Air Quality Index Analysis using Python

Now, let's get started with the task of Air Quality Index Analysis by importing the necessary Python libraries and the dataset:

```
import pandas as pd
import plotly.express as px
import plotly.io as pio
import plotly.graph_objects as go
pio.templates.default = "plotly_white"

data = pd.read_csv("/content/delhiaqi.csv")
print(data.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
```

I'll convert the date column in the dataset into a datetime data type and move forward:

```
data['date'] = pd.to_datetime(data['date'])
```

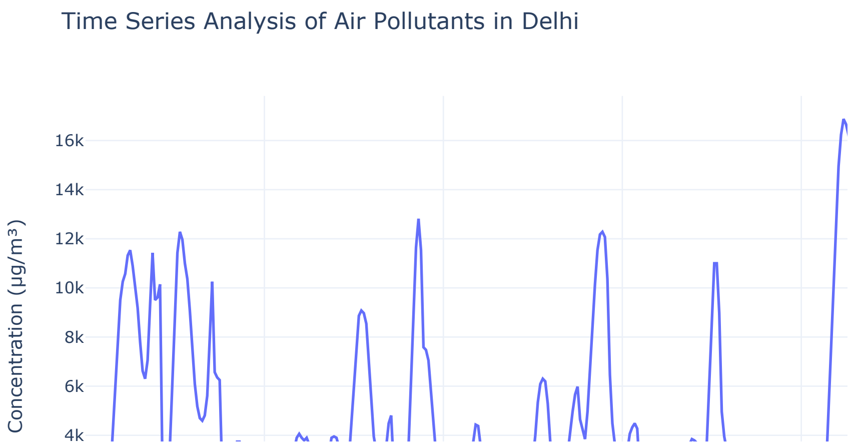
Now, let's have a look at the descriptive statistics of the data:

```
print(data.describe())
```

```
                 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
```

Now let's have a look at the intensity of each pollutant over time in the air quality:

```
# time series plot for each air pollutant
fig = go.Figure()

for pollutant in ['co', 'no', 'no2', 'o3', 'so2', 'pm2_5', 'pm10', 'nh3']:
    fig.add_trace(go.Scatter(x=data['date'], y=data[pollutant], mode='lines',
                             name=pollutant))

fig.update_layout(title='Time Series Analysis of Air Pollutants in Delhi',
                  xaxis_title='Date', yaxis_title='Concentration (µg/m³)')
fig.show()
```




In the above code, we are creating a time series plot for each air pollutant in the dataset. It helps analyze the intensity of air pollutants over time.

Calculating Air Quality Index

Now, before moving forward, we need to calculate the air quality index and its category. AQI is typically computed based on the concentration of various pollutants, and each pollutant has its sub-index. Here's how we can calculate AQI:

```
# Define AQI breakpoints and corresponding AQI values
aqi_breakpoints = [
    (0, 12.0, 50), (12.1, 35.4, 100), (35.5, 55.4, 150),
    (55.5, 150.4, 200), (150.5, 250.4, 300), (250.5, 350.4, 400),
    (350.5, 500.4, 500)
]

def calculate_aqi(pollutant_name, concentration):
    for low, high, aqi in aqi_breakpoints:
        if low <= concentration <= high:
            return aqi
    return None

def calculate_overall_aqi(row):
    aqi_values = []
    pollutants = ['co', 'no', 'no2', 'o3', 'so2', 'pm2_5', 'pm10', 'nh3']
    for pollutant in pollutants:
        aqi = calculate_aqi(pollutant, row[pollutant])
        if aqi is not None:
            aqi_values.append(aqi)
    return max(aqi_values)

# Calculate AQI for each row
data['AQI'] = data.apply(calculate_overall_aqi, axis=1)

# Define AQI categories
aqi_categories = [
    (0, 50, 'Good'), (51, 100, 'Moderate'), (101, 150, 'Unhealthy for Sensitive Groups'),
    (151, 200, 'Unhealthy'), (201, 300, 'Very Unhealthy'), (301, 500, 'Hazardous')
]

def categorize_aqi(aqi_value):
    for low, high, category in aqi_categories:
        if low <= aqi_value <= high:
            return category
    return None

# Categorize AQI
data['AQI Category'] = data['AQI'].apply(categorize_aqi)
print(data.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  AQI    AQI Category
0   5.83  300  Very Unhealthy
1   7.66  300  Very Unhealthy
2  11.40  400       Hazardous
```

```
3  13.55  400       Hazardous
4  14.19  400       Hazardous
```

