Air Quality Analysis and Prediction in Tamil Nadu

Date	**28-10-2023**
Team ID	**3886**
Project Name	**Air Quality Analysis and Predicion in Tamil Nadu**
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Problem Statement:

Overview:

The problem statement revolves around improving the accuracy of an existing predictive model. The existing model may have limitations in terms of prediction accuracy, especially when dealing with complex and dynamic datasets. Incorporate machine learning algorithms to enhance prediction accuracy. Optimize data collection and preprocessing techniques. Perform advanced feature engineering to extract valuable insights from the data. Select and train models that can adapt to various scenarios. Leverage geographic analysis to uncover location-specific patterns and trends.

INTRODUCTION:

Air quality analysis and predictions in Tamil Nadu involve the systematic assessment of ambient air pollution levels and forecasting future trends to safeguard public health and the environment. This process combines data collection from air quality monitoring stations, satellite imagery, and meteorological data to generate insights into pollutant concentrations and their potential impact. These predictions aid in making informed decisions for pollution control measures, urban planning, and public health initiatives. By analyzing historical data and employing advanced modeling techniques, authorities can mitigate the adverse effects of air pollution, reduce health risks, and promote sustainable development throughout the state of Tamil Nadu.

Analysis Approach:

The project starts by importing necessary Python libraries for data analysis, including NumPy, Pandas, Matplotlib, Seaborn, and scikit-learn.

The dataset, which is presumably air quality data for Tamil Nadu in 2014, is loaded using Pandas from a CSV file.

The dataset is explored by examining its structure, summary statistics, and column names to get an initial understanding of the data.

Data Exploration:

dataset.info() provides information about the dataset, including data types and missing values.

dataset.describe() presents summary statistics for each numerical column.

dataset.columns lists the column names in the dataset.

Data Visualization:

The project uses various visualization techniques to gain insights from the data:

Histogram for SO2 Levels: Visualizes the distribution of SO2 levels in Tamil Nadu.

Scatter Plot of NO2 vs. RSPM/PM10: Examines the relationship between NO2 and RSPM/PM10 levels.

Bar Chart for State-wise SO2 Levels: Displays the average SO2 levels for different states in Tamil Nadu.

Pairplot and Histograms: Further explores the relationships between variables and distributions of different pollutants.

Correlation Matrix: Calculates and visualizes the correlation between air quality parameters.

Calculating Averages:

Average levels of SO2, NO2, and RSPM/PM10 are calculated for different cities or areas within Tamil Nadu. The average levels provide insights into pollution variations across the region.

Creating Visualizations:

Bar plots are used to visualize the average levels of SO2, NO2, and RSPM/PM10 in different areas. This provides a clear visual representation of pollution levels across various locations.

Insights into Air Pollution Trends:

The project uses visualizations to illustrate the distribution and trends in air quality parameters.

The correlation matrix helps identify any relationships between pollutants.

The bar charts for different areas show variations in pollution levels, helping to pinpoint areas with higher pollution.

Code implementation:

IMPORTING LIBRARIES

```
import numpy as np
import pandas as pd
import os
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
import warnings
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score
```

LOADING THE DATASET

```
dataset= pd.read_csv("C:\\Users\\SANTH\\Downloads\\
cpcb_dly_aq_tamil_nadu-2014.csv")
```

DATA EXPLORATION:

```
dataset
```

```
      Stn Code Sampling Date       State City/Town/Village/Area  \
0           38    01-02-2014  Tamil Nadu                Chennai
1           38    01-07-2014  Tamil Nadu                Chennai
2           38    21-01-2014  Tamil Nadu                Chennai
3           38    23-01-2014  Tamil Nadu                Chennai
4           38    28-01-2014  Tamil Nadu                Chennai
...        ...           ...         ...                    ...
2874       773    12-03-2014  Tamil Nadu                Trichy
2875       773    12-10-2014  Tamil Nadu                Trichy
2876       773    17-12-2014  Tamil Nadu                Trichy
2877       773    24-12-2014  Tamil Nadu                Trichy
2878       773    31-12-2014  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]



dataset.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
```

```
dataset.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
```

```
dataset.columns
```

