CSCE 5320: Scientific Data Visualization
Increment-1

Group number:12

Github link:

https://github.com/TogaruPravalika/DV_Visualizing-the-impact-of-climate-change-on-global-agriculture

Project Title:

VISUALISING THE IMPACT OF CLIMATE CHANGE ON GLOBAL AGRICULTURE

Team Members:

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Goals and Objectives:

MOTIVATION:

The goal of "Visualizing the Effect of Climate Change on Global Agriculture" is to increase public understanding of how climate change may affect the world's food supply and agricultural output. Worldwide variations in temperature, precipitation patterns, and extreme weather events are already having an impact on agricultural productivity, resulting in lower crop yields, food shortages, and higher food costs.

This project can assist policymakers, farmers, and other stakeholders in better understanding the potential risks and challenges associated with climate change and in developing strategies for adapting to and mitigating these impacts by visualizing data on the impact of climate change on global agriculture. The project can also aid in educating the general public about the significance of taking action on climate change and the part that agriculture plays in tackling it.

The ultimate objective of this project is to employ data visualization and analysis to enhance efforts to address the effects of climate change on agriculture and food security and to encourage more informed decision-making.

SIGNIFICANCE:

"Visualizing the Effect of Climate Change on Global Agriculture" is significant because it has the ability to raise awareness of how climate change is affecting food security and agricultural output around the world. Millions of people around the world depend on the agricultural sector as a source of food and a living. Nonetheless, the implications of climate change on agriculture are already evident in many areas and are anticipated to worsen with time.

This project can assist policymakers, farmers, and other stakeholders in better understanding the potential risks and challenges associated with climate change and in developing strategies for adapting to and mitigating these impacts by visualizing data on the impact of climate change on global agriculture. For instance, illustrating the effects of changes in temperature and precipitation on crop yields can assist farmers in selecting the right crops to plant at the right time, and illustrating the effects of extreme weather events can assist policy makers in preparing for and responding to disasters like floods and droughts.

Also, this project has the ability to increase public awareness of how critical it is to address climate change and its effects on food security worldwide. This initiative can assist in educating the public about the need for climate action and the part that agriculture plays in combating global climate change by providing data in an understandable and interesting way.

In general, this project's significance lies in its potential to use data visualization and analysis to foster more informed decision-making, to support initiatives to address the impacts of climate change on agriculture and food security, and to increase public awareness of the significance of addressing climate change.

OBJECTIVES:

The following could be the major goals of "Visualizing the Effect of Climate Change on World Agriculture":

To gather and evaluate information on how climate change is affecting crop yields, frequency and intensity of extreme weather events, temperature and precipitation patterns, and other aspects of global agricultural production.
To create interactive data visualizations that let consumers explore and comprehend the intricate connections between ag productivity, food security, and climate change.

To use the data visualizations to support more informed decision-making by policymakers, farmers, and other stakeholders and to increase awareness of the possible effects of climate change on global agriculture and food security.

To find important patterns and trends in the data that might guide management and policy choices targeted at reducing the effects of climate change on agriculture and food security.

Assist initiatives to increase climate resilience in the agricultural sector by giving decision-makers data and insights that can aid in their ability to foresee and address risks and issues related to the climate.

The overall goals of this project are to better understand the effects of climate change on global agriculture through data visualization and analysis, and to support efforts to increase climate resilience in the agricultural sector through well-informed decision-making and targeted actions.

FEATURES:

This web application offers a range of features that make it a unique and useful tool for consumers. One of the key features is,

Interactive mapping: By the use of an easy-to-use, interactive map-based interface, users would be able to investigate how climate change may affect crop yields and agricultural production in various parts of the world.

Use mapping applications likeGoogle Maps API to build an interactive map that overlays information on crop yields, temperature, and other pertinent variables over a global or regional map to implement this functionality.

You might also include a slider that enables users to compare data from various years or scenarios, interactive legends, and color scales that let people examine the data in various ways to make the mapping function more engaging.

Interactive data visualizations, Customizable parameters, Real-time data updates, Multiple data sources, Accessibility, Educational resources these are the features that need to be added.

Overall, incorporating an interactive mapping feature into the "Visualizing the Impact of Climate Change on Global Agriculture" project could offer a useful tool for examining how climate change is affecting agriculture in various parts of the world and for using data to guide decisions about how to tackle climate change challenges.

