```python
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

import glob
import os

def load_weather_data(folder_path) -> pd.DataFrame:
    print("Loading weather data...")

    csv_files = glob.glob(os.path.join(folder_path, "*.csv"))

    if not csv_files:
        print(f"No CSV files found in {folder_path}. Returning an
empty DataFrame.")
        return pd.DataFrame()

    df_list = []
    for file in csv_files:
        print(f"Loading file {file}")
        df_list.append(pd.read_csv(file, index_col="datetime"))

    weather = pd.concat(df_list, axis=0)
    weather.index = pd.to_datetime(weather.index)
    return weather

weather = load_weather_data("weather_data/")

# Convert index into a pandas datetime
weather.index = pd.to_datetime(weather.index)
weather.head()
```

```
Loading weather data...
Loading file weather_data/kericho, kenya 2024_01_01 to 2024_12_31.csv
Loading file weather_data/kericho, kenya 2022_01_01 to 2022_12_31.csv

Loading file weather_data/nakuru, kenya 2020_01_01 to 2021_12_31.csv
Loading file weather_data/kericho, kenya 2021_01_01 to 2021_12_31.csv
Loading file weather_data/kericho, kenya 2020_01_01 to 2020_12_31.csv
Loading file weather_data/kericho, kenya 2023_01_01 to 2023_12_31.csv

                      name  tempmax  tempmin  temp  feelslikemax  \
datetime
2024-01-01  Kericho, Kenya     25.0     14.7  19.9          25.0
2024-01-02  Kericho, Kenya     27.0     15.3  20.8          28.8
2024-01-03  Kericho, Kenya     27.1     13.8  21.2          28.6
2024-01-04  Kericho, Kenya     25.4     12.3  19.8          25.4
2024-01-05  Kericho, Kenya     26.0     13.2  19.5          26.0

            feelslikemin  feelslike   dew  humidity  precip  ...
solarenergy  \
datetime                                                     ...  

2024-01-01          14.7       19.9  17.2      84.6    11.2  ...  
14.3  
2024-01-02          15.3       20.9  17.3      81.4     9.9  ...  
19.9  
2024-01-03          13.8       21.2  17.9      82.3     6.8  ...  
20.1  
2024-01-04          12.3       19.8  16.0      80.7     1.5  ...  
23.1  
2024-01-05          13.2       19.5  16.5      84.2     3.4  ...  
20.7  

            uvindex severerisk              sunrise  
sunset  \
datetime  

2024-01-01        7       30.0  2024-01-01T06:37:56  2024-01-
01T18:46:26  
2024-01-02        8       30.0  2024-01-02T06:38:25  2024-01-
02T18:46:54  
2024-01-03        9       30.0  2024-01-03T06:38:53  2024-01-
03T18:47:22  
2024-01-04        9       10.0  2024-01-04T06:39:21  2024-01-
04T18:47:49  
2024-01-05        9       10.0  2024-01-05T06:39:48  2024-01-
05T18:48:16  

            moonphase              conditions  \
datetime
2024-01-01       0.67  Rain, Partially cloudy
2024-01-02       0.71  Rain, Partially cloudy
2024-01-03       0.74  Rain, Partially cloudy
2024-01-04       0.75  Rain, Partially cloudy
2024-01-05       0.80  Rain, Partially cloudy

                                                  description  icon  \
datetime
2024-01-01        Partly cloudy throughout the day with rain.  rain
2024-01-02        Partly cloudy throughout the day with rain.  rain
2024-01-03  Partly cloudy throughout the day with a chance...  rain
2024-01-04        Partly cloudy throughout the day with rain.  rain
2024-01-05        Partly cloudy throughout the day with rain.  rain

                                                   stations
datetime
2024-01-01  HKKI,63708099999,63709099999,63710099999,remote
2024-01-02  HKKI,63708099999,63709099999,63710099999,remote
2024-01-03  HKKI,63708099999,63709099999,63710099999,remote
2024-01-04  HKKI,63708099999,63709099999,63710099999,remote
```

```
2024-01-05  HKKI,63708099999,63709099999,63710099999,remote

[5 rows x 32 columns]
```

```python
print(weather["name"].unique())
print()
weather.info()
```

```
['Kericho, Kenya' 'Nakuru, Kenya']

<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 2558 entries, 2024-01-01 to 2023-12-31
Data columns (total 32 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   name              2558 non-null   object 
 1   tempmax           2558 non-null   float64
 2   tempmin           2558 non-null   float64
 3   temp              2558 non-null   float64
 4   feelslikemax      2558 non-null   float64
 5   feelslikemin      2558 non-null   float64
 6   feelslike         2558 non-null   float64
 7   dew               2558 non-null   float64
 8   humidity          2558 non-null   float64
 9   precip            2558 non-null   float64
 10  precipprob        2558 non-null   int64  
 11  precipcover       2558 non-null   float64
 12  preciptype        2096 non-null   object 
 13  snow              2558 non-null   int64  
 14  snowdepth         2558 non-null   int64  
 15  windgust          2558 non-null   float64
 16  windspeed         2558 non-null   float64
 17  winddir           2558 non-null   float64
 18  sealevelpressure  2558 non-null   float64
 19  cloudcover        2558 non-null   float64
 20  visibility        2537 non-null   float64
 21  solarradiation    2558 non-null   float64
 22  solarenergy       2558 non-null   float64
 23  uvindex           2558 non-null   int64  
 24  severerisk        1087 non-null   float64
 25  sunrise           2558 non-null   object 
 26  sunset            2558 non-null   object 
 27  moonphase         2558 non-null   float64
 28  conditions        2558 non-null   object 
 29  description       2558 non-null   object 
 30  icon              2558 non-null   object 
 31  stations          2558 non-null   object 
dtypes: float64(20), int64(4), object(8)
memory usage: 659.5+ KB
```