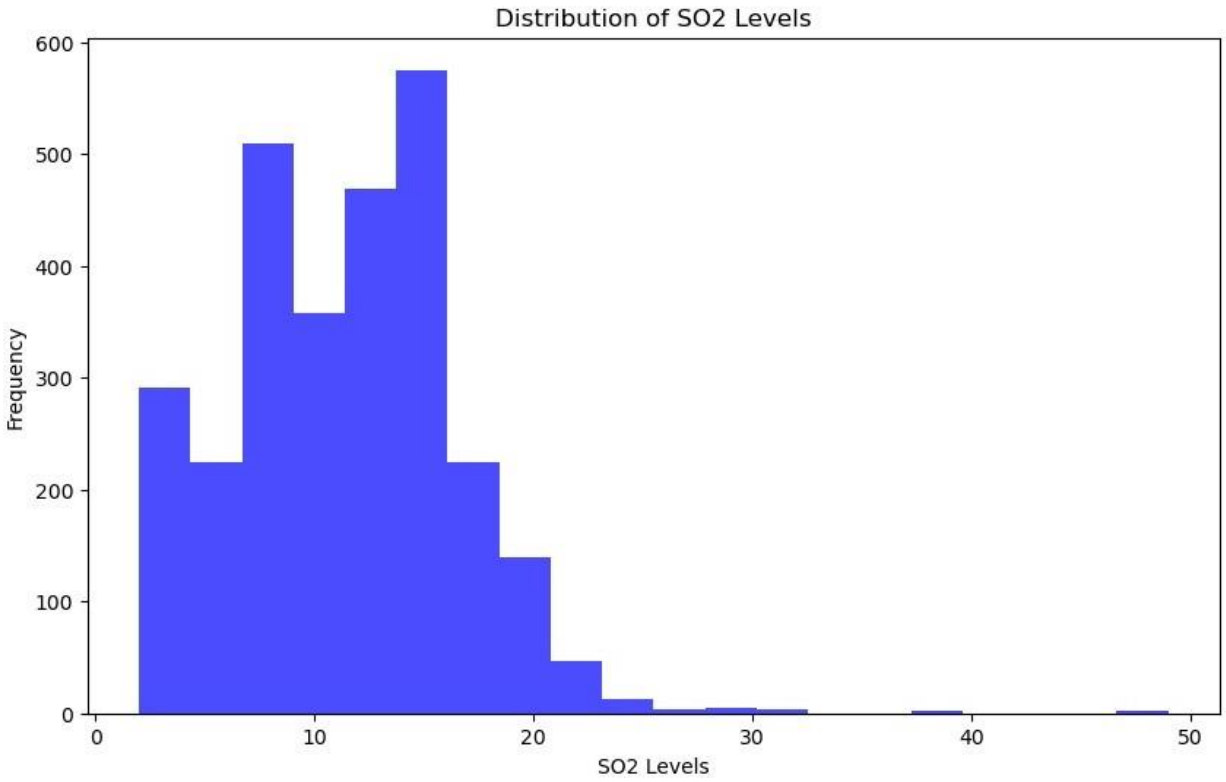
```
Index(['Stn Code', 'Sampling Date', 'State', 'City/Town/Village/Area',
       'Location of Monitoring Station', 'Agency', 'Type of Location',
'SO2',
       'NO2', 'RSPM/PM10', 'PM 2.5'],
      dtype='object')
```

DATA VISUALIZATION:

1.Histogram for SO2 levels

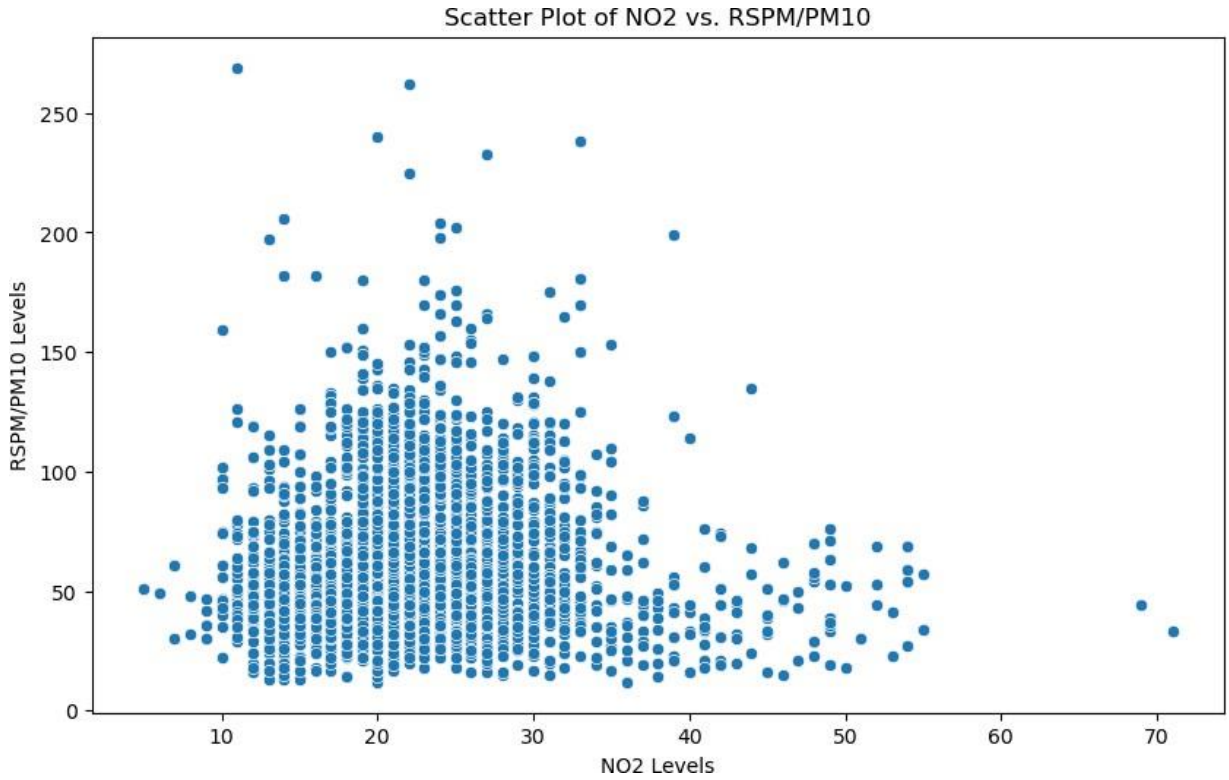
```
plt.figure(figsize=(10, 6))
plt.hist(dataset['SO2'], bins=20, color='blue', alpha=0.7)
plt.title('Distribution of SO2 Levels')
plt.xlabel('SO2 Levels')
```

```
plt.ylabel('Frequency')
plt.show()
```



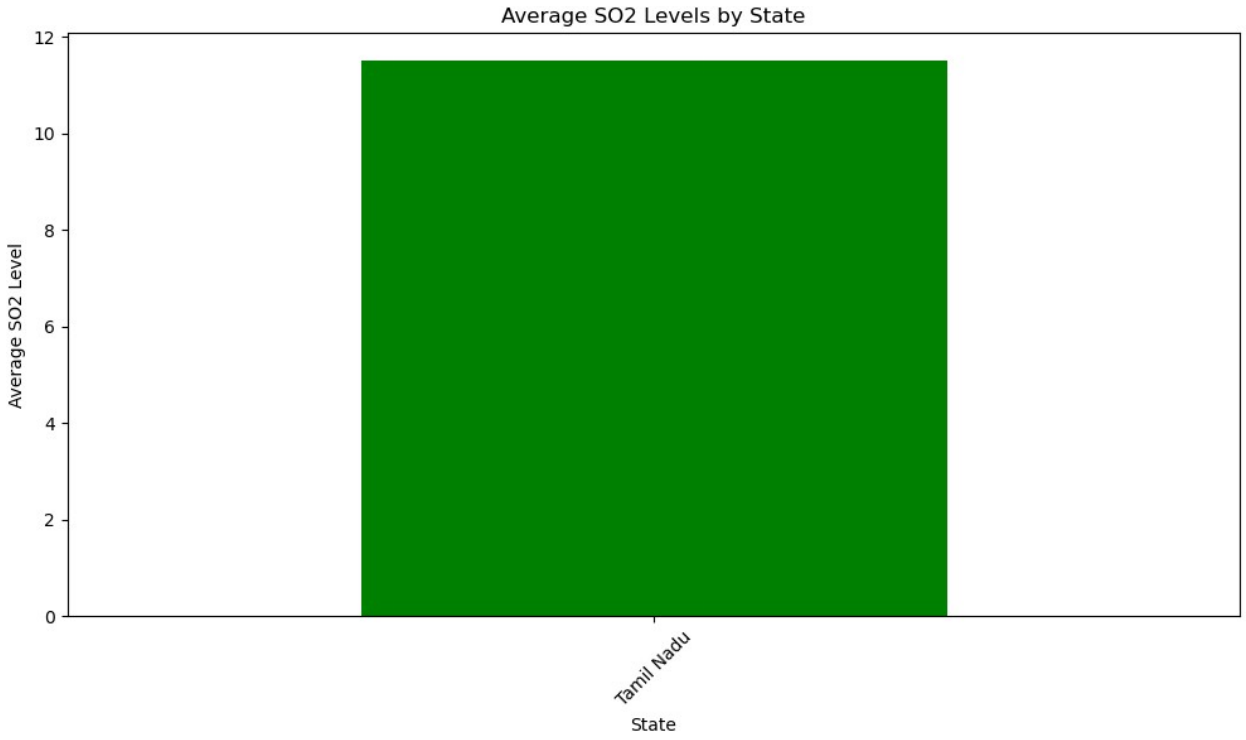
1.Scatter plot of NO2 vs. RSPM/PM10

```
plt.figure(figsize=(10, 6))
sns.scatterplot(x='NO2', y='RSPM/PM10', data=dataset)
plt.title('Scatter Plot of NO2 vs. RSPM/PM10')
plt.xlabel('NO2 Levels')
plt.ylabel('RSPM/PM10 Levels')
plt.show()
```



