ads-phase5

November 1, 2023

1 Project Objectives:

#The project's objective was to analyze air quality in Tamil Nadu by examining historical data, with a focus on SO2, NO2, and RSPM/PM10 levels. We implemented data preprocessing, visualization, and linear regression modeling. Example outputs include time series plots and predictive models.

#This analysis offers insights into trends, showing fluctuations in pollutant levels over time. The code aids in estimating air quality, providing valuable information for understanding and managing pollution in Tamil Nadu.

2 ANALYSIS

3 The analysis of air quality data in Tamil Nadu offers valuable insights into air pollution trends and pollution levels in the region in the following ways:

#**Temporal Trends:** #By visualizing time series data for pollutants like SO2, NO2, and RSPM/PM10, the analysis reveals how pollution levels change over time. Patterns, fluctuations, and long-term trends become apparent, aiding in understanding the impact of various factors on air quality.

#**Spatial Variations:** #Heatmaps and location-based visualizations show variations in pollutant levels across different monitoring stations in Tamil Nadu. This helps identify areas with consistently high or low pollution, which can inform policy decisions and resource allocation.

#**Statistical Summaries:** #Summary statistics and box plots provide a comprehensive view of the distribution of pollutant concentrations. Mean, median, and standard deviation values, as well as potential outliers, offer insights into the central tendency and variability of air pollution levels.

#**Regression Modeling:** #The linear regression model for estimating RSPM/PM10 levels based on SO2 and NO2 concentrations allows us to make predictions and understand how these key pollutants contribute to particulate matter in the air. This can be crucial for pollution control efforts.

#Overall, the analysis enables stakeholders, policymakers, and researchers to gain a deeper understanding of air pollution trends in Tamil Nadu. This understanding can drive informed decisions and interventions to improve air quality, protect public health, and mitigate environmental impacts.

```
[ ]: import pandas as pd
     import matplotlib.pyplot as plt
```

```
[ ]: # Assuming your data is in a CSV file
     data = pd.read_csv('/content/cpcb_dly_aq_tamil_nadu-2014 (1).csv')
```

4 Data Preprocessing:

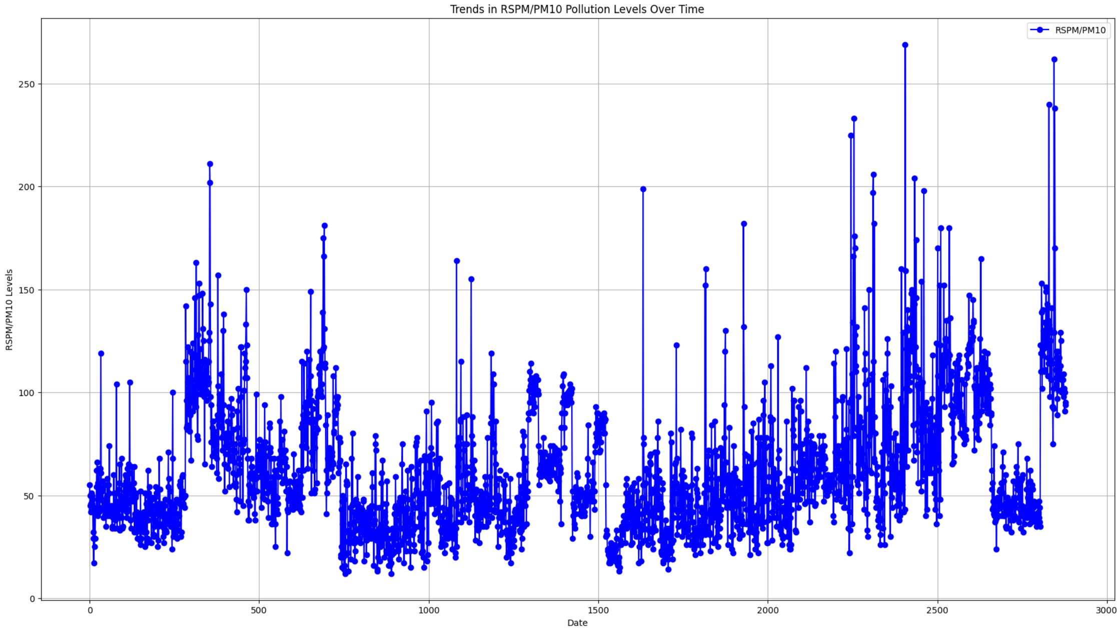
# We cleaned and structured the air quality dataset, handling missing values and data format conversions.

```
[ ]: # Display basic statistics
     print(data.describe())

     # Check for missing values
     print(data.isnull().sum())

     # Check unique values in categorical columns
     print(data['State'].unique())
     print(data['City/Town/Village/Area'].unique())
     # ... Repeat for other categorical columns
```

```
          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
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
['Tamil Nadu']
['Chennai' 'Coimbatore' 'Cuddalore' 'Madurai' 'Mettur' 'Salem'
 'Thoothukudi' 'Trichy']
```

[ ]:

```
import matplotlib.pyplot as plt
# Plot a line chart for RSPM/PM10 levels over time
plt.figure(figsize=(22,12))
plt.plot(data.index, data['RSPM/PM10'], marker='o', linestyle='-', color='b',␣
 ↪label='RSPM/PM10')
plt.xlabel('Date')
plt.ylabel('RSPM/PM10 Levels')
plt.title('Trends in RSPM/PM10 Pollution Levels Over Time')
plt.grid(True)
plt.legend()
plt.show()
```



5 Groups the air quality data by date

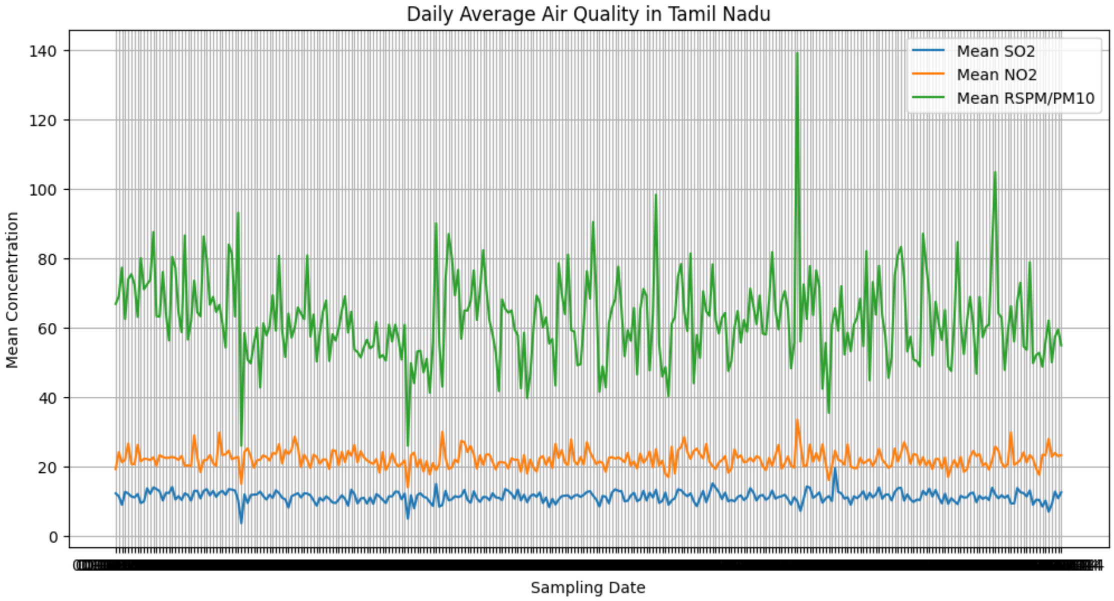
6 Calculates the mean values for SO2, NO2, and RSPM/PM10, and plots the daily average air quality in Tamil Nadu. The line chart provides a clear visualization of how these pollutant concentrations vary over time, aiding in understanding daily air quality trends and fluctuations.

