000000 0.00977237 0.00954993 0.00933254 0.00911991 0.00891251
##  [7] 0.00870964 0.00851138 0.00831763 0.00812831 0.00794328 0.00776247
## [13] 0.00758578 0.00741310 0.00724436 0.00707946 0.00691831 0.00676083
## [19] 0.00660693 0.00645654 0.00630957 0.00616595 0.00602559 0.00588844
## [25] 0.00575440 0.00562341 0.00549540 0.00537032 0.00524807 0.00512861
## [31] 0.00501187 0.00489779 0.00478630 0.00467735 0.00457088 0.00446683
## [37] 0.00436516 0.00426580 0.00416869 0.00407380 0.00398107 0.00389045
## [43] 0.00380189 0.00371535 0.00363078 0.00354813 0.00346737 0.00338844
## [49] 0.00331131 0.00323594 0.00316228 0.00309030 0.00301995 0.00295121
## [55] 0.00288403 0.00281838 0.00275423 0.00269153 0.00263027 0.00257040
## [61] 0.00251189 0.00245471 0.00239883 0.00234422 0.00229087 0.00223872
## [67] 0.00218776 0.00213796 0.00208930 0.00204173 0.00199526 0.00194984
## [73] 0.00190546 0.00186209 0.00181970 0.00177828 0.00173780 0.00169824
## [79] 0.00165959 0.00162181 0.00158489 0.00154882 0.00151356 0.00147910
## [85] 0.00144544 0.00141254 0.00138038 0.00134896 0.00131826 0.00128825
## [91] 0.00125893 0.00123027 0.00120226 0.00117489 0.00114815 0.00112202
## [97] 0.00109648 0.00107152 0.00104713 0.00102329 0.00100000
```

```
cbg$cbg_ridge_model_lambda$ridge_model$coefficients
```

```
##  [1] "Error in cbg$cbg_ridge_model_lambda$ridge_model$coefficients: subscript out of bounds"
```

```
cbg$cbg_ridge_model_lambda$ridge_model$lambda[1]
```

```
## [1] 0.01000000
```

```
cbg$cbg_ridge_model_lambda$ridge_model$coefficients[,1]
```

```
##  [1] "Error in cbg$cbg_ridge_model_lambda$ridge_model$coefficients: subscript out of bounds"
```

```
par(mfrow=c(2,2))
plot.ts(cbg$cbg_ridge_model_lambda$ridge_model$lambda,main="Plot of cbg ridge model lambda")
qqnorm(cbg$cbg_ridge_model_lambda$ridge_model$lambda, cex=1.5,pch=19,col="blue")
qqline(cbg$cbg_ridge_model_lambda$ridge_model$lambda,col="red",lwd=2)
acf(cbg$cbg_ridge_model_lambda$ridge_model$lambda,lwd=2,ylim=c(-1,1))
```

A.4 Performance Matrics

```
cbg$cbg_ridge_perf_mat
```

```
##  [1] "Error Measures:"
##  [2] "  mnum.error mnum.rmse mnum.mpe mnum.mape"
##  [3] "1  0.0000000  0.0000000 0.0000000 0.0000000"
```

```
cbg$cbg_ridge_perf_mat[2,2]
```

```
## [1] 0.0000000
```

```
cbg$cbg_ridge_perf_mat[2,4]
```

```
## [1] 0.0000000
```

```
cbg$cbg_ridge_perf_mat[2,3]
```

```
## [1] 0.0000000
```

```
cbg$cbg_ridge_perf_mat[2,1]
```

```
## [1] 0.0000000
```

C. Lasso Regression

C.1 Model Training

```
cbg$cbg_lasso_model_lambda$lambda[1]
```

```
## [1] 0.01000000
```

```
cbg$cbg_lasso_model_lambda$lambda[1]
```

```
## [1] 0.01000000
```

```
cbg$cbg_lasso_model_lambda$lambda[1]
```

```
## [1] 0.01000000
```

```
par(mfrow=c(2,2))
plot.ts(cbg$cbg_lasso_model_lambda$lambda,main="Plot of cbg lasso model lambda")
qqnorm(cbg$cbg_lasso_model_lambda$lambda, cex=1.5,pch=19,col="blue")
qqline(cbg$cbg_lasso_model_lambda$lambda,col="red",lwd=2)
acf(cbg$cbg_lasso_model_lambda$lambda,lwd=2,ylim=c(-1,1))
```

C.2 Prediction

```
cbg$cbg_lasso_model_lambda$p.lasso
```

```
##  [1] "Predicted 1 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000
```

C.3 Assumption