INCREMENT-1:

Domain:

- **Python :** We have used python programming for implementation of this project. It has a standard library where it provides many modules and functions for performing various tasks efficiently. It is easy language with few lines of codes compared to java, C++ and some other languages. And moreover we can run this on various platforms for making various applications.

- **Tailwind CSS:** We have Tailwind CSS which makes modern web interfaces. It gives a wide range of styles, colors to the web interface. It gives a key advantage for us to create highly responsive designs. It is also customizable for modifying the framework. Its flexibility allowed the users to use it in a broad range where it is highly popular in making responsive web interfaces. It mainly focuses on CSS utility classes used to build designs very fastly and efficiently.

- **Javascript:** It is high level programming language where we have used this for creating the web pages. Basically javascript makes the web page more interactive and dynamic. It is used to create web pages where we can make changes without making refresh of the web page. It is used to create complex web applications.

- **React Js:** It is a javascript library used for creating user interfaces. It is used for creating reusable UI components and managing the application in efficient way. The main advantage of React JS is its usage of virtual Document object model. It allows us to update the data without refreshing the page. By using this we can reuse the code in different parts of UI.

- **Google Charts:** We have used google charts for creating data visualisations. It is used for creating interactive bar charts, pie charts, stacked bar charts. It is also used to create live data visualisations. We can create visualisations by simply adding google charts library in application and use javascript for creating charts.

- **Chart Js:** We have used chart js for creating chart and graphs with customisation. This is easy to use and very simple which takes less time to apply. This library provides efficient documentation for creating charts. It provides us various options for appearance of the chart.It provides for functionality of tooltips and annotations.

- **Rest API:** We have used this for styling the designs of APIs. It uses HTTP methods for manipulation. It also provides working of the data using JSON. It also provides set of guidelines for creating and maintaining web services. It is very flexible to use.

Data Abstraction:

- Country
- Crop Type
- Season
- Yield Percentage
- Year
- Water Levels
- Temperature

1. **Country** - In the taken dataset there are 13 country data .
2. **Crop Type** - In which country which type of crop type of crop is growing
3. **Season** -It indicates the seasons data of the each country
4. **Yield Percentage -** How the production of every crop in the 13 different country
5. **Year -** It indicated 3 tears of the data
6. **Water Levels -** It indicated the water level of the each country
7. **Temperature-** It indicates different temperature respective to their countries

Attribute Name	Data Type
Country	String
Crop Type	String
Season	String
Yield percentage	Float or Decimal
Water levels	Float or Decimal
Temperature	Float or Decimal

Task Abstraction:

- Data Collection
- Data Transformation
- Logic building
- Graph representation

Data Collection:

The data gathered from the Kaggle which consist of 6 attributes, Which describes how climate conditions affect the crop growth and yield percentage. With this data we can analyse how the climate factors are affecting the agriculture growth.

Data Transformation:

After the data gathering process, the data transformation process begins. In this process there are 25000 rows of data which need to be normalised to avoid disturbance in data we need to remove null values. For the data transformation process we have used the python pandas module to normalise the data.

Normalising data helps us to give accurate results while building data algorithms, Normalising data processes involves removing and adding columns to get meaningful data.