In the above code, we are defining AQI breakpoints and corresponding AQI values for various air pollutants according to the Air Quality Index (AQI) standards. The aqi_breakpoints list defines the concentration ranges and their corresponding AQI values for different pollutants. We then define two functions:

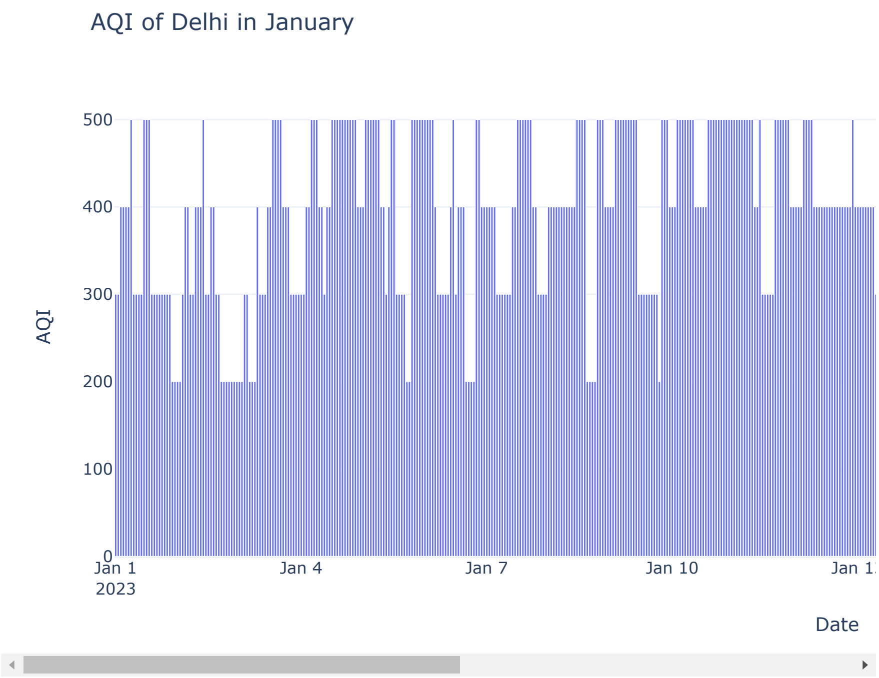
- calculate_aqi: to calculate the AQI for a specific pollutant and concentration by finding the appropriate range in the aqi_breakpoints
- calculate_overall_aqi: to calculate the overall AQI for a row in the dataset by considering the maximum AQI value among all pollutants

The calculated AQI values are added as a new column in the dataset. Additionally, we defined AQI categories in the aqi_categories list and used the categorize_aqi function to assign an AQI category to each AQI value. The resulting AQI categories are added as a new column as AQI Category in the dataset.

## Analyzing AQI of Delhi

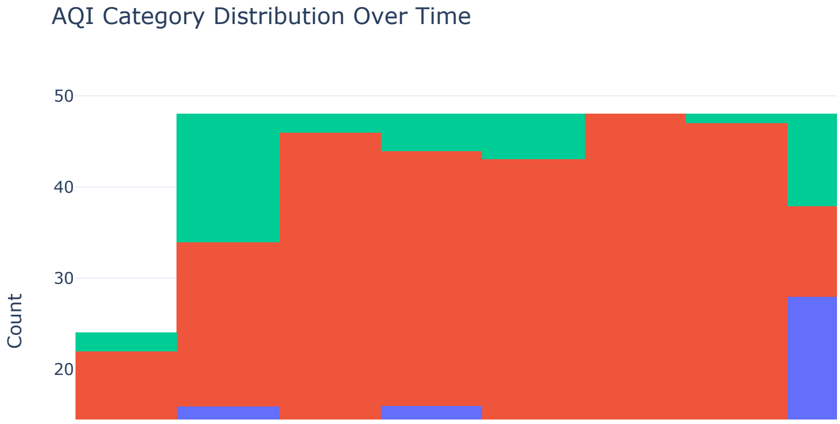
Now, let's have a look at the AQI of Delhi in January:

```
# AQI over time
fig = px.bar(data, x="date", y="AQI",
             title="AQI of Delhi in January")
fig.update_xaxes(title="Date")
fig.update_yaxes(title="AQI")
fig.show()
```