```
par(mfrow=c(2,2))
plot.ts(cbg$cbg_lasso_model_lambda$lambda,main="Plot of cbg lasso model lambda")
qqnorm(cbg$cbg_lasso_model_lambda$lambda, cex=1.5,pch=19,col="blue")
qqline(cbg$cbg_lasso_model_lambda$lambda,col="red",lwd=2)
acf(cbg$cbg_lasso_model_lambda$lambda,lwd=2,ylim=c(-1,1))
```



```
cbg$cbg_lasso_model_lambda$p.lasso
```

```
##  [1] "Predicted 1 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000
```

```
cbg$cbg_lasso_model_lambda$p.lasso[1]
```

```
## [1] "Predicted 1 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000"
```

```
cbg$cbg_lasso_model_lambda$p.lasso[2]
```

```
## [1] "Predicted 2 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000"
```

```
cbg$cbg_lasso_model_lambda$p.lasso[3]
```

```
## [1] "Predicted 3 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000"
```

C.4 Performance Matrics

```
cbg$cbg_lasso_perf_mat
```

```
##  [1] "Error Measures:"
##  [2] "  mnum.error mnum.rmse mnum.mpe mnum.mape"
##  [3] "1  0.0000000  0.0000000 0.0000000 0.0000000"
```

```
cbg$cbg_lasso_perf_mat[2,2]
```

```
## [1] 0.0000000
```

```
cbg$cbg_lasso_perf_mat[2,4]
```

```
## [1] 0.0000000
```

```
cbg$cbg_lasso_perf_mat[2,3]
```

```
## [1] 0.0000000
```

```
cbg$cbg_lasso_perf_mat[2,1]
```

```
## [1] 0.0000000
```

D. Elastic Net

D.1 Model training

```
cbg$cbg_elastic_model_lambda$lambda[1]
```

```
## [1] 0.01000000
```

```
cbg$cbg_elastic_model_lambda$lambda[1]
```

```
## [1] 0.01000000
```

```
cbg$cbg_elastic_model_lambda$lambda[1]
```

```
## [1] 0.01000000
```

```
par(mfrow=c(2,2))
plot.ts(cbg$cbg_elastic_model_lambda$lambda,main="Plot of cbg elastic model lambda")
qqnorm(cbg$cbg_elastic_model_lambda$lambda, cex=1.5,pch=19,col="blue")
qqline(cbg$cbg_elastic_model_lambda$lambda,col="red",lwd=2)
acf(cbg$cbg_elastic_model_lambda$lambda,lwd=2,ylim=c(-1,1))
```



```
cbg$cbg_elastic_model_lambda$p.elastic
```

```
##  [1] "Predicted 1 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000
```

D.3 Assumptions

```
par(mfrow=c(2,2))
plot.ts(cbg$cbg_elastic_model_lambda$lambda,main="Plot of cbg elastic model lambda")
qqnorm(cbg$cbg_elastic_model_lambda$lambda, cex=1.5,pch=19,col="blue")
qqline(cbg$cbg_elastic_model_lambda$lambda,col="red",lwd=2)
acf(cbg$cbg_elastic_model_lambda$lambda,lwd=2,ylim=c(-1,1))
```



```
cbg$cbg_elastic_model_lambda$p.elastic
```

```
##  [1] "Predicted 1 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000
```

```
cbg$cbg_elastic_model_lambda$p.elastic[1]
```

```
## [1] "Predicted 1 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000"
```

```
cbg$cbg_elastic_model_lambda$p.elastic[2]
```

```
## [1] "Predicted 2 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000"
```

```
cbg$cbg_elastic_model_lambda$p.elastic[3]
```

```
## [1] "Predicted 3 - [1,] 1.0000000 1.0000000 1.0000000 1.0000000 1.0000000"
```

D.4 Performance Matrics

```
cbg$cbg_elastic_perf_mat
```

```
##  [1] "Error Measures:"
##  [2] "  mnum.error mnum.rmse mnum.mpe mnum.mape"
##  [3] "1  0.0000000  0.0000000 0.0000000 0.0000000"
```

```
cbg$cbg_elastic_perf_mat[2,2]
```

```
## [1] 0.0000000
```

```
cbg$cbg_elastic_perf_mat[2,4]
```

```
## [1] 0.0000000
```

```
cbg$cbg_elastic_perf_mat[2,3]
```

```
## [1] 0.0000000
```

```
cbg$cbg_elastic_perf_mat[2,1]
```

```
## [1] 0.0000000
```

E. SVR : support vector regression

E.1 Model Training

```
cbg$cbg_svr_model
```

```
##  [1] "Error in cbg$cbg_svr_model: object 'cbg$cbg_svr_model' not found"
```

	Model error per	Model scaling per	Kernel	Model intercepts	Gamma	Cost	Epsilon	Degree	Coef0	Number of support vectors	Total scaling
cbg$cbg_svr_model	1.000	1.000	2.000	1.000	0.500	1.000	0.100	3.000	0.000	1.000	1.000