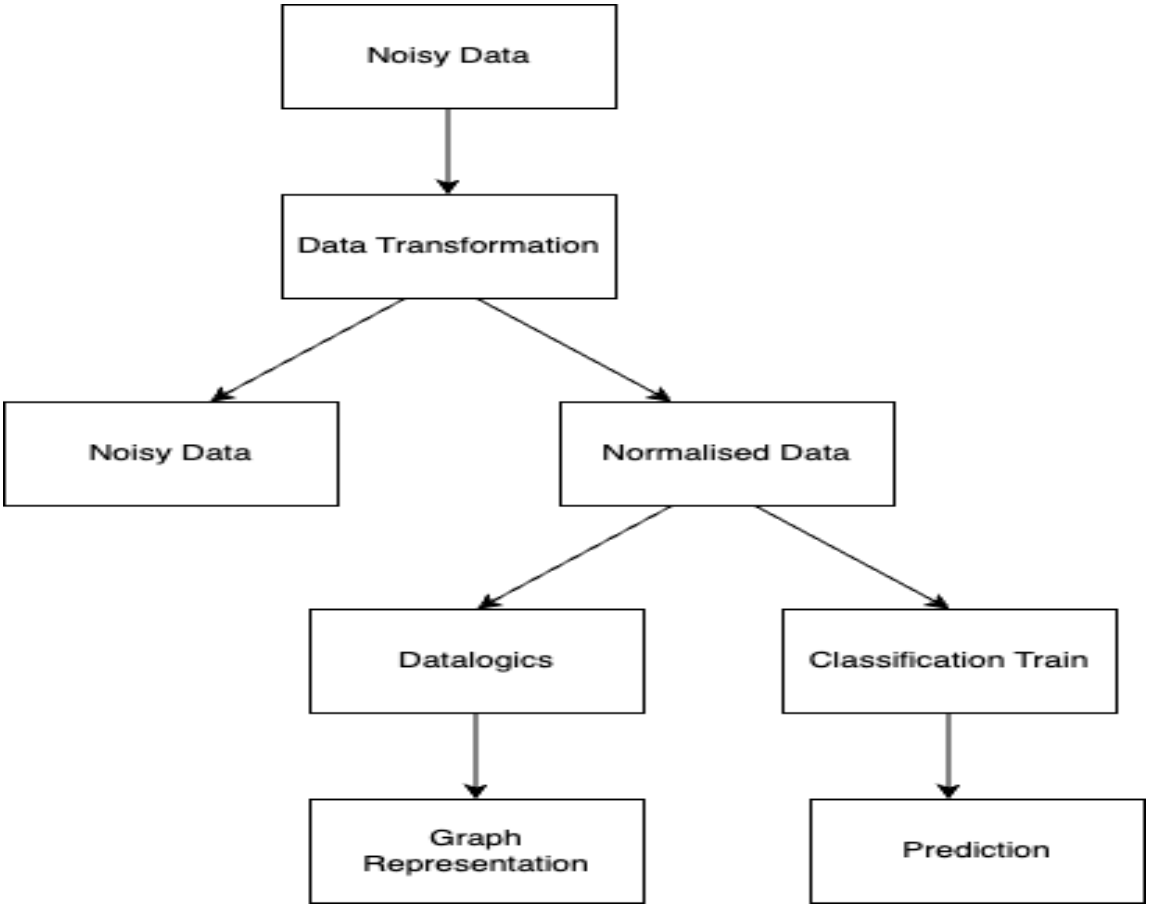
Logic Building:

Once the data transformation data process is done the normalised data is dumped in the API, And then data drag form the API to write the logics in java script which is a powerful language to get the data in the sequential order.

Graph representation:

From the data algorithm function we will call those functions in the UI, In data algorithm functions we have organised the data, We will call the data algorithm function to google charts and chart.js which helps us to Visualise the data in Graphical representation.

Work Flow:



Implementation using Tools:

- Visual Studio Code
- Jupyter Notesbook

Visual Studio Code:

Microsoft's Visual Studio is an IDE that lets its users create their own graphical user interfaces (GUIs), consoles, websites, mobile apps, and cloud services. Both managed and native code may be generated with the help of this IDE. It is built using several Windows API, Windows Store, and Microsoft Silverlight components. This is because it is not a language-specific IDE; you may use it to create code in a variety of languages. C#, C++, VB, Python, and JavaScript are all examples of such languages. There are presently 36 different languages that may be used to code. It's compatible with Macs and PCs.

Jupyter notebook:

The online Jupyter Notebook program is free and open-source, allowing users to create and share documents with live code, equations, visualizations, and text. Maintaining and enhancing the Jupyter Notebook is the job of the Project Jupyter team. The Python project was the inspiration for Jupyter Notebooks, however IPython Notebook came before it. Because it primarily supports Julia, Python, and R, it was given the moniker "Jupyter" to reflect this fact. The IPython kernel that enables programming in Python is already included in Jupyter, and there are more than a hundred more kernels available.

Framework Components:

Python : We have used python programming for implementation of this project. It has a standard library where it provides many modules and functions for performing various tasks efficiently. It is easy language with few lines of codes compared to java, C++ and some other languages. And moreover we can run this on various platforms for making various applications.

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Preliminary Result for Analysis:

Below are the UI screenshots that we get after running the code file. We can see Water Analysis, Temperature Analysis, Yield percentage across the world, Interactive chart, Agriculture crops analysis tabs on the interface along with their description in the below feature page. When we click on get started, it will automatically take us to water analysis. Let’s predict option will navigate to prediction page which will be covered in increment2.