[ ]:

```
# Group data by date and calculate mean values
daily_mean = data.groupby('Sampling Date').mean()

# Plot daily average air quality
```

```
plt.figure(figsize=(12, 6))
plt.plot(daily_mean.index, daily_mean['SO2'], label='Mean SO2')
plt.plot(daily_mean.index, daily_mean['NO2'], label='Mean NO2')
plt.plot(daily_mean.index, daily_mean['RSPM/PM10'], label='Mean RSPM/PM10')
plt.xlabel('Sampling Date')
plt.ylabel('Mean Concentration')
plt.title('Daily Average Air Quality in Tamil Nadu')
plt.legend()
plt.grid(True)
plt.show()
```

```
<ipython-input-5-4b27baf3318f>:2: FutureWarning: The default value of
numeric_only in DataFrameGroupBy.mean is deprecated. In a future version,
numeric_only will default to False. Either specify numeric_only or select only
columns which should be valid for the function.
  daily_mean = data.groupby('Sampling Date').mean()
```

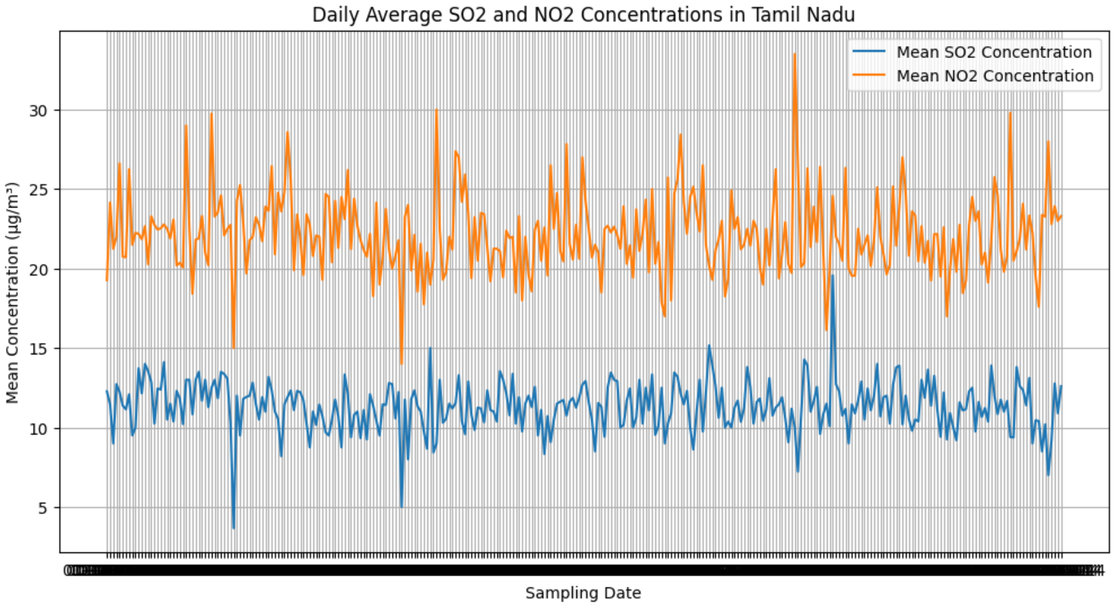


7 Concentrations of Sulfur Dioxide (SO2) and Nitrogen Dioxide (NO2)

#Calculates the daily average concentrations of Sulfur Dioxide (SO2) and Nitrogen Dioxide (NO2) in Tamil Nadu. The resulting line chart provides insights into how these pollutants' levels change over time. It aids in visualizing and understanding the variations in SO2 and NO2 concentrations, essential for monitoring air quality in the region.

[ ]:

```
# Calculate daily average SO2 and NO2 concentrations for all monitoring stations
daily_mean = data.groupby('Sampling Date')[['SO2', 'NO2']].mean()

# Plot daily average SO2 and NO2 concentrations
plt.figure(figsize=(12, 6))
plt.plot(daily_mean.index, daily_mean['SO2'], label='Mean SO2 Concentration')
plt.plot(daily_mean.index, daily_mean['NO2'], label='Mean NO2 Concentration')
plt.xlabel('Sampling Date')
plt.ylabel('Mean Concentration (µg/m³)')  # Units may vary based on your data
plt.title('Daily Average SO2 and NO2 Concentrations in Tamil Nadu')
plt.legend()
plt.grid(True)
plt.show()
```



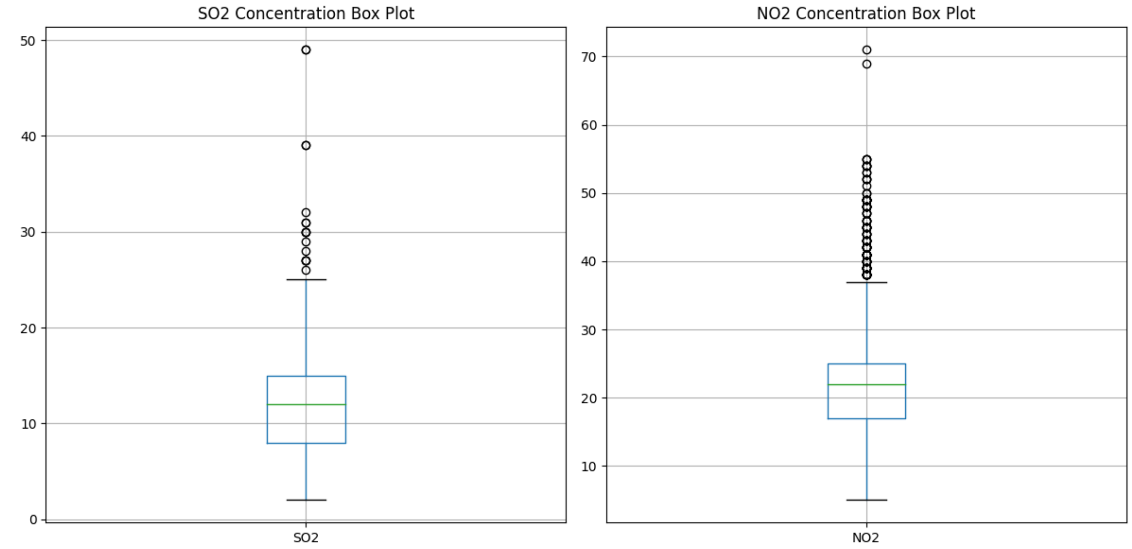
8 Displays statistics for Sulfur Dioxide (SO2) and Nitrogen Dioxide (NO2) concentrations

# computes and displays statistics for Sulfur Dioxide (SO2) and Nitrogen Dioxide (NO2) concentrations. It generates two box plots, one for SO2 and the other for NO2. These plots help visualize the distribution of concentration values, showing the central tendency, spread, and potential outliers in the data, aiding in the identification of extreme values and data variability.

[ ]:

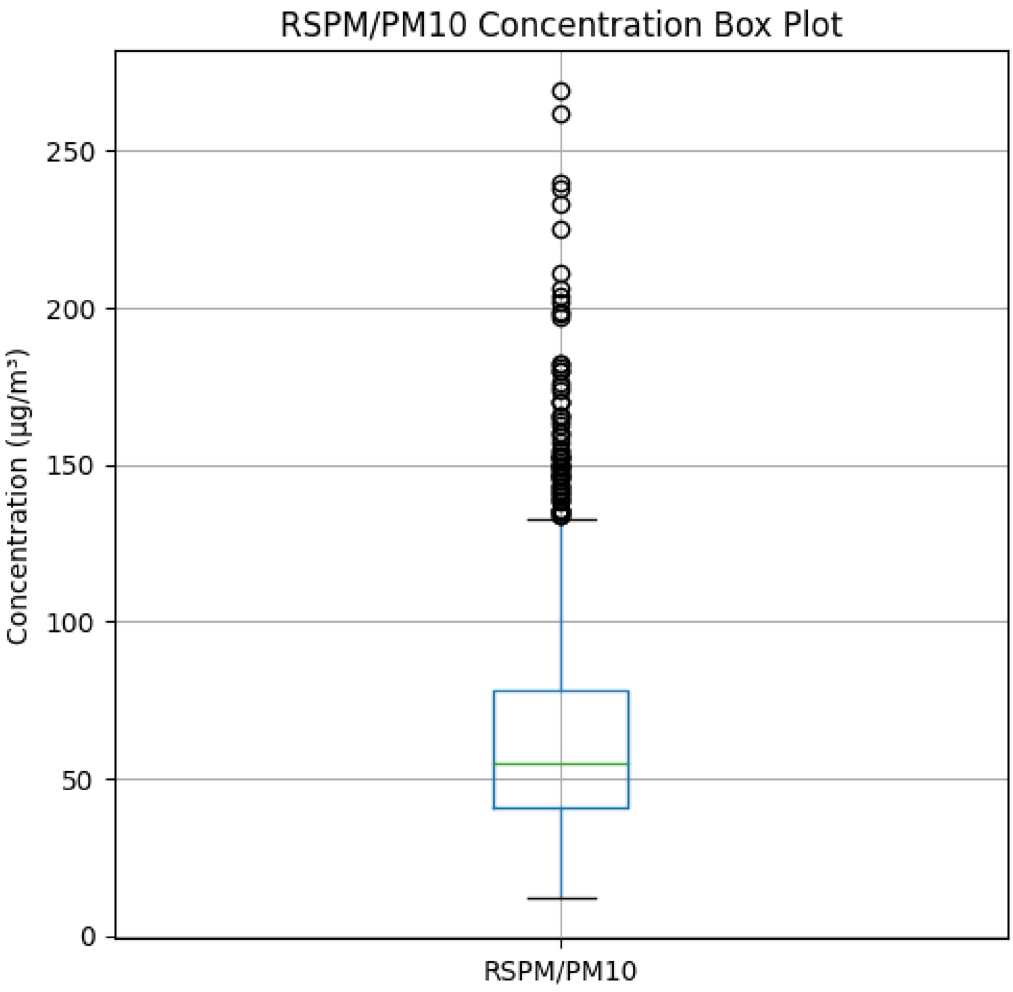
```
# Summary statistics
so2_stats = data['SO2'].describe()
no2_stats = data['NO2'].describe()
```

```python
# Box plots to visualize the distribution and identify outliers
plt.figure(figsize=(12, 6))
plt.subplot(1, 2, 1)
data.boxplot(column='SO2')
plt.title('SO2 Concentration Box Plot')

plt.subplot(1, 2, 2)
data.boxplot(column='NO2')
plt.title('NO2 Concentration Box Plot')

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



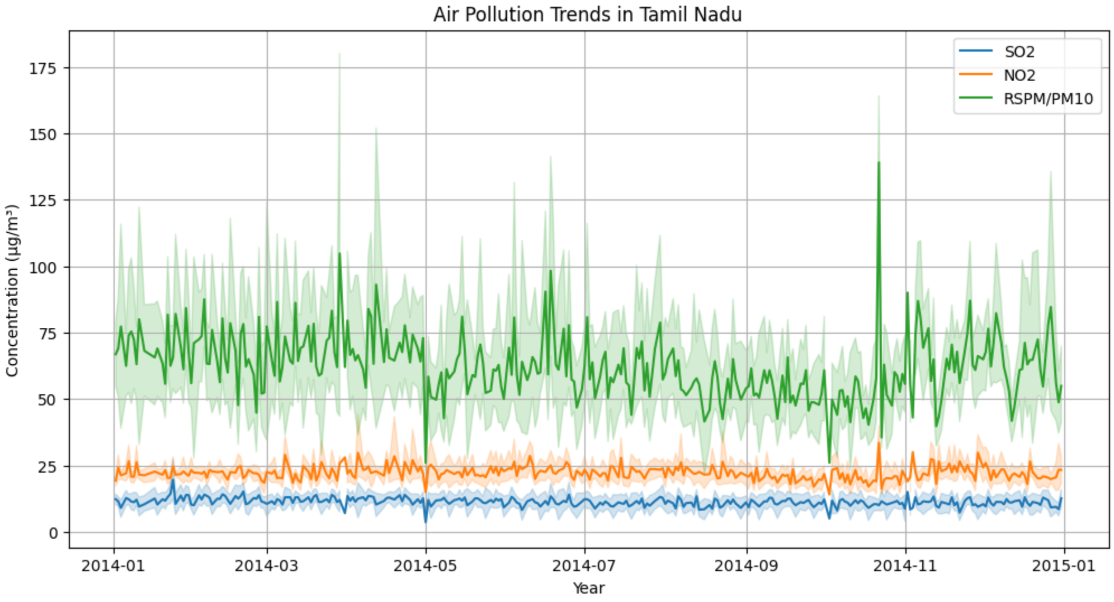
[ ]:

```python
# Summary statistics
rspm_pm10_stats = data['RSPM/PM10'].describe()

# Box plot to visualize the distribution and identify outliers
plt.figure(figsize=(6, 6))
data.boxplot(column='RSPM/PM10')
plt.title('RSPM/PM10 Concentration Box Plot')
plt.ylabel('Concentration (µg/m³)')  # Units may vary based on your data
plt.grid(True)
plt.show()
```



[ ]:
```python
import seaborn as sns

# Preprocess the data
# - Convert the 'Sampling Date' column to datetime format
data['Sampling Date'] = pd.to_datetime(data['Sampling Date'])
# - Filter data for Tamil Nadu
tn_data = data[data['State'] == 'Tamil Nadu']

# Visualize trends in air pollution over time
plt.figure(figsize=(12, 6))

# Plot time series of SO2, NO2, and RSPM/PM10 concentrations
for pollutant in ['SO2', 'NO2', 'RSPM/PM10']:
    sns.lineplot(data=tn_data, x='Sampling Date', y=pollutant, label=pollutant)

plt.xlabel('Year')
plt.ylabel('Concentration (µg/m³)')
plt.title('Air Pollution Trends in Tamil Nadu')
plt.legend()
plt.grid(True)
plt.show()
```

```
<ipython-input-9-8fdd52923255>:5: UserWarning: Parsing dates in DD/MM/YYYY
format when dayfirst=False (the default) was specified. This may lead to
inconsistently parsed dates! Specify a format to ensure consistent parsing.
  data['Sampling Date'] = pd.to_datetime(data['Sampling Date'])
```

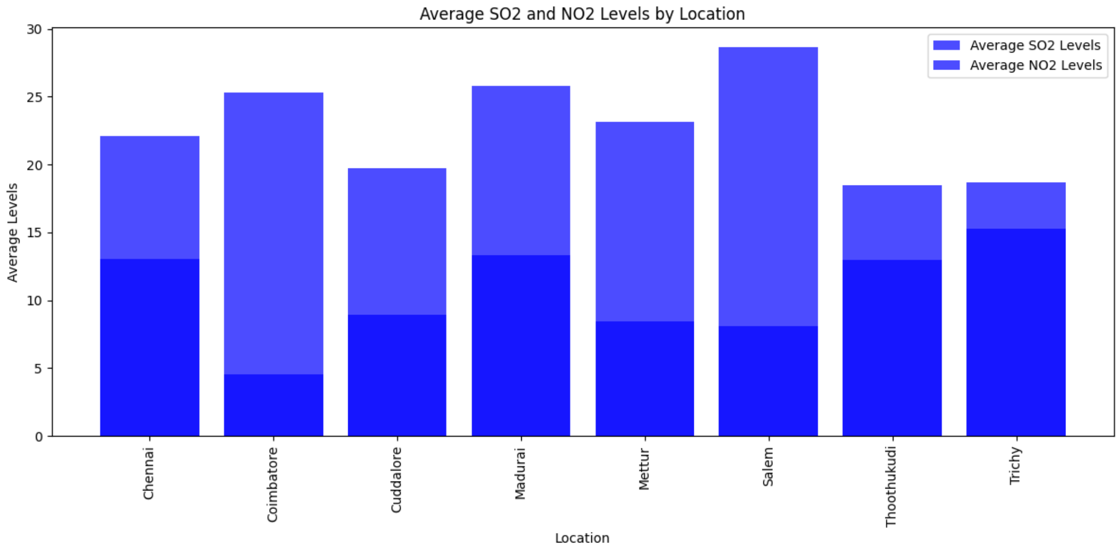


9 Data Visualization:

10 We used Matplotlib and Seaborn to create visualizations such as time series plots to explore pollutant trends.