2.Bar chart for State-wise SO2 levels

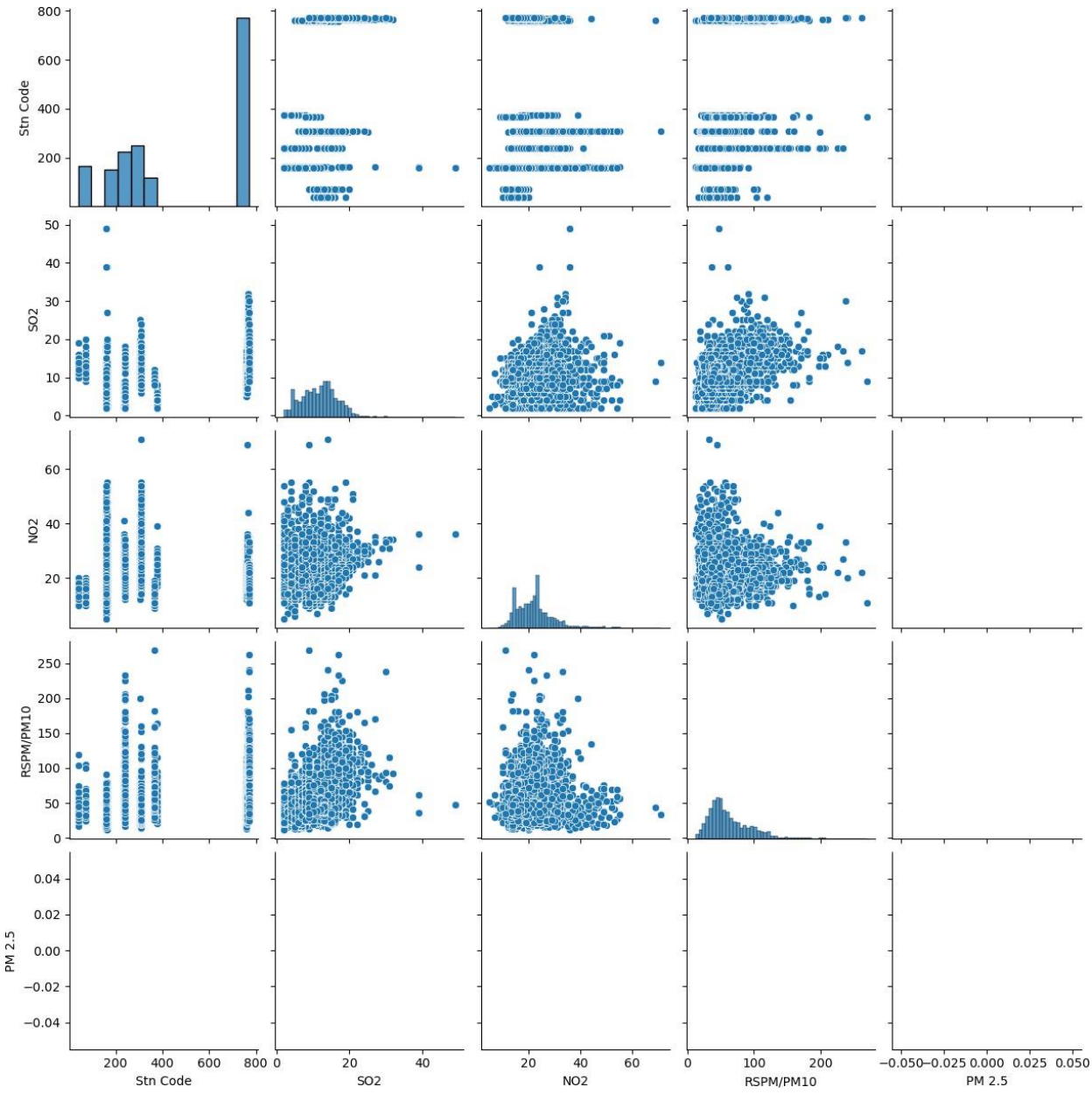
```
statewise_so2 = dataset.groupby('State')
['SO2'].mean().sort_values(ascending=False)
plt.figure(figsize=(12, 6))
statewise_so2.plot(kind='bar', color='green')
plt.title('Average SO2 Levels by State')
plt.xlabel('State')
plt.ylabel('Average SO2 Level')
plt.xticks(rotation=45)
plt.show()
```




```
plt.figure(figsize=(12,8))
sns.pairplot(dataset)
```

