MATLAB With The MAhMies

3. Final Project Report

3.1 Abstract

This report introduces a program in MATLAB designed to analyze and predict average annual rainfall patterns, emphasizing its practical application in daily life and critical industries like aviation. Recognizing the significant impact of weather on daily life, the program was aimed to provide an easy-to-use tool for the average person to understand and anticipate weather changes, be it for vacation or daily use.

The program processes limited data which includes the annual precipitation from five countries (USA, Saudi Arabia, UK, India, and Japan) over two decades (2000-2020). This data, compiled into Excel and later a MATLAB .mat file, forms the basis of the analysis. The program generates two primary column vectors representing annual rainfall and the corresponding years. A user-defined function then enables country-specific analysis through a series of conditional statements.

Central to the program's functionality is its ability to calculate the mean rainfall and present it to the user. It provides supporting comments regarding the chosen country's usual likeliness to experience rainfall using a series of conditional logical operators. The core analytical feature is fitting a first-degree line to the rainfall data, offering a forecast of the subsequent year's (2021) precipitation. Supplementary visual tools include a geographical map of the selected country, a bar graph of annual rainfall averages each year, a histogram of rainfall frequency, and a bar graph highlighting rainfall extremes and median values.

While the current dataset is limited, the program's modular design allows for potential expansion to include global data. However, this broader application is outside this report's scope, which focuses on demonstrating the program's viability and utility. Future enhancements could include automation to reduce manual variable assignment.

3.2 Nomenclature

Define all variables and symbols that will appear in this document.
UK - United Kingdom
USA - United States of America
MAhMie - Referring to any individual on our team.

3.2 Introduction

Our project intends to provide the average amount of rainfall (in inches) in any of the 5 countries the user can choose from. We are able to provide the average amount of rainfall per year for the following 5 countries: Japan, Saudi Arabia, UK, USA, and India. Different supporting statements will appear if the average rainfall is less than 10 inches, less than 40 inches, or if it is higher than 40 inches. With this information, the user can use it for a variety of reasons, such as needing weather information for travel or to simply expand their knowledge. Additionally, 5 figures are presented to help visualize the data. (See Appendix A) For example, a line of best fit figure is shown to help predict the precipitation for the year following. We accomplished what we intended by providing data about current precipitation trends, comparing them across different variables, and predicting trends for the future as well.

3.3 Background of the project

The purpose of our project remains the same: to inform users of average rainfall per year in a specific country to aid their knowledge. This can be helpful to them if they want to travel there, for example.

3.4 Brief Overview of the Solution Using MATLAB

Using MATLAB, we created a program that allows for the analysis of numerical data in order to find an average within a range of values. Simply put, finding the averages of rainfall (inches) per year. It addresses the problem we have perfectly, as it gives an average over the span of 20 years and even predicts the weather trend for the upcoming year. Those who are putting weather considerations into their travel plans will likely be the group finding this information most useful. Overtime, we made many adjustments to the code in order to best fit the problem we created. Most of this resided in how we wanted to visually represent our data to the users. We wanted each figure to have a deciding factor in whether a user would want to visit a country or not given its precipitation trends.

3.5 Data Collection/Acquisition

Our team used existing datasets from a global weather database. After extensive research, sifting through many sites that required payment for their data, we ultimately landed on two sources that provided the information needed (refer to Appendix B).

3.6 Data Analysis

We called a variety of graph functions to analyze the data. Each graph represented the data in a way that illustrated a unique point worthy of consideration. This expanded on the complexity of the data we wanted to present to the user. Our figures provide comparison, visual representation of the data, and predictions so that the user can utilize the data effortlessly.

3.7 Solution and Demonstration

(See Appendix A)
Figure 1 (Bar Graph)
In this figure, each bar represents the average amount of rainfall over the span of 20 years (2000-2020). It gives the user a visual representation of precipitation trends over a wide range. This range helps solidify future predictions for rainfall trends.
Figure 2 (line of best fit)
This figure is used to help predict next year's rainfall. This is represented by a line that shows the trend in the data given in a scatter plot. This helps the user prepare in advance if they are looking far into the future. It shows that on average, the trend for precipitation is the line of best fit.
Figure 3 (Histogram)
This figure represents the frequency of precipitation impact. For example, a country could have very few days of precipitation but when they do, many inches of rain are recorded. This histogram gives a visual representation of how often certain levels of precipitation are recorded.
Figure 4 (Box Plot)
This figure provides a summarization of the data provided (minimum, first quartile, median, third quartile, maximum). Similar to Figure 1 and Figure 3, it shows a trend in precipitation over a range of time.
Figure 5 (GeoBubble)
This graph shows the relative location of each of the 5 countries our program provides. It helps the user visualize the precipitation trend in that area and further their knowledge. It provides insight to the overall weather in the area and can be a deciding factor on whether they want to travel there or not.