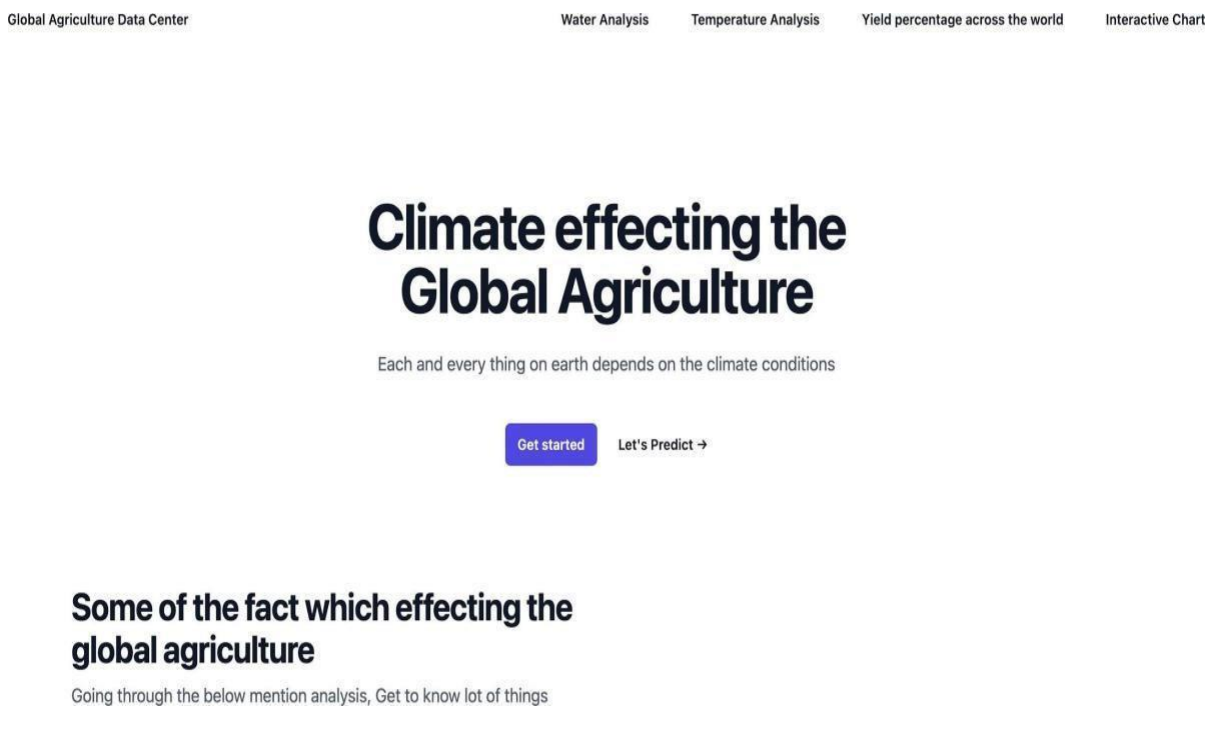

Fig 1.1: User Home Page

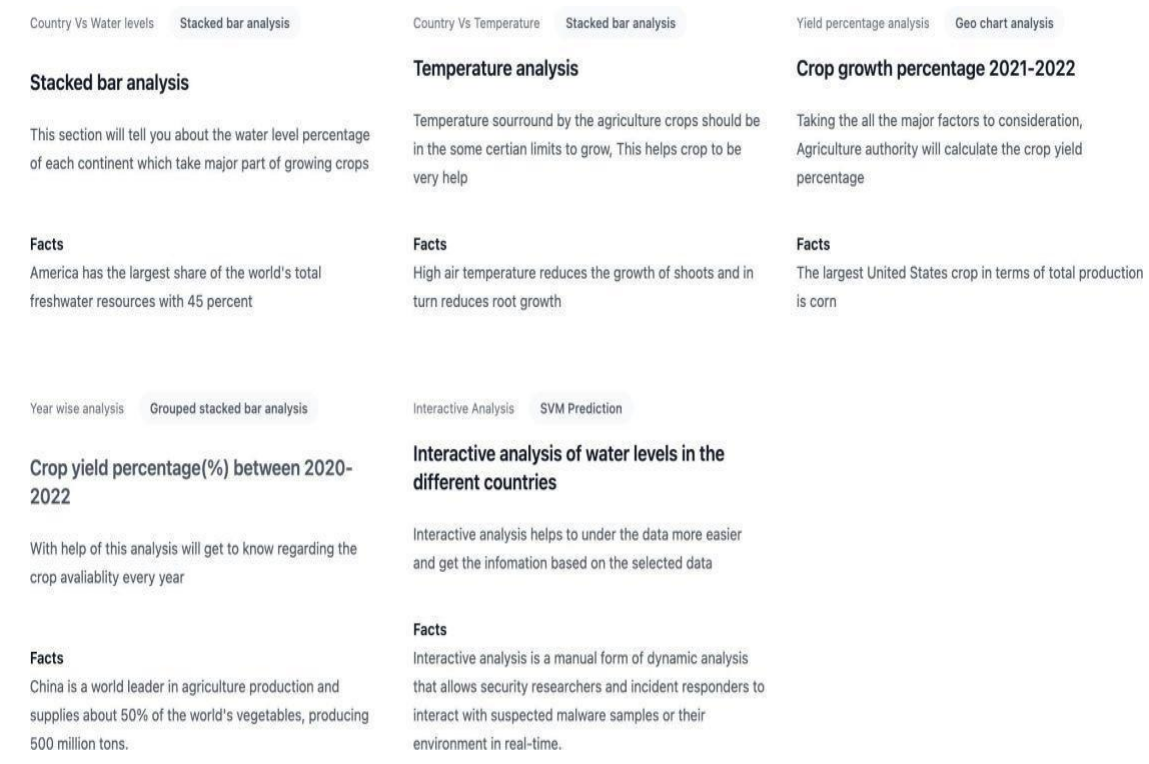

Fig 1.2: Feature page

Below is the stacked bar analysis for water level for 3 years. Here, we will get information about water level available in each country for yield production.

