```
import pandas as pd
import matplotlib.pyplot as plt
```

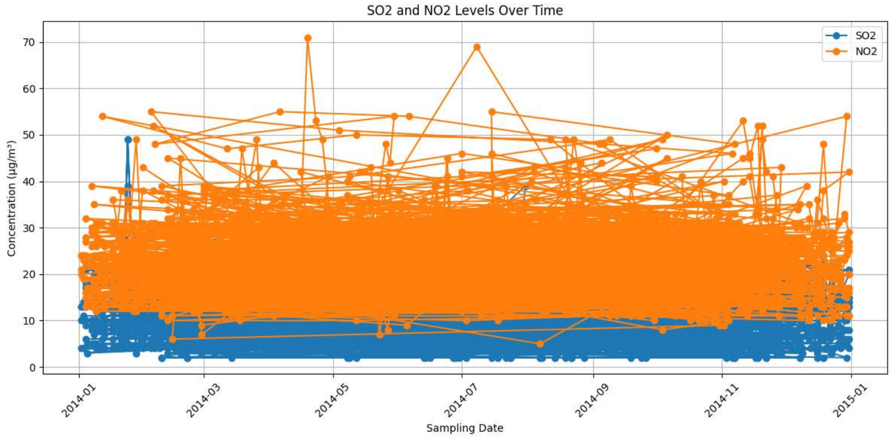
```
data_path = "/content/cpcb_dly_aq_tamil_nadu-2014.csv"
df = pd.read_csv(data_path)
```

```
df.replace("NA", float('nan'), inplace=True)
```

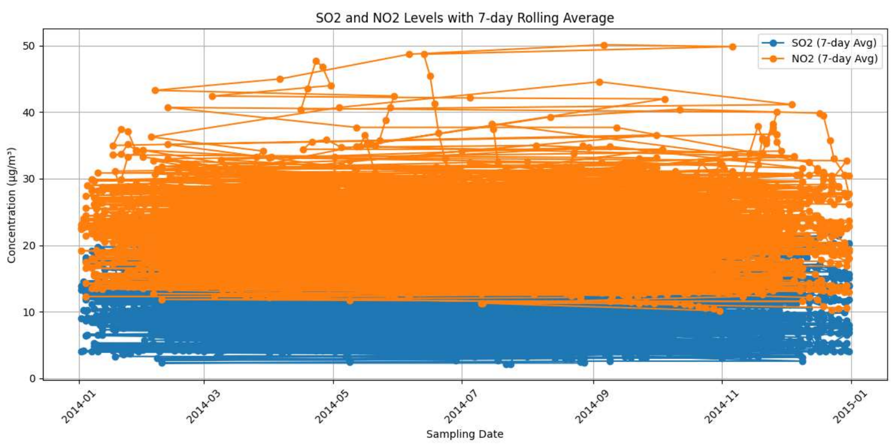
```
# Display the first few rows of the DataFrame
print(df.head())

# Get summary statistics for numerical columns
print(df.describe())
```

```
   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

                   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

                                  Agency Type of Location   SO2   NO2  \
0  Tamilnadu State Pollution Control Board  Industrial Area  11.0  17.0
1  Tamilnadu State Pollution Control Board  Industrial Area  13.0  17.0
2  Tamilnadu State Pollution Control Board  Industrial Area  12.0  18.0
3  Tamilnadu State Pollution Control Board  Industrial Area  15.0  16.0
4  Tamilnadu State Pollution Control Board  Industrial Area  13.0  14.0

   RSPM/PM10  PM 2.5
0       55.0     NaN
1       45.0     NaN
2       50.0     NaN
3       46.0     NaN
4       42.0     NaN
          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
```

