ENSF 592 Spring 2023
Project Report

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MODULES:

The modules needed to run this climate_data.py program are:

```
import sys
import pandas as pd
import matplotlib.pyplot as plt
```

PROGRAM SUMMARY:

This program enables users to view the historical climate change data for different countries using climate change indicators like temperature change, climate-altering land cover index, and climate-related disaster frequencies. The data for the three indicators were obtained to build a combined dataframe for this project. The three datasets that were used are:

- Annual Surface Temperature Change [1]
- Land Cover and Land Cover Altering Indicator (Carbon Sequestration) [2]
- Climate-related Disaster Frequency [3]

To ensure data consistency, only the common years for which the data was present were merged into the dataframe. The index used to identify countries is the ISO3 code which is what the user is required to enter. The full names of the countries can be long, and tedious to type, which is why ISO3 is used. For instance, the country Madagascar, Rep. of can be entered as MDG.

The program starts by asking for two inputs:

1. The ISO3 code of the first country.
2. The ISO3 code of the second country to compare with.

If an invalid input is entered, the user is prompted to re-enter a valid input. The user may also enter 'exit' to terminate the program anytime. After the selection, the mean value of each indicator or parameter is displayed for the 29-year period for both countries. Refer to **Figure 1** in **Appendix A** to view the screenshot when Canada and USA were selected as an example.

Next, the user is asked to select a parameter or climate change indicator from the menu. A pivot table is shown for the user to view the values and compare between the 2 countries. And a bar graph is also plotted and displayed as a visual representation of the comparison. In the example, temperature change is selected as an indicator for the comparison between USA and Canada; results can be seen in **Appendix B** as **Figure 2** and **Figure 3** respectively.

The final two prompts allow the user to view the aggregate statistics for the entire climate data dataset (**Figure 4**), and how many countries experienced more than 20 climate-related disasters in a particular year (**Figure 5**), if any. If the user pleases to skip any of these

prompts, any key other than y or Y can be entered. The result of entering Y in both those prompts are shown in **Appendix C**. Thereafter an excel file is generated and exported to the working directory to indicate the end of the program.

Refer to **Appendix D Table.1** that illustrates how this program has met the project specifications.

REFERENCES:

[1] Annual Surface Temperature Change, FAO Temperature Change, February 27, 2021. [Online]. Available: https://climatedata.imf.org/datasets/4063314923d74187be9596f10d034914/explore

[2] Land Cover Accounts, FAO Land Cover; IMF staff calculations, October 26, 2021. [Online]. Available: https://climatedata.imf.org/datasets/b1e6c0ea281f47b285addae0cbb28f4b/explore

[3] Climate-related Disasters Frequency, EM-DAT, CRED / UCLouvain, Brussels, Belgium, February 27, 2021. [Online]. Available: https://climatedata.imf.org/datasets/b13b69ee0dde43a99c811f592af4e821/explore

Appendix A – Initial Prompts

```
$ python climate_data.py
ENSF592 Climate Data Statistics
Influence of climate change on various indicators for countries across several years

Compare the climate change indicator statistics for any 2 countries of your choice over a period of 29 years

Please enter the ISO3 code of the country (example: CAN, USA) or enter 'exit' to exit the program: Can
Now pick a second country to compare with the first country.
Please enter the ISO3 code of the country (example: CAN, USA) or enter 'exit' to exit the program: USA

You chose the countries Canada and United States

The mean aggregate statistics for the 2 countries over a period of 29 years is shown below:
For Canada:
Temperature Change             1.158759
Land Cover Index              99.571262
Extreme Temperature            0.000000
Wildfires                      0.000000
Storms                         0.965517
Landslides                     0.000000
Droughts                       0.000000
Floods                         1.137931
Total Disasters                2.827586
Fractional Total Disaster      0.979499
Fractional Land Cover Index    0.513028

For United States:
Temperature Change             0.863345
Land Cover Index              99.168032
Extreme Temperature            0.000000
Wildfires                      0.000000
Storms                        14.827586
Landslides                     0.137931
Droughts                       0.448276
Floods                         4.413793
Total Disasters               23.172414
```