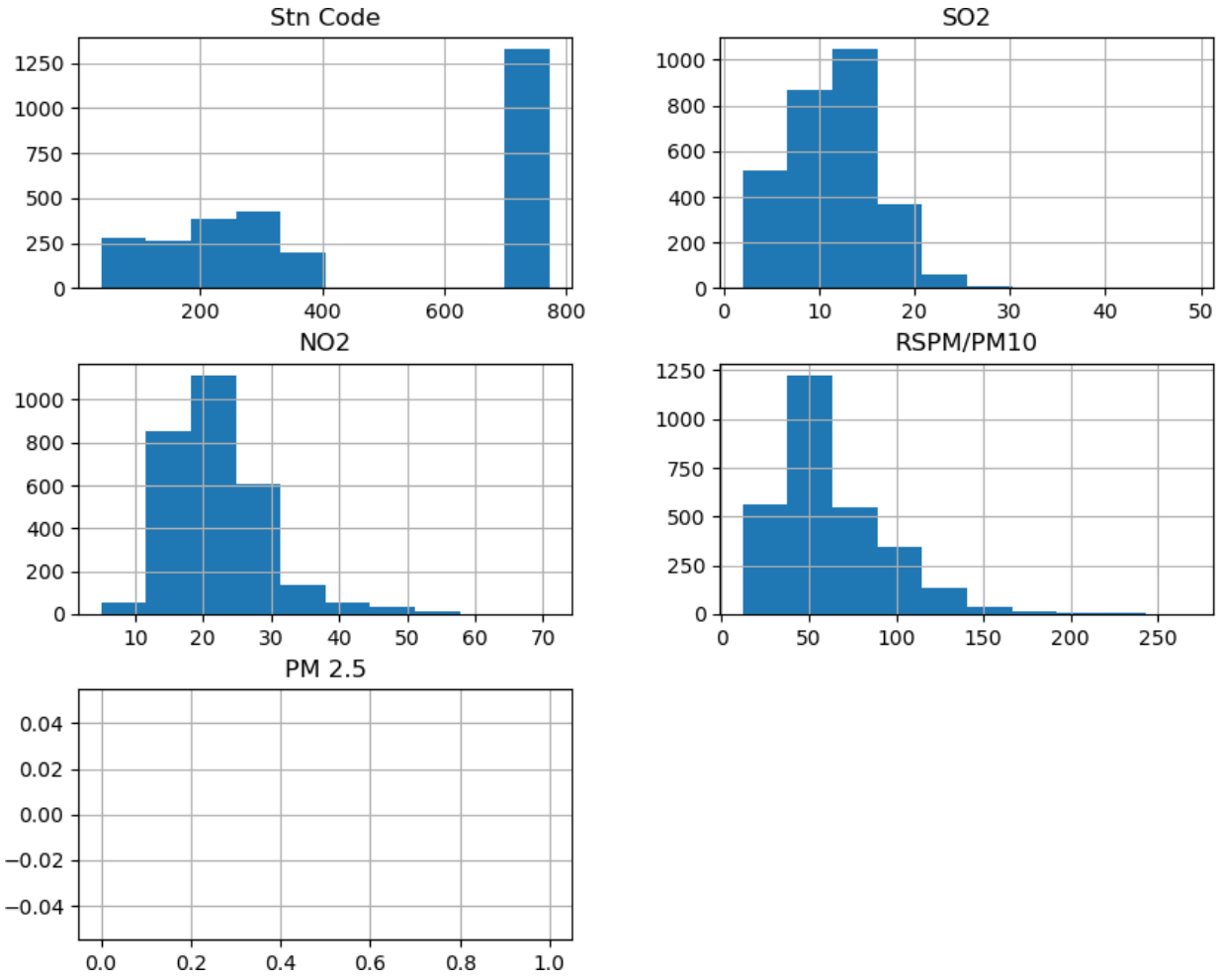
```
<seaborn.axisgrid.PairGrid at 0x207303588e0>
```

```
<Figure size 1200x800 with 0 Axes>
```




```
dataset.hist(figsize=(10,8))
```

```
array([[<AxesSubplot:title={'center':'Stn Code'}>,
        <AxesSubplot:title={'center':'SO2'}>],
       [<AxesSubplot:title={'center':'NO2'}>,
        <AxesSubplot:title={'center':'RSPM/PM10'}>],
       [<AxesSubplot:title={'center':'PM 2.5'}>, <AxesSubplot:>]],
      dtype=object)
```