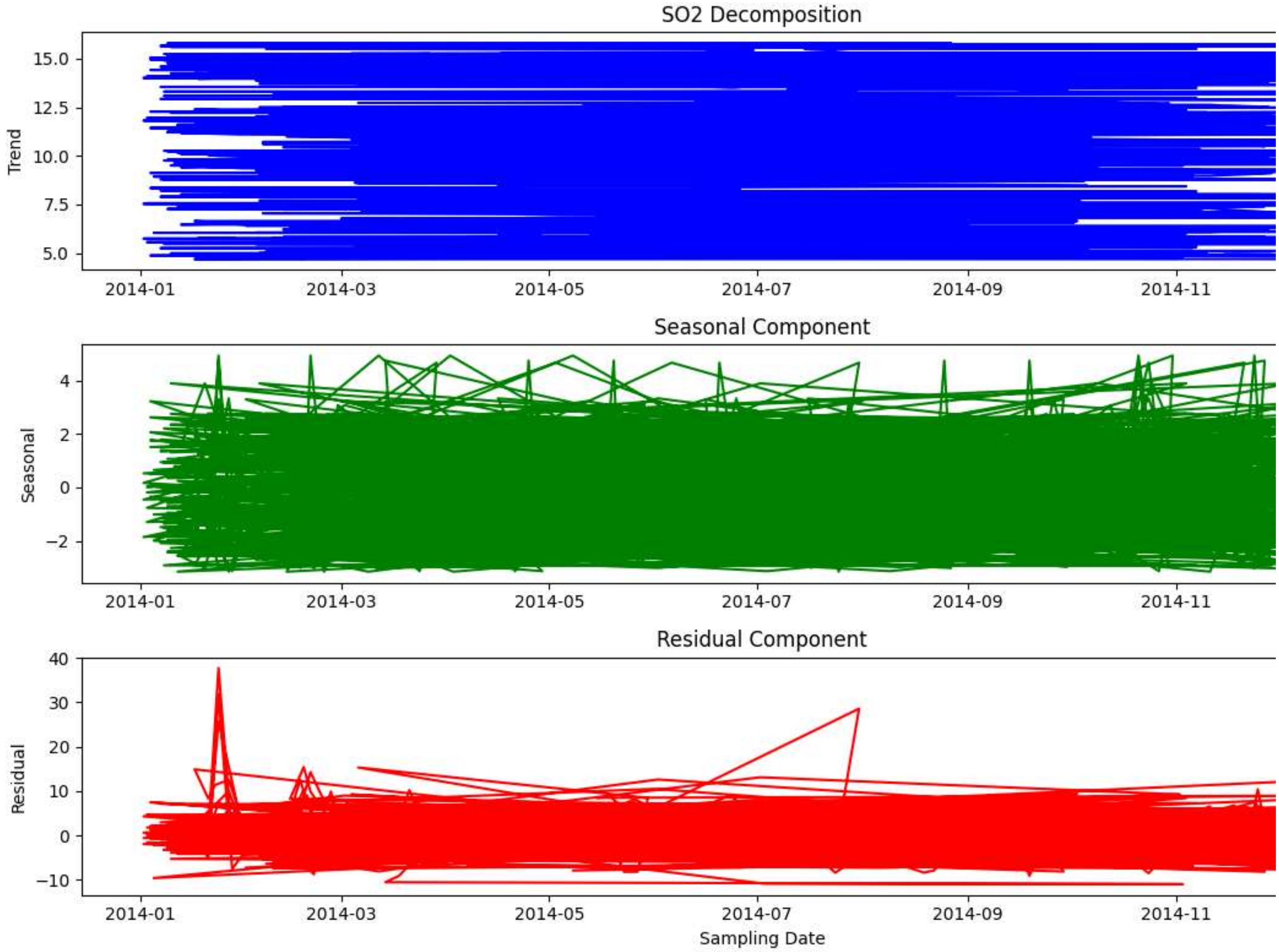
```
# Convert 'Sampling Date' to a datetime object for time series analysis
df['Sampling Date'] = pd.to_datetime(df['Sampling Date'], format='%d-%m-%y')

# Plot SO2 and NO2 levels over time
plt.figure(figsize=(12, 6))
plt.plot(df['Sampling Date'], df['SO2'], label='SO2', marker='o')
plt.plot(df['Sampling Date'], df['NO2'], label='NO2', marker='o')
plt.title('SO2 and NO2 Levels Over Time')
plt.xlabel('Sampling Date')
plt.ylabel('Concentration (µg/m³)')
plt.legend()
plt.grid(True)
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```

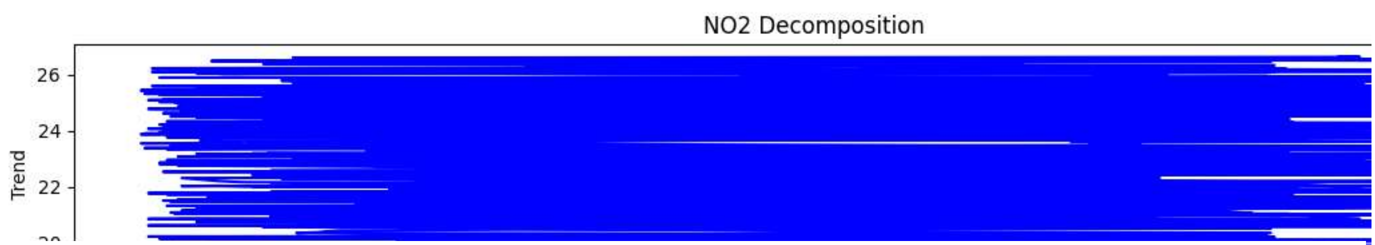



