Air Quality Analysis

PHASE-4

INTRODUCTION.

In this part we will continue building our project.

Perform:

Air quality analysis

Calculate average SO2, NO2, and RSPM/PM10 levels across different monitoring stations, cities, or areas. Identify pollution trends and areas with high pollution levels.

Create visualizations

Create visualizations using data visualization libraries (e.g., Matplotlib, Seaborn).

imorting libraries

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.preprocessing import PolynomialFeatures
from sklearn import metrics
from sklearn.metrics import mean_squared_error
from sklearn.metrics import r2_score
from sklearn.tree import DecisionTreeRegressor
import xgboost as xgb
from sklearn.cluster import KMeans
```

Given data set

```
air=pd.read_csv('/content/Air quality-analysis-2014.csv')
```

Original dataset with columns and rows

```
air

      Stn Code Sampling Date       State City/Town/Village/Area  \
0           38      01-02-14  Tamil Nadu                 Chennai
1           38      01-07-14  Tamil Nadu                 Chennai
2           38      21-01-14  Tamil Nadu                 Chennai
3           38      23-01-14  Tamil Nadu                 Chennai
```

```
4           38      28-01-14  Tamil Nadu                Chennai
...        ...           ...         ...                    ...
2874       773      12-03-14  Tamil Nadu                 Trichy
2875       773      12-10-14  Tamil Nadu                 Trichy
2876       773      17-12-14  Tamil Nadu                 Trichy
2877       773      24-12-14  Tamil Nadu                 Trichy
2878       773      31-12-14  Tamil Nadu                 Trichy

                        Location of Monitoring Station  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
...                                                ...   
2874                         Central Bus Stand, Trichy   
2875                         Central Bus Stand, Trichy   
2876                         Central Bus Stand, Trichy   
2877                         Central Bus Stand, Trichy   
2878                         Central Bus Stand, Trichy   

                                       Agency  \
0     Tamilnadu State Pollution Control Board   
1     Tamilnadu State Pollution Control Board   
2     Tamilnadu State Pollution Control Board   
3     Tamilnadu State Pollution Control Board   
4     Tamilnadu State Pollution Control Board   
...                                       ...   
2874  Tamilnadu State Pollution Control Board   
2875  Tamilnadu State Pollution Control Board   
2876  Tamilnadu State Pollution Control Board   
2877  Tamilnadu State Pollution Control Board   
2878  Tamilnadu State Pollution Control Board   

                        Type of Location   SO2   NO2  RSPM/PM10  PM 
2.5  
0                        Industrial Area  11.0  17.0       55.0     
NaN  
1                        Industrial Area  13.0  17.0       45.0     
NaN  
2                        Industrial Area  12.0  18.0       50.0     
NaN  
3                        Industrial Area  15.0  16.0       46.0     
NaN  
4                        Industrial Area  13.0  14.0       42.0     
NaN  
...                                  ...   ...   ...        ...     ..
.  
2874  Residential, Rural and other Areas  15.0  18.0      102.0     
NaN  
```

```
2875  Residential, Rural and other Areas  12.0  14.0       91.0
NaN
2876  Residential, Rural and other Areas  19.0  22.0      100.0
NaN
2877  Residential, Rural and other Areas  15.0  17.0       95.0
NaN
2878  Residential, Rural and other Areas  14.0  16.0       94.0
NaN

[2879 rows x 11 columns]
```

Describing given Data

```
air.describe()

          Stn Code          SO2          NO2    RSPM/PM10  PM 2.5
count  2879.000000  2868.000000  2866.000000  2875.000000     0.0
mean    475.750261    11.503138    22.136776    62.494261     NaN
std     277.675577     5.051702     7.128694    31.368745     NaN
min      38.000000     2.000000     5.000000    12.000000     NaN
25%     238.000000     8.000000    17.000000    41.000000     NaN
50%     366.000000    12.000000    22.000000    55.000000     NaN
75%     764.000000    15.000000    25.000000    78.000000     NaN
max     773.000000    49.000000    71.000000   269.000000     NaN
```

Information of Dataset

```
air.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2879 entries, 0 to 2878
Data columns (total 11 columns):
 #   Column                          Non-Null Count  Dtype  
---  ------                          --------------  -----  
 0   Stn Code                        2879 non-null   int64  
 1   Sampling Date                   2879 non-null   object 
 2   State                           2879 non-null   object 
 3   City/Town/Village/Area          2879 non-null   object 
 4   Location of Monitoring Station  2879 non-null   object 
 5   Agency                          2879 non-null   object 
 6   Type of Location                2879 non-null   object 
 7   SO2                             2868 non-null   float64
 8   NO2                             2866 non-null   float64
 9   RSPM/PM10                       2875 non-null   float64
 10  PM 2.5                          0 non-null      float64
dtypes: float64(4), int64(1), object(6)
memory usage: 247.5+ KB
```

checking missing values

```
air.isnull().sum()
```

```
Stn Code                                 0
Sampling Date                            0
State                                    0
City/Town/Village/Area                   0
Location of Monitoring Station           0
Agency                                   0
Type of Location                         0
SO2                                     11
NO2                                     13
RSPM/PM10                                4
PM 2.5                                2879
dtype: int64
```

```
air_fillna = air
```

```
air_fillna.fillna(air_fillna.mean(), inplace=True)
# count the number of NaN values in each column
print(air_fillna.isnull().sum())

air_fillna
```

```
Stn Code                                 0
Sampling Date                            0
State                                    0
City/Town/Village/Area                   0
Location of Monitoring Station           0
Agency                                   0
Type of Location                         0
SO2                                      0
NO2                                      0
RSPM/PM10                                0
PM 2.5                                2879
dtype: int64
```

```
<ipython-input-10-644c425b2295>:1: FutureWarning: The default value of
numeric_only in DataFrame.mean is deprecated. In a future version, it
will default to False. In addition, specifying 'numeric_only=None' is
deprecated. Select only valid columns or specify the value of
numeric_only to silence this warning.
  air_fillna.fillna(air_fillna.mean(), inplace=True)
```

```
      Stn Code Sampling Date       State City/Town/Village/Area  \
0           38      01-02-14  Tamil Nadu                Chennai
1           38      01-07-14  Tamil Nadu                Chennai
2           38      21-01-14  Tamil Nadu                Chennai
3           38      23-01-14  Tamil Nadu                Chennai
4           38      28-01-14  Tamil Nadu                Chennai
...        ...           ...         ...                    ...
2874       773      12-03-14  Tamil Nadu                 Trichy
```

```
2875       773      12-10-14  Tamil Nadu                 Trichy
2876       773      17-12-14  Tamil Nadu                 Trichy
2877       773      24-12-14  Tamil Nadu                 Trichy
2878       773      31-12-14  Tamil Nadu                 Trichy

                        Location of Monitoring Station  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai
...                                                ...
2874                         Central Bus Stand, Trichy
2875                         Central Bus Stand, Trichy
2876                         Central Bus Stand, Trichy
2877                         Central Bus Stand, Trichy
2878                         Central Bus Stand, Trichy

                                       Agency  \
0     Tamilnadu State Pollution Control Board
1     Tamilnadu State Pollution Control Board
2     Tamilnadu State Pollution Control Board
3     Tamilnadu State Pollution Control Board
4     Tamilnadu State Pollution Control Board
...                                       ...
2874  Tamilnadu State Pollution Control Board
2875  Tamilnadu State Pollution Control Board
2876  Tamilnadu State Pollution Control Board
2877  Tamilnadu State Pollution Control Board
2878  Tamilnadu State Pollution Control Board

                        Type of Location   SO2   NO2  RSPM/PM10  PM
2.5
0                        Industrial Area  11.0  17.0       55.0
NaN
1                        Industrial Area  13.0  17.0       45.0
NaN
2                        Industrial Area  12.0  18.0       50.0
NaN
3                        Industrial Area  15.0  16.0       46.0
NaN
4                        Industrial Area  13.0  14.0       42.0
NaN
...                                  ...   ...   ...        ...     ..
.
2874  Residential, Rural and other Areas  15.0  18.0      102.0
NaN
2875  Residential, Rural and other Areas  12.0  14.0       91.0
NaN
2876  Residential, Rural and other Areas  19.0  22.0      100.0
```

```
NaN
2877  Residential, Rural and other Areas  15.0  17.0       95.0
NaN
2878  Residential, Rural and other Areas  14.0  16.0       94.0
NaN

[2879 rows x 11 columns]
```

```
le=LabelEncoder()
air['State']=le.fit_transform(air['State'])
air
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0           38      01-02-14      0                Chennai
1           38      01-07-14      0                Chennai
2           38      21-01-14      0                Chennai
3           38      23-01-14      0                Chennai
4           38      28-01-14      0                Chennai
...        ...           ...    ...                    ...
2874       773      12-03-14      0                 Trichy
2875       773      12-10-14      0                 Trichy
2876       773      17-12-14      0                 Trichy
2877       773      24-12-14      0                 Trichy
2878       773      31-12-14      0                 Trichy

                        Location of Monitoring Station  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai
...                                                ...
2874                         Central Bus Stand, Trichy
2875                         Central Bus Stand, Trichy
2876                         Central Bus Stand, Trichy
2877                         Central Bus Stand, Trichy
2878                         Central Bus Stand, Trichy

                                       Agency  \
0     Tamilnadu State Pollution Control Board
1     Tamilnadu State Pollution Control Board
2     Tamilnadu State Pollution Control Board
3     Tamilnadu State Pollution Control Board
4     Tamilnadu State Pollution Control Board
...                                       ...
2874  Tamilnadu State Pollution Control Board
2875  Tamilnadu State Pollution Control Board
2876  Tamilnadu State Pollution Control Board
2877  Tamilnadu State Pollution Control Board
2878  Tamilnadu State Pollution Control Board
```

```
                        Type of Location   SO2   NO2  RSPM/PM10  PM
2.5
0                        Industrial Area  11.0  17.0       55.0
NaN
1                        Industrial Area  13.0  17.0       45.0
NaN
2                        Industrial Area  12.0  18.0       50.0
NaN
3                        Industrial Area  15.0  16.0       46.0
NaN
4                        Industrial Area  13.0  14.0       42.0
NaN
...                                  ...   ...   ...        ...      ..
.
2874  Residential, Rural and other Areas  15.0  18.0      102.0
NaN
2875  Residential, Rural and other Areas  12.0  14.0       91.0
NaN
2876  Residential, Rural and other Areas  19.0  22.0      100.0
NaN
2877  Residential, Rural and other Areas  15.0  17.0       95.0
NaN
2878  Residential, Rural and other Areas  14.0  16.0       94.0
NaN