Figure 1: Selecting Canada and USA using ISO 3

Appendix B: Pivot Table and Bar Graph

```
Landslides                    0.137931
Droughts                      0.448276
Floods                        4.413793
Total Disasters              23.172414
Fractional Total Disaster     8.066846
Fractional Land Cover Index   0.510900

Please select the parameter or climate change indicator you want to compare from the list.
Please enter the code for the parameter you want to choose from the list below or enter 'exit' to exit the program
0: Temperature Change
1: Land Cover Index
2: Total Disasters
0
You picked the Temperature Change parameter to compare the two countries.

A pivot table showing the Temperature Change statistics for the 2 countries for the period from 1992 to 2020 is displayed below and a
 corresponding bar graph is generated as well showing the trend:
Country  Canada  United States
Year
F1992     0.100          0.395
F1993     0.342          0.004
F1994     0.467          0.466
F1995     0.938          0.630
F1996    -0.125         -0.011
F1997     0.426          0.384
F1998     2.470          1.272
F1999     1.694          0.758
F2000     1.291          1.000
F2001     1.421          0.786
F2002     0.540          0.951
F2003     1.240          0.990
F2004     0.485          0.863
F2005     1.282          1.153
F2006     2.343          1.026
F2007     1.333          1.143
F2008     0.851          0.212
```

```
F1999     1.694          0.758
F2000     1.291          1.000
F2001     1.421          0.786
F2002     0.540          0.951
F2003     1.240          0.990
F2004     0.485          0.863
F2005     1.282          1.153
F2006     2.343          1.026
F2007     1.333          1.143
F2008     0.851          0.212
F2009     0.539          0.398
F2010     2.915          0.695
F2011     1.438          0.537
F2012     2.144          1.448
F2013     1.182          0.614
F2014     0.288          0.501
F2015     1.231          1.531
F2016     2.373          2.224
F2017     1.480          1.433
F2018     0.477          1.276
F2019     1.311          1.034
F2020     1.128          1.324
Plotting the data. After viewing the bar graph, please close the pop-up to continue.
```

