Project Report

Title Page

- **Project Name:** Analyze Weather Data
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- **Date of Submission:** 24 – 01 – 2025

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1. Objective

The objective of this project is to analyze and visualize weather data from Pune to identify patterns, seasonal trends, and extreme weather events. This includes:

- Aggregating data by time periods such as months.
- Visualizing trends for temperature, humidity, and rainfall.
- Highlighting significant weather events such as heatwaves and heavy rainfall.

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2. Sources

- Dataset: Pune Weather Data (`pune_weather_with_regions.csv`)
- Tools and Libraries:
  - Python
  - Pandas
  - Matplotlib
  - Seaborn
  - Plotly
- References:
  - Documentation of the libraries used.
  - Resources on weather data analysis and visualization.

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3. Steps Taken

Data Loading and Preprocessing

- Loaded the dataset using Pandas.
- Inspected the structure of the dataset using `info()` and `head()`.
- Converted the `date` column to a datetime format for time-based analysis.
- Added a `month` column to group data for monthly trends.

Data Aggregation and Analysis

- Grouped data by month and calculated the average values for temperature, humidity, and rainfall.
- Defined thresholds to classify extreme weather events such as heatwaves (Temperature > 40°C) and heavy rainfall (Rainfall > 50 mm/day).
- Identified consecutive days of extreme weather events and filtered for significant streaks.

Data Visualization

1. Line plots were used to visualize trends in temperature and rainfall over time.
2. Scatter plots highlighted extreme weather events.
3. Bar charts showed average monthly rainfall.
4. Interactive plots using Plotly displayed temperature trends across regions.
5. Facet grids provided region-specific temperature trends.

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4. Code

Code Snippets

Data Preprocessing:

```
import pandas as pd

import matplotlib.pyplot as plt

import seaborn as sns

# Load the uploaded dataset to check its structure and understand the
columns for processing

# Define the file path

file_path = 'C:/Users/admin/neuai/Project_01/pune_weather_with_regions.csv'

# Load the dataset

weather_data = pd.read_csv(file_path)

# Display the first few rows of the dataset

weather_data.head(), weather_data.info()

# Convert 'date' column to datetime format

weather_data['date'] = pd.to_datetime(weather_data['date'], format='%d-%m-
%Y')

# Add a 'month' column for grouping

weather_data['month'] = weather_data['date'].dt.to_period('M')

# Group by 'month' and aggregate numerical values (average for temperature,
humidity, and rainfall)

monthly_aggregated_data = weather_data.groupby('month').agg({

    'Temperature': 'mean',

    'Humidity': 'mean',

    'Rainfall': 'mean'

}).reset_index()

# Convert 'month' back to a standard datetime format for clarity

monthly_aggregated_data['month'] =
monthly_aggregated_data['month'].dt.to_timestamp()
```

```
# Display the aggregated data

monthly_aggregated_data
```