```
[ ]: import matplotlib.pyplot as plt

avg_so2_no2_by_location = data.groupby('City/Town/Village/Area')[['SO2',␣
 ↪'NO2']].mean().reset_index()

# Create a bar chart for average SO2 levels by location
plt.figure(figsize=(12, 6))
plt.bar(avg_so2_no2_by_location['City/Town/Village/Area'],␣
 ↪avg_so2_no2_by_location['SO2'], label='Average SO2 Levels', alpha=0.7,␣
 ↪color='b')
```

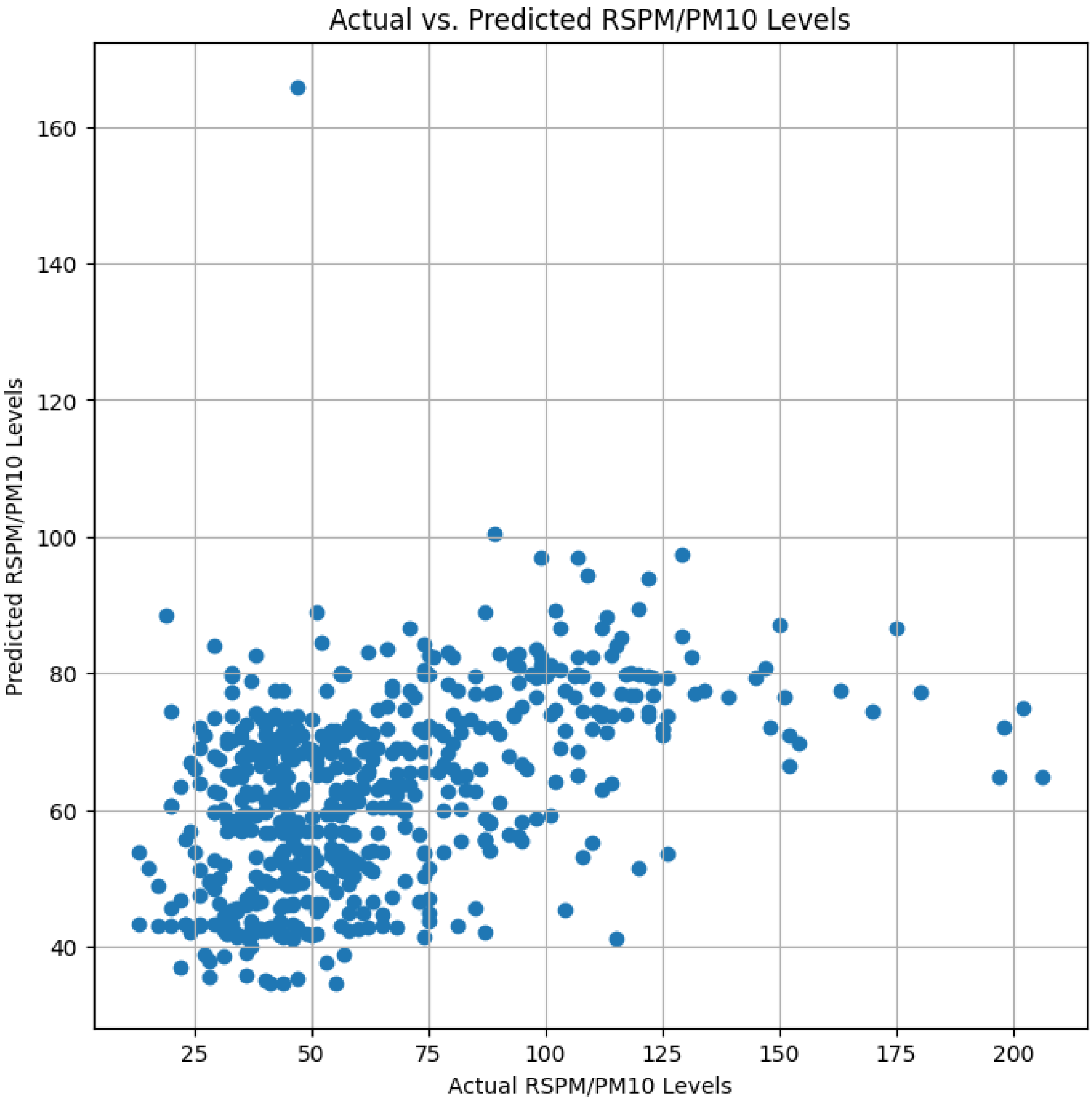
```
# Create a bar chart for average NO2 levels by location
plt.bar(avg_so2_no2_by_location['City/Town/Village/Area'],␣
 ↪avg_so2_no2_by_location['NO2'], label='Average NO2 Levels', alpha=0.7,␣
 ↪color='b')

plt.xlabel('Location')
plt.ylabel('Average Levels')
plt.title('Average SO2 and NO2 Levels by Location')
plt.xticks(rotation=90)  # Rotate x-axis labels for better readability
plt.legend()
plt.tight_layout()
plt.show()
```



[ ]:
```
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score

# Preprocess the data and select relevant columns
data['Sampling Date'] = pd.to_datetime(data['Sampling Date'])
tn_data = data[data['State'] == 'Tamil Nadu']
selected_columns = ['SO2', 'NO2', 'RSPM/PM10']
tn_data = tn_data[selected_columns].dropna()  # Remove rows with missing values

# Split the data into training and testing sets
X = tn_data[['SO2', 'NO2']]
y = tn_data['RSPM/PM10']
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)

# Create and train a linear regression model
model = LinearRegression()
model.fit(X_train, y_train)

# Make predictions on the test set
y_pred = model.predict(X_test)

# Evaluate the model
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print(f'Mean Squared Error: {mse}')
print(f'R-squared (Coefficient of Determination): {r2}')

# Plot the predicted vs. actual values
plt.figure(figsize=(8, 8))
plt.scatter(y_test, y_pred)
plt.xlabel('Actual RSPM/PM10 Levels')
plt.ylabel('Predicted RSPM/PM10 Levels')
plt.title('Actual vs. Predicted RSPM/PM10 Levels')
plt.grid(True)
plt.show()
```

```
Mean Squared Error: 835.4788249190386
R-squared (Coefficient of Determination): 0.20658507746336507
```



```
[ ]: !pip install folium geopandas
```

```
Requirement already satisfied: folium in /usr/local/lib/python3.10/dist-packages
(0.14.0)
Requirement already satisfied: geopandas in /usr/local/lib/python3.10/dist-
packages (0.13.2)
Requirement already satisfied: branca>=0.6.0 in /usr/local/lib/python3.10/dist-
packages (from folium) (0.6.0)
Requirement already satisfied: jinja2>=2.9 in /usr/local/lib/python3.10/dist-
packages (from folium) (3.1.2)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages
(from folium) (1.23.5)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-
```