[2879 rows x 11 columns]
```

```
le=LabelEncoder()
air['Stn Code']=le.fit_transform(air['Stn Code'])
air
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01-02-14      0                Chennai
1            0      01-07-14      0                Chennai
2            0      21-01-14      0                Chennai
3            0      23-01-14      0                Chennai
4            0      28-01-14      0                Chennai
...        ...           ...    ...                    ...
2874        29      12-03-14      0                 Trichy
2875        29      12-10-14      0                 Trichy
2876        29      17-12-14      0                 Trichy
2877        29      24-12-14      0                 Trichy
2878        29      31-12-14      0                 Trichy

                        Location of Monitoring Station  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai
```

```
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai
...                                                ...
2874                         Central Bus Stand, Trichy
2875                         Central Bus Stand, Trichy
2876                         Central Bus Stand, Trichy
2877                         Central Bus Stand, Trichy
2878                         Central Bus Stand, Trichy

                                       Agency  \
0     Tamilnadu State Pollution Control Board
1     Tamilnadu State Pollution Control Board
2     Tamilnadu State Pollution Control Board
3     Tamilnadu State Pollution Control Board
4     Tamilnadu State Pollution Control Board
...                                       ...
2874  Tamilnadu State Pollution Control Board
2875  Tamilnadu State Pollution Control Board
2876  Tamilnadu State Pollution Control Board
2877  Tamilnadu State Pollution Control Board
2878  Tamilnadu State Pollution Control Board

                        Type of Location   SO2   NO2  RSPM/PM10  PM
2.5
0                        Industrial Area  11.0  17.0       55.0
NaN
1                        Industrial Area  13.0  17.0       45.0
NaN
2                        Industrial Area  12.0  18.0       50.0
NaN
3                        Industrial Area  15.0  16.0       46.0
NaN
4                        Industrial Area  13.0  14.0       42.0
NaN
...                                  ...   ...   ...        ...     ..
.
2874  Residential, Rural and other Areas  15.0  18.0      102.0
NaN
2875  Residential, Rural and other Areas  12.0  14.0       91.0
NaN
2876  Residential, Rural and other Areas  19.0  22.0      100.0
NaN
2877  Residential, Rural and other Areas  15.0  17.0       95.0
NaN
2878  Residential, Rural and other Areas  14.0  16.0       94.0
NaN

[2879 rows x 11 columns]
```

```
le=LabelEncoder()
air['SO2']=le.fit_transform(air['SO2'])
air
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01-02-14      0                Chennai   
1            0      01-07-14      0                Chennai   
2            0      21-01-14      0                Chennai   
3            0      23-01-14      0                Chennai   
4            0      28-01-14      0                Chennai   
...        ...           ...    ...                    ...   
2874        29      12-03-14      0                 Trichy   
2875        29      12-10-14      0                 Trichy   
2876        29      17-12-14      0                 Trichy   
2877        29      24-12-14      0                 Trichy   
2878        29      31-12-14      0                 Trichy   

                        Location of Monitoring Station  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
...                                                ...   
2874                       Central Bus Stand, Trichy   
2875                       Central Bus Stand, Trichy   
2876                       Central Bus Stand, Trichy   
2877                       Central Bus Stand, Trichy   
2878                       Central Bus Stand, Trichy   

                                   Agency  \
0     Tamilnadu State Pollution Control Board   
1     Tamilnadu State Pollution Control Board   
2     Tamilnadu State Pollution Control Board   
3     Tamilnadu State Pollution Control Board   
4     Tamilnadu State Pollution Control Board   
...                                       ...   
2874  Tamilnadu State Pollution Control Board   
2875  Tamilnadu State Pollution Control Board   
2876  Tamilnadu State Pollution Control Board   
2877  Tamilnadu State Pollution Control Board   
2878  Tamilnadu State Pollution Control Board   

                        Type of Location  SO2   NO2  RSPM/PM10  PM 2.5

0                        Industrial Area    9  17.0       55.0     NaN

1                        Industrial Area   12  17.0       45.0     NaN

2                        Industrial Area   11  18.0       50.0     NaN
```

```
3                         Industrial Area   14  16.0       46.0     NaN
4                         Industrial Area   12  14.0       42.0     NaN
...                                   ...  ...   ...        ...     ...
2874  Residential, Rural and other Areas   14  18.0      102.0     NaN
2875  Residential, Rural and other Areas   11  14.0       91.0     NaN
2876  Residential, Rural and other Areas   18  22.0      100.0     NaN
2877  Residential, Rural and other Areas   14  17.0       95.0     NaN
2878  Residential, Rural and other Areas   13  16.0       94.0     NaN

[2879 rows x 11 columns]
```

```
le=LabelEncoder()
air['Agency']=le.fit_transform(air['Agency'])
air
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01-02-14      0                Chennai   
1            0      01-07-14      0                Chennai   
2            0      21-01-14      0                Chennai   
3            0      23-01-14      0                Chennai   
4            0      28-01-14      0                Chennai   
...        ...           ...    ...                    ...   
2874        29      12-03-14      0                 Trichy   
2875        29      12-10-14      0                 Trichy   
2876        29      17-12-14      0                 Trichy   
2877        29      24-12-14      0                 Trichy   
2878        29      31-12-14      0                 Trichy   

                        Location of Monitoring Station  Agency  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
...                                                ...     ...   
2874                          Central Bus Stand, Trichy       1   
2875                          Central Bus Stand, Trichy       1   
2876                          Central Bus Stand, Trichy       1   
2877                          Central Bus Stand, Trichy       1   
2878                          Central Bus Stand, Trichy       1   

                        Type of Location  SO2   NO2  RSPM/PM10  PM 2.5
```

```
0                        Industrial Area    9  17.0        55.0     NaN
1                        Industrial Area   12  17.0        45.0     NaN
2                        Industrial Area   11  18.0        50.0     NaN
3                        Industrial Area   14  16.0        46.0     NaN
4                        Industrial Area   12  14.0        42.0     NaN
...                                  ...  ...   ...         ...     ...
2874  Residential, Rural and other Areas   14  18.0       102.0     NaN
2875  Residential, Rural and other Areas   11  14.0        91.0     NaN
2876  Residential, Rural and other Areas   18  22.0       100.0     NaN
2877  Residential, Rural and other Areas   14  17.0        95.0     NaN
2878  Residential, Rural and other Areas   13  16.0        94.0     NaN

[2879 rows x 11 columns]
```

```
le=LabelEncoder()
air['RSPM/PM10']=le.fit_transform(air['RSPM/PM10'])
air
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01-02-14      0                Chennai
1            0      01-07-14      0                Chennai
2            0      21-01-14      0                Chennai
3            0      23-01-14      0                Chennai
4            0      28-01-14      0                Chennai
...        ...           ...    ...                    ...
2874        29      12-03-14      0                 Trichy
2875        29      12-10-14      0                 Trichy
2876        29      17-12-14      0                 Trichy
2877        29      24-12-14      0                 Trichy
2878        29      31-12-14      0                 Trichy

                        Location of Monitoring Station  Agency  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
...                                                ...     ...
2874                         Central Bus Stand, Trichy       1
```

```
2875                         Central Bus Stand, Trichy       1
2876                         Central Bus Stand, Trichy       1
2877                         Central Bus Stand, Trichy       1
2878                         Central Bus Stand, Trichy       1

                        Type of Location  SO2   NO2  RSPM/PM10  PM 2.5

0                        Industrial Area    9  17.0         43     NaN

1                        Industrial Area   12  17.0         33     NaN

2                        Industrial Area   11  18.0         38     NaN

3                        Industrial Area   14  16.0         34     NaN

4                        Industrial Area   12  14.0         30     NaN

...                                  ...  ...   ...        ...     ...

2874  Residential, Rural and other Areas   14  18.0         91     NaN

2875  Residential, Rural and other Areas   11  14.0         80     NaN

2876  Residential, Rural and other Areas   18  22.0         89     NaN

2877  Residential, Rural and other Areas   14  17.0         84     NaN

2878  Residential, Rural and other Areas   13  16.0         83     NaN


[2879 rows x 11 columns]
```

```
air['Sampling Date'] =air['Sampling Date'].str.replace('-', ' ')
air
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01 02 14      0                Chennai
1            0      01 07 14      0                Chennai
2            0      21 01 14      0                Chennai
3            0      23 01 14      0                Chennai
4            0      28 01 14      0                Chennai
...        ...           ...    ...                    ...
2874        29      12 03 14      0                 Trichy
2875        29      12 10 14      0                 Trichy
2876        29      17 12 14      0                 Trichy
2877        29      24 12 14      0                 Trichy
2878        29      31 12 14      0                 Trichy

                        Location of Monitoring Station  Agency  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
```

```
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
...                                                ...     ...
2874                          Central Bus Stand, Trichy      1
2875                          Central Bus Stand, Trichy      1
2876                          Central Bus Stand, Trichy      1
2877                          Central Bus Stand, Trichy      1
2878                          Central Bus Stand, Trichy      1

                        Type of Location  SO2   NO2  RSPM/PM10  PM 2.5

0                        Industrial Area    9  17.0         43     NaN

1                        Industrial Area   12  17.0         33     NaN

2                        Industrial Area   11  18.0         38     NaN

3                        Industrial Area   14  16.0         34     NaN

4                        Industrial Area   12  14.0         30     NaN

...                                  ...  ...   ...        ...     ...