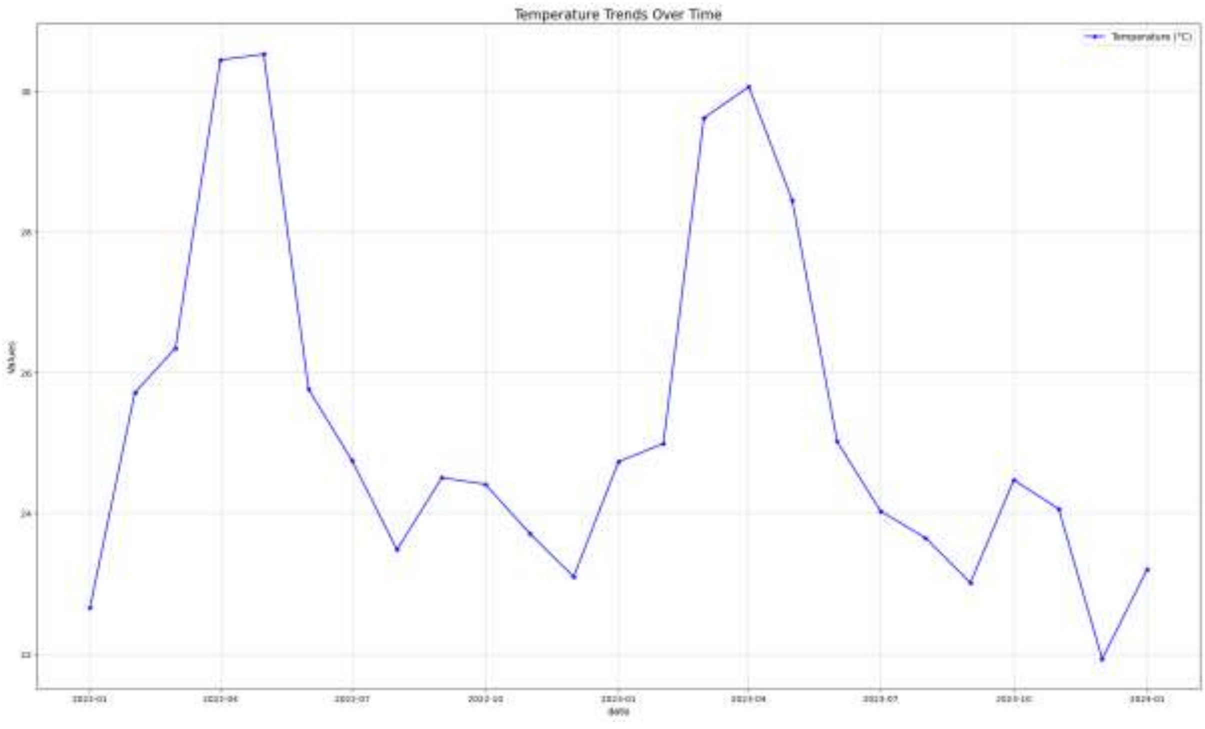
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 735 entries, 0 to 734
Data columns (total 5 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   date         735 non-null    object
 1   Temperature  735 non-null    float64
 2   Humidity     735 non-null    float64
 3   Rainfall     735 non-null    float64
 4   Region       735 non-null    object
dtypes: float64(3), object(2)
memory usage: 28.8+ KB
```

[14]:

	month	Temperature	Humidity	Rainfall
0	2022-01-01	22.657258	50.901882	10.119381
1	2022-02-01	25.712798	36.196429	10.245773
2	2022-03-01	26.345430	39.340054	10.036565
3	2022-04-01	30.440278	33.965278	9.938343
4	2022-05-01	30.522849	44.698925	9.935651
5	2022-06-01	25.759722	75.156944	9.907846
6	2022-07-01	24.747312	81.998656	9.661393
7	2022-08-01	23.481183	86.151882	9.824858
8	2022-09-01	24.505556	83.158333	10.029824

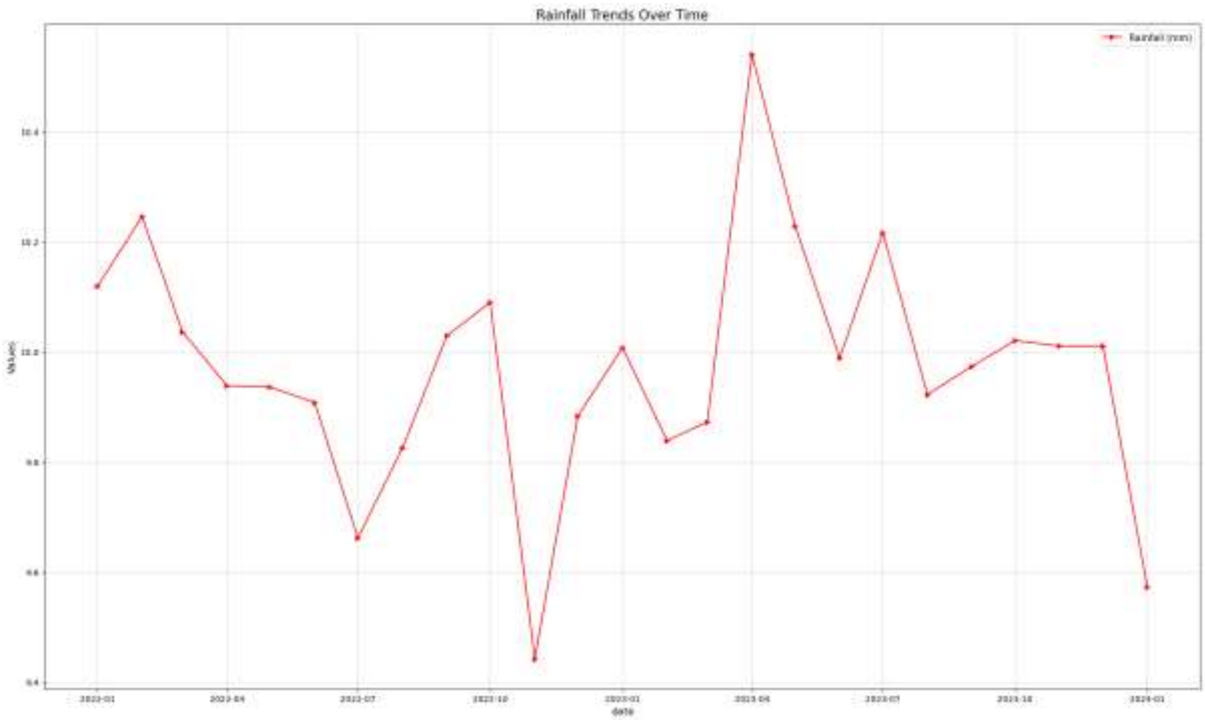
Ploting line plots visualize Temperature trends over time.:

```
plt.figure(figsize=(20,12))

plt.plot(monthly_aggregated_data['month'],
monthly_aggregated_data['Temperature'], marker='*', color='blue',
label='Temperature (°C)')

plt.title('Temperature Trends Over Time', fontsize=16)

plt.xlabel('date', fontsize=12)

plt.ylabel('Values', fontsize=12)

plt.grid(alpha=0.5)

plt.legend(fontsize=11)

plt.tight_layout()

plt.show()
```



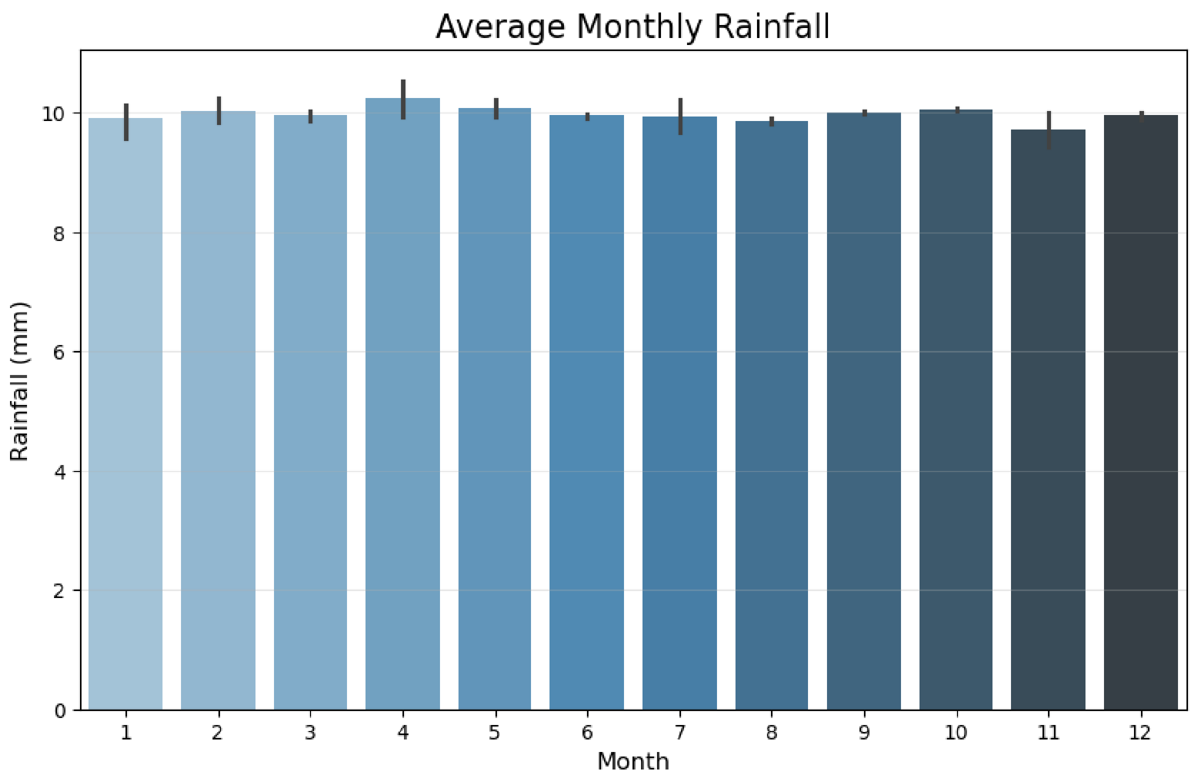
Ploting line plots visualize Rainfall trends over time :