Figure 2: Pivot table showing yearly temperature change for Canada and USA

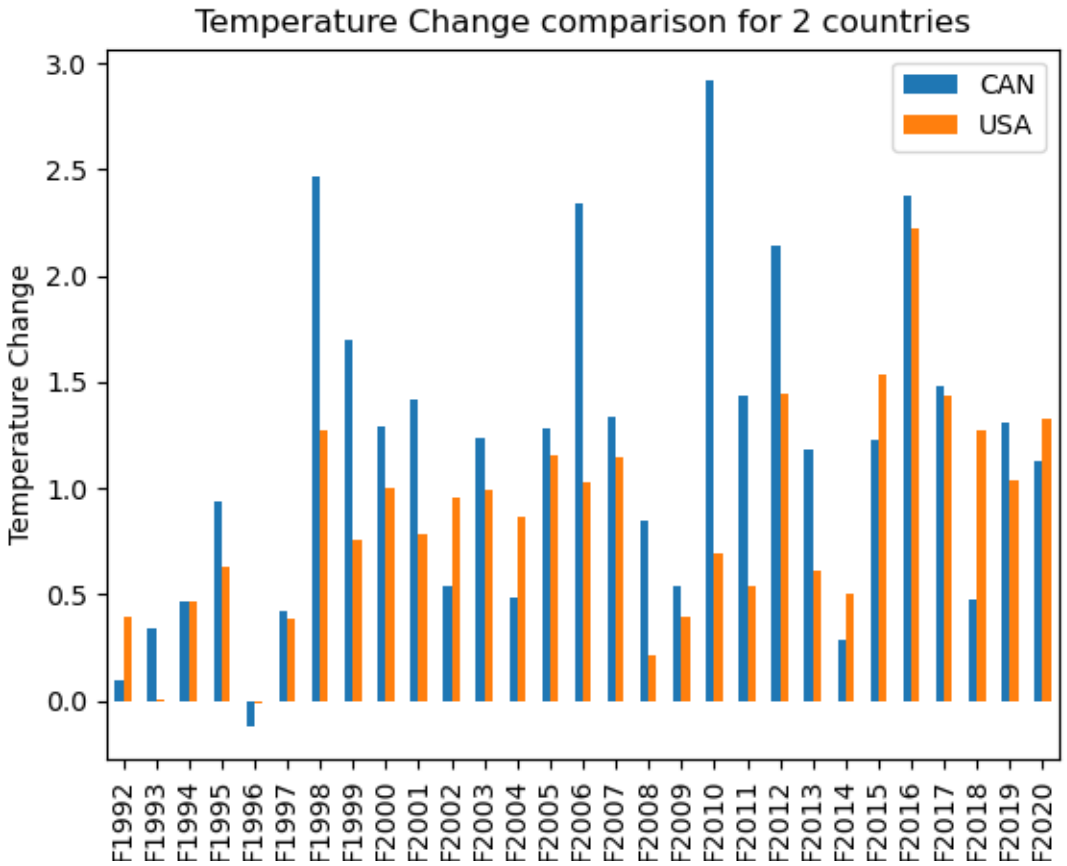

Figure 3: Plot generated using Matplotlib

Appendix C

```
F2020     1.128          1.324
Plotting the data. After viewing the bar graph, please close the pop-up to continue.
Would you be interested in knowing the aggregate statistics for the entire climate data dataset?
Enter 'Y' for yes or enter any other key to skip this step and continue: y

The aggregate stats for the entire Climate Data dataset is:
       Temperature Change  Land Cover Index  ...  Fractional Total Disaster  Fractional Land Cover Index
count         5771.000000       5771.000000  ...                5771.000000                  5771.000000
mean             0.855102         97.576986  ...                   0.502513                     0.502513
std              0.583697         30.235265  ...                   1.050495                     0.158677
min             -1.310000          0.000000  ...                   0.000000                     0.000000
25%              0.471000         95.276030  ...                   0.000000                     0.492700
50%              0.822000         99.693218  ...                   0.272480                     0.504119
75%              1.208500        100.570033  ...                   0.606061                     0.517393
max              3.691000        668.209843  ...                  17.575758                     3.669702

[8 rows x 11 columns]
Would you be interested in knowing how many countries experienced more than 20 climate-related disasters in a year?
Enter 'Y' for yes or enter any other key to skip this step and continue:
```

Figure 4: Aggregate statistics of the entire climate data dataset

```
Would you be interested in knowing how many countries experienced more than 20 climate-related disasters in a year?
Enter 'Y' for yes or enter any other key to skip this step and continue: y

The countries (along with their ISO3 codes and year) that experienced more than 20 climate-related disasters a year are:
('CHN', 'China, P.R.: Mainland', 'F2000')
('CHN', 'China, P.R.: Mainland', 'F2001')
('CHN', 'China, P.R.: Mainland', 'F2002')
('CHN', 'China, P.R.: Mainland', 'F2005')
('CHN', 'China, P.R.: Mainland', 'F2006')
('CHN', 'China, P.R.: Mainland', 'F2008')
('CHN', 'China, P.R.: Mainland', 'F2009')
('CHN', 'China, P.R.: Mainland', 'F2010')
('CHN', 'China, P.R.: Mainland', 'F2012')
('CHN', 'China, P.R.: Mainland', 'F2013')
('CHN', 'China, P.R.: Mainland', 'F2014')
('CHN', 'China, P.R.: Mainland', 'F2015')
('CHN', 'China, P.R.: Mainland', 'F2016')
('CHN', 'China, P.R.: Mainland', 'F2017')
('IDN', 'Indonesia', 'F2020')
('IND', 'India', 'F2005')
('IND', 'India', 'F2018')
('PHL', 'Philippines', 'F2009')
('PHL', 'Philippines', 'F2011')
('USA', 'United States', 'F1992')
('USA', 'United States', 'F1993')
('USA', 'United States', 'F1997')
('USA', 'United States', 'F1998')
('USA', 'United States', 'F1999')
('USA', 'United States', 'F2000')
('USA', 'United States', 'F2001')
('USA', 'United States', 'F2002')
```