2874  Residential, Rural and other Areas   14  18.0         91     NaN

2875  Residential, Rural and other Areas   11  14.0         80     NaN

2876  Residential, Rural and other Areas   18  22.0         89     NaN

2877  Residential, Rural and other Areas   14  17.0         84     NaN

2878  Residential, Rural and other Areas   13  16.0         83     NaN


[2879 rows x 11 columns]
```

```
air
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01 02 14      0                Chennai
1            0      01 07 14      0                Chennai
2            0      21 01 14      0                Chennai
3            0      23 01 14      0                Chennai
4            0      28 01 14      0                Chennai
...        ...           ...    ...                    ...
2874        29      12 03 14      0                 Trichy
2875        29      12 10 14      0                 Trichy
2876        29      17 12 14      0                 Trichy
2877        29      24 12 14      0                 Trichy
2878        29      31 12 14      0                 Trichy
```

```
                        Location of Monitoring Station  Agency  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
...                                                ...     ...
2874                         Central Bus Stand, Trichy       1
2875                         Central Bus Stand, Trichy       1
2876                         Central Bus Stand, Trichy       1
2877                         Central Bus Stand, Trichy       1
2878                         Central Bus Stand, Trichy       1

                        Type of Location  SO2   NO2  RSPM/PM10  PM 2.5

0                        Industrial Area    9  17.0          43     NaN

1                        Industrial Area   12  17.0          33     NaN

2                        Industrial Area   11  18.0          38     NaN

3                        Industrial Area   14  16.0          34     NaN

4                        Industrial Area   12  14.0          30     NaN

...                                  ...  ...   ...         ...     ...

2874  Residential, Rural and other Areas   14  18.0          91     NaN

2875  Residential, Rural and other Areas   11  14.0          80     NaN

2876  Residential, Rural and other Areas   18  22.0          89     NaN

2877  Residential, Rural and other Areas   14  17.0          84     NaN

2878  Residential, Rural and other Areas   13  16.0          83     NaN


[2879 rows x 11 columns]
```

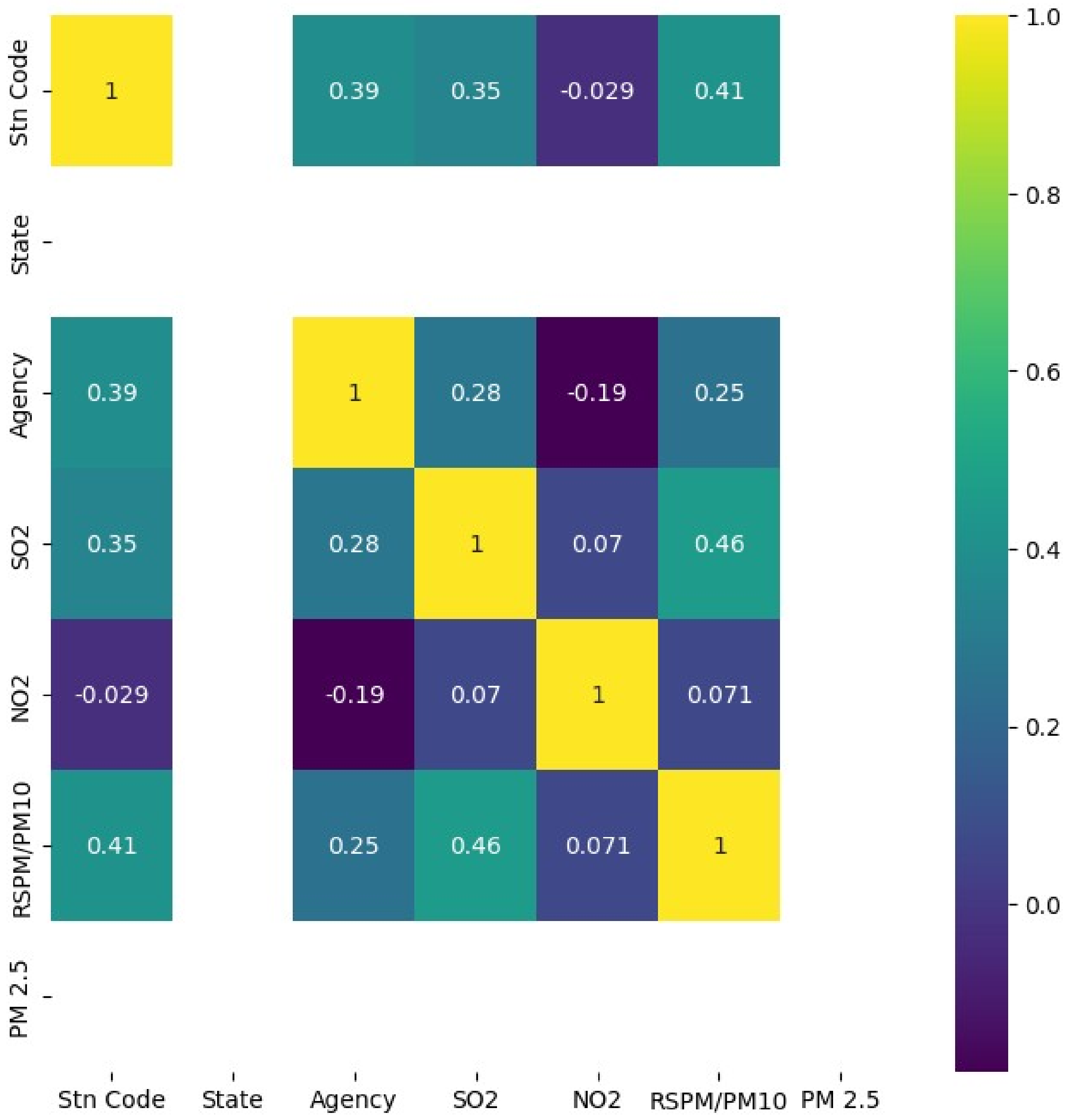
```
air.columns
```

```
Index(['Stn Code', 'Sampling Date', 'State', 'City/Town/Village/Area',
       'Location of Monitoring Station', 'Agency', 'Type of Location',
'SO2',
       'NO2', 'RSPM/PM10', 'PM 2.5'],
      dtype='object')
```

Model Analysis

```
corr = air.corr()
plt.figure(figsize=(8,8))
sns.heatmap(corr, cmap='viridis', annot=True)
```

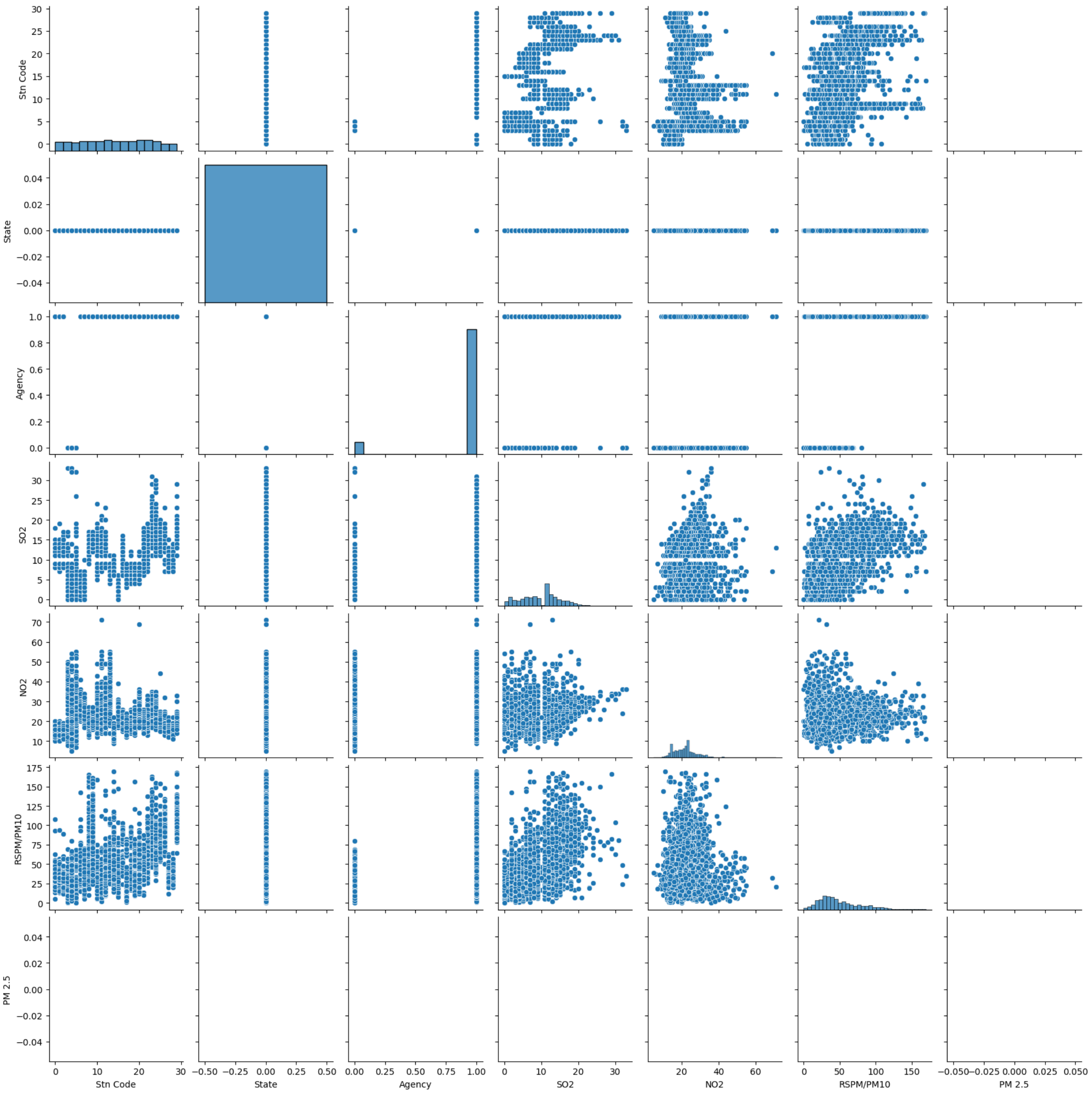
```
<ipython-input-31-5aecfe2bd3f6>:1: FutureWarning: The default value of
numeric_only in DataFrame.corr is deprecated. In a future version, it
will default to False. Select only valid columns or specify the value
of numeric_only to silence this warning.
  corr = air.corr()