Data Cleaning and Formatting

In this section we are going to make the columns atomic; that is remove any comma separated, extra spaced data within our dataframe.

```
def clean_string_column(df, column_name):
    """
    Reformats a string column in a Pandas DataFrame:
    - Removes all whitespace.
    - Removes all commas.
    - Converts to lowercase.
    - Replaces remaining spaces (if any after initial cleanup) with
underscores.

    Args:
        df (pd.DataFrame): The input DataFrame.
        column_name (str): The name of the column to clean.

    Returns:
        pd.DataFrame: The DataFrame with the cleaned column.
    """
    # Ensure the column is of string type to apply string methods
    df[column_name] = df[column_name].astype(str)

    df[column_name] = df[column_name].str.replace(r'\s+', '_',
regex=True)
    df[column_name] = df[column_name].str.replace(',', '')
    df[column_name] = df[column_name].str.lower()
    df[column_name] = df[column_name].str.replace(' ', '_')

    return df

# Clean conditions column
# Clean the name column
weather = clean_string_column(weather.copy(), "conditions")
weather = clean_string_column(weather.copy(), "name")

print(weather["conditions"].unique())
print(weather["name"].unique())
```

```
['rain_partially_cloudy' 'rain_overcast' 'partially_cloudy' 'clear'
'rain'
 'overcast']
['kericho_kenya' 'nakuru_kenya']
```

Group the data into seasons

Grouping data into seasons will allow us to get the seasonal averages required to check if a crop is suitable to grow in certain location.

```python
def get_season(month):
    if month in [1, 2, 3]:
        return "JFM"    # January, February, March season
    elif month in [4, 5, 6]:
        return "AMJ"    # April, May, June season
    elif month in [7, 8, 9]:
        return "JAS"    # July, August, September season
    else:
        return "OND"    # October, November, December season

weather = weather.copy()
weather["year"] = weather.index.year
weather["month"] = weather.index.month
weather["season"] = weather["month"].apply(get_season)
weather["season"]
```

```
datetime
2024-01-01    JFM
2024-01-02    JFM
2024-01-03    JFM
2024-01-04    JFM
2024-01-05    JFM
             ...
2023-12-27    OND
2023-12-28    OND
2023-12-29    OND
2023-12-30    OND
2023-12-31    OND
Name: season, Length: 2558, dtype: object
```

```python
# Grouping data into seasons will allow us to get
# seasonal averages eg;
seasonal_data = weather.groupby(["year", "season"])
seasonal_avg = seasonal_data.mean(numeric_only=True)
seasonal_avg
```

```
               tempmax    tempmin       temp  feelslikemax
feelslikemin  \
year season

2020 AMJ     26.329121  13.618132  19.870879     26.745604
13.618132
     JAS     25.728804  12.726630  19.005435     25.893478
12.726630
     JFM     27.556044  13.421429  20.626374     27.913736
13.416484
     OND     26.595109  13.493478  20.022826     26.925543
13.493478
2021 AMJ     26.789560  14.856593  20.409890     27.081319
14.856593
```

```
     JAS     26.069565  14.612500  19.848913     26.115761
14.612500
     JFM     27.916111  14.389444  20.856667     27.653333
14.377222
     OND     27.703261  14.214674  20.759239     27.736957
14.214674
2022 AMJ     28.030769  16.250549  22.171429     28.498901
16.250549
     JAS     27.458696  16.291304  21.848913     27.535870
16.291304
     JFM     29.608889  16.204444  22.990000     29.945556
16.204444
     OND     28.448913  16.503261  22.389130     28.738043
16.503261
2023 AMJ     28.431868  12.857143  20.678022     29.051648
12.857143
     JAS     28.926087  12.840217  20.758696     28.947826
12.840217
     JFM     30.192222  16.831111  23.636667     30.038889
16.831111
     OND     28.144565  13.030435  20.834783     28.926087
13.030435
2024 AMJ     28.319780  14.083516  21.273626     29.368132
14.083516
     JAS     29.070652  13.140217  20.960870     29.023913
13.140217
     JFM     28.972527  13.940659  21.791209     29.948352
13.940659
     OND     29.209783  12.927174  21.158696     29.846739
12.927174

             feelslike        dew   humidity     precip
precipprob  ...  \
year
season                                                                 ...
2020 AMJ     19.934066  15.144505  76.447802   8.265934
86.263736  ...
     JAS     19.028804  14.062500  75.062500   4.465217
86.413043  ...
     JFM     20.693956  14.695055  71.714286   4.730769
80.769231  ...
     OND     20.076087  14.245109  72.010326   4.314130
72.282609  ...
2021 AMJ     20.468132  14.587363  71.915934   4.871978
78.021978  ...
     JAS     19.869022  13.732065  70.046739   4.461957
83.695652  ...
     JFM     20.832222  12.350556  62.283333   2.140000
51.666667  ...
```

```
     OND     20.771739  13.404891  65.711957   2.663587
78.804348  ...
2022 AMJ     22.246154  16.752747  73.462637   6.579121
86.813187  ...
     JAS     21.857609  15.452174  69.027174   3.707609
90.217391  ...
     JFM     23.052222  15.928889  67.526667   3.168889
68.888889  ...
     OND     22.422826  16.054348  69.705435   4.883696
86.956522  ...
2023 AMJ     20.757143  16.123077  77.093407   7.653846
92.307692  ...
     JAS     20.770652  14.615217  70.380435   3.895652
89.130435  ...
     JFM     23.551111  14.857778  61.908889   4.746667
48.888889  ...
     OND     20.921739  16.061957  76.271739   9.731522
90.217391  ...
2024 AMJ     21.420879  16.808791  77.429670  10.136264
96.703297  ...
     JAS     20.957609  14.882609  70.869565   3.558696
92.391304  ...
     JFM     21.932967  16.305495  73.540659   4.537363
81.318681  ...
     OND     21.235870  15.602174  72.980435   6.805435
93.478261  ...

                winddir  sealevelpressure  cloudcover  visibility  \
year season
2020 AMJ     193.210440       1016.967582   63.553846   22.155249
     JAS     177.209783       1016.288587   64.353261   22.263587
     JFM     242.989011       1015.947802   62.648901   22.378571
     OND     226.109783       1015.379348   61.746739   21.599457
2021 AMJ     216.178571       1016.113187   61.883516   20.070330
     JAS     172.289130       1017.050543   67.831522   20.278804
     JFM     247.634444       1013.963333   61.131667   20.779375
     OND     184.864130       1014.742391   64.295652   22.298370
2022 AMJ     193.554945       1015.818681   62.496703   15.173626
     JAS     182.160870       1016.483696   63.772826   15.227174
     JFM     219.447778       1014.490000   57.216667   15.506667
     OND     189.744565       1014.981522   69.233696   15.957609
2023 AMJ     157.451648       1016.307692   64.369231   18.602198
     JAS     146.133696       1017.110870   60.772826   19.560870
     JFM     226.798889       1014.773333   48.450000   14.945556
     OND     173.875000       1015.241304   66.505435   19.822826
2024 AMJ     196.976923       1016.682418   63.405495   17.879121
     JAS     168.793478       1017.026087   65.659783   18.433696
     JFM     185.272527       1016.324176   59.865934   18.590110
     OND     175.157609       1015.810870   62.992391   18.636957
```

```
             solarradiation  solarenergy   uvindex  severerisk
moonphase  \
year season

2020 AMJ          169.781868    14.700000  7.774725         NaN
0.487033
     JAS          140.741848    12.362500  7.125000         NaN
0.488478
     JFM          250.495604    21.623077  8.901099         NaN
0.472418
     OND          214.257609    18.463043  8.842391         NaN
0.472391
2021 AMJ          244.623626    21.128022  8.703297         NaN
0.485934
     JAS          219.351630    18.944022  7.896739         NaN
0.510761
     JFM          274.459444    23.710000  9.388889         NaN
0.469444
     OND          251.354891    21.697283  8.902174         NaN
0.506957
2022 AMJ          237.440659    20.485714  8.483516   29.890110
0.461209
     JAS          220.217391    19.027174  7.923913   21.956522
0.479022
     JFM          275.688889    23.793333  9.344444   10.740741
0.473222
     OND          245.295652    21.179348  8.695652   16.521739
0.487826
2023 AMJ          234.404396    20.237363  8.318681   33.406593
0.468352
     JAS          229.320652    19.788043  8.184783   18.478261
0.481087
     JFM          276.237778    23.862222  9.333333   13.222222
0.467889
     OND          240.830435    20.790217  8.804348   21.413043
0.499674
2024 AMJ          223.718681    19.313187  8.175824   27.857143
0.477363
     JAS          219.116304    18.922826  7.869565   18.804348
0.495978
     JFM          264.164835    22.816484  9.098901   13.736264
0.496154
     OND          241.244565    20.838043  8.706522   16.086957
0.490109

                month
year season
2020 AMJ      5.00000
     JAS      7.98913
     JFM      2.00000
     OND     11.00000
2021 AMJ      5.00000
     JAS      7.98913
     JFM      2.00000
     OND     11.00000
2022 AMJ      5.00000
     JAS      7.98913
     JFM      2.00000
     OND     11.00000
2023 AMJ      5.00000
     JAS      7.98913
     JFM      2.00000
     OND     11.00000
2024 AMJ      5.00000
     JAS      7.98913
     JFM      2.00000
     OND     11.00000

[20 rows x 25 columns]
```

