Project 1.2 - Exploring Weather Trends in Multiple Cities

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Project Outline

I. Tools Used

  1. Python

    a. Data Clean-Up

    b. Data Visualization

    c. Observations

  2. TexShop

    a. To export the Jupyter Notebook (. ipynb) as a PDF

  3. Excel

    a. To review city list

II. Data Collection

  1. Extracted city data from Udacity schema page

    a. Selected the below cities:

      i. New York

      ii. Boston

      iii. Miami

    b. Used:

      i. `SELECT * FROM [city_data] WHERE city=’New York’;`

      ii. `SELECT * FROM [city_data] WHERE city=’Boston’;`

      iii. `SELECT * FROM [city_data] WHERE city=’Miami’;`

III. Project Preparation [on Terminal]

1. Created a virtual environment for the project: `weather_trends`
2. Installed libraries to the environment: `pip install`

IV. Jupyter Notebook

1. Imported libraries:
    a. Pandas – to clean & model the data
    b. NumPy – to calculate the moving average (*did not use*)
    c. MatPlotLib – to plot the chart
    d. IPython Display – to include tables, charts, & hyperlinks in LaTex PDF export
2. Load Data
    a. New York City & Global Data:
        i. `pd.read_csv(file names)`
    b. Skimmed the city list on Excel and chose the above cities
3. Clean Data
    a. City Data
        i. Searched for null values & dropped any existing ones: `df.info()` & `df.dropna()`
        ii. Reset index: `df.reset_index()`
    b. Global Data
        i. Renamed columns to match the City Data table: `df.rename(columns=)`
        ii. Searched for null values & found none: `df.info()`
    c. Merge Tables

i. Joined tables by the “Year” columns: `pd.merge(on=’Year’, how=’left)`

ii. Dropped City & Country columns: `df.drop(columns=[’City’, ‘Country’])`

iii. Searched for null values & dropped any existing ones: `df.dropna()`

4. Find Moving Average

a. Used the Rolling Method to find the M.A. for the “NYC Temp” & “Global Temp.” columns:

i. `df.rolling()`

b. Added the moving averages to a new table: `pd.DataFrame()`

i. Set the moving average to periods of 15 years.

c. Set the “Year” column as the index: `df.set_index(‘Year)`

d. Exported the table as a .csv file: `df.to_csv()`

5. Descriptive Stats

a. Calculated the below & added them to a DataFrame: `pd.DataFrame()`

i. Mean: `df.mean()`

ii. Min.: `df.min()`

iii. Max.: `df.max()`

iv. Median: `df.median()`

v. Range: `df_max – df_min`

vi. Standard Deviation: `df.std()`

vii. Skewness: `df.skew()`

viii. Mode: `df.mode()`

6. Visualize the Data

    a. Plot the table and customize the lines: `df.plot()`

    b. Labeled the Title & Axes: `plt.title(), plt.xlabel(), plt.ylabel()`

    c. Added a grid & ticks: `plt.grid(), plt.xticks(), plt.yticks()`

    d. Added a legend & customized: `plt.legend()`

    e. Exported the chart as a .png file: `plt.savefig()`

7. Observations

    a. Displayed descriptive statistics table: `display(stats_df)`

    b. Changed the cell types to Markdown before adding observations

8. Citations

    a. Hyperlinked the websites used with their titles: `[Webpage Title](URL)`

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1 Import Dependencies

[1]:

```
# For clean-up & plot

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

%matplotlib inline

# For tables & chart to show in PDF download

from IPython.display import set_matplotlib_formats
set_matplotlib_formats('png', 'pdf')

# For hyperlinks to show in PDF download

from IPython.core.display import HTML
```

2 Load Data

[2]:

```
nyc_data = "RawData/nyc_data.csv"
bos_data = "RawData/bos_data.csv"
mia_data = "RawData/mia_data.csv"
glo_data = "RawData/global_data.csv"

nyc = pd.read_csv(nyc_data)
bos = pd.read_csv(bos_data)
mia = pd.read_csv(mia_data)
glo = pd.read_csv(glo_data)
```

3 Clean Data

3.1 Selected Cities' Data

3.1.1 NYC Data

[3]:
```
display(nyc.head())
```

```
   year      city        country  avg_temp
0  1743  New York  United States      3.26
1  1744  New York  United States     11.66
2  1745  New York  United States      1.13
3  1746  New York  United States       NaN
4  1747  New York  United States       NaN
```