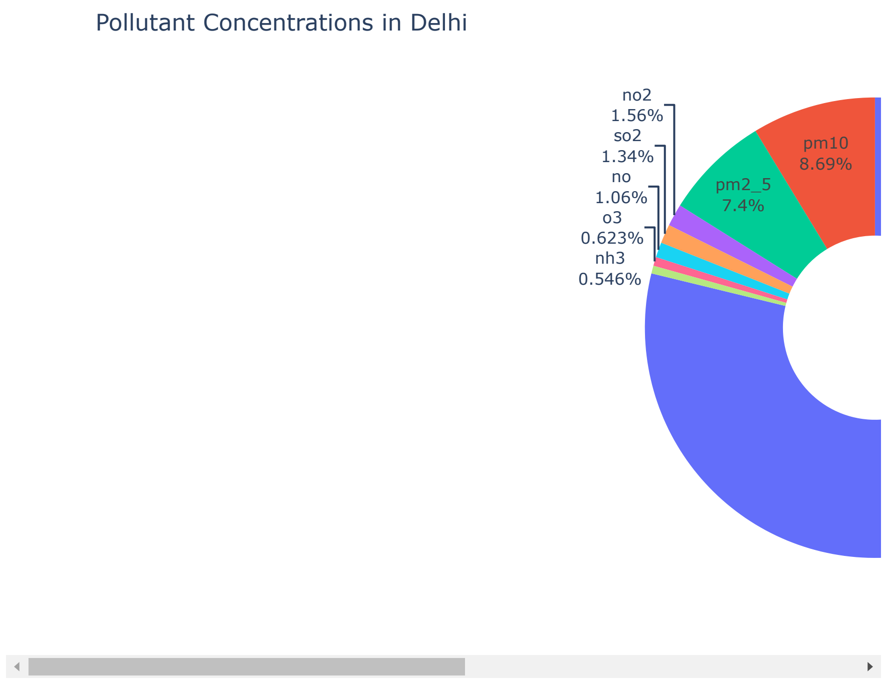

Now, let's have a look at the AQI category distribution:

```
fig = px.histogram(data, x="date",
                   color="AQI Category",
                   title="AQI Category Distribution Over Time")
fig.update_xaxes(title="Date")
fig.update_yaxes(title="Count")
fig.show()
```




Now, let's have a look at the distribution of pollutants in the air quality of Delhi:

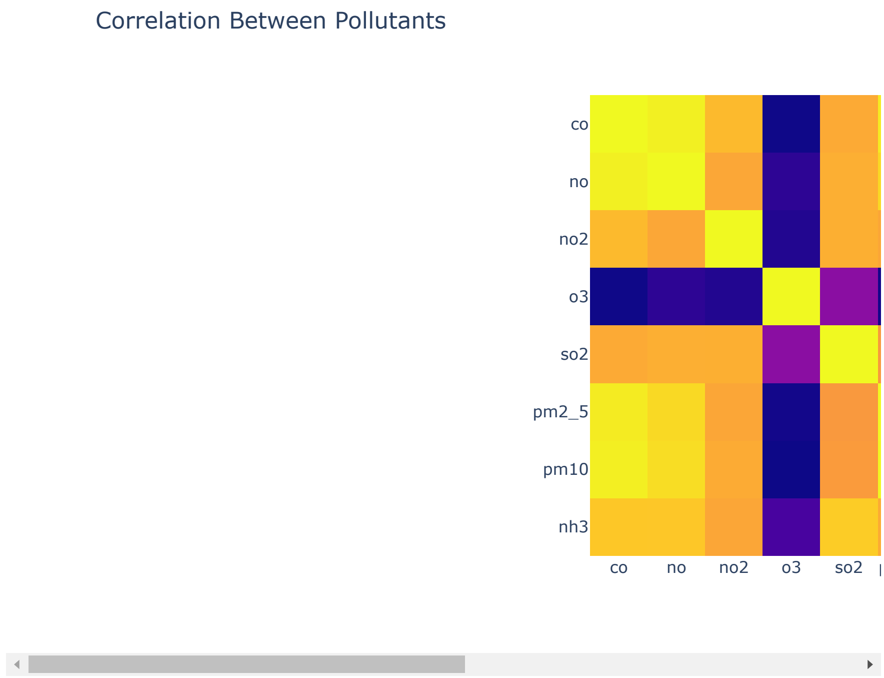
```
# Define pollutants and their colors
pollutants = ["co", "no", "no2", "o3", "so2", "pm2_5", "pm10", "nh3"]
pollutant_colors = px.colors.qualitative.Plotly

# Calculate the sum of pollutant concentrations
total_concentrations = data[pollutants].sum()

# Create a DataFrame for the concentrations
concentration_data = pd.DataFrame({
    "Pollutant": pollutants,
    "Concentration": total_concentrations
})

# Create a donut plot for pollutant concentrations
fig = px.pie(concentration_data, names="Pollutant", values="Concentration",
             title="Pollutant Concentrations in Delhi",
             hole=0.4, color_discrete_sequence=pollutant_colors)

# Update layout for the donut plot
fig.update_traces(textinfo="percent+label")
fig.update_layout(legend_title="Pollutant")

# Show the donut plot
fig.show()
```