Weather in Kericho

We are now going to check how the weather is in `kericho_kenya` Then we are going to check if `coffee` crop is suitable to grow there.

```
kericho_weather = weather[weather["name"] == "kericho_kenya"]
if kericho_weather.empty:
    print("No weather data found for Kericho")
    exit(1)

# Now lets take a look at the total seasonal rain per season
total_seasonal_rain = kericho_weather.groupby(["year", "season"])
["precip"].sum()
print(total_seasonal_rain)

# What about the average rain per season?
avg_seasonal_rain = kericho_weather.groupby(["season"])
["precip"].mean()
avg_seasonal_rain
```

```
year  season
2020  AMJ        934.6
      JAS        383.7
      JFM        642.6
      OND        605.1
2021  AMJ        607.8
      JAS        355.8
      JFM        265.9
      OND       335.6
2022  AMJ       598.7
      JAS       341.1
      JFM       285.2
      OND       449.3
2023  AMJ       696.5
      JAS       358.4
      JFM       427.2
      OND       895.3
2024  AMJ       922.4
      JAS       327.4
      JFM       412.9
      OND       626.1
Name: precip, dtype: float64
```

```
season
AMJ    8.263736
JAS    3.840000
JFM    4.499558
OND    6.329130
Name: precip, dtype: float64
```

```
# Threshold for coffee crop
coffee_thresholds = {
    "min_temp": 15,
    "max_temp": 24,
    "min_precip": 300,
    "max_precip": 600,
    "min_humidity": 60,
    "max_humidity": 80,
    "min_solarradiation": 12,
    "max_solarradiation": 22
}

def get_suitable_seasons(weather, crop_thresholds):
    seasonal_data = weather.groupby(["year", "season"]).agg({
        "temp": "mean",
        "humidity": "mean",
        "precip": "sum",
        "solarradiation": "mean"
    }).reset_index()

    # Evaluate each season
    suitable_seasons = []

    for _, row in seasonal_data.iterrows():
        score = 0
        total = 4  # number of parameters being checked

        season_temp = row["temp"]
        season_precip = row["precip"]
        season_humidity = row["humidity"]
        season_solarradiation = row["solarradiation"]

        if crop_thresholds["min_temp"] <= season_temp <=
crop_thresholds["max_temp"]:
            score += 1
        if crop_thresholds["min_precip"] <= season_precip <=
crop_thresholds["max_precip"]:
            score += 1
        if crop_thresholds["min_humidity"] <= season_humidity <=
crop_thresholds["max_humidity"]:
            score += 1
        if crop_thresholds["min_solarradiation"] <=
season_solarradiation <= crop_thresholds["max_solarradiation"]:
            score += 1

        if score / total >= 0.75:
            suitable_seasons.append({
                "year": int(row["year"]),
                "season": row["season"],
                "score": score / total,
                "avg_temp": round(row["temp"], 1),
                "total_rain": round(row["precip"], 1),
                "avg_humidity": round(row["humidity"], 1),
                "avg_solarradiation": round(row["solarradiation"], 1)
            })

    return suitable_seasons

suitable_seasons = get_suitable_seasons(kericho_weather,
coffee_thresholds)
print("Suitable seasons for growing coffe in Kericho")
suitable_seasons
```

```
Suitable seasons for growing coffe in Kericho
```

```
[{'year': 2020,
  'season': 'JAS',
  'score': 0.75,
  'avg_temp': 20.7,
  'total_rain': 383.7,
  'avg_humidity': 74.5,
  'avg_solarradiation': 62.2},
 {'year': 2021,
  'season': 'JAS',
  'score': 0.75,
  'avg_temp': 21.9,
  'total_rain': 355.8,
  'avg_humidity': 69.2,
  'avg_solarradiation': 222.2},
 {'year': 2021,
  'season': 'OND',
  'score': 0.75,
  'avg_temp': 22.5,
  'total_rain': 335.6,
  'avg_humidity': 66.3,
  'avg_solarradiation': 250.6},
 {'year': 2022,
  'season': 'AMJ',
  'score': 0.75,
  'avg_temp': 22.2,
  'total_rain': 598.7,
  'avg_humidity': 73.5,
  'avg_solarradiation': 237.4},
 {'year': 2022,
  'season': 'JAS',
  'score': 0.75,
  'avg_temp': 21.8,
  'total_rain': 341.1,
  'avg_humidity': 69.0,
  'avg_solarradiation': 220.2},
 {'year': 2022,
  'season': 'OND',
  'score': 0.75,
  'avg_temp': 22.4,
  'total_rain': 449.3,
  'avg_humidity': 69.7,
  'avg_solarradiation': 245.3},
 {'year': 2023,
  'season': 'JAS',
  'score': 0.75,
  'avg_temp': 20.8,
  'total_rain': 358.4,
  'avg_humidity': 70.4,
  'avg_solarradiation': 229.3},
 {'year': 2023,
  'season': 'JFM',
  'score': 0.75,
  'avg_temp': 23.6,
  'total_rain': 427.2,
  'avg_humidity': 61.9,
  'avg_solarradiation': 276.2},
 {'year': 2024,
  'season': 'JAS',
  'score': 0.75,
  'avg_temp': 21.0,
  'total_rain': 327.4,
  'avg_humidity': 70.9,
  'avg_solarradiation': 219.1},
 {'year': 2024,
  'season': 'JFM',
  'score': 0.75,
  'avg_temp': 21.8,
  'total_rain': 412.9,
  'avg_humidity': 73.5,
  'avg_solarradiation': 264.2}]
```