[4]:
```
# Drop Null Values

nyc.dropna(inplace=True)


# Update Column Names

nyc_update = nyc.rename(columns={"year": 'Year',
                                 "city": 'City',
                                 "country": 'Country',
                                 "avg_temp": 'NYC Temp. (C°)'})

# Reset Index

nyc_df = nyc_update.reset_index(drop=True)

display(nyc_df.head())
```

```
   Year      City        Country  NYC Temp. (C°)
0  1743  New York  United States            3.26
1  1744  New York  United States           11.66
2  1745  New York  United States            1.13
3  1750  New York  United States           10.07
4  1751  New York  United States           10.79
```

3.1.2 Boston Data

[5]:
```
display(bos.head())
```

```
   year    city        country  avg_temp
0  1743  Boston  United States      1.19
1  1744  Boston  United States      9.63
2  1745  Boston  United States     -1.37
3  1746  Boston  United States       NaN
4  1747  Boston  United States       NaN
```

[6]:
```
# Drop Null Values
```

```
bos.dropna(inplace=True)


# Update Column Names

bos_update = bos.rename(columns={"year": 'Year',
                                 "city": 'City',
                                 "country": 'Country',
                                 "avg_temp": 'BOS Temp. (C°)'})

# Reset Index

bos_df = bos_update.reset_index(drop=True)

display(bos_df.head())
```

```
   Year    City        Country  BOS Temp. (C°)
0  1743  Boston  United States            1.19
1  1744  Boston  United States            9.63
2  1745  Boston  United States           -1.37
3  1750  Boston  United States            7.88
4  1751  Boston  United States            8.60
```

3.1.3 Miami Data

[7]:

```
display(mia.head())
```

```
   year   city        country  avg_temp
0  1758  Miami  United States     23.05
1  1759  Miami  United States     22.56
2  1760  Miami  United States     15.14
3  1761  Miami  United States       NaN
4  1762  Miami  United States       NaN
```

[8]:

```
# Drop Null Values

mia.dropna(inplace=True)


# Update Column Names

mia_update = mia.rename(columns={"year": 'Year',
                                 "city": 'City',
                                 "country": 'Country',
                                 "avg_temp": 'MIA Temp. (C°)'})


# Reset Index
```

```
mia_df = mia_update.reset_index(drop=True)

display(mia_df.head())
```

```
   Year   City        Country  MIA Temp. (C°)
0  1758  Miami  United States           23.05
1  1759  Miami  United States           22.56
2  1760  Miami  United States           15.14
3  1768  Miami  United States           21.77
4  1769  Miami  United States           22.57
```

3.2 Global Data

```
[9]: display(glo.head())
```

```
   year  avg_temp
0  1750      8.72
1  1751      7.98
2  1752      5.78
3  1753      8.39
4  1754      8.47
```

```
[10]: # Check for null values

      glo.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 266 entries, 0 to 265
Data columns (total 2 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   year      266 non-null    int64
 1   avg_temp  266 non-null    float64
dtypes: float64(1), int64(1)
memory usage: 4.3 KB
```

```
[11]: # Update Column Names

      glo_df = glo.rename(columns={"year": 'Year',
                                   "avg_temp": 'Global Temp. (C°)'})

      display(glo_df.head())
```

```
   Year  Global Temp. (C°)
0  1750               8.72
1  1751               7.98
2  1752               5.78
3  1753               8.39
4  1754               8.47
```

3.3 Merge ALL Tables

[12]:

```python
# Merge

merge1 = pd.merge(nyc_df, bos_df, on="Year", how="left")
merge2 = pd.merge(merge1, mia_df, on="Year", how="left")
final_merge = pd.merge(merge2, glo_df, on="Year", how="left")

# Review column names to drop

final_merge.columns
```

[12]:

```
Index(['Year', 'City_x', 'Country_x', 'NYC Temp. (C°)', 'City_y', 'Country_y',
       'BOS Temp. (C°)', 'City', 'Country', 'MIA Temp. (C°)',
       'Global Temp. (C°)'],
      dtype='object')
```