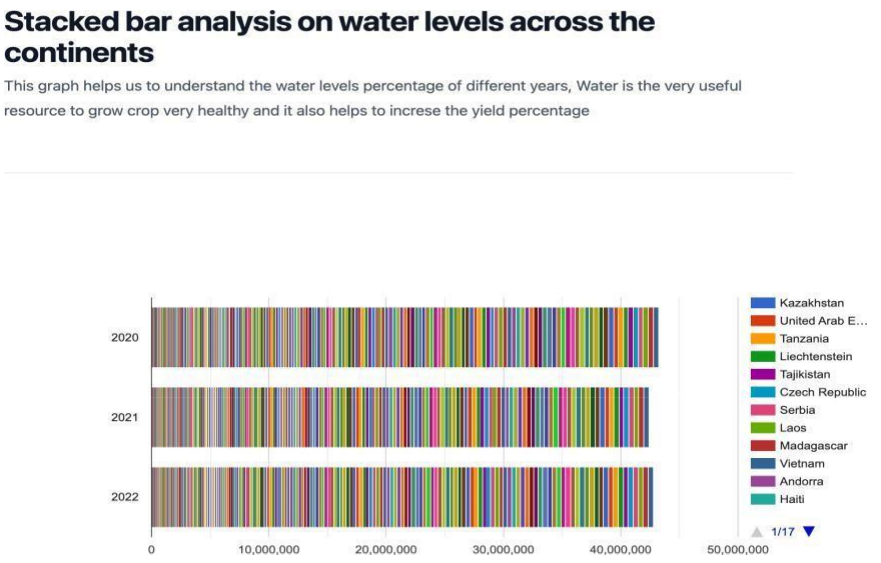

Fig 1.3: Stacked bar analysis water level vs country

Below is the stacked bar analysis for temperature. Here, we will get information about temperature condition in each country for last 3 years for yield production.