Results

As we can see from the above results, coffee is suitable to be grown in Kericho on every season.

Reformatting Weather Conditions

I've realised that the column `conditions` is always set to `Rain, Partially Cloudy`, even on days that have extremely low `precip` values. To correct this invalid data, I am going to implement a rule-based classifier using hardcoded thresholds on features like `precip`, `humidity` and `cloudcover`, to assign a label like:

```
- "Rain"
- "Partially cloudy"
- "Overcast"
- "Clear"
```

I am going to set a ruleset of:

```
- Rain: precip > 2.0 mm
- Overcast: cloudcover > 80%
- Partially cloudy: cloudcover > 40% or humidity > 70%
- High solar radiation: solarradiation > 200
- Clear: everything else
```

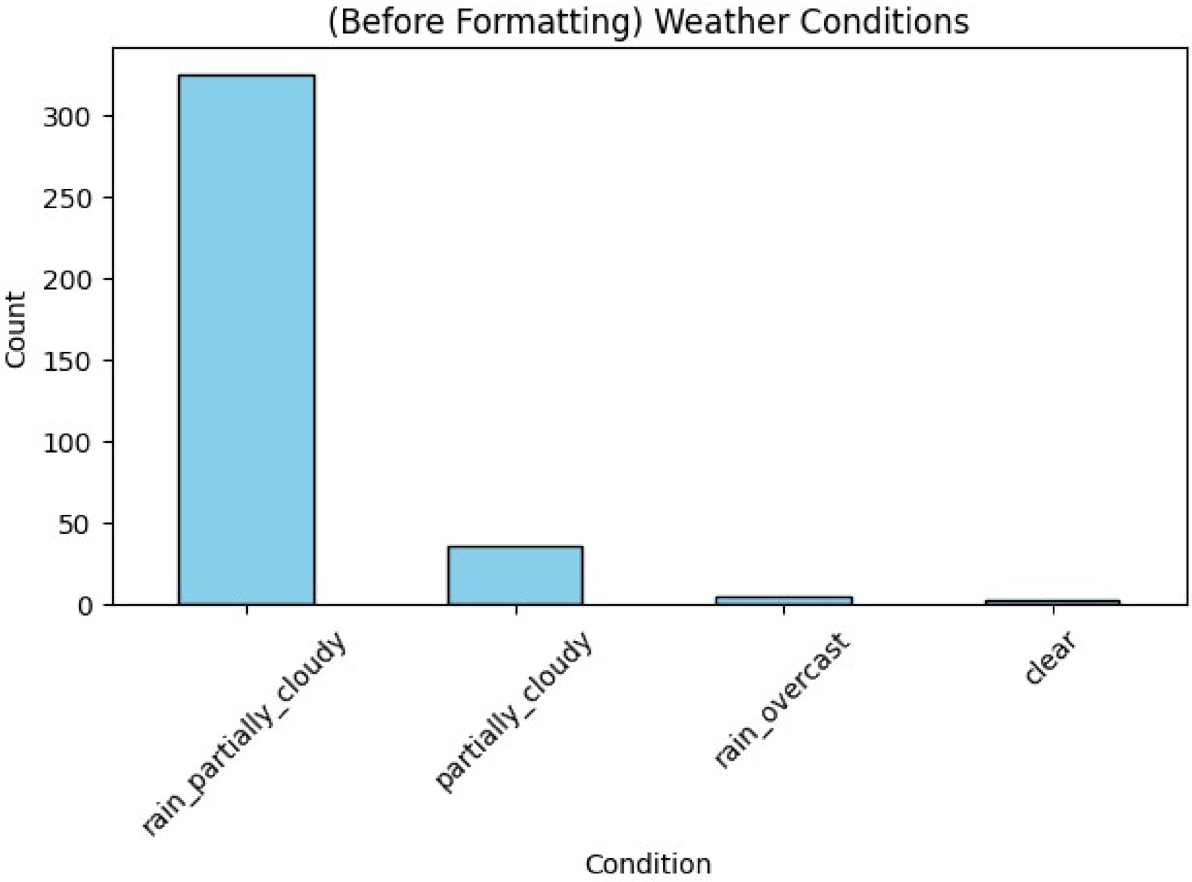
```
# Count unique values in the year 2020
kericho_2020 = kericho_weather[kericho_weather.index.year ==
2020].copy()
print(type(kericho_2020))

kericho_2020["conditions"].unique()
```

```
<class 'pandas.core.frame.DataFrame'>
```