```
packages (from folium) (2.31.0)
Requirement already satisfied: fiona>=1.8.19 in /usr/local/lib/python3.10/dist-
packages (from geopandas) (1.9.5)
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-
packages (from geopandas) (23.2)
Requirement already satisfied: pandas>=1.1.0 in /usr/local/lib/python3.10/dist-
packages (from geopandas) (1.5.3)
Requirement already satisfied: pyproj>=3.0.1 in /usr/local/lib/python3.10/dist-
packages (from geopandas) (3.6.1)
Requirement already satisfied: shapely>=1.7.1 in /usr/local/lib/python3.10/dist-
packages (from geopandas) (2.0.2)
Requirement already satisfied: attrs>=19.2.0 in /usr/local/lib/python3.10/dist-
packages (from fiona>=1.8.19->geopandas) (23.1.0)
Requirement already satisfied: certifi in /usr/local/lib/python3.10/dist-
packages (from fiona>=1.8.19->geopandas) (2023.7.22)
Requirement already satisfied: click~=8.0 in /usr/local/lib/python3.10/dist-
packages (from fiona>=1.8.19->geopandas) (8.1.7)
Requirement already satisfied: click-plugins>=1.0 in
/usr/local/lib/python3.10/dist-packages (from fiona>=1.8.19->geopandas) (1.1.1)
Requirement already satisfied: cligj>=0.5 in /usr/local/lib/python3.10/dist-
packages (from fiona>=1.8.19->geopandas) (0.7.2)
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages
(from fiona>=1.8.19->geopandas) (1.16.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.10/dist-
packages (from fiona>=1.8.19->geopandas) (67.7.2)
Requirement already satisfied: MarkupSafe>=2.0 in
/usr/local/lib/python3.10/dist-packages (from jinja2>=2.9->folium) (2.1.3)
Requirement already satisfied: python-dateutil>=2.8.1 in
/usr/local/lib/python3.10/dist-packages (from pandas>=1.1.0->geopandas) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-
packages (from pandas>=1.1.0->geopandas) (2023.3.post1)
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.10/dist-packages (from requests->folium) (3.3.1)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-
packages (from requests->folium) (3.4)
Requirement already satisfied: urllib3<3,>=1.21.1 in
/usr/local/lib/python3.10/dist-packages (from requests->folium) (2.0.7)
```

[ ]:

```
!pip install gmaps
```

```
Collecting gmaps
  Downloading gmaps-0.9.0.tar.gz (1.1 MB)
                           1.1/1.1 MB
8.2 MB/s eta 0:00:00
  Preparing metadata (setup.py) … done
Requirement already satisfied: ipython>=5.3.0 in /usr/local/lib/python3.10/dist-
packages (from gmaps) (7.34.0)
Requirement already satisfied: ipywidgets>=7.0.0 in
```

```
/usr/local/lib/python3.10/dist-packages (from gmaps) (7.7.1)
Requirement already satisfied: traitlets>=4.3.0 in
/usr/local/lib/python3.10/dist-packages (from gmaps) (5.7.1)
Collecting geojson>=2.0.0 (from gmaps)
  Downloading geojson-3.0.1-py3-none-any.whl (15 kB)
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages
(from gmaps) (1.16.0)
Requirement already satisfied: setuptools>=18.5 in
/usr/local/lib/python3.10/dist-packages (from ipython>=5.3.0->gmaps) (67.7.2)
Collecting jedi>=0.16 (from ipython>=5.3.0->gmaps)
  Downloading jedi-0.19.1-py2.py3-none-any.whl (1.6 MB)
                           1.6/1.6 MB
46.0 MB/s eta 0:00:00
Requirement already satisfied: decorator in
/usr/local/lib/python3.10/dist-packages (from ipython>=5.3.0->gmaps) (4.4.2)
Requirement already satisfied: pickleshare in /usr/local/lib/python3.10/dist-
packages (from ipython>=5.3.0->gmaps) (0.7.5)
Requirement already satisfied: prompt-toolkit!=3.0.0,!=3.0.1,<3.1.0,>=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from ipython>=5.3.0->gmaps) (3.0.39)
Requirement already satisfied: pygments in /usr/local/lib/python3.10/dist-
packages (from ipython>=5.3.0->gmaps) (2.16.1)
Requirement already satisfied: backcall in /usr/local/lib/python3.10/dist-
packages (from ipython>=5.3.0->gmaps) (0.2.0)
Requirement already satisfied: matplotlib-inline in
/usr/local/lib/python3.10/dist-packages (from ipython>=5.3.0->gmaps) (0.1.6)
Requirement already satisfied: pexpect>4.3 in /usr/local/lib/python3.10/dist-
packages (from ipython>=5.3.0->gmaps) (4.8.0)
Requirement already satisfied: ipykernel>=4.5.1 in
/usr/local/lib/python3.10/dist-packages (from ipywidgets>=7.0.0->gmaps) (5.5.6)
Requirement already satisfied: ipython-genutils~=0.2.0 in
/usr/local/lib/python3.10/dist-packages (from ipywidgets>=7.0.0->gmaps) (0.2.0)
Requirement already satisfied: widgetsnbextension~=3.6.0 in
/usr/local/lib/python3.10/dist-packages (from ipywidgets>=7.0.0->gmaps) (3.6.6)
Requirement already satisfied: jupyterlab-widgets>=1.0.0 in
/usr/local/lib/python3.10/dist-packages (from ipywidgets>=7.0.0->gmaps) (3.0.9)
Requirement already satisfied: jupyter-client in /usr/local/lib/python3.10/dist-
packages (from ipykernel>=4.5.1->ipywidgets>=7.0.0->gmaps) (6.1.12)
Requirement already satisfied: tornado>=4.2 in /usr/local/lib/python3.10/dist-
packages (from ipykernel>=4.5.1->ipywidgets>=7.0.0->gmaps) (6.3.2)
Requirement already satisfied: parso<0.9.0,>=0.8.3 in
/usr/local/lib/python3.10/dist-packages (from jedi>=0.16->ipython>=5.3.0->gmaps)
(0.8.3)
Requirement already satisfied: ptyprocess>=0.5 in
/usr/local/lib/python3.10/dist-packages (from
pexpect>4.3->ipython>=5.3.0->gmaps) (0.7.0)
Requirement already satisfied: wcwidth in /usr/local/lib/python3.10/dist-
packages (from prompt-
toolkit!=3.0.0,!=3.0.1,<3.1.0,>=2.0.0->ipython>=5.3.0->gmaps) (0.2.8)
```

```
Requirement already satisfied: notebook>=4.4.1 in
/usr/local/lib/python3.10/dist-packages (from
widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (6.5.5)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.10/dist-packages
(from notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps)
(3.1.2)
Requirement already satisfied: pyzmq<25,>=17 in /usr/local/lib/python3.10/dist-
packages (from
notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (23.2.1)
Requirement already satisfied: argon2-cffi in /usr/local/lib/python3.10/dist-
packages (from
notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (23.1.0)
Requirement already satisfied: jupyter-core>=4.6.1 in
/usr/local/lib/python3.10/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (5.4.0)
Requirement already satisfied: nbformat in /usr/local/lib/python3.10/dist-
packages (from
notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (5.9.2)
Requirement already satisfied: nbconvert>=5 in /usr/local/lib/python3.10/dist-
packages (from
notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (6.5.4)
Requirement already satisfied: nest-asyncio>=1.5 in
/usr/local/lib/python3.10/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (1.5.8)
Requirement already satisfied: Send2Trash>=1.8.0 in
/usr/local/lib/python3.10/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (1.8.2)
Requirement already satisfied: terminado>=0.8.3 in
/usr/local/lib/python3.10/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (0.17.1)
Requirement already satisfied: prometheus-client in
/usr/local/lib/python3.10/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (0.17.1)
Requirement already satisfied: nbclassic>=0.4.7 in
/usr/local/lib/python3.10/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (1.0.0)
Requirement already satisfied: python-dateutil>=2.1 in
/usr/local/lib/python3.10/dist-packages (from jupyter-
client->ipykernel>=4.5.1->ipywidgets>=7.0.0->gmaps) (2.8.2)
Requirement already satisfied: platformdirs>=2.5 in
/usr/local/lib/python3.10/dist-packages (from jupyter-core>=4.6.1->notebook>=4.4
.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (3.11.0)
Requirement already satisfied: jupyter-server>=1.8 in
/usr/local/lib/python3.10/dist-packages (from nbclassic>=0.4.7->notebook>=4.4.1-
>widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (1.24.0)
Requirement already satisfied: notebook-shim>=0.2.3 in
/usr/local/lib/python3.10/dist-packages (from nbclassic>=0.4.7->notebook>=4.4.1-
>widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (0.2.3)
```