```
# Calculate the 7-day rolling average for SO2 and NO2
df['SO2_7day_avg'] = df['SO2'].rolling(window=7).mean()
df['NO2_7day_avg'] = df['NO2'].rolling(window=7).mean()

# Plot the 7-day rolling averages
plt.figure(figsize=(12, 6))
plt.plot(df['Sampling Date'], df['SO2_7day_avg'], label='SO2 (7-day Avg)', marker='o')
plt.plot(df['Sampling Date'], df['NO2_7day_avg'], label='NO2 (7-day Avg)', marker='o')
plt.title('SO2 and NO2 Levels with 7-day Rolling Average')
plt.xlabel('Sampling Date')
plt.ylabel('Concentration (µg/m³)')
plt.legend()
plt.grid(True)
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```

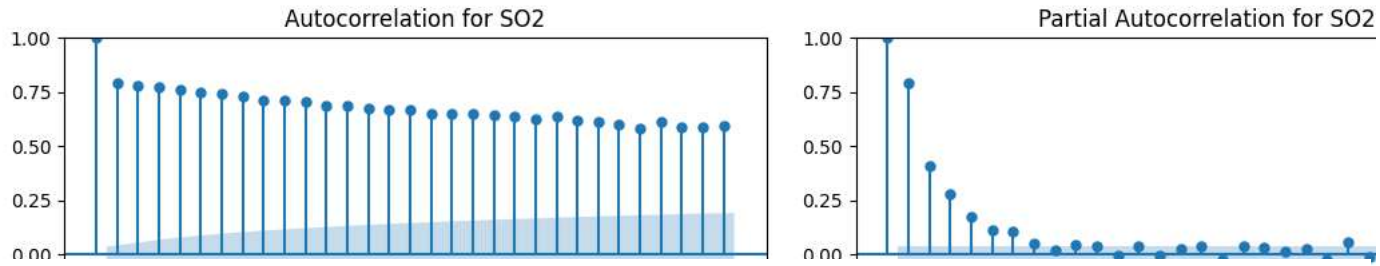


```
from statsmodels.tsa.seasonal import seasonal_decompose

# Perform time series decomposition on SO2 and NO2 data
decomposition_SO2 = seasonal_decompose(df['SO2'], model='additive', period=365)
decomposition_NO2 = seasonal_decompose(df['NO2'], model='additive', period=365)

# Plot the decomposed components for SO2
plt.figure(figsize=(12, 8))

plt.subplot(3, 1, 1)
plt.plot(df['Sampling Date'], decomposition_SO2.trend, label='Trend', color='blue')
plt.title('SO2 Decomposition')
plt.ylabel('Trend')

plt.subplot(3, 1, 2)
plt.plot(df['Sampling Date'], decomposition_SO2.seasonal, label='Seasonal', color='green')
plt.title('Seasonal Component')
plt.ylabel('Seasonal')

plt.subplot(3, 1, 3)
plt.plot(df['Sampling Date'], decomposition_SO2.resid, label='Residual', color='red')
plt.title('Residual Component')
plt.xlabel('Sampling Date')
plt.ylabel('Residual')

plt.tight_layout()
plt.show()

# Plot the decomposed components for NO2
plt.figure(figsize=(12, 8))

plt.subplot(3, 1, 1)
plt.plot(df['Sampling Date'], decomposition_NO2.trend, label='Trend', color='blue')
plt.title('NO2 Decomposition')
plt.ylabel('Trend')

plt.subplot(3, 1, 2)
plt.plot(df['Sampling Date'], decomposition_NO2.seasonal, label='Seasonal', color='green')
plt.title('Seasonal Component')
plt.ylabel('Seasonal')

plt.subplot(3, 1, 3)
plt.plot(df['Sampling Date'], decomposition_NO2.resid, label='Residual', color='red')
plt.title('Residual Component')
plt.xlabel('Sampling Date')
plt.ylabel('Residual')

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

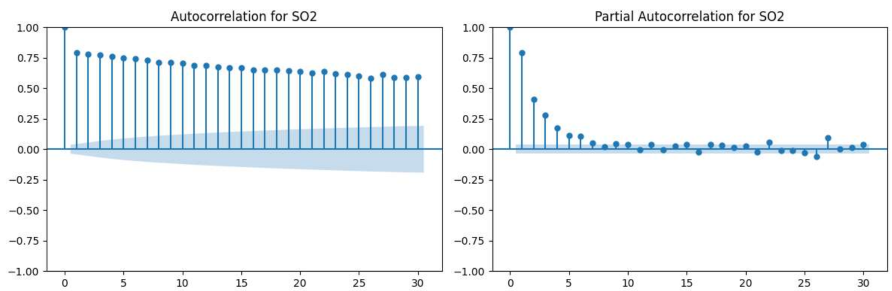