Now, let's have a look at the correlation between pollutants:

```
# Correlation Between Pollutants
correlation_matrix = data[pollutants].corr()
fig = px.imshow(correlation_matrix, x=pollutants,
                y=pollutants, title="Correlation Between Pollutants")
```

```
                 y=pollutants, title='Correlation Between Pollutants')
fig.show()
```



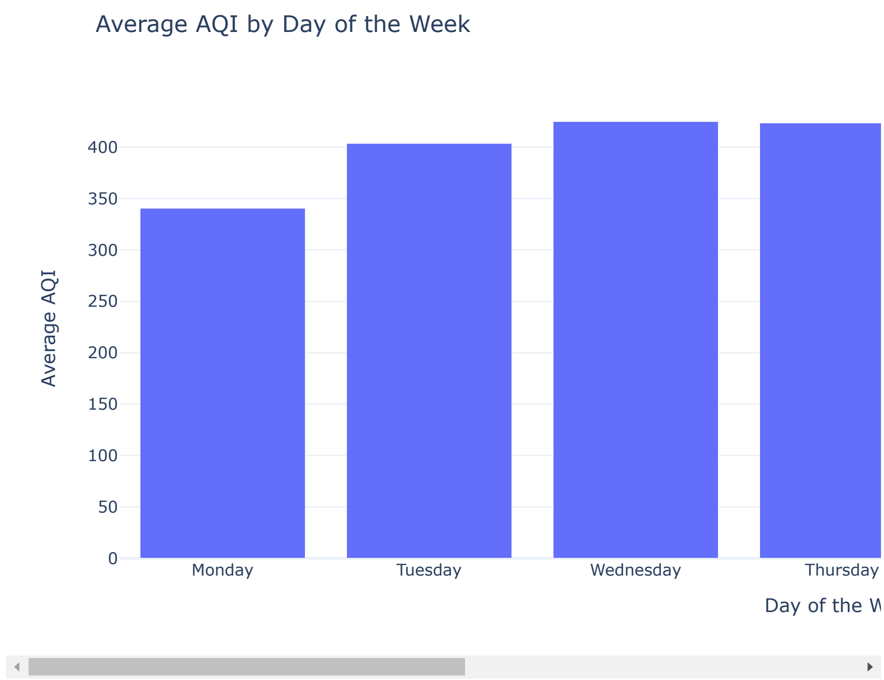

The correlation matrix displayed here represents the correlation coefficients between different air pollutants in the dataset. Correlation coefficients measure the strength and direction of the linear relationship between two variables, with values ranging from -1 to 1. Overall, the positive correlations among CO, NO, NO2, SO2, PM2.5, PM10, and NH3 suggest that they may share common sources or have similar pollution patterns, while O3 exhibits an inverse relationship with the other pollutants, which may be due to its role as both a pollutant and a natural atmospheric oxidant.

Now, let's have a look at the hourly average trends of AQI in Delhi:

```
# Extract the hour from the date
data['Hour'] = pd.to_datetime(data['date']).dt.hour

# Calculate hourly average AQI
hourly_avg_aqi = data.groupby('Hour')['AQI'].mean().reset_index()

# Create a line plot for hourly trends in AQI
fig = px.line(hourly_avg_aqi, x='Hour', y='AQI',
              title='Hourly Average AQI Trends in Delhi (Jan 2023)')
fig.update_xaxes(title="Hour of the Day")
fig.update_yaxes(title="Average AQI")
fig.show()
```

Now, let's have a look at the average AQI by day of the week in Delhi:

```
# Average AQI by Day of the Week
data['Day_of_Week'] = data['date'].dt.day_name()
average_aqi_by_day = data.groupby('Day_of_Week')['AQI'].mean().reindex(['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday
fig = px.bar(average_aqi_by_day, x=average_aqi_by_day.index, y='AQI',
             title='Average AQI by Day of the Week')
fig.update_xaxes(title="Day of the Week")
fig.update_yaxes(title="Average AQI")
fig.show()
```




It shows that the air quality in Delhi is worse on Wednesdays and Thursdays. So, this is how you can analyze the air quality index of a specific location using Python.

## Summary

Air quality index (AQI) analysis is a crucial aspect of environmental data science that involves monitoring and analyzing air quality in a specific location. It aims to provide a numerical value representative of overall air quality, essential for public health and environmental management. I hope you liked this article on Air Quality Index Analysis using Python.