<Axes: >
```



Model Comparison

```
sns.pairplot(air)
```

```
<seaborn.axisgrid.PairGrid at 0x7e6e89283b50>
```

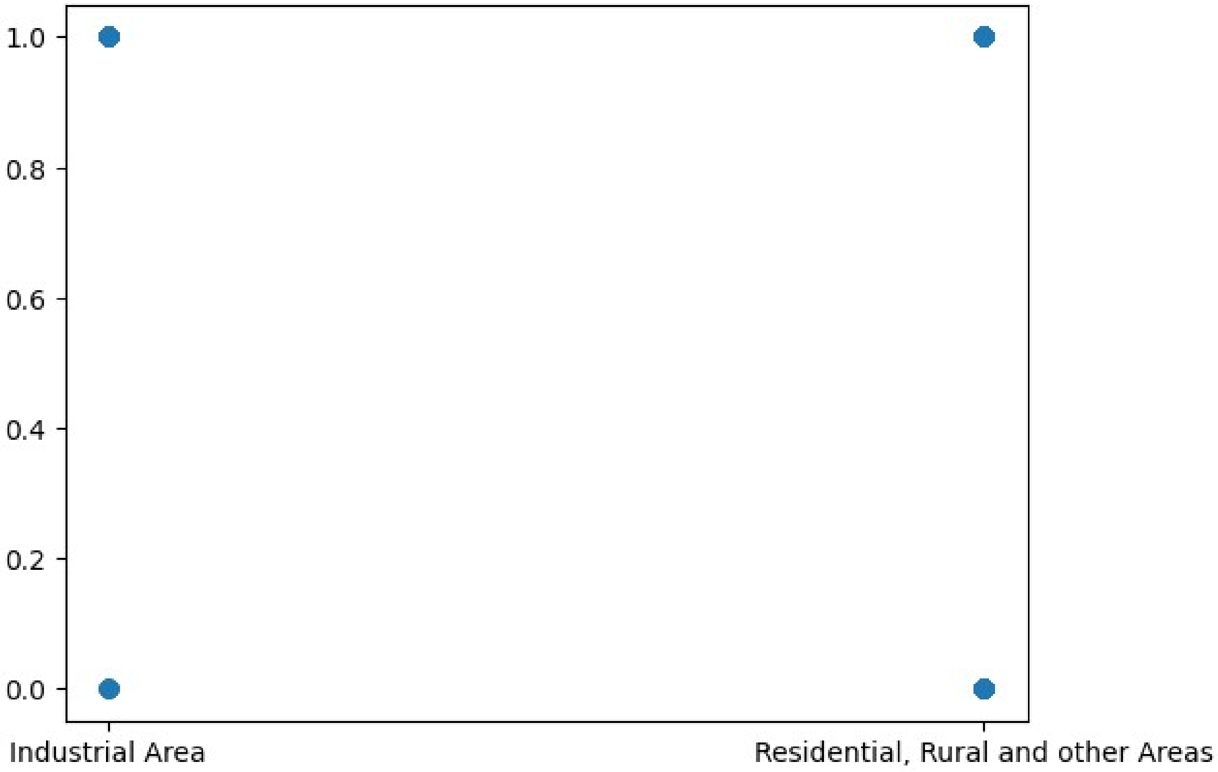


Model Evaluation

```
sns.regplot( y="Agency",x="Type of Location",  data=air)
```

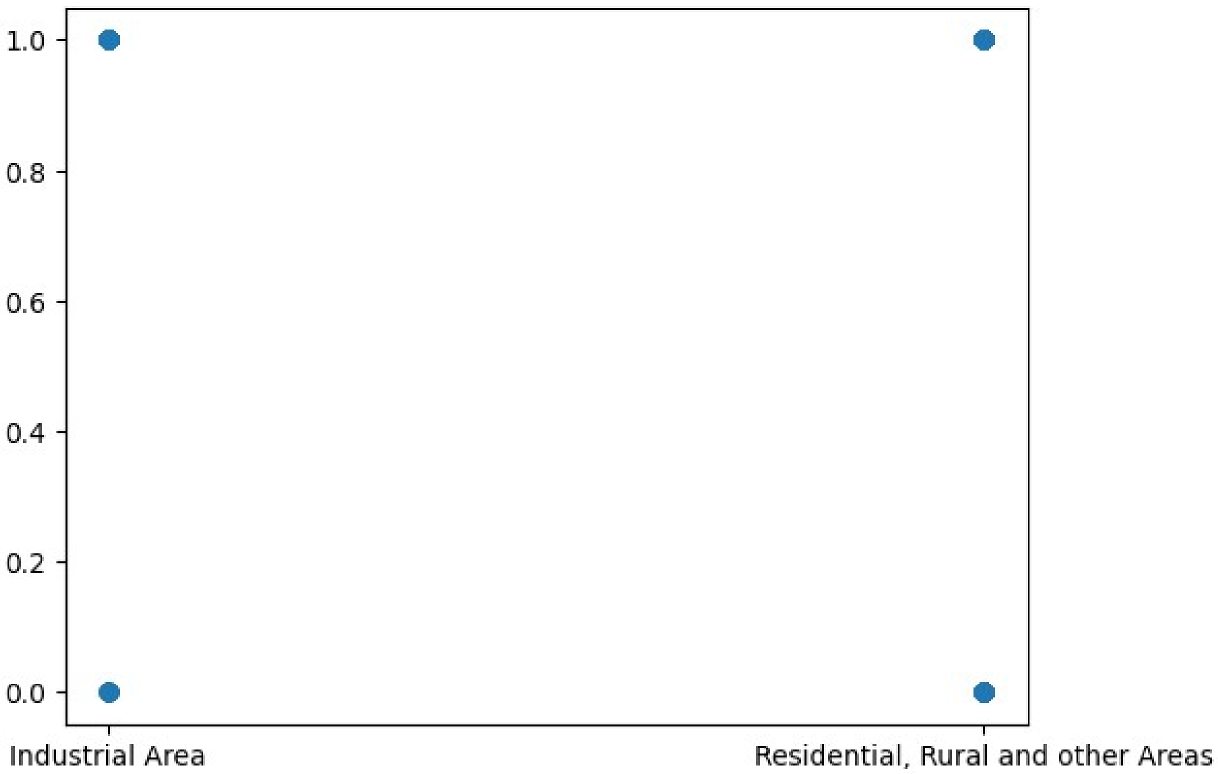
```
----------------------------------------------------------------------
-----
```

```
UFuncTypeError                            Traceback (most recent call
last)
<ipython-input-37-f1cb546c44ae> in <cell line: 1>()
----> 1 sns.regplot( y="Agency",x="Type of Location",  data=air)

/usr/local/lib/python3.10/dist-packages/seaborn/regression.py in
regplot(data, x, y, x_estimator, x_bins, x_ci, scatter, fit_reg, ci,
n_boot, units, seed, order, logistic, lowess, robust, logx, x_partial,
y_partial, truncate, dropna, x_jitter, y_jitter, label, color, marker,
scatter_kws, line_kws, ax)
    757     scatter_kws["marker"] = marker
    758     line_kws = {} if line_kws is None else copy.copy(line_kws)
--> 759     plotter.plot(ax, scatter_kws, line_kws)
    760     return ax
    761 

/usr/local/lib/python3.10/dist-packages/seaborn/regression.py in
plot(self, ax, scatter_kws, line_kws)
    366 
    367         if self.fit_reg:
--> 368             self.lineplot(ax, line_kws)
    369 
    370         # Label the axes

/usr/local/lib/python3.10/dist-packages/seaborn/regression.py in
lineplot(self, ax, kws)
    411         """Draw the model."""
    412         # Fit the regression model
--> 413         grid, yhat, err_bands = self.fit_regression(ax)
    414         edges = grid[0], grid[-1]
    415 

/usr/local/lib/python3.10/dist-packages/seaborn/regression.py in
fit_regression(self, ax, x_range, grid)
    197                 else:
    198                     x_min, x_max = ax.get_xlim()
--> 199             grid = np.linspace(x_min, x_max, 100)
    200         ci = self.ci
    201 

/usr/local/lib/python3.10/dist-packages/numpy/core/overrides.py in
linspace(*args, **kwargs)

/usr/local/lib/python3.10/dist-packages/numpy/core/function_base.py in
linspace(start, stop, num, endpoint, retstep, dtype, axis)
    125     # Convert float/complex array scalars to float, gh-3504
    126     # and make sure one can use variables that have an
__array_interface__, gh-6634
--> 127     start = asanyarray(start) * 1.0
    128     stop  = asanyarray(stop)  * 1.0
    129

UFuncTypeError: ufunc 'multiply' did not contain a loop with signature
matching types (dtype('<U15'), dtype('float64')) -> None
```



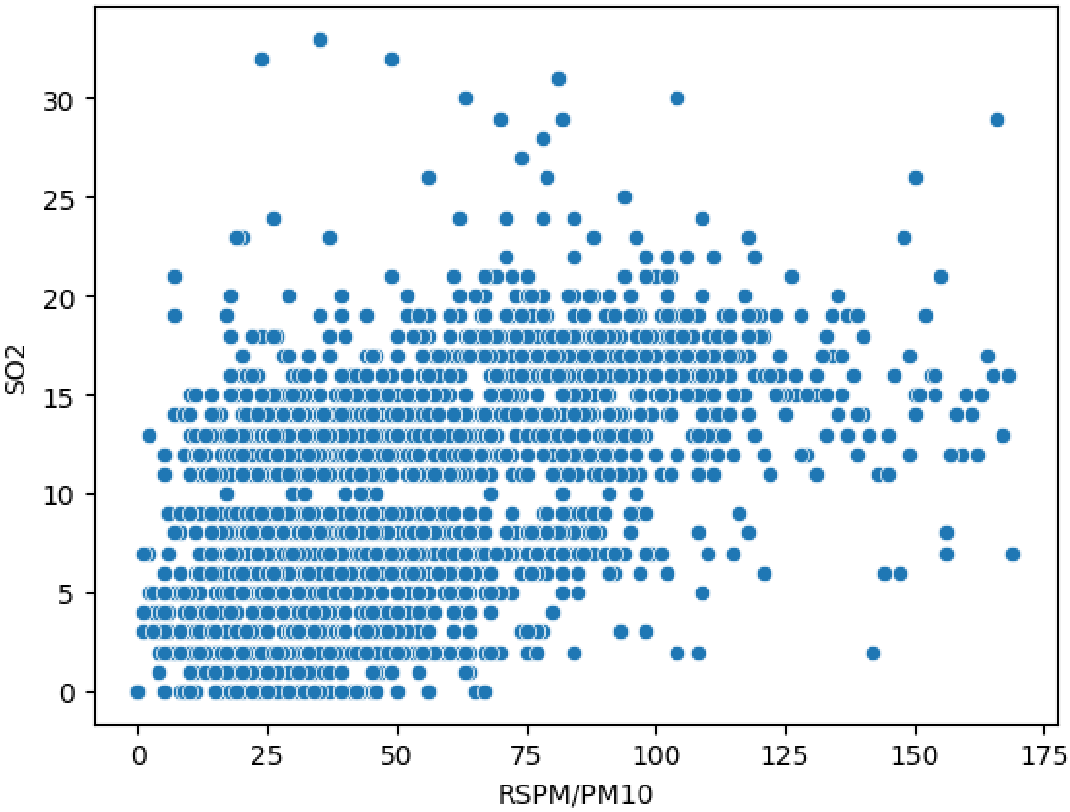
```
sns.regplot( y="Agency",x="Type of Location",  data=air)