```
plt.figure(figsize=(20,12))

plt.plot(monthly_aggregated_data['month'],
monthly_aggregated_data['Rainfall'], marker='>', color='red',
label='Rainfall (mm)')

plt.title('Rainfall Trends Over Time', fontsize=16)

plt.xlabel('date', fontsize=12)

plt.ylabel('Values', fontsize=12)

plt.grid(alpha=0.5)

plt.legend(fontsize=11)

plt.tight_layout()

plt.show()
```



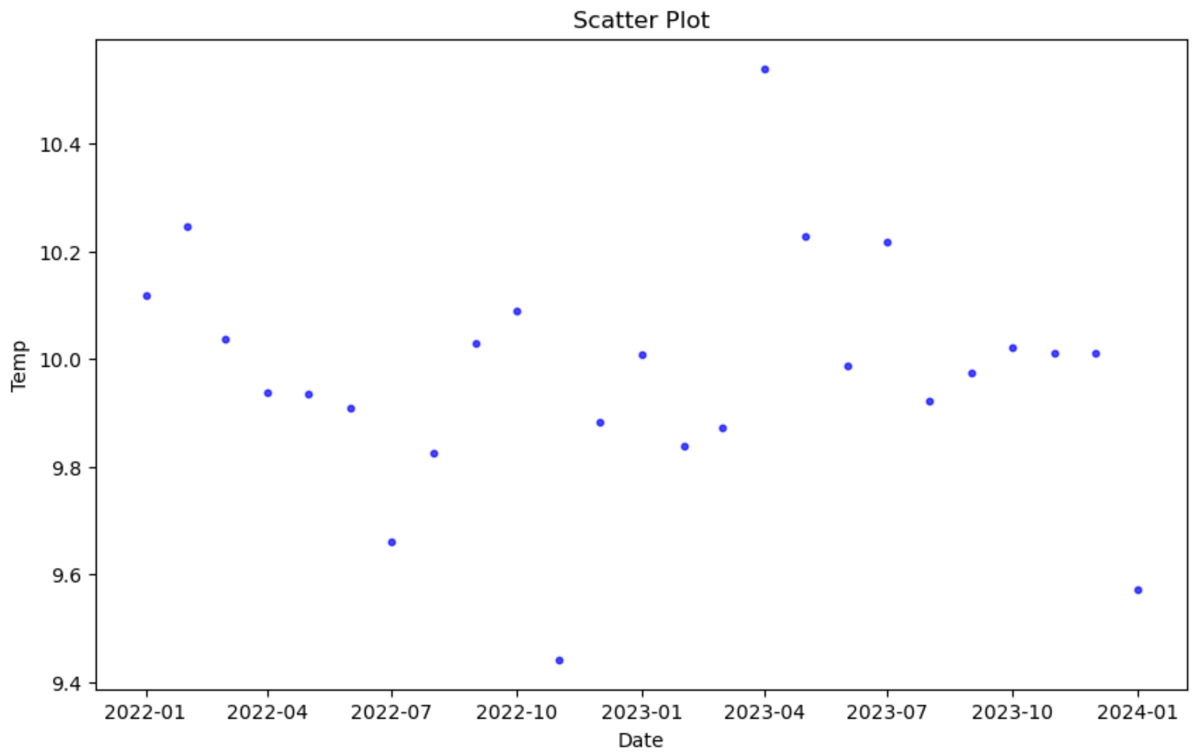
Ploting Bar plots visualize Rainfall trends over time.:

```
# Bar graph for Rainfall Over Time

plt.figure(figsize=(10, 6))

sns.barplot(x=monthly_aggregated_data['month'].dt.month,
y=monthly_aggregated_data['Rainfall'], palette="Blues_d")

plt.title('Average Monthly Rainfall', fontsize=16)

plt.xlabel('Month', fontsize=12)

plt.ylabel('Rainfall (mm)', fontsize=12)

plt.grid(axis='y', alpha=0.3)

plt.show()
```



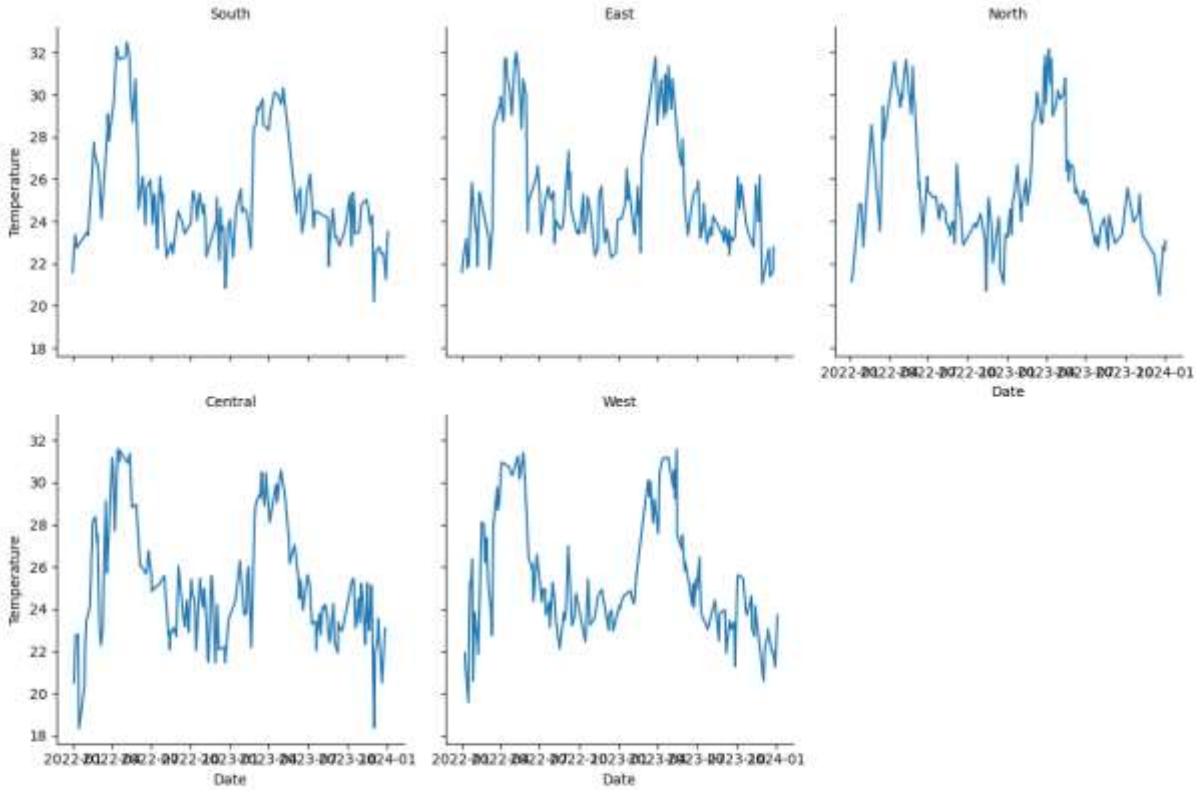
Ploting scatter plots visualize Temperature trends over time.:

```
plt.figure(figsize=(10, 6))
plt.scatter(monthly_aggregated_data['month'],
monthly_aggregated_data['Rainfall'],  s=10 ,alpha=0.7, c='blue')  # Replace
'x_column' and 'y_column'
plt.xlabel('Date')  # Replace with your column name or label
plt.ylabel('Temp')  # Replace with your column name or label
plt.title('Scatter Plot')
plt.show()
```



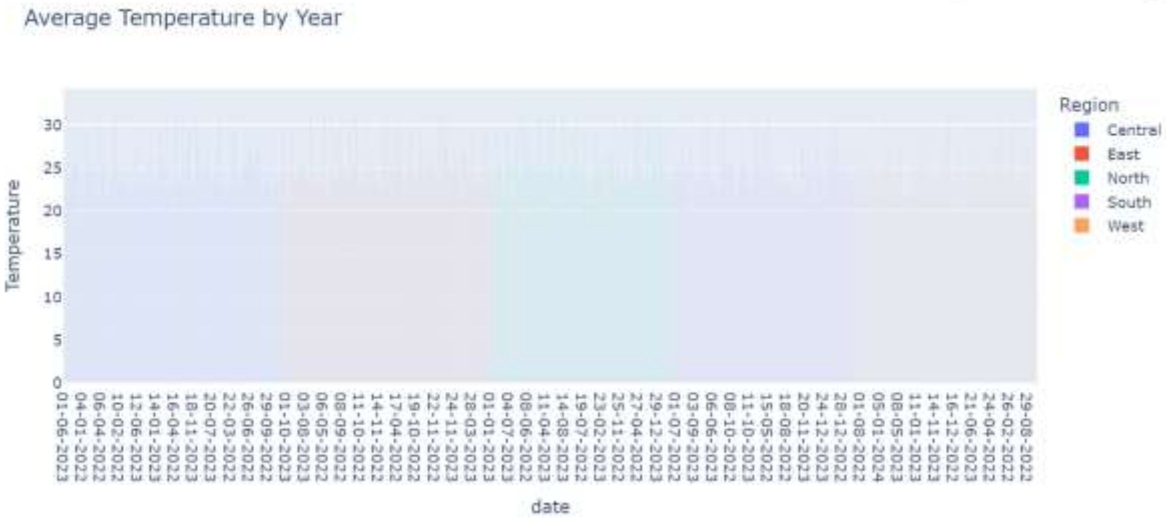
Compare trends across multiple regions or time periods. :

```
g = sns.FacetGrid(weather_data, col='Region', col_wrap=3, height=4,
sharey=True)
g.map(sns.lineplot, 'date', 'Temperature')
g.set_titles('{col_name}')
g.set_axis_labels('Date', 'Temperature')
plt.show()
```



Add interactive visualizations using Plotly or Dash for better user engagement. :

```
grouped_data = rain.groupby(['Region',
'date'])['Temperature'].mean().reset_index()

print(cleaned_data)
import plotly.express as px

# Interactive line plot
fig = px.line(weather_data, x='date', y='Temperature', color='Region',
title='Temperature Trends Across Regions')
fig.show()

# Interactive grouped bar chart
fig = px.bar(grouped_data, x='date', y='Temperature', color='Region',
barmode='group', title='Average Temperature by Year')
fig.show()
```



Identify and analyze extreme weather events (e.g., heatwaves, heavy rainfall) :

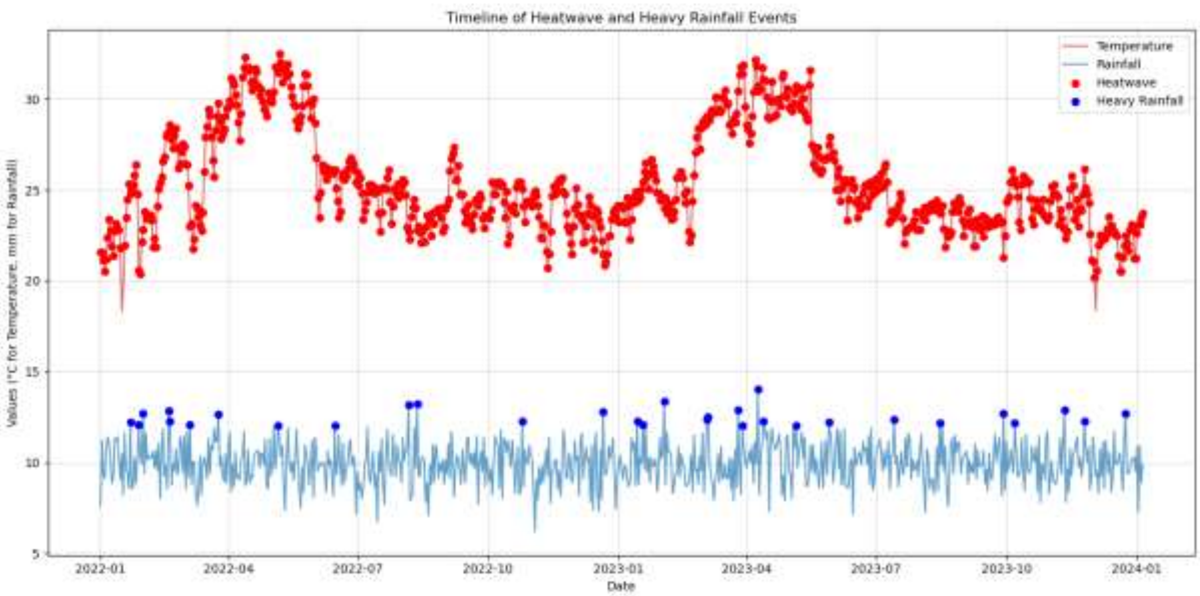
```
# Define thresholds
heatwave_threshold = 20  # Example: Temperature > 40°C
heavy_rainfall_threshold = 12  # Example: Rainfall > 50 mm/day
weather_data =
pd.read_csv('C:/Users/admin/neuai/Project_01/pune_weather_with_regions.csv'
)
# Convert 'date' column to datetime format
weather_data['date'] = pd.to_datetime(weather_data['date'], format='%d-%m-
%Y')