[13]:

```python
# Drop Irrelevant Columns

data_df = final_merge.drop(columns=['City_x', 'Country_x', 'City_y',␣
 ↪'Country_y', 'City', 'Country'])


# Drop Null Values

data_df.dropna(inplace=True)


# Reset Index

cities = data_df.reset_index(drop=True)

# Drop rows to only display 1913 - 2013 (100-year period)

cities_df = cities.drop(cities.index[range(143)])

display(cities_df.head())
```

```
     Year  NYC Temp. (C°)  BOS Temp. (C°)  MIA Temp. (C°)  Global Temp. (C°)
143  1913           10.76            8.58           23.29               8.30
144  1914            9.02            6.89           22.80               8.59
145  1915            9.85            7.98           22.66               8.59
146  1916            9.10            7.05           23.02               8.23
147  1917            8.24            6.04           22.59               8.02
```

[14]:

```python
# Get entry count

index = cities_df.index
```

```
cities_count = len(index)

print(cities_count)
```

```
101
```

4 Find the Moving Average

[15]:

```
# Calculate the moving average for all

nyc_ma = cities_df["NYC Temp. (C°)"].rolling(15, min_periods=1).mean()
bos_ma = cities_df["BOS Temp. (C°)"].rolling(15, min_periods=1).mean()
mia_ma = cities_df["MIA Temp. (C°)"].rolling(15, min_periods=1).mean()
glo_ma = cities_df["Global Temp. (C°)"].rolling(15, min_periods=1).mean()
years = cities_df["Year"]


# Add values to a new DataFrame

ma_df = pd.DataFrame({'NYC M.A. (C°)': nyc_ma,
                      'BOS M.A. (C°)': bos_ma,
                      'MIA M.A. (C°)': mia_ma,
                      'Global M.A. (C°)': glo_ma,
                      'Year': years})

display(ma_df.head())
```

```
     NYC M.A. (C°)  BOS M.A. (C°)  MIA M.A. (C°)  Global M.A. (C°)  Year
143      10.760000       8.580000      23.290000          8.300000  1913
144       9.890000       7.735000      23.045000          8.445000  1914
145       9.876667       7.816667      22.916667          8.493333  1915
146       9.682500       7.625000      22.942500          8.427500  1916
147       9.394000       7.308000      22.872000          8.346000  1917
```

[16]:

```
# Round values to 2 decimal points

round_df = ma_df.round({'NYC M.A. (C°)': 2,
                        'BOS M.A. (C°)': 2,
                        'MIA M.A. (C°)': 2,
                        'Global M.A. (C°)': 2})

display(round_df.head())
```

```
     NYC M.A. (C°)  BOS M.A. (C°)  MIA M.A. (C°)  Global M.A. (C°)  Year
143          10.76           8.58          23.29              8.30  1913
144           9.89           7.74          23.04              8.44  1914
145           9.88           7.82          22.92              8.49  1915
```

```
146           9.68           7.62          22.94              8.43  1916
147           9.39           7.31          22.87              8.35  1917
```

[17]:
```python
# Set 'Year' column as the index

mulcities_df = round_df.set_index('Year')

mulcities_df.to_csv("../project_1/Output/MultipleCitiesDataset.csv", index=True)

display(mulcities_df.head())
```

```
      NYC M.A. (C°)  BOS M.A. (C°)  MIA M.A. (C°)  Global M.A. (C°)
Year
1913          10.76           8.58          23.29              8.30
1914           9.89           7.74          23.04              8.44
1915           9.88           7.82          22.92              8.49
1916           9.68           7.62          22.94              8.43
1917           9.39           7.31          22.87              8.35
```

5 Calculate Descriptive Statistics

5.1 Mean

[18]:
```python
mean = mulcities_df.mean()

print(mean)
```

```
NYC M.A. (C°)       10.018515
BOS M.A. (C°)        7.910297
MIA M.A. (C°)       23.314752
Global M.A. (C°)     8.729307
dtype: float64
```

5.2 Median

[19]:
```python
median = mulcities_df.median()

print(median)
```

```
NYC M.A. (C°)        9.97
BOS M.A. (C°)        7.86
MIA M.A. (C°)       23.23
Global M.A. (C°)     8.65
dtype: float64
```

