Delhi AQI Analysis

```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
from scipy import stats
import statsmodels.api as sm
```

Load Dataset

```python
# Example - adjust path if needed
df = pd.read_csv("delhiaqi.csv")


df.info()
df.describe()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 561 entries, 0 to 560
Data columns (total 9 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   date    561 non-null    object 
 1   co      561 non-null    float64
 2   no      561 non-null    float64
 3   no2     561 non-null    float64
 4   o3      561 non-null    float64
 5   so2     561 non-null    float64
 6   pm2_5   561 non-null    float64
 7   pm10    561 non-null    float64
 8   nh3     561 non-null    float64
dtypes: float64(8), object(1)
memory usage: 39.6+ KB
```

```
                 co          no         no2          o3         so2  \
count    561.000000  561.000000  561.000000  561.000000  561.000000   
mean    3814.942210   51.181979   75.292496   30.141943   64.655936   
std     3227.744681   83.904476   42.473791   39.979405   61.073080   
min      654.220000    0.000000   13.370000    0.000000    5.250000   
25%     1708.980000    3.380000   44.550000    0.070000   28.130000   
50%     2590.180000   13.300000   63.750000   11.800000   47.210000   
75%     4432.680000   59.010000   97.330000   47.210000   77.250000   
max    16876.220000  425.580000  263.210000  164.510000  511.170000   

             pm2_5         pm10         nh3
```

```
count   561.000000   561.000000  561.000000
mean    358.256364   420.988414   26.425062
std     227.359117   271.287026   36.563094
min      60.100000    69.080000    0.630000
25%     204.450000   240.900000    8.230000
50%     301.170000   340.900000   14.820000
75%     416.650000   482.570000   26.350000
max    1310.200000  1499.270000  267.510000
```

```
df.head()
```

```
                  date        co     no    no2    o3    so2   pm2_5
pm10  \
0  2023-01-01 00:00:00  1655.58   1.66  39.41  5.90  17.88  169.29
194.64
1  2023-01-01 01:00:00  1869.20   6.82  42.16  1.99  22.17  182.84
211.08
2  2023-01-01 02:00:00  2510.07  27.72  43.87  0.02  30.04  220.25
260.68
3  2023-01-01 03:00:00  3150.94  55.43  44.55  0.85  35.76  252.90
304.12
4  2023-01-01 04:00:00  3471.37  68.84  45.24  5.45  39.10  266.36
322.80

     nh3
0   5.83
1   7.66
2  11.40
3  13.55
4  14.19
```

Data Cleaning (Handle Nulls, Duplicates, Date formatting)

```
# Drop duplicates
df = df.drop_duplicates()

# Check missing values
print(df.isnull().sum())


# Convert date column (adjust column name if different)
df['date'] = pd.to_datetime(df['date'])
```

```
date     0
co       0
no       0
no2      0
o3       0
so2      0
pm2_5    0
```

```
pm10     0
nh3      0
dtype: int64
```

Feature Engineering (Extract month, season etc.)

```
# Extract month & year
df['month'] = df['date'].dt.month
df['year'] = df['date'].dt.year
df['day'] = df['date'].dt.day

# Define seasons for Delhi
def season(month):
    if month in [12,1,2]:
        return 'Winter'
    elif month in [3,4,5]:
        return 'Summer'
    elif month in [6,7,8,9]:
        return 'Monsoon'
    else:
        return 'Post-Monsoon'

df['season'] = df['month'].apply(season)
```

AQI Calculation

```
df['AQI'] = df['pm2_5']

# Composite AQI
df['AQI_composite'] =
df[['pm2_5','pm10','no2','o3','so2']].max(axis=1)

df[['date','AQI','AQI_composite']].head()
```

	date	AQI	AQI_composite
0	2023-01-01 00:00:00	169.29	194.64
1	2023-01-01 01:00:00	182.84	211.08
2	2023-01-01 02:00:00	220.25	260.68
3	2023-01-01 03:00:00	252.90	304.12
4	2023-01-01 04:00:00	266.36	322.80