Visualising Correlation:

```
dataset.corr()
```

	Stn Code	SO2	NO2	RSPM/PM10	PM 2.5
Stn Code	1.000000	0.263537	-0.043257	0.336190	NaN
SO2	0.263537	1.000000	0.078246	0.445152	NaN
NO2	-0.043257	0.078246	1.000000	0.068277	NaN
RSPM/PM10	0.336190	0.445152	0.068277	1.000000	NaN
PM 2.5	NaN	NaN	NaN	NaN	NaN

calculating Averages:

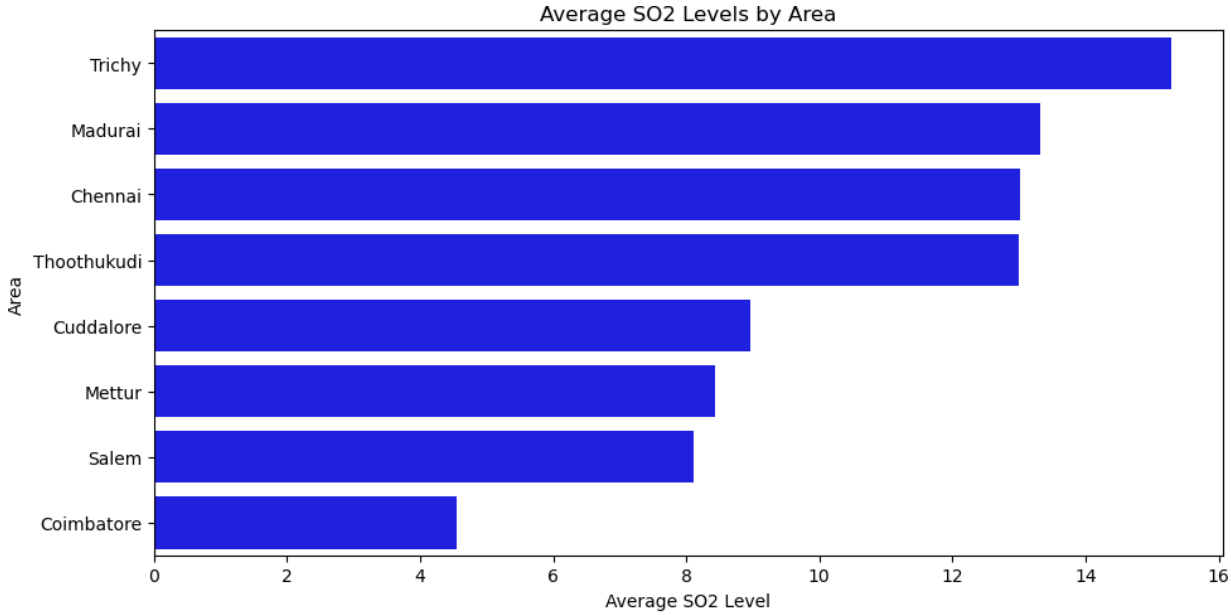
```
so2_by_area = dataset.groupby('City/Town/Village/Area')
['SO2'].mean().sort_values(ascending=False)
```