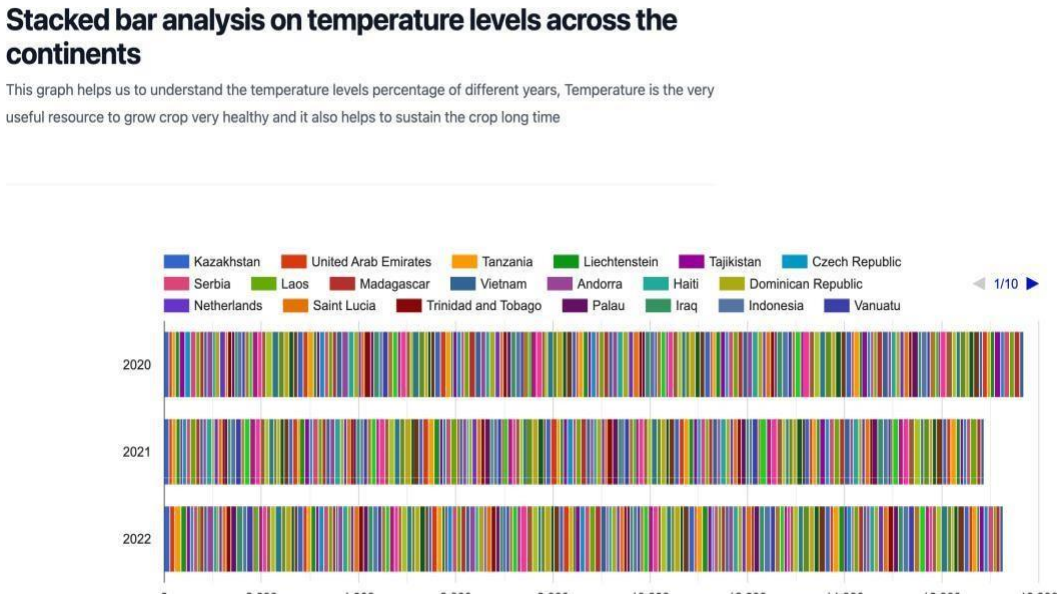

Fig 1.4: Stacked bar analysis Temperature vs country

Below is the Geo chart analysis which gives yield production in each country. Least production is in red colour, while highest is in green.

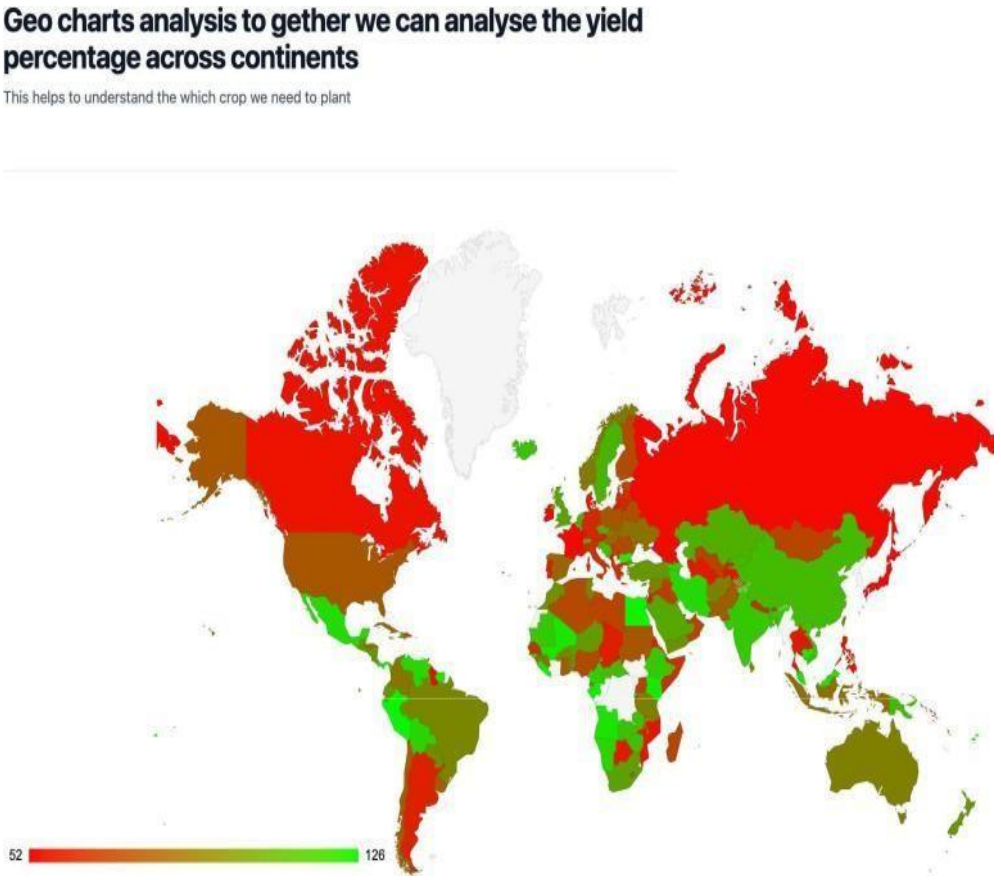

Fig 1.5: Yield Production vs Country Geo chart Analysis

Below is the Pie chart interactive analysis using slider. Suppose if we give slider values as 120-200, it will give all the countries which has yield production within that value from last 3 years and in the pie chart, we can see yield percentage contribution for each country within that value.