EDA - Visualizations

```
df.describe()
```

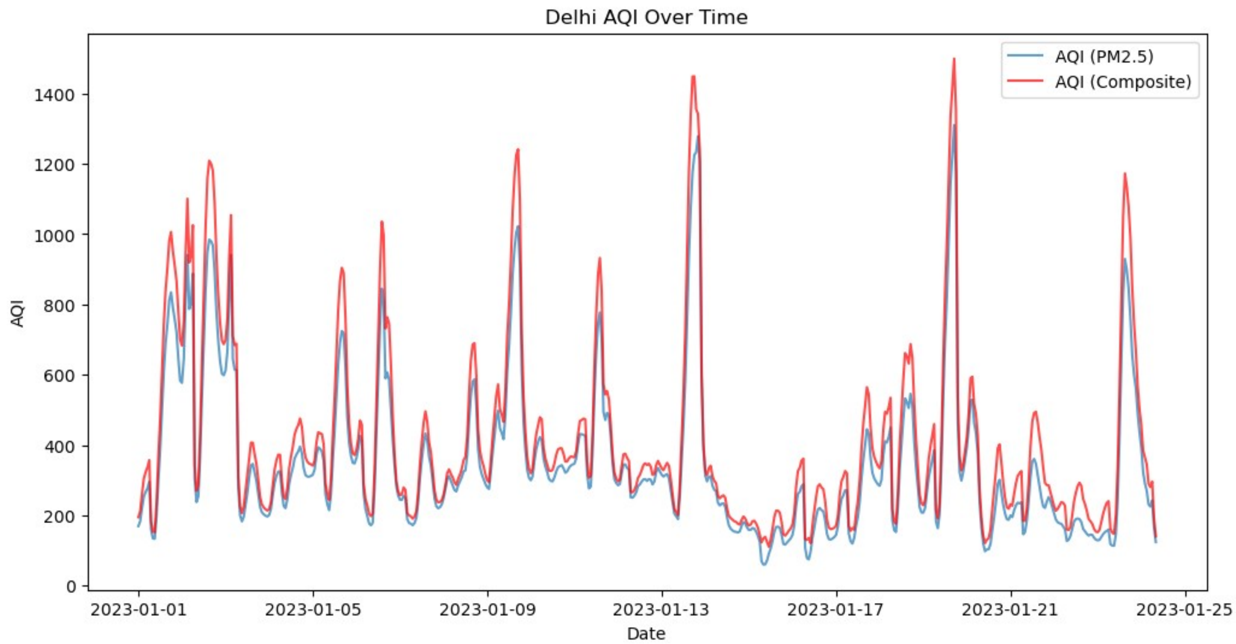
```
                      date          co          no         no2
o3  \
count                  561  561.000000  561.000000  561.000000
561.000000
```

```
mean   2023-01-12 16:00:00   3814.942210   51.181979   75.292496
30.141943
min    2023-01-01 00:00:00    654.220000    0.000000   13.370000
0.000000
25%    2023-01-06 20:00:00   1708.980000    3.380000   44.550000
0.070000
50%    2023-01-12 16:00:00   2590.180000   13.300000   63.750000
11.800000
75%    2023-01-18 12:00:00   4432.680000   59.010000   97.330000
47.210000
max    2023-01-24 08:00:00  16876.220000  425.580000  263.210000
164.510000
std                    NaN   3227.744681   83.904476   42.473791
39.979405

              so2         pm2_5          pm10         nh3  month    year
\
count  561.000000   561.000000   561.000000  561.000000  561.0   561.0

mean    64.655936   358.256364   420.988414   26.425062    1.0  2023.0

min      5.250000    60.100000    69.080000    0.630000    1.0  2023.0

25%     28.130000   204.450000   240.900000    8.230000    1.0  2023.0

50%     47.210000   301.170000   340.900000   14.820000    1.0  2023.0

75%     77.250000   416.650000   482.570000   26.350000    1.0  2023.0

max    511.170000  1310.200000  1499.270000  267.510000    1.0  2023.0

std     61.073080   227.359117   271.287026   36.563094    0.0     0.0


              day          AQI  AQI_composite
count  561.000000   561.000000     561.000000
mean    12.192513   358.256364     421.589537
min      1.000000    60.100000     110.640000
25%      6.000000   204.450000     240.900000
50%     12.000000   301.170000     340.900000
75%     18.000000   416.650000     482.570000
max     24.000000  1310.200000    1499.270000
std      6.756374   227.359117     270.597421
```