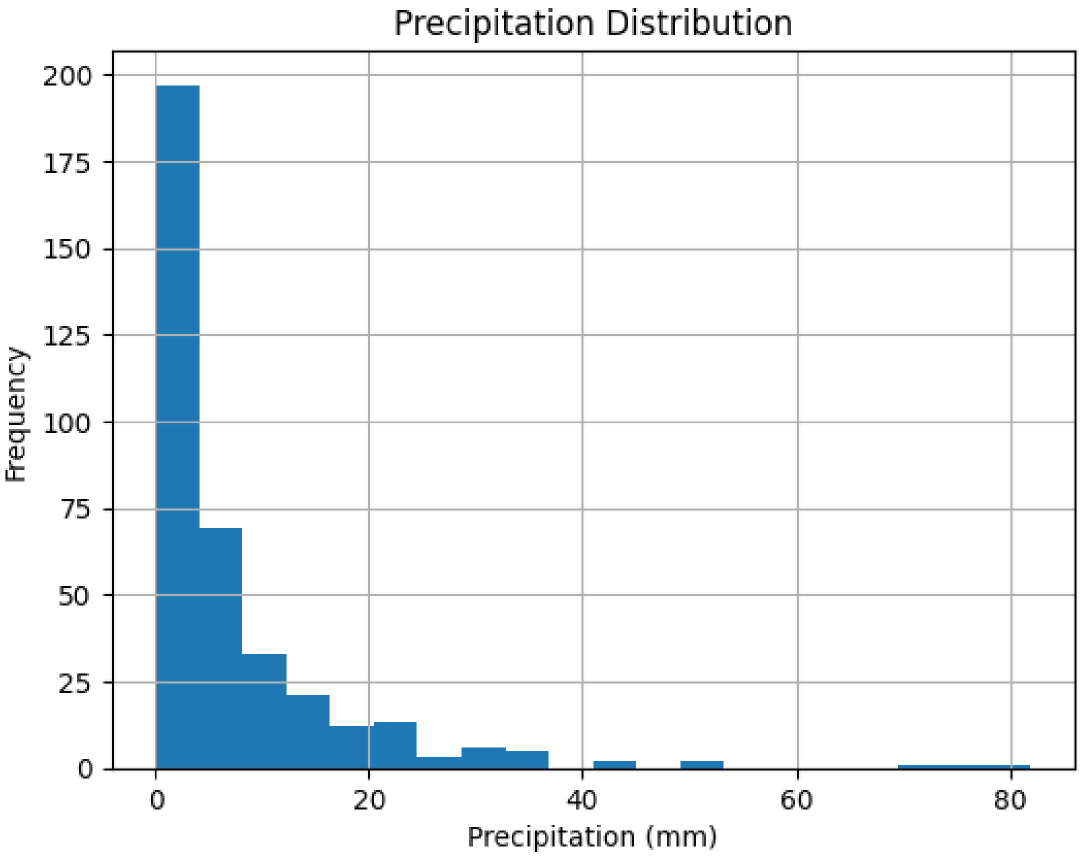
```
array(['partially_cloudy', 'rain_partially_cloudy', 'clear',
       'rain_overcast'], dtype=object)
```

```
# Plot bar chart
counts = kericho_2020["conditions"].value_counts()
counts.plot(kind='bar', color='skyblue', edgecolor='black')
```

```
plt.title("(Before Formatting) Weather Conditions")
plt.xlabel("Condition")
plt.ylabel("Count")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



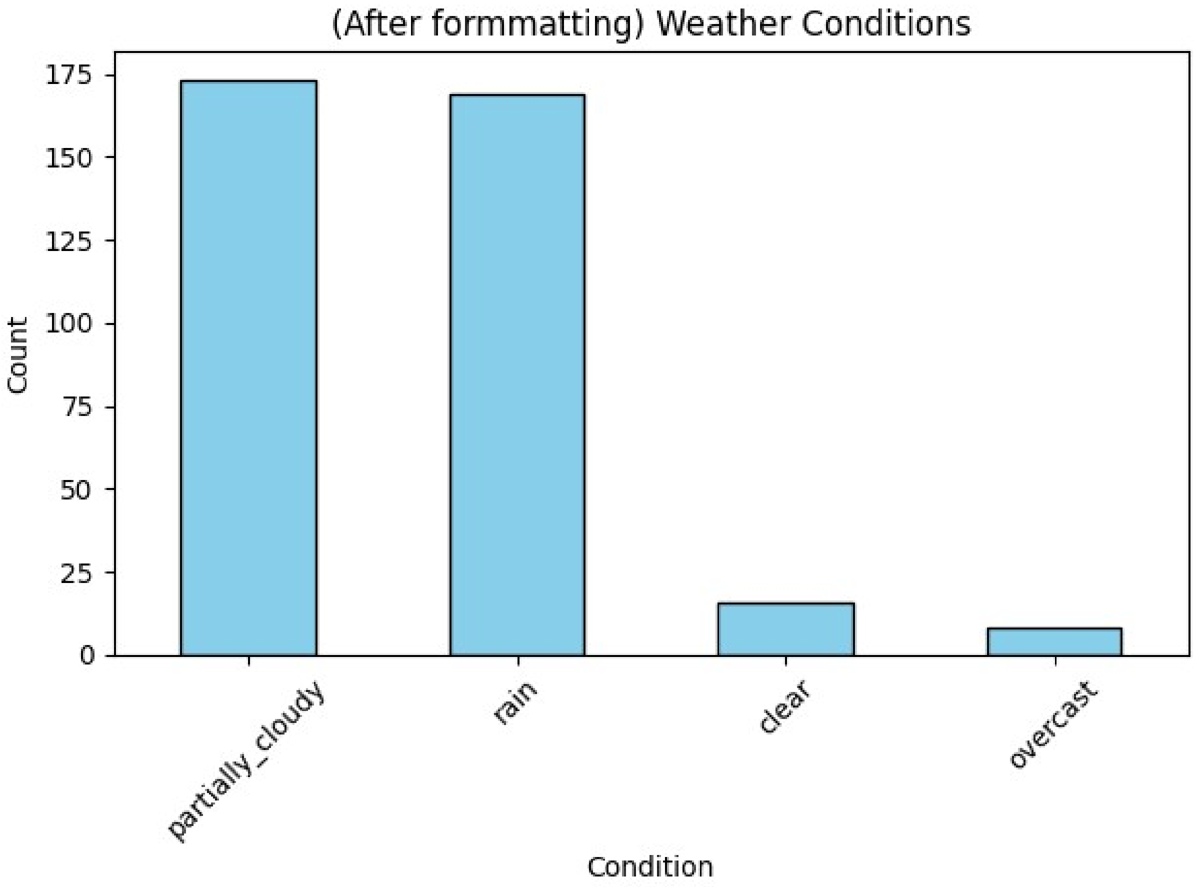
```
# Plot a histogram for rainfall distribution
kericho_2020["precip"].hist(bins=20)
plt.title("Precipitation Distribution")
plt.xlabel("Precipitation (mm)")
plt.ylabel("Frequency")
plt.show()
```