```
Requirement already satisfied: lxml in /usr/local/lib/python3.10/dist-packages
(from nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.
0->gmaps) (4.9.3)
Requirement already satisfied: beautifulsoup4 in /usr/local/lib/python3.10/dist-
packages (from nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidg
ets>=7.0.0->gmaps) (4.11.2)
Requirement already satisfied: bleach in /usr/local/lib/python3.10/dist-packages
(from nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.
0->gmaps) (6.1.0)
Requirement already satisfied: defusedxml in /usr/local/lib/python3.10/dist-
packages (from nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidg
ets>=7.0.0->gmaps) (0.7.1)
Requirement already satisfied: entrypoints>=0.2.2 in
/usr/local/lib/python3.10/dist-packages (from nbconvert>=5->notebook>=4.4.1->wid
getsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (0.4)
Requirement already satisfied: jupyterlab-pygments in
/usr/local/lib/python3.10/dist-packages (from nbconvert>=5->notebook>=4.4.1->wid
getsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (0.2.2)
Requirement already satisfied: MarkupSafe>=2.0 in
/usr/local/lib/python3.10/dist-packages (from nbconvert>=5->notebook>=4.4.1->wid
getsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (2.1.3)
Requirement already satisfied: mistune<2,>=0.8.1 in
/usr/local/lib/python3.10/dist-packages (from nbconvert>=5->notebook>=4.4.1->wid
getsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (0.8.4)
Requirement already satisfied: nbclient>=0.5.0 in
/usr/local/lib/python3.10/dist-packages (from nbconvert>=5->notebook>=4.4.1->wid
getsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (0.8.0)
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-
packages (from nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidg
ets>=7.0.0->gmaps) (23.2)
Requirement already satisfied: pandocfilters>=1.4.1 in
/usr/local/lib/python3.10/dist-packages (from nbconvert>=5->notebook>=4.4.1->wid
getsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (1.5.0)
Requirement already satisfied: tinycss2 in /usr/local/lib/python3.10/dist-
packages (from nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidg
ets>=7.0.0->gmaps) (1.2.1)
Requirement already satisfied: fastjsonschema in /usr/local/lib/python3.10/dist-
packages (from
nbformat->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps)
(2.18.1)
Requirement already satisfied: jsonschema>=2.6 in
/usr/local/lib/python3.10/dist-packages (from
nbformat->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps)
(4.19.1)
Requirement already satisfied: argon2-cffi-bindings in
/usr/local/lib/python3.10/dist-packages (from argon2-cffi->notebook>=4.4.1->widg
etsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (21.2.0)
Requirement already satisfied: attrs>=22.2.0 in /usr/local/lib/python3.10/dist-
```

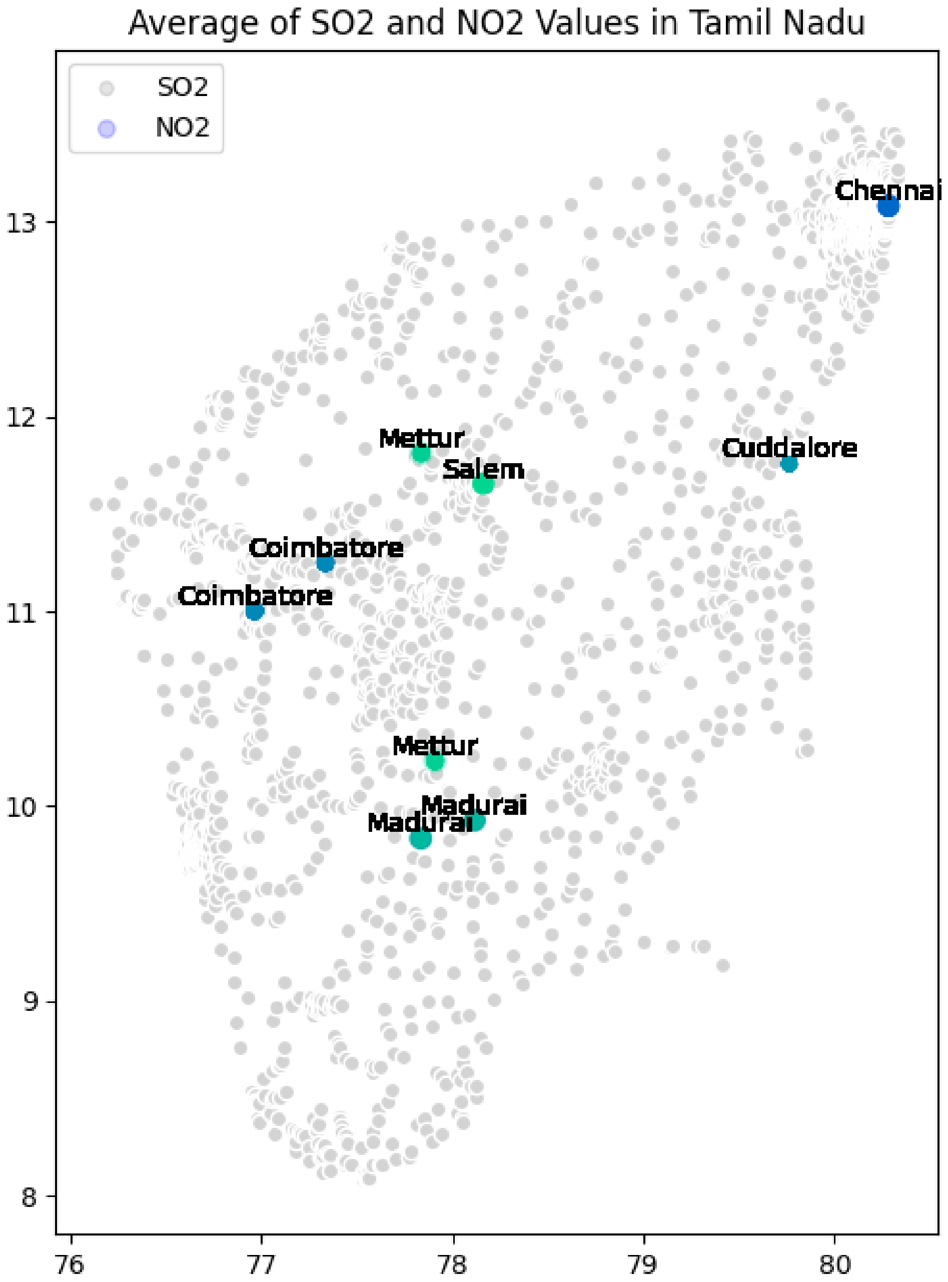
```
packages (from jsonschema>=2.6->nbformat->notebook>=4.4.1->widgetsnbextension~=3
.6.0->ipywidgets>=7.0.0->gmaps) (23.1.0)
Requirement already satisfied: jsonschema-specifications>=2023.03.6 in
/usr/local/lib/python3.10/dist-packages (from jsonschema>=2.6->nbformat->noteboo
k>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (2023.7.1)
Requirement already satisfied: referencing>=0.28.4 in
/usr/local/lib/python3.10/dist-packages (from jsonschema>=2.6->nbformat->noteboo
k>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (0.30.2)
Requirement already satisfied: rpds-py>=0.7.1 in /usr/local/lib/python3.10/dist-
packages (from jsonschema>=2.6->nbformat->notebook>=4.4.1->widgetsnbextension~=3
.6.0->ipywidgets>=7.0.0->gmaps) (0.10.6)
Requirement already satisfied: anyio<4,>=3.1.0 in
/usr/local/lib/python3.10/dist-packages (from jupyter-server>=1.8->nbclassic>=0.
4.7->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps)
(3.7.1)
Requirement already satisfied: websocket-client in
/usr/local/lib/python3.10/dist-packages (from jupyter-server>=1.8->nbclassic>=0.
4.7->notebook>=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps)
(1.6.4)
Requirement already satisfied: cffi>=1.0.1 in /usr/local/lib/python3.10/dist-
packages (from argon2-cffi-bindings->argon2-cffi->notebook>=4.4.1->widgetsnbexte
nsion~=3.6.0->ipywidgets>=7.0.0->gmaps) (1.16.0)
Requirement already satisfied: soupsieve>1.2 in /usr/local/lib/python3.10/dist-
packages (from beautifulsoup4->nbconvert>=5->notebook>=4.4.1->widgetsnbextension
~=3.6.0->ipywidgets>=7.0.0->gmaps) (2.5)
Requirement already satisfied: webencodings in /usr/local/lib/python3.10/dist-
packages (from bleach->nbconvert>=5->notebook>=4.4.1->widgetsnbextension~=3.6.0-
>ipywidgets>=7.0.0->gmaps) (0.5.1)
Requirement already satisfied: idna>=2.8 in /usr/local/lib/python3.10/dist-
packages (from anyio<4,>=3.1.0->jupyter-server>=1.8->nbclassic>=0.4.7->notebook>
=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (3.4)
Requirement already satisfied: sniffio>=1.1 in /usr/local/lib/python3.10/dist-
packages (from anyio<4,>=3.1.0->jupyter-server>=1.8->nbclassic>=0.4.7->notebook>
=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (1.3.0)
Requirement already satisfied: exceptiongroup in /usr/local/lib/python3.10/dist-
packages (from anyio<4,>=3.1.0->jupyter-server>=1.8->nbclassic>=0.4.7->notebook>
=4.4.1->widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (1.1.3)
Requirement already satisfied: pycparser in /usr/local/lib/python3.10/dist-
packages (from cffi>=1.0.1->argon2-cffi-bindings->argon2-cffi->notebook>=4.4.1->
widgetsnbextension~=3.6.0->ipywidgets>=7.0.0->gmaps) (2.21)
Building wheels for collected packages: gmaps
  Building wheel for gmaps (setup.py) … done
  Created wheel for gmaps: filename=gmaps-0.9.0-py2.py3-none-any.whl
size=2076086
sha256=40b7725c2867fe885f2fe0fd33fff84621eb01e27185d11647a72f1cab3cc5a8
  Stored in directory: /root/.cache/pip/wheels/b3/c2/dc/48b3ef16c2184dae51a003f1
7eb5d065bbbf1af3437d9f14e3
Successfully built gmaps
```