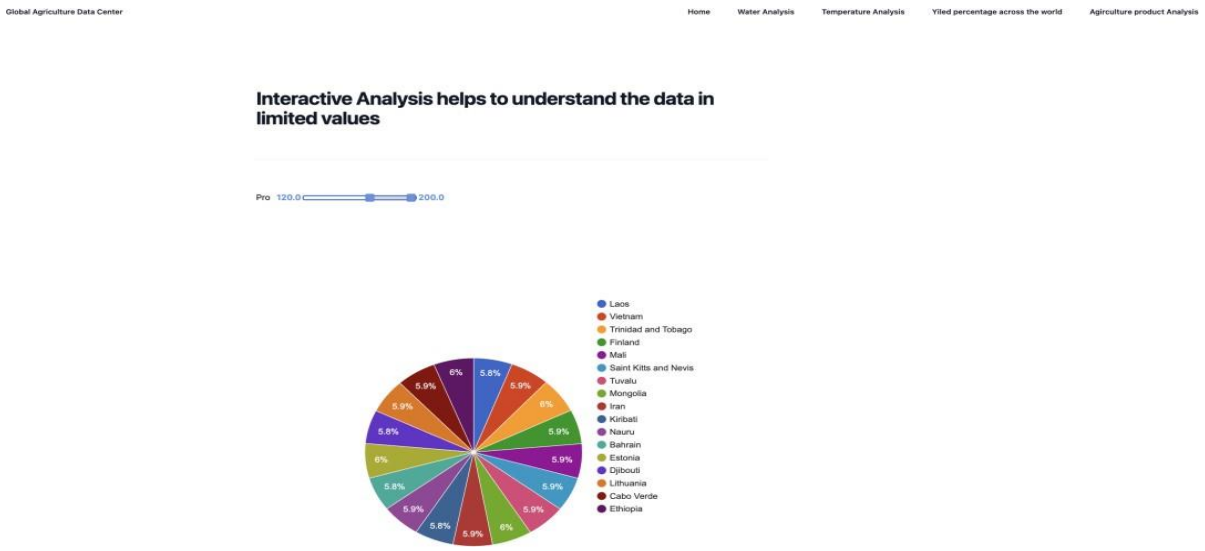

Fig 1.6: Interactive Analysis using slider – Pie Chart

Below is the Pie chart interactive analysis using highlighter. If we click on the country legend on the side, we can see the related pie will get highlighted.

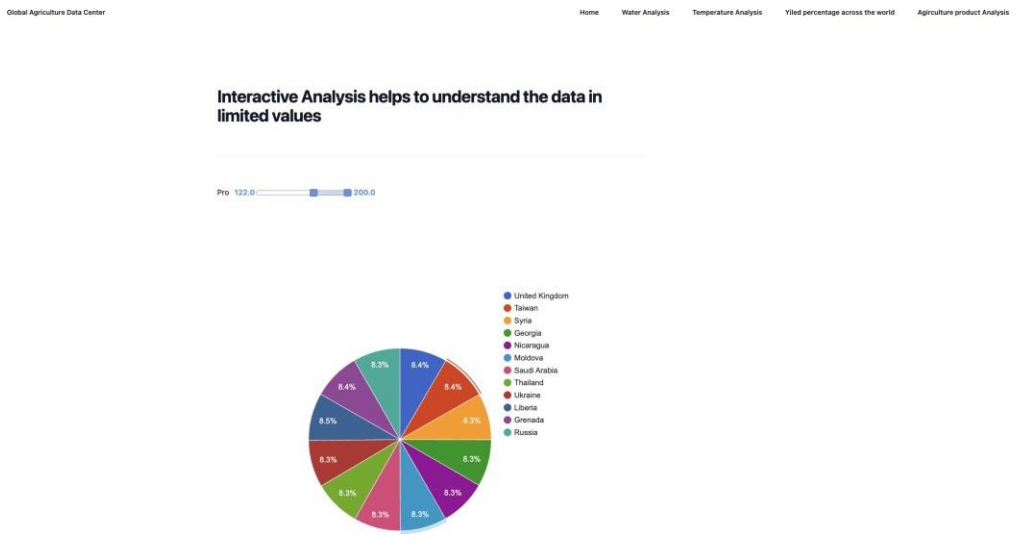

Fig 1.7: Interactive Analysis by highlighting country - Pie Chart

Below is the stacked bar graph for yield Production of 7 Agricultural crops for the last three years.