AQI Over Time (Code)

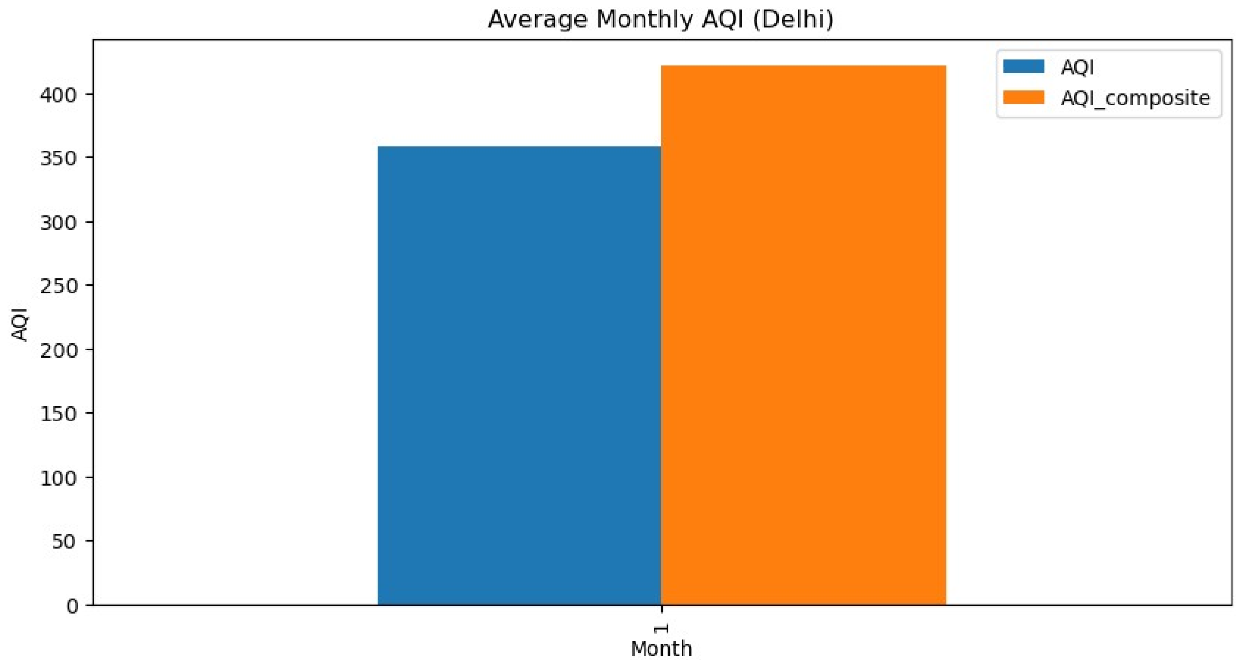
```
plt.figure(figsize=(12,6))
plt.plot(df['date'], df['AQI'], label="AQI (PM2.5)", alpha=0.7)
plt.plot(df['date'], df['AQI_composite'], label="AQI (Composite)",
alpha=0.7, color='red')
```

```
plt.title("Delhi AQI Over Time")
plt.xlabel("Date")
plt.ylabel("AQI")
plt.legend()
plt.show()
```