5.3 Mode

[20]:

```
mode = mulcities_df.mode()

# Convert column names to index

mode_2 = mode.transpose()

# Convert '0' to a string & rename

mode_3 = mode_2.rename(columns = {0:'Mode'}, inplace=True)

mode_4 = pd.DataFrame(mode_3, columns=['Mode'])

# Convert DataFrame to a float64

mode_df = mode_2["Mode"].astype(str).astype('float64')

print(mode_df)
```

```
NYC M.A. (C°)        9.85
BOS M.A. (C°)        7.75
MIA M.A. (C°)       23.20
Global M.A. (C°)     8.65
Name: Mode, dtype: float64
```

5.4 Minimum

[21]:

```
df_min = mulcities_df.min()

print(df_min)
```

```
NYC M.A. (C°)        9.39
BOS M.A. (C°)        7.28
MIA M.A. (C°)       22.87
Global M.A. (C°)     8.30
dtype: float64
```

5.5 Maximum

[22]:

```
df_max = mulcities_df.max()

print(df_max)
```

```
NYC M.A. (C°)       10.93
BOS M.A. (C°)        8.88
MIA M.A. (C°)       23.82
Global M.A. (C°)     9.50
dtype: float64
```

5.6 Range

[23]:

```
df_range = df_max - df_min

print(df_range)
```

```
NYC M.A. (C°)       1.54
BOS M.A. (C°)       1.60
MIA M.A. (C°)       0.95
Global M.A. (C°)    1.20
dtype: float64
```

5.7 Skewness

[24]:

```
skew = mulcities_df.skew()

print(skew)
```

```
NYC M.A. (C°)       0.547463
BOS M.A. (C°)       0.504626
MIA M.A. (C°)       0.583991
Global M.A. (C°)    1.069131
dtype: float64
```

5.8 Standard Deviation

[25]:

```
stan_dev = mulcities_df.std()

print(stan_dev)
```

```
NYC M.A. (C°)       0.329938
BOS M.A. (C°)       0.342311
MIA M.A. (C°)       0.255740
Global M.A. (C°)    0.293381
dtype: float64
```

5.9 Add to a DataFrame

[26]:

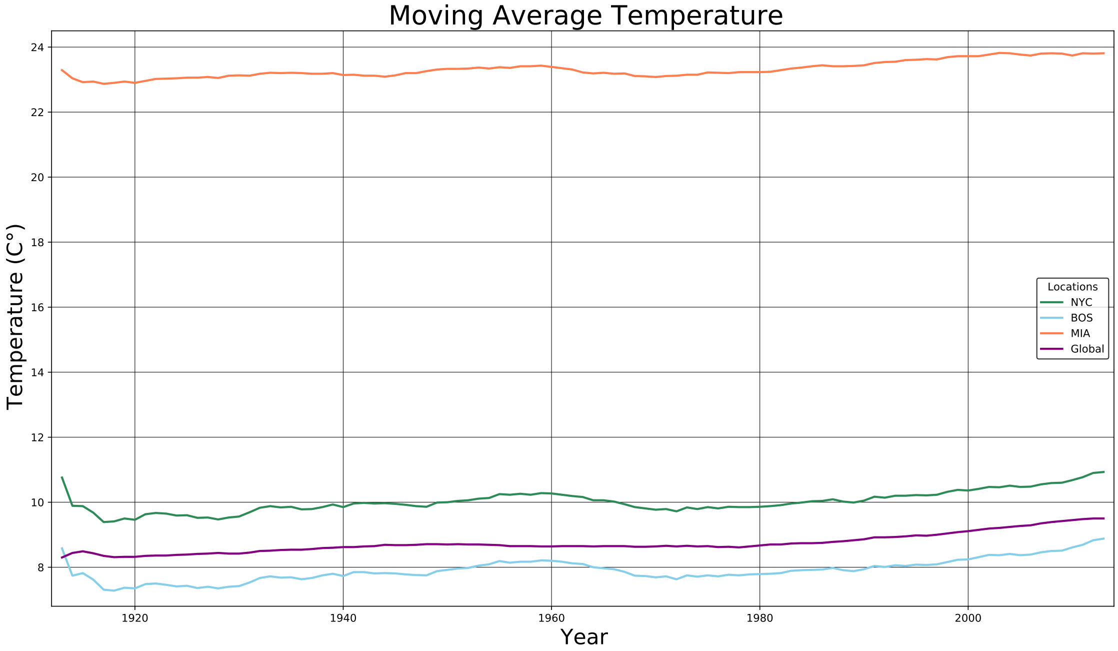
```
stats = pd.DataFrame({'Mean': mean,
                      'Median': median,
                      'Mode': mode_df,
                      'Min': df_min,
                      'Max': df_max,
                      'Range': df_range,
                      'Skew': skew,
                      'Standard Deviation': stan_dev})

stats_df = stats.round({'Mean': 2,
                        'Median': 2,
                        'Mode': 2,
                        'Min': 2,
                        'Max': 2,
                        'Range': 2,
                        'Skew': 2,
                        'Standard Deviation': 2})
```