```
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf

# Autocorrelation and Partial Autocorrelation Plots for SO2
plt.figure(figsize=(12, 4))
plt.subplot(1, 2, 1)
plot_acf(df['SO2'], lags=30, ax=plt.gca())
plt.title('Autocorrelation for SO2')

plt.subplot(1, 2, 2)
plot_pacf(df['SO2'], lags=30, ax=plt.gca())
plt.title('Partial Autocorrelation for SO2')

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




```
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf

# Autocorrelation and Partial Autocorrelation Plots for SO2
plt.figure(figsize=(12, 4))
plt.subplot(1, 2, 1)
plot_acf(df['SO2'], lags=30, ax=plt.gca())
plt.title('Autocorrelation for SO2')

plt.subplot(1, 2, 2)
plot_pacf(df['SO2'], lags=30, ax=plt.gca())
plt.title('Partial Autocorrelation for SO2')

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

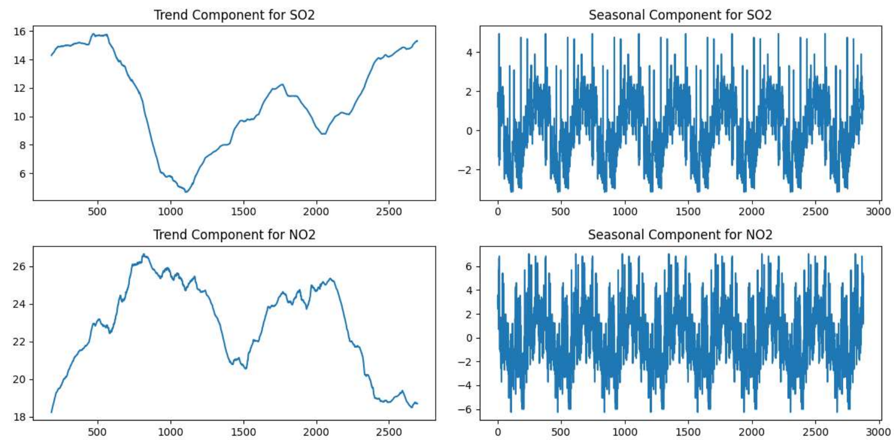