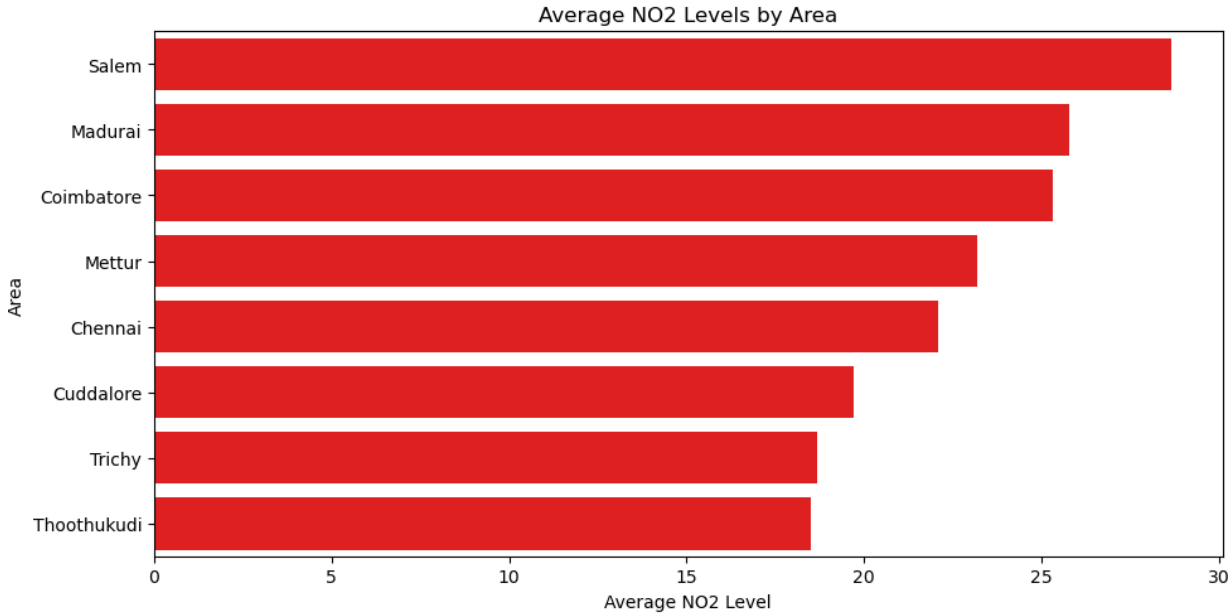
```
no2_by_area = dataset.groupby('City/Town/Village/Area')
['NO2'].mean().sort_values(ascending=False)


rspm_pm10_by_area = dataset.groupby('City/Town/Village/Area')
['RSPM/PM10'].mean().sort_values(ascending=False)
print("Average SO2 levels by City/Town/Village/Area:")
print(so2_by_area)

print("\nAverage NO2 levels by City/Town/Village/Area:")
print(no2_by_area)

print("\nAverage RSPM/PM10 levels by City/Town/Village/Area:")
print(rspm_pm10_by_area)
```

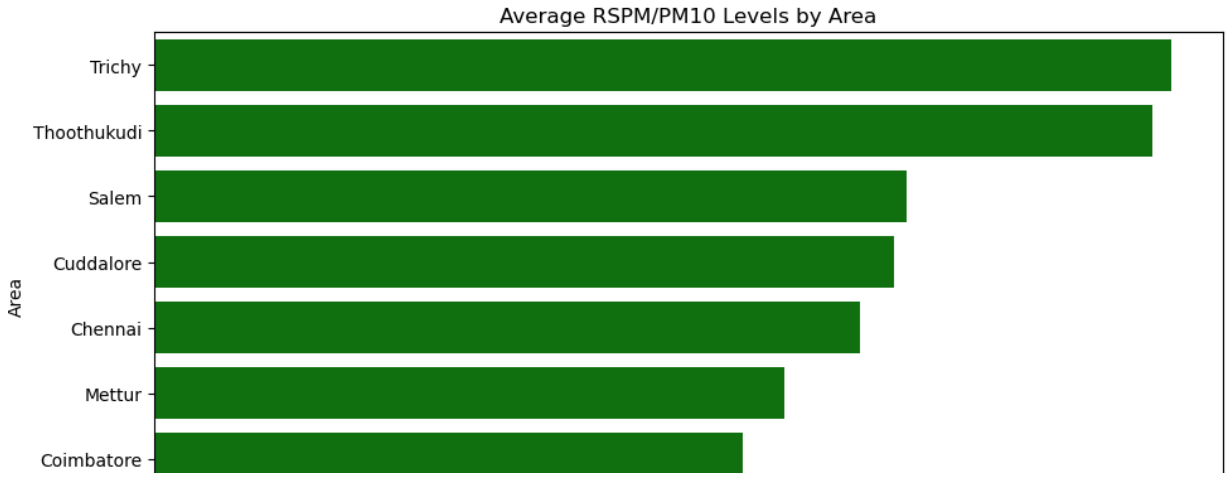
```
Average SO2 levels by City/Town/Village/Area:
City/Town/Village/Area
Trichy          15.293956
Madurai         13.319728
Chennai         13.014042
Thoothukudi     12.989691
Cuddalore        8.965986
Mettur           8.429268
Salem            8.114504
Coimbatore       4.541096
Name: SO2, dtype: float64

Average NO2 levels by City/Town/Village/Area:
City/Town/Village/Area
Salem           28.664122
Madurai         25.768707
Coimbatore      25.325342
Mettur          23.185366
Chennai         22.088442
Cuddalore       19.710884
Trichy          18.695055
Thoothukudi     18.512027
Name: NO2, dtype: float64

Average RSPM/PM10 levels by City/Town/Village/Area:
City/Town/Village/Area
Trichy          85.054496
Thoothukudi     83.458904
Salem           62.954198
Cuddalore       61.881757
Chennai         58.998000
Mettur          52.721951
Coimbatore      49.217241
Madurai         45.724490
Name: RSPM/PM10, dtype: float64
```