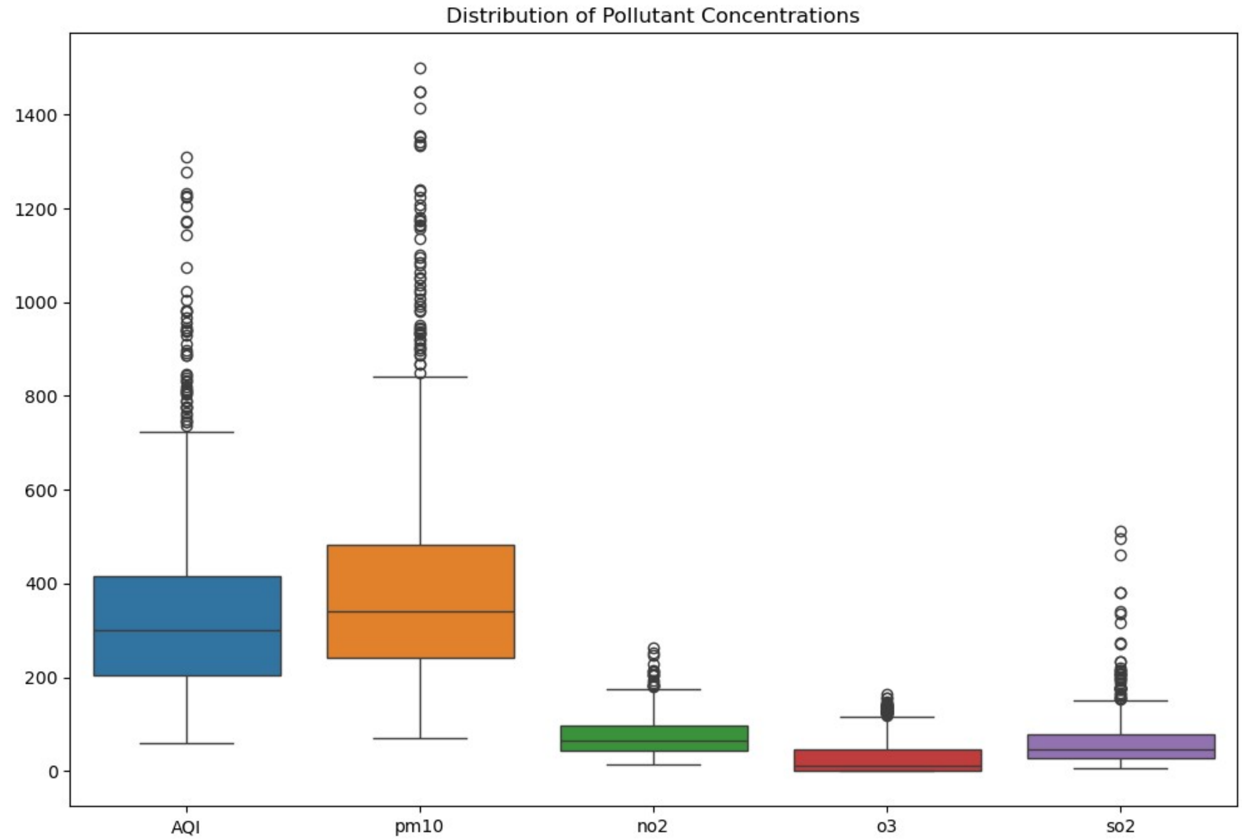
Seasonal Trends

```
df['month'] = df['date'].dt.month
monthly = df.groupby('month')[['AQI','AQI_composite']].mean()

monthly.plot(kind='bar', figsize=(10,5))
plt.title("Average Monthly AQI (Delhi)")
plt.xlabel("Month")
plt.ylabel("AQI")
plt.show()
```