```
def group_weather_conditions(row):
    if row["precip"] > 4.0:
        return "rain"
    elif row["cloudcover"] > 80:
        return "overcast"
    elif row["cloudcover"] < 15 and row["solarradiation"] > 500:
        return "sunny"
    elif row["cloudcover"] > 40 or row["humidity"] > 70:
        return "partially_cloudy"
    else:
        return "clear"

kericho_2020["conditions"] =
kericho_2020.apply(group_weather_conditions, axis=1)
kericho_2020["conditions"].value_counts()
```

```
conditions
partially_cloudy    173
rain                169
clear                16
overcast              8
Name: count, dtype: int64
```

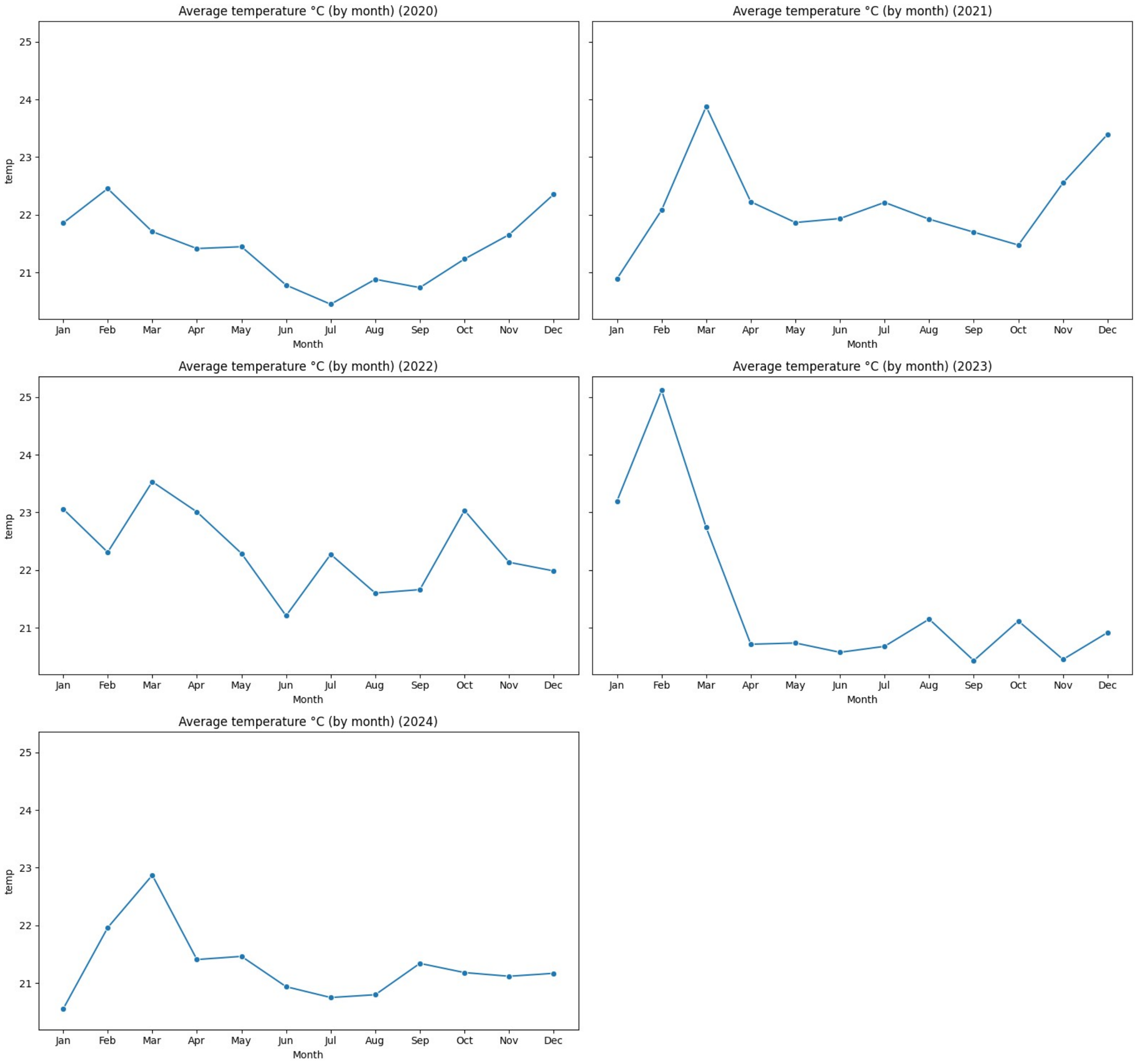
```
# Count new unique values
counts = kericho_2020["conditions"].value_counts()