creating visualization:

```
import matplotlib.pyplot as plt
import seaborn as sns


so2_by_area = dataset.groupby('City/Town/Village/Area')
['SO2'].mean().sort_values(ascending=False)
no2_by_area = dataset.groupby('City/Town/Village/Area')
['NO2'].mean().sort_values(ascending=False)
rspm_pm10_by_area = dataset.groupby('City/Town/Village/Area')
['RSPM/PM10'].mean().sort_values(ascending=False)

fig, axes = plt.subplots(3, 1, figsize=(10, 15))

sns.barplot(x=so2_by_area.values, y=so2_by_area.index, ax=axes[0],
color='blue')
axes[0].set_title('Average SO2 Levels by Area')
axes[0].set_xlabel('Average SO2 Level')
axes[0].set_ylabel('Area')


sns.barplot(x=no2_by_area.values, y=no2_by_area.index, ax=axes[1],
color='red')
axes[1].set_title('Average NO2 Levels by Area')
axes[1].set_xlabel('Average NO2 Level')
axes[1].set_ylabel('Area')


sns.barplot(x=rspm_pm10_by_area.values, y=rspm_pm10_by_area.index,
ax=axes[2], color='green')
axes[2].set_title('Average RSPM/PM10 Levels by Area')
axes[2].set_xlabel('Average RSPM/PM10 Level')
axes[2].set_ylabel('Area')

plt.tight_layout()
plt.show()
```


Average SO2 Levels by Area
Trichy
Madurai
Chennai
Thoothukudi
Cuddalore
Mettur
Salem
Coimbatore
Area
0
2
4
6
8
10
12
14
16
Average SO2 Level


Average NO2 Levels by Area
Salem
Madurai
Coimbatore
Mettur
Chennai
Cuddalore
Trichy
Thoothukudi
Area
0
5
10
15
20
25
30
Average NO2 Level


Average RSPM/PM10 Levels by Area
Trichy
Thoothukudi
Salem
Cuddalore
Chennai
Mettur
Coimbatore
Area

Insights into air pollution:

* The histogram of SO2 levels indicates the distribution of this pollutant, helping to identify the range of SO2 levels recorded.

* The scatter plot of NO2 vs. RSPM/PM10 can reveal any potential correlations or patterns between these two pollutants.

* State-wise SO2 level comparisons show which areas within Tamil Nadu experience higher average SO2 pollution.

* The correlation matrix helps in understanding the relationships between different pollutants, which can be crucial for identifying potential sources of pollution.

* Average pollutant levels by area provide a clear picture of pollution disparities within Tamil Nadu, helping to pinpoint areas that might require more attention in terms of air quality management.

The combination of data exploration, visualization, and statistical analysis in this code offers a comprehensive overview of air pollution trends and pollution levels in Tamil Nadu, which can be valuable for policymakers and researchers working to address air quality issues in the region.

Conclusion:

The analysis provides an overview of air quality in Tamil Nadu for the year 2014.It shows the distribution of SO2 levels and the relationship between NO2 and RSPM/PM10 levels.The bar chart highlighting the average SO2 levels by state identifies regions with higher pollution levels, which can be used for further investigation and targeted interventions.The analysis of average levels by City/Town/Village/Area allows for a localized understanding of air quality, which can be valuable for local authorities and residents.The correlation analysis can help in identifying any significant relationships between air quality parameters, which can inform policies and actions to improve air quality.