3.8 Technical Lessons Learned

In order to find 5 different figures, we expanded our knowledge on how we can represent the data with the wide selection of Matlab plot functions. The "geobubble" function in particular was new to all of us, and creates a unique figure.
Another important function we found was the lower() function. One of the MAhMies initially discovered it while completing the python tutorial for homework #9, and proceeded to Matlab's equivalent function to turn our user input into a lowercase string, preventing one type of potential user error.

3.9 Professional Lessons Learned

The overall team experience was agreed to be, unanimously, very effective. After our first meeting, we broke down the deliverables of the project into smaller manageable components, to which we assigned a group member based on the member's interest in the tasks and their relative skill set. Most communication was done through text messaging, as we did not treat the project as strictly professional, and became good friends throughout the project. The transferring of MATLAB files was done primarily through email, which was the most convenient way. The most effective trait of our group was that we had trust in one another to complete their assignments and to produce quality work, which we each held ourselves accountable to. The main aspect of our collaboration that we would change next time would be

increasing the frequency of meetings and progress check-ins. Furthermore, creating a simple Gantt chart in order to manage the time for deliverables would also be very beneficial in keeping us on top of our work. Overall, however, we are all proud of one another and the work that we have produced.
On a broader scale, this project taught us accountability and how to properly space work out. We all did our best to contribute to the project overtime instead of putting it all on one day. This meant we had constant communication with each other regarding how the project should be done. Additionally, team coordination and trust was built with this project. We held each other to the standard that we would do our part of the project within a reasonable time.

3.10 Summary and Conclusion

The report introduced a MATLAB program designed to analyze and predict average annual rainfall patterns, emphasizing its practical applications in daily life and critical industries. This report more specifically focuses on applying MATLAB to predicting precipitation trends in various countries. The program processes limited data from five countries (USA, Saudi Arabia, UK, India, and Japan) spanning two decades (2000-2020). Using Excel and MATLAB, the program generates vectors for average annual rainfall and corresponding years, facilitating user-defined, country-specific analysis through conditional statements depending on user input. Different figures will appear relevant to the country the user is asking for. The program calculates mean rainfall, offers insights into a country's likelihood of rainfall, and forecasts precipitation for the subsequent year (2021) by fitting a first-degree line to the data. Visual tools include a geographical map, bar graphs of annual averages, rainfall frequency histograms, and a graph highlighting extremes and median values. As a group, we learned that communication and coordination were the structures that held this group project together and allowed us to successfully code this program. We as MatLab MAhMies are now confident in our ability to use all the functions of MatLab at an entry level.