6 Visualize The Data

[27]:

```
# Build Line Chart



## Plot the chart
mulcities_df.plot(linestyle='-',
                  color=['seagreen', 'skyblue', 'coral', 'purple'],
                  figsize=(18, 10),
                  linewidth=2)

## Add chart properties

### Labels

plt.title('Moving Average Temperature', fontsize=25)
plt.xlabel('Year', fontsize=20)
plt.ylabel('Temperature (C°)', fontsize=20)

### Add a blurb describing the chart's purpose

plt.text(1920, 4.5,
         "Note: This line chart represents the correlation between Global, New␣
 ↪York City, Boston, & Miami temperatures.",
         fontsize=15,
         style='italic')
plt.text(1925, 4.0,
         "Plot points represent the moving average of 15 years in a 100-year␣
 ↪period",
         fontsize=15,
         style='italic')

### Grid

plt.grid(linewidth=0.5, color='black')
plt.xticks()
plt.yticks()

plt.xlim(1912, 2014)
```

```python
plt.ylim(6.8, 24.5)


### Legend
legend = plt.legend(title = "Locations",
                    frameon=True,
                    edgecolor='black',
                    labels=['NYC', 'BOS', 'MIA', 'Global'])


# Save Chart
plt.savefig("../project_1/Output/TrendsPlot2.png", bbox_inches='tight')

plt.show()
```



Note: This line chart represents the correlation between Global, New York City, Boston, & Miami temperatures. Plot points represent the moving average of 15 years in a 100-year period

7 Observations

7.1 Statistics

[28]:
```python
display(stats_df)
```

```
                 Mean  Median   Mode   Min    Max  Range  Skew  \
NYC M.A. (C°)   10.02    9.97   9.85  9.39  10.93   1.54  0.55
BOS M.A. (C°)    7.91    7.86   7.75  7.28   8.88   1.60  0.50
```

```
MIA M.A. (C°)     23.31   23.23  23.20  22.87  23.82   0.95  0.58
Global M.A. (C°)   8.73    8.65   8.65   8.30   9.50   1.20  1.07

                  Standard Deviation
NYC M.A. (C°)                   0.33
BOS M.A. (C°)                   0.34
MIA M.A. (C°)                   0.26
Global M.A. (C°)                0.29
```

7.2 Are your cities hotter or cooler on average compared to the global average? Has the difference been consistent over time?

- New York City & Miami, on average, are consistently hotter than the Global temperature while Boston is consistently cooler.

7.3 How do the changes in your cities' temperatures over time compare to the changes in the global average?

- New York: New York City's average temperatures fluctuate from hotter temperatures (11° C), to cooler ones (9.5° C). Then the temperatures gradually increase to 10.9 - 11° C.

- Boston: Boston's average temperatures fluctuate from hotter temperatures (8.5° C), to cooler ones (7° C). Then the temperatures gradually increase to 8.5° C. This is expected as New England weather is generally colder than most states in the Northeast.

- Miami: Miami's average temperatures fluctuate between hotter temperatures 22.5° C & 23° C. Then the temperatures remain just above 23.5° C at first, then gradually increase to just below 24° C. This is expected as Florida has a tropical climate.

- Global: The global average temperatures fluctuate between cooler temperatures 8° C and 8.5° C. Then the temperatures gradually increase about 9.8° C.

7.4 What does the overall trend look like? Is the world getting hotter or cooler? Has the trend been consistent over the last few hundred years?

- The world is getting hotter over the progressing years. This has been a consistent, gradual increase.

- You'll notice that Boston has the lowest temperatures between the 1913 - 2013.

8 Citations

8.1 To Review the Data

Clean-Up: Pandas Documentation

Moving Average: Rolling Method

8.2 To Plot the Chart

Line Graph: Python Graph Gallery

8.3 To Export to PDF

How-To: Open Library

Download Link: MacTex

To Embed Hyperlinks: StackOverflow