---------------------------------------------------------------------------
UFuncTypeError                            Traceback (most recent call
last)
<ipython-input-39-f1cb546c44ae> in <cell line: 1>()
----> 1 sns.regplot( y="Agency",x="Type of Location",  data=air)

/usr/local/lib/python3.10/dist-packages/seaborn/regression.py in
regplot(data, x, y, x_estimator, x_bins, x_ci, scatter, fit_reg, ci,
n_boot, units, seed, order, logistic, lowess, robust, logx, x_partial,
y_partial, truncate, dropna, x_jitter, y_jitter, label, color, marker,
scatter_kws, line_kws, ax)
    757     scatter_kws["marker"] = marker
    758     line_kws = {} if line_kws is None else copy.copy(line_kws)
--> 759     plotter.plot(ax, scatter_kws, line_kws)
    760     return ax
    761
```

```
/usr/local/lib/python3.10/dist-packages/seaborn/regression.py in
plot(self, ax, scatter_kws, line_kws)
    366 
    367         if self.fit_reg:
--> 368             self.lineplot(ax, line_kws)
    369 
    370         # Label the axes

/usr/local/lib/python3.10/dist-packages/seaborn/regression.py in
lineplot(self, ax, kws)
    411         """Draw the model."""
    412         # Fit the regression model
--> 413         grid, yhat, err_bands = self.fit_regression(ax)
    414         edges = grid[0], grid[-1]
    415 

/usr/local/lib/python3.10/dist-packages/seaborn/regression.py in
fit_regression(self, ax, x_range, grid)
    197                 else:
    198                     x_min, x_max = ax.get_xlim()
--> 199             grid = np.linspace(x_min, x_max, 100)
    200         ci = self.ci
    201 

/usr/local/lib/python3.10/dist-packages/numpy/core/overrides.py in
linspace(*args, **kwargs)

/usr/local/lib/python3.10/dist-packages/numpy/core/function_base.py in
linspace(start, stop, num, endpoint, retstep, dtype, axis)
    125     # Convert float/complex array scalars to float, gh-3504
    126     # and make sure one can use variables that have an
__array_interface__, gh-6634
--> 127     start = asanyarray(start) * 1.0
    128     stop  = asanyarray(stop)  * 1.0
    129 

UFuncTypeError: ufunc 'multiply' did not contain a loop with signature
matching types (dtype('<U15'), dtype('float64')) -> None
```



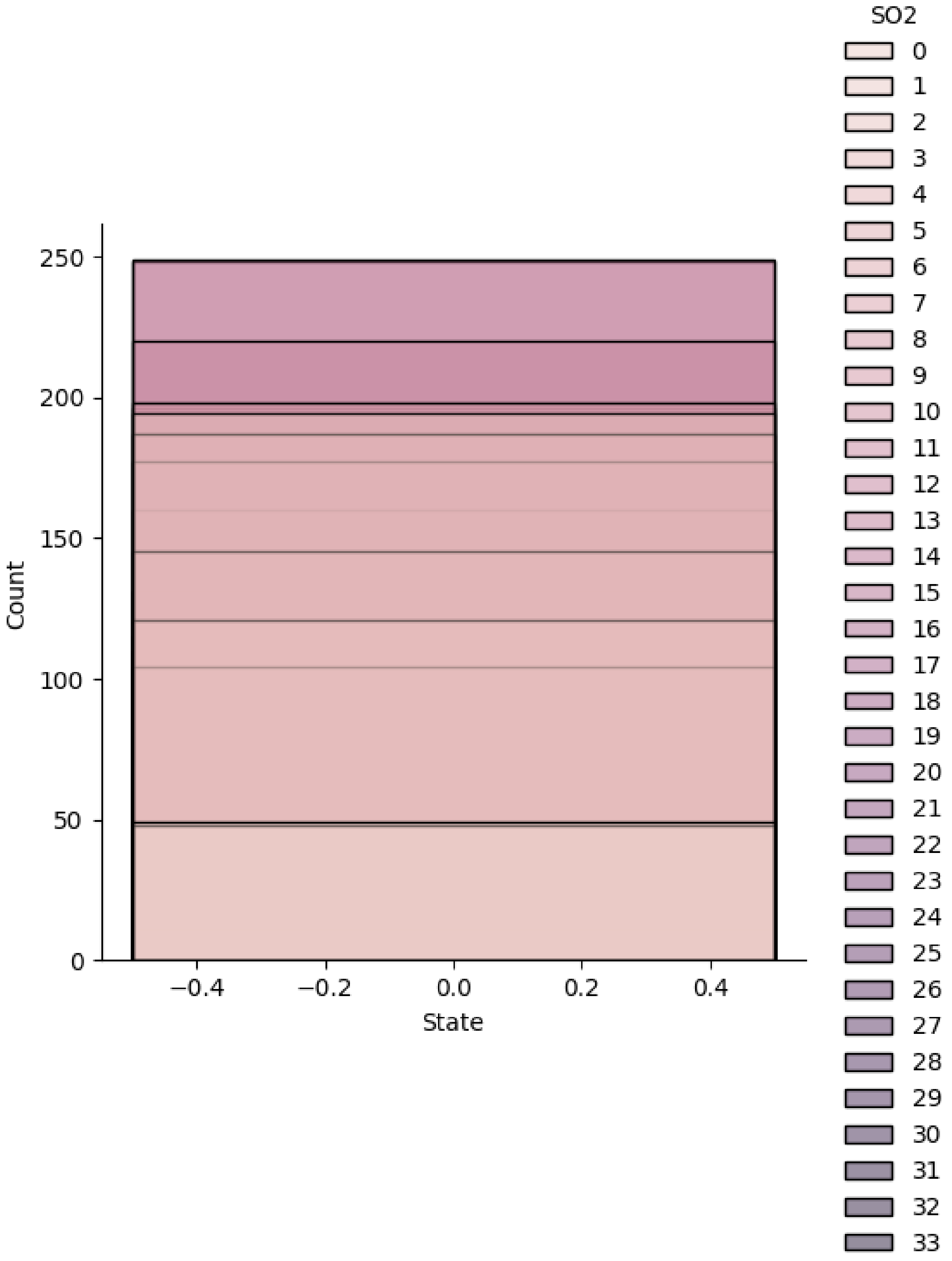
```
sns.scatterplot( y="SO2",x="RSPM/PM10",  data=air)
```

```
<Axes: xlabel='RSPM/PM10', ylabel='SO2'>
```



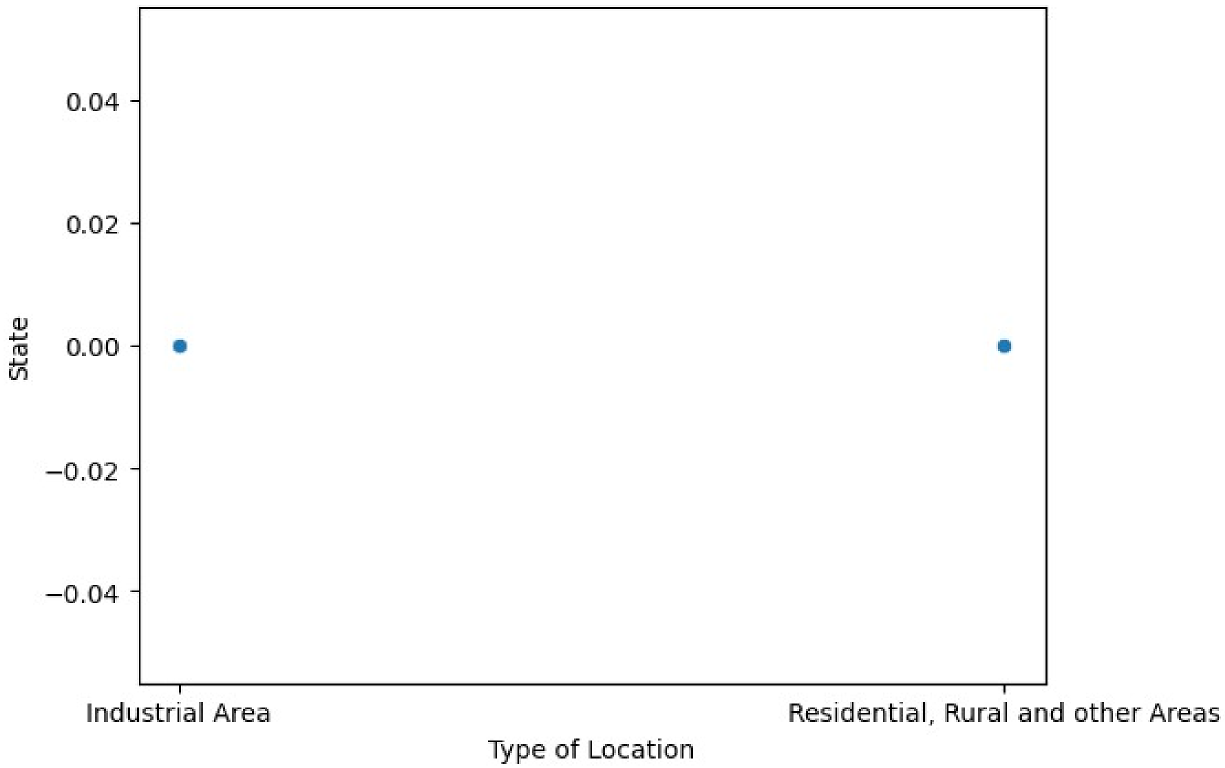
```
sns.displot(air, x="State", hue="SO2",  common_norm=False)
```