# Add a 'month' column for grouping
weather_data['month'] = weather_data['date'].dt.to_period('M')

# Add extreme event columns
weather_data['heatwave'] = weather_data['Temperature'] > heatwave_threshold
weather_data['heavy_rainfall'] = weather_data['Rainfall'] >
heavy_rainfall_threshold

# Identify consecutive heatwave days
weather_data['heatwave_streak'] =
weather_data['heatwave'].astype(int).groupby(weather_data['Region']).cumsum
()

# Filter for events lasting more than 3 days
heatwave_events = weather_data[weather_data['heatwave_streak'] >= 3]
print(heatwave_events)
```

```
...            date  Temperature   Humidity   Rainfall   Region    month  heatwave  \
     10  2022-01-11    22.750000  51.083333  11.309362    South  2022-01      True
     11  2022-01-12    23.166667  51.833333  11.233322     East  2022-01      True
     12  2022-01-13    22.833333  61.583333  11.387355    South  2022-01      True
     13  2022-01-14    22.791667  65.166667  10.125745  Central  2022-01      True
     14  2022-01-15    21.791667  64.041667   9.051436     East  2022-01      True
     ..         ...          ...        ...        ...      ...      ...       ...
     730 2024-01-01    22.625000  48.416667  10.877698    North  2024-01      True
     731 2024-01-02    23.083333  45.375000   7.290903    South  2024-01      True
     732 2024-01-03    23.083333  46.708333  10.949645    North  2024-01      True
     733 2024-01-04    23.500000  47.250000   8.889198    South  2024-01      True
     734 2024-01-05    23.708333  45.833333   9.850423     West  2024-01      True

          heavy_rainfall  heatwave_streak
     10            False                3
     11            False                3
     12            False                4
     13            False                3
     14            False                4
     ..              ...              ...
     730           False              137
     731           False              137
     732           False              138
     733           False              138
     734           False              136

     [724 rows x 9 columns]
```

```
# Count events by region
event_counts = weather_data.groupby('Region')[['heatwave',
'heavy_rainfall']].sum()
print(event_counts)