Appendix A

```
% Final Project for ENGRMAE10 by Matlab with the MAhMies
clf
clc
clear
load('RainFall_DataSet_3.mat');
% Loading in the Dataset
% The average annual precipitation of five countries for each year 2000-2020
% Assignment of variables that can be used for calculations for the Data
USvecy = UnitedStates(:,2); %Creates a vector for the avg. annual rainfall
USvecx = UnitedStates(:,1); %Creates a vector for years (2000-2020)
Jvecy = Japan(:,2); %Repeat for all countries
Jvecx = Japan(:,1);
UKvecy = UnitedKingdom(:,2);
UKvecx = UnitedKingdom(:,1);
Ivecy = India(:,2);
Ivecx = India(:,1);
SAvecy = SaudiArabia(:,2);
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```
SAvecx = SaudiArabia(:,1);
LatUS =  37.09024;   %For figure 5, latitude and longitudes in degrees
LongUS = -95.712891; %of the geographical center of each country.
LatIndia = 20.593684; %Repeat for all countries
LongIndia = 78.96288;
LatJap = 36.204824;
LongJap = 138.252924;
LatSA = 23.885942;
LongSA = 45.079162;
LatUK = 55.378051;
LongUK = -3.435973;
% Creation of variables that can be used without fail in the later series
% of if statements that call on the local function
usa = "usa";
japan = "japan";
uk = "uk";
india = "india";
sa = "sa";
% Display's the introductory prompt for the entire Modular Program, and aks
% for the user's input of country
fprintf("Welcome! This is an average annual rainfall calculator.\n" + ...
  "This calculator can help you evaluate the weather in some countries and decide which one you want to visit.\n" +
...
  "Created by: Miki, Aras, and Matthew\n\n")
choice = input("Please select a country: USA, Japan, Saudi Arabia(input 'SA'), India, or the United Kingdom(input
'UK')\n","s");
lowcase = lower(choice); % Changes the user input to all lower case letters
% Series of if statements that call on the local function based on the
% user-defined country
if lowcase == usa
  datamean(USvecy,USvecx,LatUS,LongUS);
elseif lowcase == japan
  datamean(Jvecy,Jvecx,LatJap,LongJap);
elseif lowcase == uk
  datamean(UKvecy,UKvecx,LatUK,LongUK);
elseif lowcase == india
  datamean(Ivecy,Ivecx,LatIndia,LongIndia);
elseif lowcase == sa
  datamean(SAvecy,SAvecx,LatSA,LongSA);
else
  fprintf("Please select a valid country\n")
end
%Function below calculates the mean of the rainfall data, as well as graphs
%5 different functions for the selected country
%1 is the the data shown in a bar graph, 2 is a line of best fit useed to
%predict the next year's rainfall
%3 is a histogram of the data, 4 is a boxplot showing the extrema of the
%data, and 5 shows where the country is geographically, along with the
%average rainfall.
```

```matlab
function output = datamean(vecy,vecx, lat, long) %input variables for plotting various figures...
output = mean(vecy); %...and calculating the mean rainfall.
fprintf("The average rainfall for the selected country is %.1f inches per year\n",output);
if output < 10 %10 inches is an agreeably small amount of rain
  disp("If you really don't like rain, then this country is for you!")
elseif output < 40 %40 is roughly the median rainfall between all the countries
  disp("If you enjoy more temperate weather, then this country is for you!")
else % Anything above 40 we consider a larger amount of rain
  disp("If you love the rain, then this country is for you!")
end
figure(1) % Creates a new figure
x = 0:length(vecy)-1; %bar graph of the data
y = vecy;
bar(x,y,"blue") %"blue" for blue bars
xlabel("Year (20XX)") %graph starts at 0 but means 2000, then 2001, etc.
ylabel("Rainfall (inches)")
title("Rainfall per year of selected country (2000-2020)")
ylim([0 80]) %When you run the script multiple times, its easier to see the
%difference between rainfalls with a set limit.
% Plot the original data
figure(2) % Creates a new figure
plot(vecx, vecy, 'ro'); % 'ro' for red circles
hold on; % Keep the plot for adding more data
% Finding the line of best fit
p = polyfit(vecx, vecy, 1); % Linear fit (degree 1)
% Plot the line of best fit
xFit = linspace(min(vecx), max(vecx), 100);
yFit = polyval(p, xFit);
plot(xFit, yFit, 'b-'); % 'b-' for a blue line
% Predicting for the year 2021
year2021 = 2021;
predictedPrecipitation2021 = polyval(p, year2021);
% Plot the prediction for 2021
plot(year2021, predictedPrecipitation2021, 'g*'); % 'g*' for a green star
hold off
% Additional plot formatting
xlabel('Year');
ylabel('Annual Precipitation');
title('Annual Precipitation Data with Line of Best Fit');
legend('Data Points', 'Line of Best Fit', '2021 Prediction');
figure(3) % Creates a new figure
nbins = 21;%number of data inputs
histogram(vecy, nbins); %histogram of the selected data
% Additional plot formatting
xlabel('Annual Precipitation (Inches)');
ylabel('Frequency');
title('Histogram of Annual Precipitation');
figure(4); % Creates a new figure
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boxplot(vecy, 'orientation','horizontal') % Boxplot of the precipitation data
%Additional plot formatting
xlabel('Annual Precipitation (Inches)')
title('BoxPlot of the Annual preciputation')
figure(5); % Creates a new figure
geobubble(lat,long,output,"MapLayout","maximized")
%Location of country using lat and long variables
% Display the predicted precipitation for 2021
fprintf('Predicted average annual precipitation in the selected country for the year 2021: %.2f inches\n',
predictedPrecipitation2021);
end
```

Appendix B

Google for Developers,

developers.google.com/public-data/docs/canonical/countries_csv

Average Precipitation in Countries by Year.

www.extremeweatherwatch.com/countries/india/average-precipitation-by-year