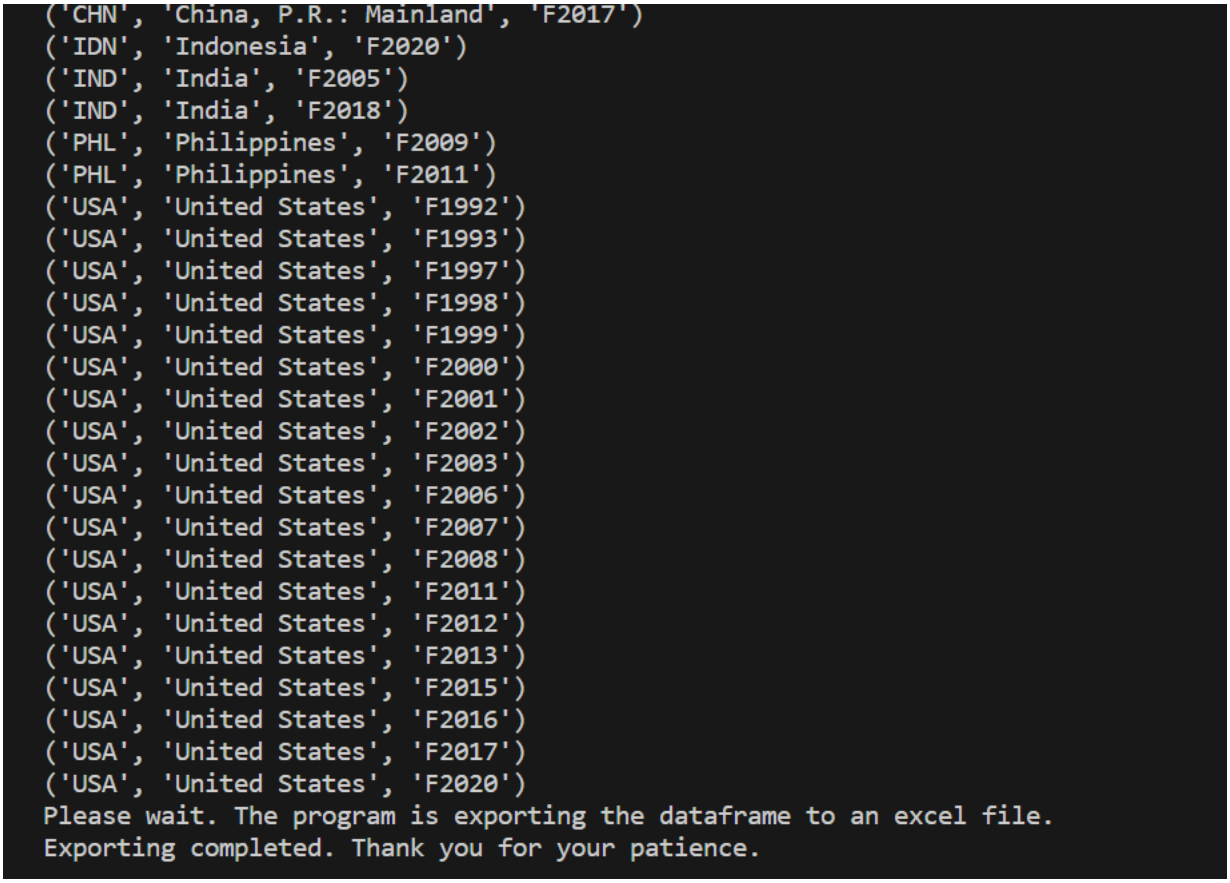

Figure 5: More than 20 climate-related disasters in a year

Appendix D – SPECIFICATION JUSTIFICATIONS

Table 1: Table summarizing the compliance of the program with the given specifications

Stage 1: Dataset Selection ○ You must use at least three separate Excel sheets or files that can be related in some way. ○ Your final combined dataset (see next stage) must have at least ten columns and 200 rows. ○ You may edit the given datasets before you begin coding, but your program should not modify the Excel files directly. ○ You may not hard-code/copy-paste any information into your program except for the Excel column names.	• 3 Excel file: Annual_Surface_Temperature_Change.csv, Climate-related_Disasters_Frequency.csv, Land_Cover_Accounts.csv • The combined dataframe has more than 200 columns and 10 columns • The Excel files were not modified and nothing was hard coded.

Stage 2: DataFrame Creation ○ Import your chosen data into a Pandas DataFrame. ○ You must use at least two merge/join operations and you must delete any duplicated columns/rows that result from the merge. ○ You must create a hierarchical index of at least two levels (row or column). ○ All data should be presented in the correctly sorted order, depending on the index. ○ You may not use global variables. You must import the data within your main function. ○ Remember to check for null values or data mismatches.	• Merge operation while creating dataframe: Line 82-83 of the code • Hierarchical indexing and sorting: Line 145-146 • All null values were replaced with zeros using fillna() operation: Line 85
Stage 3: User Entry ○ Your application must return useful information. Design an interface that allows users to search based on some sort of criteria or keywords. ○ The user must provide at least two pieces of information/selection (e.g. “school name” and “grade”). ○ Give the user clear input instructions. If an invalid entry is given, use try/except statements to handle the error and continue to prompt for user input. ○ You must not hard-code any data values (the data within your spreadsheets could be changed!). ○ Any output information must be clearly defined using printed headers (DataFrame tables) or sentences (scalar values).	• Please see **Appendices A, B and C** for the user entry stage. • For incorrect inputs, try/except is used to print the appropriate message and allow for re-entry. The input is case-insensitive, and any spaces before or after the input are stripped using .strip()

Stage 4: Analysis and Calculations ○ You may choose what data trends to present from your data. However, you must meet the following specifications. ○ Use the describe method to print aggregate stats for the entire dataset. ○ Add at least two columns to the combined dataset. ○ Use an aggregation computation for a subset of the data. ○ Use a masking operation. ○ Use the groupby operation at least once. ○ Create and print a pivot table. ○ Include at least two user-defined functions or a class that contains two methods.	• Implemented describe() method on the aggregate of entire dataset: Line 188 • Two columns were added – Fractional Total Disaster (Line 129, 138) Fractional Land Cover Index (Line 135, 138) • Aggregation computation for a subset of the dataframe using .mean(): (Line 218, 248) • Masking operation: Line 173 • Pivot table: Line 269 • The two user-defined functions are called when the user enters two ISO3 codes for comparison
• Stage 5: Export and Matplotlib ○ At the conclusion of your program, export your entire merged, hierarchical dataset to an Excel file in the working directory. Be sure to include the index and header values. The TAs will use this to verify the structure of your dataset and your added columns. ○ Use your data to create at least one plot using Matplotlib. Save the plot as a .png file and upload to the repository.	• **Figure 3** in **Appendix B** shows the plot generated • Excel file is generated and exported at the end of the program (**Figure 5** in **Appendix C**)