# Plot bar chart
counts.plot(kind='bar', color='skyblue', edgecolor='black')

plt.title("(After formmatting) Weather Conditions")
plt.xlabel("Condition")
plt.ylabel("Count")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



Plot Weather Data For Kericho For The Years 2020-2024

This will enable us to view the shape of the data and confirm if it aligns to already established climate patterns. Data that aligns to already established climate patterns is more trustworthy than one that is not.

```
# Plot our weather data onto a graph to see how it looks like
def plt_weather_data(weather, columnname, title):
    weather = weather.copy()
    weather['year'] = weather.index.year
    weather['month'] = weather.index.month

    years = sorted(weather['year'].unique())
    n_years = len(years)

    # Create subplot grid (1 row per 2 columns)
    cols = 2
    rows = (n_years + 1) // cols

    fig, axes = plt.subplots(rows, cols, figsize=(16, 5 * rows),
sharey=True)
    axes = axes.flatten()

    month_names = ['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun',
                   'Jul', 'Aug', 'Sep', 'Oct', 'Nov', 'Dec']

    for i, year in enumerate(years):
        df_year = weather[weather['year'] == year]
        monthly_avg = df_year.groupby('month')[columnname].mean()

        # Plot
        ax = axes[i]
        sns.lineplot(
            x=month_names,
            y=monthly_avg.values,
            marker="o",
            ax=ax
        )
        ax.set_title(f"{title} ({year})")
        ax.set_xlabel("Month")
        ax.set_ylabel(columnname)

    # Hide unused subplots if number of years is odd
    for j in range(i + 1, len(axes)):
        fig.delaxes(axes[j])

    plt.tight_layout()
    plt.show()


plt_weather_data(kericho_weather, "temp", "Average temperature °C (by
month)")
plt_weather_data(kericho_weather, "precip", "Average rainfall per
month")
```



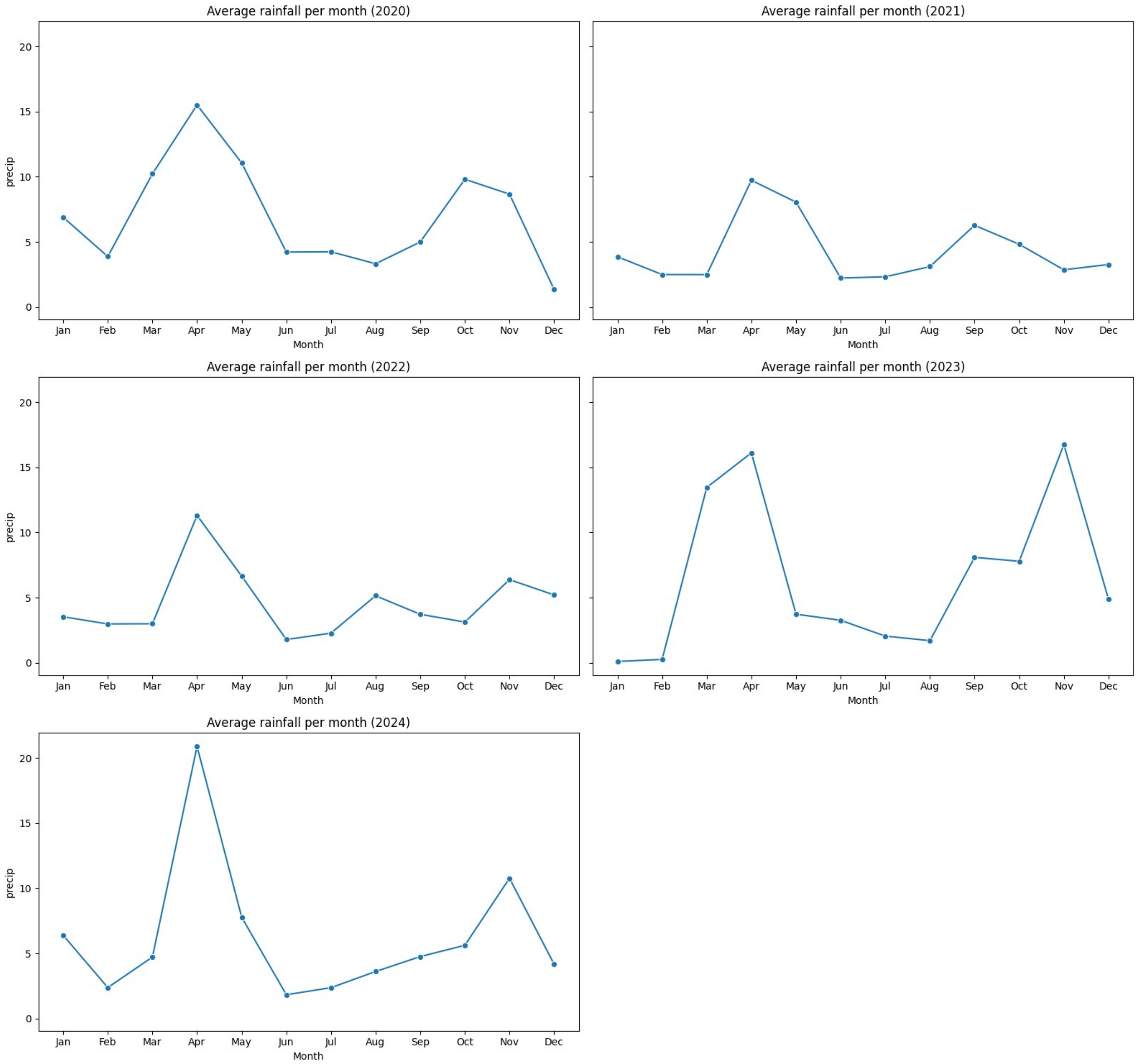
Average temperature °C (by month) (2020)

Average temperature °C (by month) (2021)

Average temperature °C (by month) (2022)

Average temperature °C (by month) (2023)

Average temperature °C (by month) (2024)


Average rainfall per month (2020)

Average rainfall per month (2021)

Average rainfall per month (2022)

Average rainfall per month (2023)

Average rainfall per month (2024)

Forecasting

In this section, I am going to implement a weather forecasting model called **Climatological Forecasting**.