```
<seaborn.axisgrid.FacetGrid at 0x7e6e8838d240>
```



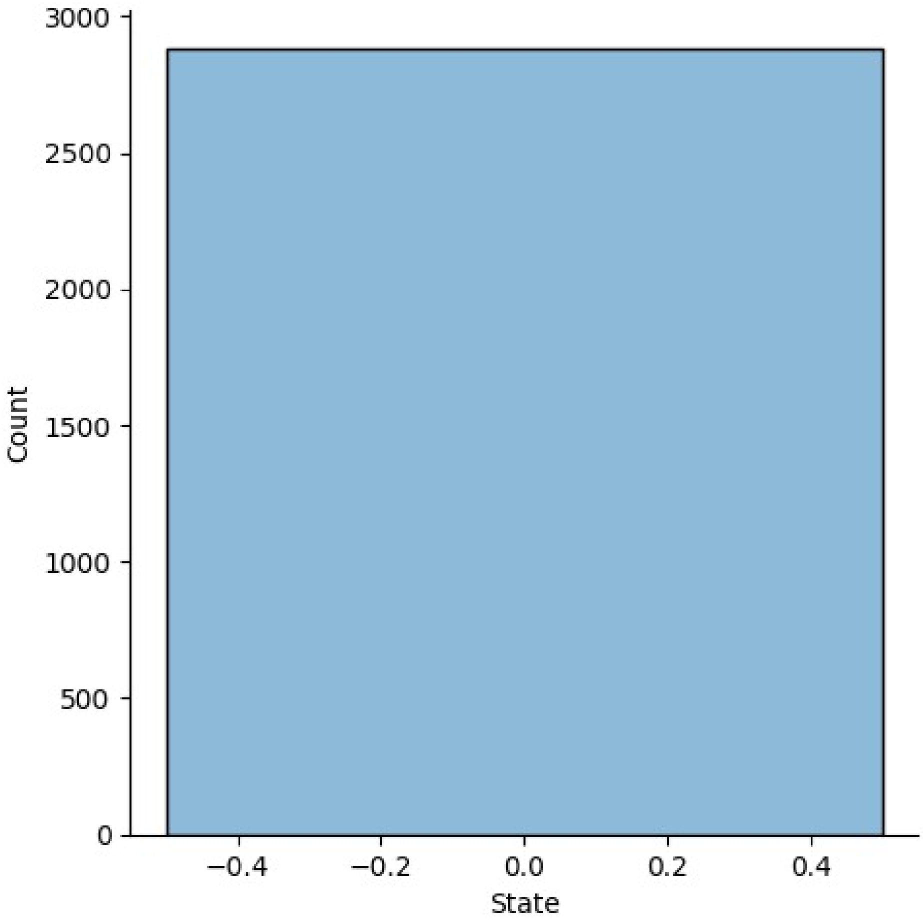
```
sns.scatterplot(air, x='Type of Location',y="State")
```

```
<Axes: xlabel='Type of Location', ylabel='State'>
```



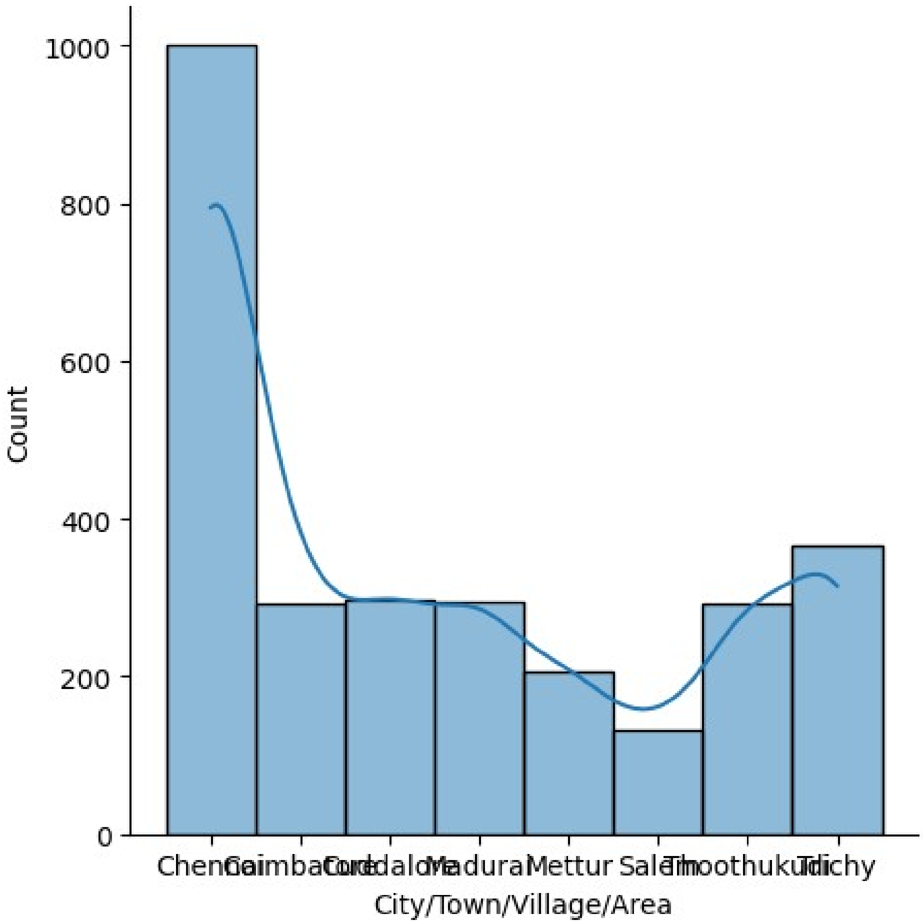
```
sns.displot(air, x="State",kde=True)
```

```
<seaborn.axisgrid.FacetGrid at 0x7e6e84973700>
```



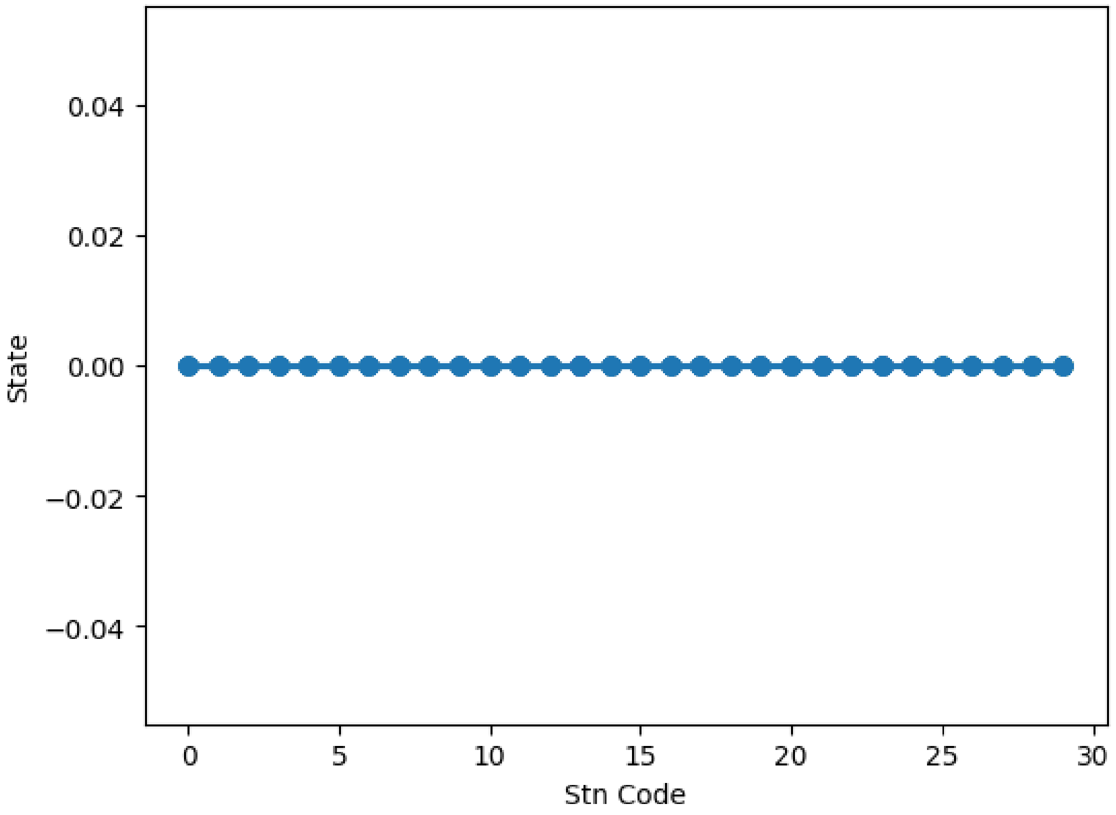
```
sns.displot(air, x="City/Town/Village/Area", kde=True)
```

```
<seaborn.axisgrid.FacetGrid at 0x7e6e88465b40>
```



```
sns.regplot( y="State",x="Stn Code",  data=air)
```

```
<Axes: xlabel='Stn Code', ylabel='State'>
```



```
x=air[['Stn Code','Sampling Date',    'State',
      'City/Town/Village/Area',  'Location of Monitoring Station',
      'Agency',  'Type of Location',   'SO2',     'NO2',
      'RSPM/PM10',    'PM 2.5']]

x

      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01 02 14      0                Chennai
1            0      01 07 14      0                Chennai
2            0      21 01 14      0                Chennai
3            0      23 01 14      0                Chennai
4            0      28 01 14      0                Chennai
...        ...           ...    ...                    ...
2874        29      12 03 14      0                 Trichy
2875        29      12 10 14      0                 Trichy
2876        29      17 12 14      0                 Trichy
2877        29      24 12 14      0                 Trichy
2878        29      31 12 14      0                 Trichy

                        Location of Monitoring Station  Agency  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
```

```
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
...                                                ...     ...
2874                        Central Bus Stand, Trichy       1
2875                        Central Bus Stand, Trichy       1
2876                        Central Bus Stand, Trichy       1
2877                        Central Bus Stand, Trichy       1
2878                        Central Bus Stand, Trichy       1

                        Type of Location  SO2   NO2  RSPM/PM10  PM 2.5

0                        Industrial Area    9  17.0         43     NaN

1                        Industrial Area   12  17.0         33     NaN

2                        Industrial Area   11  18.0         38     NaN

3                        Industrial Area   14  16.0         34     NaN

4                        Industrial Area   12  14.0         30     NaN

...                                  ...  ...   ...        ...     ...