```
!pip install statsmodels
```

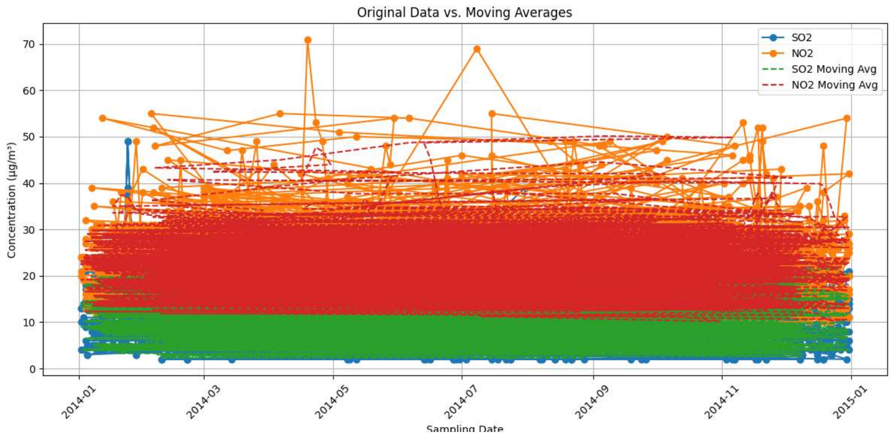
```
Requirement already satisfied: statsmodels in /usr/local/lib/python3.10/dist-packages (0.14.0)
Requirement already satisfied: numpy>=1.18 in /usr/local/lib/python3.10/dist-packages (from statsmodels) (1.23.5)
Requirement already satisfied: scipy!=1.9.2,>=1.4 in /usr/local/lib/python3.10/dist-packages (from statsmodels) (1.11.3)
Requirement already satisfied: pandas>=1.0 in /usr/local/lib/python3.10/dist-packages (from statsmodels) (1.5.3)
Requirement already satisfied: patsy>=0.5.2 in /usr/local/lib/python3.10/dist-packages (from statsmodels) (0.5.3)
Requirement already satisfied: packaging>=21.3 in /usr/local/lib/python3.10/dist-packages (from statsmodels) (23.2)
Requirement already satisfied: python-dateutil>=2.8.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.0->statsmodels) (2.8.2
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=1.0->statsmodels) (2023.3.post1)
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages (from patsy>=0.5.2->statsmodels) (1.16.0)
```

```
from statsmodels.tsa.seasonal import seasonal_decompose

# Perform seasonal decomposition on SO2 and NO2 data
decomposition_SO2 = seasonal_decompose(df['SO2'], model='additive', period=365)
decomposition_NO2 = seasonal_decompose(df['NO2'], model='additive', period=365)

# Plot the decomposed components
plt.figure(figsize=(12, 6))
plt.subplot(2, 2, 1)
plt.plot(decomposition_SO2.trend, label='Trend')
plt.title('Trend Component for SO2')

plt.subplot(2, 2, 2)
plt.plot(decomposition_SO2.seasonal, label='Seasonal')
plt.title('Seasonal Component for SO2')
```

```
plt.subplot(2, 2, 3)
plt.plot(decomposition_NO2.trend, label='Trend')
plt.title('Trend Component for NO2')

plt.subplot(2, 2, 4)
plt.plot(decomposition_NO2.seasonal, label='Seasonal')
plt.title('Seasonal Component for NO2')

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




```
# Calculate moving averages for SO2 and NO2
window_size = 7  # Adjust the window size as needed
df['SO2_MA'] = df['SO2'].rolling(window=window_size).mean()
df['NO2_MA'] = df['NO2'].rolling(window=window_size).mean()

# Plot the original data and moving averages
plt.figure(figsize=(12, 6))
plt.plot(df['Sampling Date'], df['SO2'], label='SO2', marker='o')
plt.plot(df['Sampling Date'], df['NO2'], label='NO2', marker='o')
plt.plot(df['Sampling Date'], df['SO2_MA'], label='SO2 Moving Avg', linestyle='--')
plt.plot(df['Sampling Date'], df['NO2_MA'], label='NO2 Moving Avg', linestyle='--')
plt.title('Original Data vs. Moving Averages')
plt.xlabel('Sampling Date')
plt.ylabel('Concentration (µg/m³)')
plt.legend()
plt.grid(True)
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```




```
import itertools
from statsmodels.tsa.arima_model import ARIMA

# Define a function for grid search
def grid_search_arima(data, p_values, d_values, q_values):
    best_aic = float("inf")
    best_order = None

    for p, d, q in itertools.product(p_values, d_values, q_values):
        order = (p, d, q)
        try:
            model = ARIMA(data, order=order)
            results = model.fit(disp=0)
            aic = results.aic

            if aic < best_aic:
                best_aic = aic
                best_order = order

        except:
            continue

    return best_order, best_aic

# Define the ranges for p, d, and q values
p_values = range(5)
d_values = range(2)
q_values = range(5)

# Perform grid search
best_order, best_aic = grid_search_arima(df['SO2'], p_values, d_values, q_values)
print(f'Best ARIMA Order: {best_order} (AIC={best_aic})')
```

```
Best ARIMA Order: None (AIC=inf)
```