**Data Visualization on Different Parameters:-**

1. Time (Year/Month/Day):

- Line Chart: To show trends in air quality over time.

- Area Chart: To display the magnitude of air quality metrics over time.

- Heat Map: To highlight variations over different periods.

2. Pollutant Concentration (PM2.5, PM10, NO2, SO2, O3, CO, etc.):

- Line Chart: For trends of each pollutant over time.

- Stacked Area Chart: To show the contribution of each pollutant over time.

- Bubble Chart: To visualize the concentration levels of pollutants across different cities and times.

3. City/Location:

- Map: To show geographical distribution of air quality.

- Bar Chart: To compare air quality between cities.

- Tree-map: To represent the hierarchy and proportion of air quality data.

4. Seasonal/Monthly Variation:

- Box Plot: To show distribution and identify outliers for different months or seasons.

- Seasonal Line Chart: To compare the average air quality across seasons

5. Day of the Week:

- Heat Map: To visualize air quality variations over different days of the week.

- Bar Chart: To compare average air quality for each day.

6. Temperature, Humidity, and Weather Conditions

[ Temperature, Air temperature,Rainfall(RF), Relative Humidity(RH),

Speed of Wind(VWS), Direction of wind(WS)]

- Scatter Plot: To show the relationship between weather conditions and air quality.

- Dual-Axis Chart: To compare air quality with temperature/humidity over time.

7. Environmental Parameters:

- Wind Speed and Direction: Correlate air quality with wind patterns.

- Rainfall: Analyze the cleansing effect of rainfall on air quality.

8. Health Advisory Levels:

- Color-coded Line Chart or Bar Chart: To indicate different levels of health advisories associated with AQI values.

- Gauge Chart: To visualize the current air quality level against advisory thresholds.

**Based on PM2.5 & PM10**

PM is carrier of various pollutants of size 2.5 and 10:

1. Time Series Analysis:

- Line Chart: Display trends of PM2.5 and PM10 over time.

-Dual-Axis Line Chart:\*Compare PM2.5 and PM10 concentrations on the same timeline.

- Area Chart:\*Visualize the magnitude and fluctuations in particulate matter concentrations over time.

2. Geographical Distribution:

- Filled Map: Show average or peak PM2.5 and PM10 levels by city or region.

- Heat Map: Highlight areas with the highest concentrations of particulate matter.

- Symbol Map:Use varying sizes of circles to represent different concentration levels of PM2.5 and PM10 across cities.

3. Comparative Analysis:

- Bar Chart: Compare average PM2.5 and PM10 levels across multiple cities/states.

- Box Plot: Display the distribution, median, and outliers of PM2.5 and PM10 levels for different

cities or regions.

- Side-by-Side Bar Chart: Compare monthly or yearly averages of PM2.5 and PM10.

4. Correlation Analysis:

- Scatter Plot: Examine the relationship between PM2.5 and PM10 concentrations.

5. Trend Analysis:

- Moving Average Line Chart: Smooth out short-term fluctuations to identify longer-term trends in PM2.5 and PM10 levels.

- Seasonal Decomposition: Break down the time series data into trend, seasonal, and residual components.

6. Day of Week/Hourly Patterns:

- Heat Map: Show average PM2.5 and PM10 concentrations for each day of the week and each hour of the day to identify specific periods of high pollution.

**Air Quality Index (AQI) :-**

The Air Quality Index (AQI) is a numerical scale used to communicate how polluted the air currently is or how polluted it is forecast to become.

Components of AQI:

1. Pollutants Measured:
   * PM2.5
   * PM10
   * NO2 (Nitrogen Dioxide)
   * SO2 (Sulfur Dioxide)
   * O3 (Ozone)
   * CO (Carbon Monoxide)

**AQI Categories:** Each pollutant has its own AQI scale, but the highest value among these pollutants is used to determine the overall AQI for a given location(city,state. The AQI is typically categorized into several bands, such as:

* **Good (0-50):** Air quality is considered satisfactory, and air pollution poses little or no risk.
* **Moderate (51-100):** Air quality is acceptable; however, there may be some risk for a small number of people who are unusually sensitive to air pollution.
* **Unhealthy for Sensitive Groups (101-150):** Members of sensitive groups may experience health effects. The general public is not likely to be affected.
* **Unhealthy (151-200):** Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
* **Very Unhealthy (201-300):** Health alert: everyone may experience more serious health effects.
* **Hazardous (301-500):** Health warning of emergency conditions. The entire population is more likely to be affected.

1. Time Series Line Chart:

* To show how the AQI changes over time.
* Features: Use a line graph to plot AQI values across different dates or months. Different lines can represent different cities or regions.

2. Bar Chart:

* To compare AQI values across different cities or regions for a specific time period.
* Features: Use bars to represent AQI values, with different bars for different cities or regions.

3. Heatmap:

* To show the intensity of AQI across different times and locations.
* Features: Color-code cells to represent AQI levels, with darker colors indicating higher pollution levels

4. Pie Chart:

* To show the proportion of different AQI categories (e.g., Good, Moderate, Unhealthy).
* Features: Use slices to represent the percentage of days falling into each AQI category.

5. Geographical Map:

* To visualize AQI across different geographic locations.
* Features: Use color gradients or symbols on a map to represent different AQI levels across cities or regions.

6. Stacked Bar Chart:

* To show the contribution of different pollutants to the overall AQI.
* Features: Each bar represents total AQI, with segments showing the contribution of different pollutants.

7. Bubble Chart:

* To show the relationship between AQI and other variables (e.g., temperature, population density).
* Features: Use bubbles to represent cities or regions, with the size and color of the bubble indicating AQI levels.

8. Bullet Chart:

* To show AQI against predefined thresholds or targets.
* Features: Use horizontal bars to indicate AQI levels, with reference lines for different AQI categories.

**Convert Concentrations to AQI Values**

Each pollutant has its own AQI calculation formula, which generally follows this process:

1. **Determine the Concentration Range:** Identify which AQI category your pollutant concentration falls into. The AQI scale is divided into ranges, with each range corresponding to a specific AQI value. The ranges vary for each pollutant and are specified by regulatory agencies like the EPA.
2. **Use the Formula to Calculate the AQI for Each Pollutant:** The general formula to calculate the AQI for a specific pollutant is:

AQI=(Cp−Lpl)(Up−Lpl)×(Iph−Ipl)+Ipl\text{AQI} = \frac{(\text{Cp} - \text{Lpl})}{(\text{Up} - \text{Lpl})} \times (\text{Iph} - \text{Ipl}) + \text{Ipl}AQI=(Up−Lpl)(Cp−Lpl)​×(Iph−Ipl)+Ipl

where:

* + Cp\text{Cp}Cp = Concentration of the pollutant (e.g., µg/m³ for PM2.5)
  + Lpl\text{Lpl}Lpl = Lower bound of the concentration range for the AQI category
  + Up\text{Up}Up = Upper bound of the concentration range for the AQI category
  + Iph\text{Iph}Iph = Upper bound of the AQI category (e.g., 50 for "Good")
  + Ipl\text{Ipl}Ipl = Lower bound of the AQI category (e.g., 0 for "Good")

Each pollutant has its own set of concentration ranges and corresponding AQI values. These are specified by regulatory agencies like the EPA or local environmental authorities.