2874  Residential, Rural and other Areas   14  18.0         91     NaN

2875  Residential, Rural and other Areas   11  14.0         80     NaN

2876  Residential, Rural and other Areas   18  22.0         89     NaN

2877  Residential, Rural and other Areas   14  17.0         84     NaN

2878  Residential, Rural and other Areas   13  16.0         83     NaN


[2879 rows x 11 columns]
```

```
y=air[['RSPM/PM10']]
y
```

```
      RSPM/PM10
0            43
1            33
2            38
3            34
4            30
...         ...
2874         91
2875         80
2876         89
2877         84
2878         83
```

```
[2879 rows x 1 columns]
```

```
x_train, x_test, y_train, y_test = train_test_split(x,y,
random_state=42)
```

```
x_train
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
1385        16      12 10 14      0              Cuddalore
1125         6      25 03 14      0             Coimbatore
482         22      25 09 14      0                Chennai
1765        11      18 10 14      0                Madurai
1000        15      01 04 14      0             Coimbatore
...        ...           ...    ...                    ...
1638        10      07 10 14      0                Madurai
1095        15      12 06 14      0             Coimbatore
1130         6      04 11 14      0             Coimbatore
1294        16      01 08 14      0              Cuddalore
860          5      20 05 14      0                Chennai

                         Location of Monitoring Station  Agency  \
1385                                Eachangadu Villagae       1
1125                           SIDCO Office, Coimbatore       1
482                                 Anna Nagar, Chennai       1
1765  Fenner (I) Ltd. Employees Assiciation Building...       1
1000      Poniarajapuram, On the top of DEL, Coimbatore       1
...                                                 ...     ...
1638             Highway (Project -I) Building, Madurai       1
1095      Poniarajapuram, On the top of DEL, Coimbatore       1
1130                           SIDCO Office, Coimbatore       1
1294                                Eachangadu Villagae       1
860                 Thiruvottiyur Municipal Office, Chennai       0

                        Type of Location  SO2   NO2  RSPM/PM10  PM 2.5

1385  Residential, Rural and other Areas    9  21.0         56     NaN

1125                     Industrial Area    2  26.0        142     NaN

482   Residential, Rural and other Areas   13  27.0         41     NaN

1765                     Industrial Area   11  16.0         18     NaN

1000  Residential, Rural and other Areas    2  23.0         56     NaN

...                                  ...  ...   ...        ...     ...

1638  Residential, Rural and other Areas    6  22.0         16     NaN

1095  Residential, Rural and other Areas    2  18.0        104     NaN
```

```
1130                     Industrial Area    3  23.0         64     NaN

1294  Residential, Rural and other Areas    7  23.0         79     NaN

860                      Industrial Area   11  27.0         44     NaN


[2159 rows x 11 columns]

x_test

      Stn Code Sampling Date  State City/Town/Village/Area  \
471         22      25 08 14      0                Chennai   
1453        18      19 08 14      0              Cuddalore   
2377        14      09 02 14      0            Thoothukudi   
1601        10      17 02 14      0                Madurai   
1094        15      12 03 14      0             Coimbatore   
...        ...           ...    ...                    ...   
1413        18      24 03 14      0              Cuddalore   
1090        15      19 11 14      0             Coimbatore   
1512        17      25 03 14      0              Cuddalore   
630         24      29 01 14      0                Chennai   
2507         9      17 12 14      0            Thoothukudi   

                         Location of Monitoring Station  Agency  \
471                                 Anna Nagar, Chennai       1   
1453  District Environmental Engineer Office, Imperi...       1   
2377                  AVM Jewellery Building, Tuticorin       1   
1601             Highway (Project -I) Building, Madurai       1   
1094      Poniarajapuram, On the top of DEL, Coimbatore       1   
...                                                 ...     ...   
1413  District Environmental Engineer Office, Imperi...       1   
1090      Poniarajapuram, On the top of DEL, Coimbatore       1   
1512                SIPCOT Industrial Complex, Cuddalore       1   
630                                     Kilpauk, Chennai       1   
2507                            Raja Agencies, Tuticorin       1   

                        Type of Location  SO2   NO2  RSPM/PM10  PM 2.5

471   Residential, Rural and other Areas    9  21.0         33     NaN

1453  Residential, Rural and other Areas    4  15.0         30     NaN

2377  Residential, Rural and other Areas    7  11.0         69     NaN

1601  Residential, Rural and other Areas   15  23.0         42     NaN

1094  Residential, Rural and other Areas    2  23.0         75     NaN

...                                  ...  ...   ...        ...     ...
```

```
1413  Residential, Rural and other Areas    9  25.0          88     NaN

1090  Residential, Rural and other Areas    2  23.0          57     NaN

1512                     Industrial Area    7  21.0          75     NaN

630   Residential, Rural and other Areas   22  25.0          71     NaN

2507                     Industrial Area   14  18.0         139     NaN


[720 rows x 11 columns]

y_train

      RSPM/PM10
1385         56
1125        142
482          41
1765         18
1000         56
...         ...
1638         16
1095        104
1130         64
1294         79
860          44

[2159 rows x 1 columns]

y_test

      RSPM/PM10
471          33
1453         30
2377         69
1601         42
1094         75
...         ...
1413         88
1090         57
1512         75
630          71
2507        139

[720 rows x 1 columns]

LR=LinearRegression()
```

PyCaret's Regression module (pycaret.regression) is a supervised machine learning module which is used for predicting continuous values / outcomes using various techniques and algorithms. Regression can be used for predicting values / outcomes such as sales, units sold, temperature or any number which is continuous.

PyCaret's regression module has over 25 algorithms and 10 plots to analyze the performance of models. Be it hyper-parameter tuning, ensembling or advanced techniques like stacking, PyCaret's regression module has it all.

```
dataset=pd.read_csv('/content/Air quality-analysis-2014.csv')

data = dataset.sample(frac=0.9,
random_state=786).reset_index(drop=True)
data_unseen = dataset.drop(data.index).reset_index(drop=True)

print('Data for Modeling: ' + str(data.shape))
print('Unseen Data For Predictions: ' + str(data_unseen.shape))
```

```
Data for Modeling: (2591, 11)
Unseen Data For Predictions: (288, 11)
```

```
dataset_fillna = dataset

dataset_fillna.fillna(dataset_fillna.mean(), inplace=True)
# count the number of NaN values in each column
print(dataset_fillna.isnull().sum())

dataset_fillna
```

```
Stn Code                             0
Sampling Date                        0
State                                0
City/Town/Village/Area               0
Location of Monitoring Station       0
Agency                               0
Type of Location                     0
SO2                                  0
NO2                                  0
RSPM/PM10                            0
PM 2.5                            2879
dtype: int64
```

```
<ipython-input-66-b5b95eac7e1e>:1: FutureWarning: The default value of
numeric_only in DataFrame.mean is deprecated. In a future version, it
will default to False. In addition, specifying 'numeric_only=None' is
deprecated. Select only valid columns or specify the value of
numeric_only to silence this warning.
  dataset_fillna.fillna(dataset_fillna.mean(), inplace=True)
```

```
      Stn Code Sampling Date       State City/Town/Village/Area  \
0           38      01-02-14  Tamil Nadu                Chennai
```

```
1           38      01-07-14  Tamil Nadu                Chennai
2           38      21-01-14  Tamil Nadu                Chennai
3           38      23-01-14  Tamil Nadu                Chennai
4           38      28-01-14  Tamil Nadu                Chennai
...        ...           ...         ...                    ...
2874       773      12-03-14  Tamil Nadu                 Trichy
2875       773      12-10-14  Tamil Nadu                 Trichy
2876       773      17-12-14  Tamil Nadu                 Trichy
2877       773      24-12-14  Tamil Nadu                 Trichy
2878       773      31-12-14  Tamil Nadu                 Trichy

                        Location of Monitoring Station  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai   
...                                                ...   
2874                         Central Bus Stand, Trichy   
2875                         Central Bus Stand, Trichy   
2876                         Central Bus Stand, Trichy   
2877                         Central Bus Stand, Trichy   
2878                         Central Bus Stand, Trichy   

                                       Agency  \
0     Tamilnadu State Pollution Control Board   
1     Tamilnadu State Pollution Control Board   
2     Tamilnadu State Pollution Control Board   
3     Tamilnadu State Pollution Control Board   
4     Tamilnadu State Pollution Control Board   
...                                       ...   
2874  Tamilnadu State Pollution Control Board   
2875  Tamilnadu State Pollution Control Board   
2876  Tamilnadu State Pollution Control Board   
2877  Tamilnadu State Pollution Control Board   
2878  Tamilnadu State Pollution Control Board   

                        Type of Location   SO2   NO2  RSPM/PM10  PM
2.5
0                        Industrial Area  11.0  17.0       55.0         
NaN
1                        Industrial Area  13.0  17.0       45.0         
NaN
2                        Industrial Area  12.0  18.0       50.0         
NaN
3                        Industrial Area  15.0  16.0       46.0         
NaN
4                        Industrial Area  13.0  14.0       42.0         
NaN
...                                  ...   ...   ...        ...     ..
```

```
.
2874  Residential, Rural and other Areas  15.0  18.0      102.0
NaN
2875  Residential, Rural and other Areas  12.0  14.0       91.0
NaN
2876  Residential, Rural and other Areas  19.0  22.0      100.0
NaN
2877  Residential, Rural and other Areas  15.0  17.0       95.0
NaN
2878  Residential, Rural and other Areas  14.0  16.0       94.0
NaN

[2879 rows x 11 columns]
```

```
le=LabelEncoder()
dataset['State']=le.fit_transform(dataset['State'])
dataset
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0           38      01-02-14      0                Chennai
1           38      01-07-14      0                Chennai
2           38      21-01-14      0                Chennai
3           38      23-01-14      0                Chennai
4           38      28-01-14      0                Chennai
...        ...           ...    ...                    ...
2874       773      12-03-14      0                 Trichy
2875       773      12-10-14      0                 Trichy
2876       773      17-12-14      0                 Trichy
2877       773      24-12-14      0                 Trichy
2878       773      31-12-14      0                 Trichy