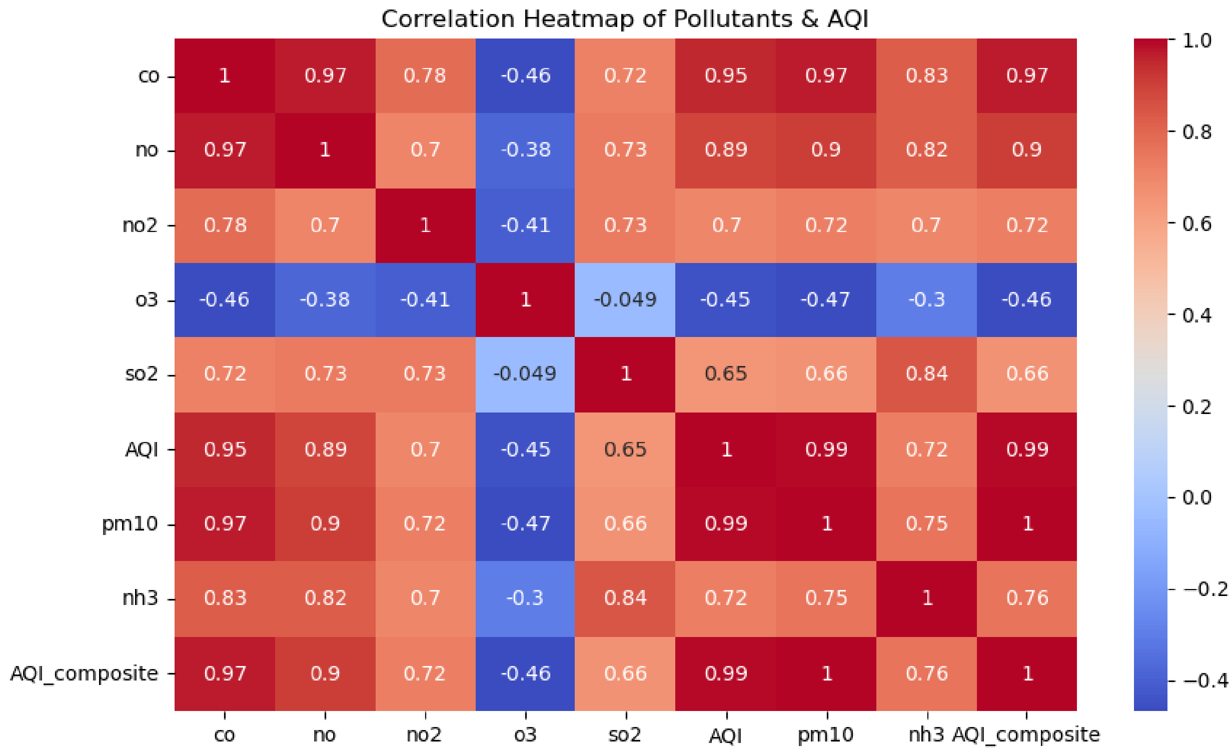
Pollutant Distributions

```
plt.figure(figsize=(12,8))
sns.boxplot(data=df[['AQI','pm10','no2','o3','so2']])
plt.title("Distribution of Pollutant Concentrations")
plt.show()
```



Correlation Heatmap

```
plt.figure(figsize=(10,6))
sns.heatmap(df[['co','no','no2','o3','so2','AQI','pm10','nh3','AQI_com
posite']].corr(),
            annot=True, cmap="coolwarm")
plt.title("Correlation Heatmap of Pollutants & AQI")
plt.show()
```



Insights & Observations

- **PM10 (r = 0.99)** is the strongest contributor to AQI, showing an almost perfect positive correlation.

- **CO (r = 0.95)** and **NO (r = 0.89)** also have very strong positive correlations with AQI, indicating they are major pollutants driving poor air quality.

- **NO2 (r = 0.70)**, **NH3 (r = 0.72)**, and **SO2 (r = 0.65–0.66)** show moderate positive correlations with AQI.

- **Ozone (O3, r ≈ –0.45)** shows a negative correlation, suggesting higher O3 levels may coincide with slightly improved AQI conditions.

- **Multicollinearity is high** among CO, PM10, and NO (correlations > 0.9), meaning these pollutants often rise together and may act as overlapping indicators.

- Overall, **PM10, CO, and NO** are the dominant pollutants influencing AQI in this dataset, consistent with common sources like traffic emissions, industrial activities, and road dust in urban areas.