# Average intensity
average_intensity = weather_data.groupby('Region')[['Temperature',
'Rainfall']].mean()
print(average_intensity)
```

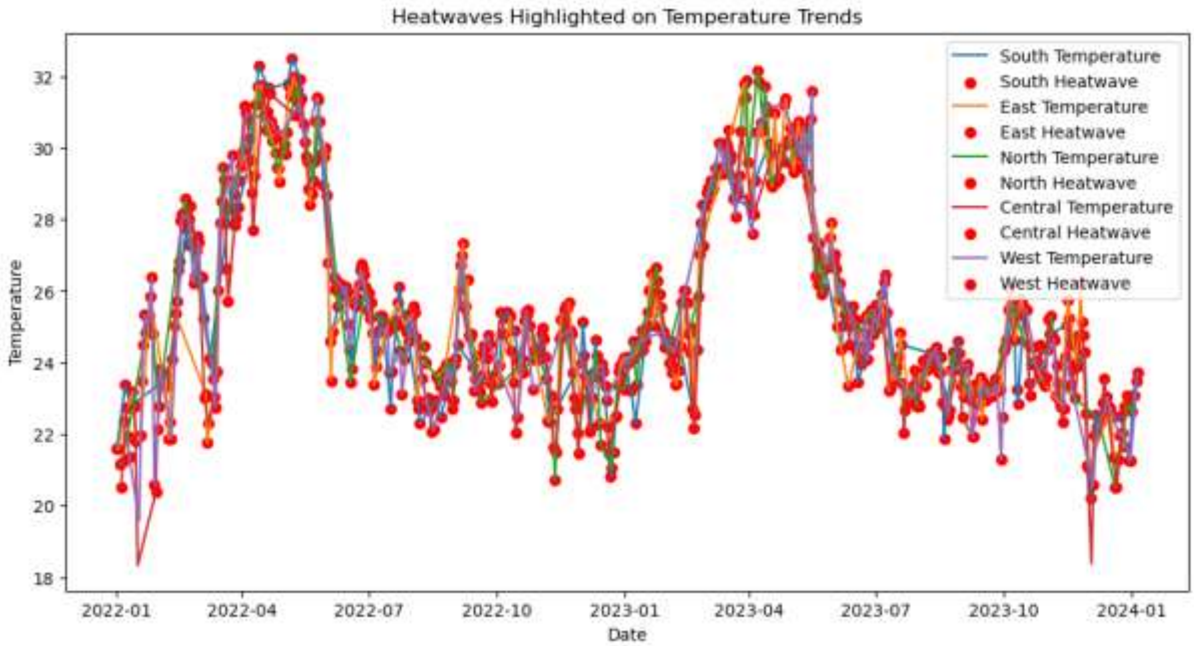
```
         heatwave  heavy_rainfall
Region
Central       163               8
East          157               6
North         138               8
South         138               3
West          136               6
         Temperature   Rainfall
Region
Central    25.001263   9.930579
East       25.477442   9.917179
North      25.877717  10.175418
South      25.271437  10.027670
West       25.291667   9.900031
```

```
plt.figure(figsize=(12, 6))
for region in weather_data['Region'].unique():
    region_data = weather_data[weather_data['Region'] == region]
    plt.plot(region_data['date'], region_data['Temperature'],
label=f'{region} Temperature')
    heatwave_days = region_data[region_data['heatwave']]
    plt.scatter(heatwave_days['date'], heatwave_days['Temperature'],
color='red', label=f'{region} Heatwave')

plt.xlabel('Date')
plt.ylabel('Temperature')
plt.title('Heatwaves Highlighted on Temperature Trends')
plt.legend()
plt.show()
```



Visualize events on a timeline :

```
import matplotlib.pyplot as plt

# Convert the 'date' column to datetime format (if not already done)
weather_data['date'] = pd.to_datetime(weather_data['date'])

# Plot the temperature and rainfall over time
plt.figure(figsize=(14, 7))

# Temperature line plot
plt.plot(weather_data['date'], weather_data['Temperature'],
label='Temperature', color='tab:red', alpha=0.7)

# Rainfall line plot
plt.plot(weather_data['date'], weather_data['Rainfall'], label='Rainfall',
color='tab:blue', alpha=0.7)

# Highlight heatwave events
heatwave_dates = weather_data[weather_data['heatwave']]['date']
heatwave_values = weather_data[weather_data['heatwave']]['Temperature']
plt.scatter(heatwave_dates, heatwave_values, color='red', label='Heatwave',
zorder=5)

# Highlight heavy rainfall events
rainfall_dates = weather_data[weather_data['heavy_rainfall']]['date']
rainfall_values = weather_data[weather_data['heavy_rainfall']]['Rainfall']
plt.scatter(rainfall_dates, rainfall_values, color='blue', label='Heavy
Rainfall', zorder=5)

# Add labels, title, and legend
plt.title('Timeline of Heatwave and Heavy Rainfall Events')
plt.xlabel('Date')
plt.ylabel('Values (°C for Temperature, mm for Rainfall)')
plt.legend()
plt.grid(alpha=0.5)
plt.tight_layout()

# Show the plot
plt.show()
```



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5. Results

- **Monthly Trends:**
  - Temperature and rainfall trends showed clear seasonal variations.
  - Heatwaves and heavy rainfall events were identified and plotted on timelines.
- **Extreme Events:**
  - Several multi-day heatwaves were detected in the data.
  - Regions with higher occurrences of extreme rainfall were highlighted.
- **Interactive Insights:**
  - Interactive visualizations allowed for detailed exploration of trends across regions.

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6. Conclusion

This project successfully analyzed weather data from Pune to uncover patterns, trends, and extreme weather events. The results can aid in better understanding local weather behavior and preparing for adverse conditions. Future work could include predictive modeling for weather events using machine learning techniques.