                        Location of Monitoring Station  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai
...                                                ...
2874                         Central Bus Stand, Trichy
2875                         Central Bus Stand, Trichy
2876                         Central Bus Stand, Trichy
2877                         Central Bus Stand, Trichy
2878                         Central Bus Stand, Trichy

                                       Agency  \
0     Tamilnadu State Pollution Control Board
1     Tamilnadu State Pollution Control Board
2     Tamilnadu State Pollution Control Board
3     Tamilnadu State Pollution Control Board
4     Tamilnadu State Pollution Control Board
```

```
...                                          ...
2874  Tamilnadu State Pollution Control Board
2875  Tamilnadu State Pollution Control Board
2876  Tamilnadu State Pollution Control Board
2877  Tamilnadu State Pollution Control Board
2878  Tamilnadu State Pollution Control Board

                        Type of Location   SO2   NO2  RSPM/PM10  PM
2.5
0                        Industrial Area  11.0  17.0       55.0
NaN
1                        Industrial Area  13.0  17.0       45.0
NaN
2                        Industrial Area  12.0  18.0       50.0
NaN
3                        Industrial Area  15.0  16.0       46.0
NaN
4                        Industrial Area  13.0  14.0       42.0
NaN
...                                  ...   ...   ...        ...     ..
.
2874  Residential, Rural and other Areas  15.0  18.0      102.0
NaN
2875  Residential, Rural and other Areas  12.0  14.0       91.0
NaN
2876  Residential, Rural and other Areas  19.0  22.0      100.0
NaN
2877  Residential, Rural and other Areas  15.0  17.0       95.0
NaN
2878  Residential, Rural and other Areas  14.0  16.0       94.0
NaN

[2879 rows x 11 columns]
```

```
le=LabelEncoder()
dataset['Stn Code']=le.fit_transform(dataset['Stn Code'])
dataset
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01-02-14      0                Chennai
1            0      01-07-14      0                Chennai
2            0      21-01-14      0                Chennai
3            0      23-01-14      0                Chennai
4            0      28-01-14      0                Chennai
...        ...           ...    ...                    ...
2874        29      12-03-14      0                 Trichy
2875        29      12-10-14      0                 Trichy
2876        29      17-12-14      0                 Trichy
2877        29      24-12-14      0                 Trichy
2878        29      31-12-14      0                 Trichy
```

```
                        Location of Monitoring Station  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai
...                                                ...
2874                         Central Bus Stand, Trichy
2875                         Central Bus Stand, Trichy
2876                         Central Bus Stand, Trichy
2877                         Central Bus Stand, Trichy
2878                         Central Bus Stand, Trichy

                                       Agency  \
0     Tamilnadu State Pollution Control Board
1     Tamilnadu State Pollution Control Board
2     Tamilnadu State Pollution Control Board
3     Tamilnadu State Pollution Control Board
4     Tamilnadu State Pollution Control Board
...                                       ...
2874  Tamilnadu State Pollution Control Board
2875  Tamilnadu State Pollution Control Board
2876  Tamilnadu State Pollution Control Board
2877  Tamilnadu State Pollution Control Board
2878  Tamilnadu State Pollution Control Board

                        Type of Location   SO2   NO2  RSPM/PM10  PM
2.5
0                        Industrial Area  11.0  17.0       55.0
NaN
1                        Industrial Area  13.0  17.0       45.0
NaN
2                        Industrial Area  12.0  18.0       50.0
NaN
3                        Industrial Area  15.0  16.0       46.0
NaN
4                        Industrial Area  13.0  14.0       42.0
NaN
...                                  ...   ...   ...        ...      ..
.
2874  Residential, Rural and other Areas  15.0  18.0      102.0
NaN
2875  Residential, Rural and other Areas  12.0  14.0       91.0
NaN
2876  Residential, Rural and other Areas  19.0  22.0      100.0
NaN
2877  Residential, Rural and other Areas  15.0  17.0       95.0
NaN
2878  Residential, Rural and other Areas  14.0  16.0       94.0
```

```
NaN

[2879 rows x 11 columns]
```

```python
le=LabelEncoder()
dataset['Agency']=le.fit_transform(dataset['Agency'])
dataset
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01-02-14      0                Chennai   
1            0      01-07-14      0                Chennai   
2            0      21-01-14      0                Chennai   
3            0      23-01-14      0                Chennai   
4            0      28-01-14      0                Chennai   
...        ...           ...    ...                    ...   
2874        29      12-03-14      0                 Trichy   
2875        29      12-10-14      0                 Trichy   
2876        29      17-12-14      0                 Trichy   
2877        29      24-12-14      0                 Trichy   
2878        29      31-12-14      0                 Trichy   

                        Location of Monitoring Station  Agency  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
...                                                ...     ...   
2874                         Central Bus Stand, Trichy       1   
2875                         Central Bus Stand, Trichy       1   
2876                         Central Bus Stand, Trichy       1   
2877                         Central Bus Stand, Trichy       1   
2878                         Central Bus Stand, Trichy       1   

                        Type of Location   SO2   NO2  RSPM/PM10  PM 
2.5  
0                        Industrial Area  11.0  17.0       55.0   
NaN  
1                        Industrial Area  13.0  17.0       45.0   
NaN  
2                        Industrial Area  12.0  18.0       50.0   
NaN  
3                        Industrial Area  15.0  16.0       46.0   
NaN  
4                        Industrial Area  13.0  14.0       42.0   
NaN  
...                                  ...   ...   ...        ...     ..
.  
2874  Residential, Rural and other Areas  15.0  18.0      102.0   
NaN  
```

```
2875  Residential, Rural and other Areas  12.0  14.0       91.0
NaN
2876  Residential, Rural and other Areas  19.0  22.0      100.0
NaN
2877  Residential, Rural and other Areas  15.0  17.0       95.0
NaN
2878  Residential, Rural and other Areas  14.0  16.0       94.0
NaN

[2879 rows x 11 columns]
```

```
le=LabelEncoder()
dataset['Type of Location']=le.fit_transform(dataset['Type of 
Location'])
dataset
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01-02-14      0                Chennai
1            0      01-07-14      0                Chennai
2            0      21-01-14      0                Chennai
3            0      23-01-14      0                Chennai
4            0      28-01-14      0                Chennai
...        ...           ...    ...                    ...
2874        29      12-03-14      0                 Trichy
2875        29      12-10-14      0                 Trichy
2876        29      17-12-14      0                 Trichy
2877        29      24-12-14      0                 Trichy
2878        29      31-12-14      0                 Trichy

                        Location of Monitoring Station  Agency  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1
...                                                ...     ...
2874                         Central Bus Stand, Trichy       1
2875                         Central Bus Stand, Trichy       1
2876                         Central Bus Stand, Trichy       1
2877                         Central Bus Stand, Trichy       1
2878                         Central Bus Stand, Trichy       1

      Type of Location   SO2   NO2  RSPM/PM10  PM 2.5
0                    0  11.0  17.0       55.0     NaN
1                    0  13.0  17.0       45.0     NaN
2                    0  12.0  18.0       50.0     NaN
3                    0  15.0  16.0       46.0     NaN
4                    0  13.0  14.0       42.0     NaN
...                ...   ...   ...        ...     ...
2874                 1  15.0  18.0      102.0     NaN
```

```
2875                   1  12.0  14.0       91.0     NaN
2876                   1  19.0  22.0      100.0     NaN
2877                   1  15.0  17.0       95.0     NaN
2878                   1  14.0  16.0       94.0     NaN

[2879 rows x 11 columns]
```

```
dataset['Sampling Date'] = dataset['Sampling Date'].str.replace('-', ' ')
dataset
```

```
      Stn Code Sampling Date  State City/Town/Village/Area  \
0            0      01 02 14      0                Chennai   
1            0      01 07 14      0                Chennai   
2            0      21 01 14      0                Chennai   
3            0      23 01 14      0                Chennai   
4            0      28 01 14      0                Chennai   
...        ...           ...    ...                    ...   
2874        29      12 03 14      0                 Trichy   
2875        29      12 10 14      0                 Trichy   
2876        29      17 12 14      0                 Trichy   
2877        29      24 12 14      0                 Trichy   
2878        29      31 12 14      0                 Trichy   

                        Location of Monitoring Station  Agency  \
0     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
1     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
2     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
3     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
4     Kathivakkam, Municipal Kalyana Mandapam, Chennai       1   
...                                                ...     ...   
2874                         Central Bus Stand, Trichy       1   
2875                         Central Bus Stand, Trichy       1   
2876                         Central Bus Stand, Trichy       1   
2877                         Central Bus Stand, Trichy       1   
2878                         Central Bus Stand, Trichy       1   

      Type of Location   SO2   NO2  RSPM/PM10  PM 2.5
0                    0  11.0  17.0       55.0     NaN
1                    0  13.0  17.0       45.0     NaN
2                    0  12.0  18.0       50.0     NaN
3                    0  15.0  16.0       46.0     NaN
4                    0  13.0  14.0       42.0     NaN
...                ...   ...   ...        ...     ...
2874                 1  15.0  18.0      102.0     NaN
2875                 1  12.0  14.0       91.0     NaN
2876                 1  19.0  22.0      100.0     NaN
2877                 1  15.0  17.0       95.0     NaN
2878                 1  14.0  16.0       94.0     NaN
```

```
[2879 rows x 11 columns]
```

The setup() function initializes the environment in pycaret and creates the transformation pipeline to prepare the data for modeling and deployment. setup() must be called before executing any other function in pycaret. It takes two mandatory parameters: a pandas dataframe and the name of the target column. All other parameters are optional and are used to customize the pre-processing pipeline (we will see them in later tutorials).

When setup() is executed, PyCaret's inference algorithm will automatically infer the data types for all features based on certain properties. The data type should be inferred correctly but this is not always the case. To account for this, PyCaret displays a table containing the features and their inferred data types after setup() is executed. If all of the data types are correctly identified enter can be pressed to continue or quit can be typed to end the expriment. Ensuring that the data types are correct is of fundamental importance in PyCaret as it automatically performs a few pre-processing tasks which are imperative to any machine learning experiment. These tasks are performed differently for each data type which means it is very important for them to be correctly configured.

In later tutorials we will learn how to overwrite PyCaret's infered data type using the numeric_features and categorical_features parameters in setup().