Let's say today is July 15, 2025, and you want to predict the weather for the next 7 days. You would:

```
1. For each target day, look back at past similar days
2. Average the values (temp, rain, humidity)
3. Use that average as your forecast
```

Climatological forecasting is especially effective for predicting long-term seasonal patterns.

```
from datetime import datetime, timedelta

# Extract month and day for grouping
weather["month_day"] = weather.index.strftime("%m-%d")
weather["year"] = weather.index.year

# Define forecast target dates
today = datetime.today().date()
upcoming_days = []
for i in range(0, 8):
    tomorrow = today + timedelta(days=i)
    upcoming_days.append(tomorrow.strftime("%m-%d"))

forecast_columns = ["tempmax", "tempmin", "temp", "humidity",
"precip", "windspeed", "conditions"]
forecast = []

# Calculate avg weather conditions over the years
for month_day in upcoming_days:
    data = weather[weather["month_day"] == month_day]

    if not data.empty:
        avg = {
            "date": f"2025-{month_day}",
        }
        for col in forecast_columns:
            if col == "conditions":
                # Most frequent condition
                mode_values = data[col].mode()
                if not mode_values.empty:
                    avg[col] = mode_values.iloc[0]
                else:
                    avg[col] = "Unknown"
            else:
                avg[col] = round(data[col].mean(), 2)
        forecast.append(avg)

forecast_df = pd.DataFrame(forecast)

# Ensure 'date' column is datetime (in case it's a string)
forecast_df['date'] = pd.to_datetime(forecast_df['date'])

# Add day name column
forecast_df['day'] = forecast_df['date'].dt.day_name()
forecast_df
```

```
        date  tempmax  tempmin   temp  humidity  precip  windspeed  \
0 2025-08-07    27.26    13.90  20.66     69.90    1.44      17.60
1 2025-08-08    27.21    13.87  20.40     71.71    5.14      20.50
2 2025-08-09    26.11    14.14  20.07     72.00    3.06      18.27
```

```
3 2025-08-10    27.33    12.99  19.94     74.19    2.03      21.31
4 2025-08-11    27.23    14.01  20.66     71.89    2.94      21.60
5 2025-08-12    26.73    14.69  20.46     73.33    9.93      22.09
6 2025-08-13    27.34    13.54  19.87     75.04    5.99      20.30
7 2025-08-14    26.57    13.74  20.07     75.33    3.90      23.41

              conditions        day
0  rain_partially_cloudy   Thursday
1  rain_partially_cloudy     Friday
2  rain_partially_cloudy   Saturday
3  rain_partially_cloudy     Sunday
4  rain_partially_cloudy     Monday
5  rain_partially_cloudy    Tuesday
6  rain_partially_cloudy  Wednesday
7  rain_partially_cloudy   Thursday
```

```
# Ensure 'date' column is datetime (in case it's a string)
forecast_df['date'] = pd.to_datetime(forecast_df['date'])

# Add day name column
forecast_df['day'] = forecast_df['date'].dt.day_name()

forecast_json = forecast_df.to_json(orient="records",
date_format="iso")
print(forecast_json)
```

```
[{"date":"2025-08-
07T00:00:00.000","tempmax":27.26,"tempmin":13.9,"temp":20.66,"humidity
":69.9,"precip":1.44,"windspeed":17.6,"conditions":"rain_partially_clo
udy","day":"Thursday"},{"date":"2025-08-
08T00:00:00.000","tempmax":27.21,"tempmin":13.87,"temp":20.4,"humidity
":71.71,"precip":5.14,"windspeed":20.5,"conditions":"rain_partially_cl
oudy","day":"Friday"},{"date":"2025-08-
09T00:00:00.000","tempmax":26.11,"tempmin":14.14,"temp":20.07,"humidit
y":72.0,"precip":3.06,"windspeed":18.27,"conditions":"rain_partially_c
loudy","day":"Saturday"},{"date":"2025-08-
10T00:00:00.000","tempmax":27.33,"tempmin":12.99,"temp":19.94,"humidit
y":74.19,"precip":2.03,"windspeed":21.31,"conditions":"rain_partially_
cloudy","day":"Sunday"},{"date":"2025-08-
11T00:00:00.000","tempmax":27.23,"tempmin":14.01,"temp":20.66,"humidit
y":71.89,"precip":2.94,"windspeed":21.6,"conditions":"rain_partially_c
loudy","day":"Monday"},{"date":"2025-08-
12T00:00:00.000","tempmax":26.73,"tempmin":14.69,"temp":20.46,"humidit
y":73.33,"precip":9.93,"windspeed":22.09,"conditions":"rain_partially_
cloudy","day":"Tuesday"},{"date":"2025-08-
13T00:00:00.000","tempmax":27.34,"tempmin":13.54,"temp":19.87,"humidit
y":75.04,"precip":5.99,"windspeed":20.3,"conditions":"rain_partially_c
loudy","day":"Wednesday"},{"date":"2025-08-
14T00:00:00.000","tempmax":26.57,"tempmin":13.74,"temp":20.07,"humidit
y":75.33,"precip":3.9,"windspeed":23.41,"conditions":"rain_partially_c
loudy","day":"Thursday"}]
```