```
Installing collected packages: jedi, geojson, gmaps
Successfully installed geojson-3.0.1 gmaps-0.9.0 jedi-0.19.1
```

#In the Air Quality Analysis, incorporating Google Maps (GMap) can visually display pollution hotspots, helping users pinpoint areas with higher pollution levels. This feature enhances spatial understanding and facilitates informed decisions for better air quality management in Tamil Nadu.

[ ]:

```python
import geopandas as gpd
import matplotlib.pyplot as plt
import pandas as pd

# Load geographic boundary data for Tamil Nadu (replace 'tamil_nadu_location.shp' with the actual file path)
tamil_nadu_boundary = gpd.read_file('/content/tamil_nadu_location.shp', encoding='utf-8')


# Merge your data with the Tamil Nadu boundary data based on a common identifier (e.g., location name)
merged_data = tamil_nadu_boundary.merge(data, left_on='NAME', right_on='City/Town/Village/Area', how='right')

# Create a map with the Tamil Nadu boundary data
ax = tamil_nadu_boundary.plot(figsize=(12, 8), color='lightgray', edgecolor='white')

# Plot the locations and values on the map
merged_data.plot(ax=ax, markersize=merged_data['SO2'], alpha=0.1, legend=True, cmap='gist_heat', label = "SO2")
merged_data.plot(ax=ax, markersize=merged_data['NO2'], alpha=0.2, legend=True, cmap='winter', label = "NO2")

# Add place names as labels to the points on the map
for x, y, label in zip(merged_data.geometry.x, merged_data.geometry.y, merged_data['City/Town/Village/Area']):
   if not pd.isna(x) and not pd.isna(y):
        plt.annotate(label, (x, y), fontsize=10, ha='center', va='bottom')


plt.title('Average of SO2 and NO2 Values in Tamil Nadu')
ax.legend()
plt.show()
```


Average of SO2 and NO2 Values in Tamil Nadu
SO2
NO2
Chennai
Mettur
Salem
Cuddalore
Coimbatore
Coimbatore
Mettur
Madurai
Madurai
13
12
11
10
9
8
76
77
78
79
80

11 Linear Regression Modeling:

12 We employed a simple linear regression model to estimate RSPM/PM10 levels based on SO2 and NO2 concentrations

13 Predict Respirable Suspended Particulate Matter (RSPM/PM10) levels

14 The segment demonstrates how to use a linear regression model to predict Respirable Suspended Particulate Matter (RSPM/PM10) levels based on Sulfur Dioxide (SO2) and Nitrogen Dioxide (NO2) levels. It loads and preprocesses the data, trains a linear regression model, and then predicts RSPM/PM10 levels for new data with specified SO2 and NO2 values.

[27]:

```python
import pandas as pd
from sklearn.linear_model import LinearRegression

# Load your air quality data into a Pandas DataFrame
data = pd.read_csv('/content/cpcb_dly_aq_tamil_nadu-2014 (1).csv')

# Preprocess the data and select relevant columns
data['Sampling Date'] = pd.to_datetime(data['Sampling Date'])
tn_data = data[data['State'] == 'Tamil Nadu']
selected_columns = ['SO2', 'NO2', 'RSPM/PM10']
tn_data = tn_data[selected_columns].dropna()  # Remove rows with missing values

# Separate the features (SO2 and NO2) from the target (RSPM/PM10)
X = tn_data[['SO2', 'NO2']]
y = tn_data['RSPM/PM10']

# Create and train a linear regression model
model = LinearRegression()
model.fit(X, y)

# Now, you can use the trained model to make predictions for new data
# Replace 'new_data' with the values of SO2 and NO2 you want to predict RSPM/
 ↪PM10 for
new_data = [[100, 200]]  # Example values for SO2 and NO2
predicted_rspm_pm10 = model.predict(new_data)

print(f'Predicted RSPM/PM10: {predicted_rspm_pm10[0]} µg/m³')
```

```
Predicted RSPM/PM10: 331.29760210728915 µg/m³
```

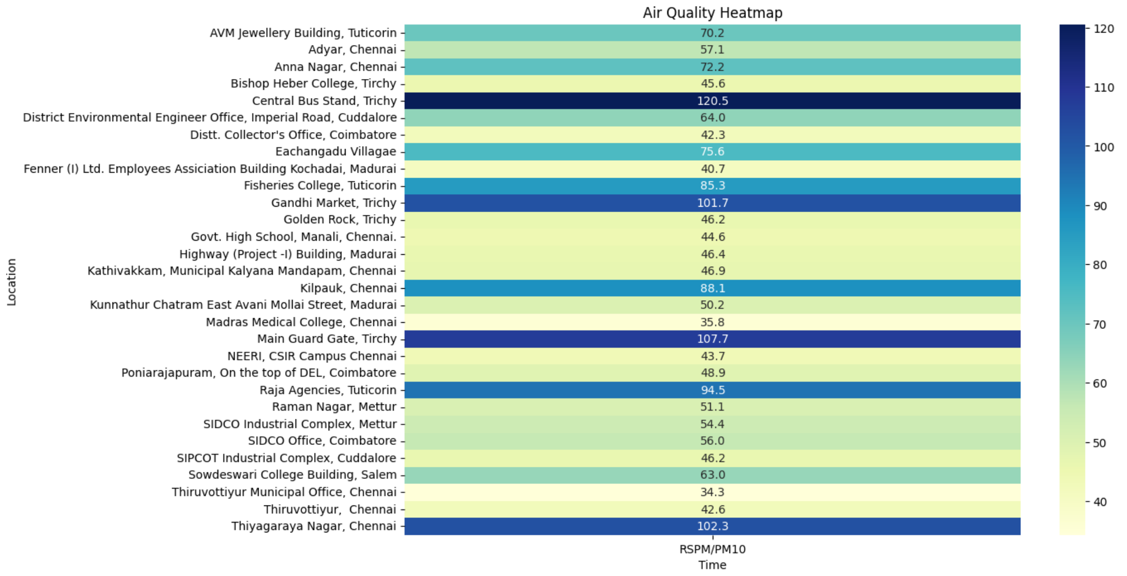
```
<ipython-input-27-3d609d8cf440>:8: UserWarning: Parsing dates in DD/MM/YYYY
format when dayfirst=False (the default) was specified. This may lead to
inconsistently parsed dates! Specify a format to ensure consistent parsing.
  data['Sampling Date'] = pd.to_datetime(data['Sampling Date'])
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does
not have valid feature names, but LinearRegression was fitted with feature names
  warnings.warn(
```

15 Heatmap to visualize pollutant levels (RSPM/PM10)

16 To loads an air quality dataset and creates a heatmap to visualize pollutant levels (RSPM/PM10) by location and time in Tamil Nadu. It uses the Seaborn library for heatmap creation. The heatmap provides a graphical representation of air quality trends across different monitoring locations over time, aiding in identifying variations and hotspots in pollution levels.

[ ]:

```python
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

# Load your air quality dataset
# Replace 'your_dataset.csv' with the actual file path
df = pd.read_csv('/content/cpcb_dly_aq_tamil_nadu-2014 (1).csv')

# Select the relevant columns for the heatmap (e.g., pollutant levels by␣
  ↪location and time)
# Replace 'Pollutant', 'Location', and 'Time' with your column names
data = df.pivot_table(index='Location of Monitoring Station', values='RSPM/
  ↪PM10')

# Create a heatmap
plt.figure(figsize=(12, 8))  # Adjust the figure size as needed
sns.heatmap(data, cmap='YlGnBu', annot=True, fmt=".1f")

# Customize the heatmap labels and title
plt.xlabel('Time')
plt.ylabel('Location')
plt.title('Air Quality Heatmap')

# Display the heatmap
plt.show()
```



[ ]:

```
import pandas as pd

# Load your CSV dataset into a DataFrame
data = pd.read_csv('/content/cpcb_dly_aq_tamil_nadu-2014 (1).csv')

# Group the data by the 'Region' column and calculate the mean for each group
grouped = data.groupby('City/Town/Village/Area')[['SO2', 'NO2', 'RSPM/PM10']].
  ↪mean()

# Display the calculated averages
print(grouped)
```

```
                              SO2        NO2  RSPM/PM10
City/Town/Village/Area
Chennai                 13.014042  22.088442  58.998000
Coimbatore               4.541096  25.325342  49.217241
Cuddalore                8.965986  19.710884  61.881757
Madurai                 13.319728  25.768707  45.724490
Mettur                   8.429268  23.185366  52.721951
Salem                    8.114504  28.664122  62.954198
Thoothukudi             12.989691  18.512027  83.458904
Trichy                  15.293956  18.695055  85.054496
```

[ ]:

```
import pandas as pd

# Load your CSV dataset into a DataFrame
data = pd.read_csv('/content/cpcb_dly_aq_tamil_nadu-2014 (1).csv')
```

```
# Group the data by the 'Region' column and calculate the mean for each group
grouped = data.groupby('Location of Monitoring Station')[['SO2', 'NO2', 'RSPM/
 ↪PM10']].mean()

# Display the calculated averages
print(grouped)
```

```
                                                          SO2        NO2  \
Location of Monitoring Station
AVM Jewellery Building, Tuticorin                    9.302083  12.697917
Adyar, Chennai                                      13.252174  18.965217
Anna Nagar, Chennai                                 13.873874  20.754545
Bishop Heber College, Tirchy                        11.800000  14.942857
Central Bus Stand, Trichy                           18.013333  21.506667
District Environmental Engineer Office, Imperia…   8.101010  19.151515
Distt. Collector's Office, Coimbatore                4.554348  25.793478
Eachangadu Villagae                                 11.916667  22.395833
Fenner (I) Ltd. Employees Assiciation Building …  13.643564  27.198020
Fisheries College, Tuticorin                        14.526882  20.204301
Gandhi Market, Trichy                               17.148649  20.797297
Golden Rock, Trichy                                 12.014085  15.000000
Govt. High School, Manali, Chennai.                 13.043011  15.408602
Highway (Project -I) Building, Madurai              11.947917  24.458333
Kathivakkam, Municipal Kalyana Mandapam, Chennai    12.925532  15.170213
Kilpauk, Chennai                                    19.232759  27.172414
Kunnathur Chatram East Avani Mollai Street, Mad…  14.340206  25.577320
Madras Medical College, Chennai                      7.418605  27.465116
Main Guard Gate, Tirchy                             17.135135  20.837838
NEERI, CSIR Campus Chennai                           5.931034  23.758621
Poniarajapuram, On the top of DEL, Coimbatore        4.126214  23.019417
Raja Agencies, Tuticorin                            15.058824  22.441176
Raman Nagar, Mettur                                  7.572816  20.407767
SIDCO Industrial Complex, Mettur                     9.294118  25.990196
SIDCO Office, Coimbatore                             4.969072  27.329897
SIPCOT Industrial Complex, Cuddalore                 6.969697  17.666667
Sowdeswari College Building, Salem                   8.114504  28.664122
Thiruvottiyur Municipal Office, Chennai              8.360465  28.069767
Thiruvottiyur,  Chennai                             13.010417  15.583333
Thiyagaraya Nagar, Chennai                          18.849558  28.250000

                                                    RSPM/PM10
Location of Monitoring Station
AVM Jewellery Building, Tuticorin                   70.175258
Adyar, Chennai                                      57.068966
Anna Nagar, Chennai                                 72.187500
Bishop Heber College, Tirchy                        45.633803
Central Bus Stand, Trichy                          120.546667
```

```
District Environmental Engineer Office, Imperia…   64.020202
Distt. Collector's Office, Coimbatore                42.322222
Eachangadu Villagae                                  75.591837
Fenner (I) Ltd. Employees Assiciation Building …   40.732673
Fisheries College, Tuticorin                         85.255319
Gandhi Market, Trichy                               101.743243
Golden Rock, Trichy                                  46.222222
Govt. High School, Manali, Chennai.                  44.612903
Highway (Project -I) Building, Madurai               46.427083
Kathivakkam, Municipal Kalyana Mandapam, Chennai     46.851064
Kilpauk, Chennai                                     88.103448
Kunnathur Chatram East Avani Mollai Street, Mad…   50.226804
Madras Medical College, Chennai                      35.837209
Main Guard Gate, Tirchy                             107.693333
NEERI, CSIR Campus Chennai                           43.678161
Poniarajapuram, On the top of DEL, Coimbatore        48.883495
Raja Agencies, Tuticorin                             94.544554
Raman Nagar, Mettur                                  51.106796
SIDCO Industrial Complex, Mettur                     54.352941
SIDCO Office, Coimbatore                             55.969072
SIPCOT Industrial Complex, Cuddalore                 46.171717
Sowdeswari College Building, Salem                   62.954198
Thiruvottiyur Municipal Office, Chennai              34.310345
Thiruvottiyur,  Chennai                              42.604167
Thiyagaraya Nagar, Chennai                          102.327434
```

[ ]:

```python
import pandas as pd

# Load your CSV dataset into a DataFrame
data = pd.read_csv('/content/cpcb_dly_aq_tamil_nadu-2014 (1).csv')

# Calculate the average pollution level for each area
data['Average_Pollution'] = data[['SO2', 'NO2', 'RSPM/PM10']].mean(axis=1)

# Sort the areas in increasing order of average pollution levels
sorted_data = data.sort_values(by='Average_Pollution',ascending = False)

# Display the sorted DataFrame
print(sorted_data[['City/Town/Village/Area', 'Average_Pollution']])
```

```
     City/Town/Village/Area  Average_Pollution
354                 Chennai         113.500000
2636                 Trichy         107.000000
438                 Chennai         102.000000
2844                 Trichy         100.333333
2846                 Trichy         100.333333
…                      …               …
1556              Cuddalore          11.333333
```

```
849                   Chennai           11.333333
1563                Cuddalore           11.333333
1557                Cuddalore           11.000000
1562                Cuddalore           10.666667

[2879 rows x 2 columns]
```