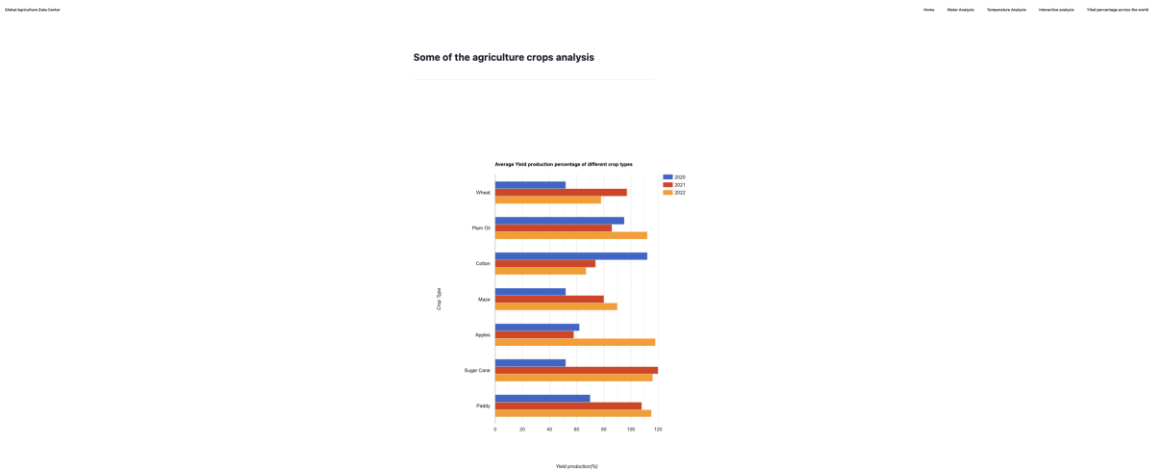

Fig 1.8: Yield Production of 7 Agricultural crops in last three years

Story Telling:

Chapter 1:

1. Who:

As a result of climate change's effects on agriculture around the world, farmers and rural communities who rely on agriculture for their livelihoods and food security are among the most in need of assistance.

2. What :

Climate change can cause droughts, floods, and heat waves, all of which have negative effects on crop yields, quality, and planting/harvesting windows. Pests and illnesses can become more common as a result of climate change, reducing crop productivity and quality. It is possible that changes in precipitation patterns and the melting of snow and ice will reduce the amount of water available for irrigation, livestock, and human use. The soil's fertility and productivity may be negatively impacted by climate change due to the increase in soil erosion, salinization, and desertification.[1]

3. When:

We have been dealing with the effects of climate change for decades, if not centuries. Over the past few decades, scientists and policymakers have paid a great deal of attention to the topic of climate change and its effects on agriculture around the world.

4. Where:

a. Climate change and its effects on farming around the world are a serious challenge. Human activities including burning fossil fuels, deforestation, and industrial operations send greenhouse gases into the atmosphere, which leads to climate change. Rising temperatures, altered precipitation patterns, and more severe weather are all results of the greenhouse effect caused by these gases. Developing nations, where agriculture is a crucial source of revenue and food security, are particularly vulnerable to the effects of climate change on their agricultural sector. More exposed to the effects of climate change, these nations typically lack the means and technology necessary to adapt to the phenomenon. Extreme weather events can cause crop failures and disruptions in global food supply networks, which affects not only developing nations but also the industrialized ones as a result of climate change.
b. As a worldwide problem, climate change and its effects on agriculture are felt everywhere. While the specific effects of climate change on crops and regions may differ, they are universal. Extreme weather events have become more common and intense as a result of climate change in some areas, while in others it has contributed to flooding and soil erosion. Climate change and extreme weather have the potential to reduce crop production, which in turn might increase food insecurity, push up food costs, and destabilize economies.

5. Why:

Human actions and their impact on the environment may be the root of the problem of climate change and its effects on agriculture around the world. The emission of greenhouse gases into the atmosphere is the primary cause of climate change because they trap heat and raise global temperatures. Human activities, including as burning fossil fuels for energy, deforestation, and industrial operations, are the biggest contributors to these greenhouse gases. Greenhouse gas emissions have increased significantly as a result of these activities since the industrial revolution.The degradation of natural resources like soil and water due to human activities like overfarming, deforestation, and pollution also contributes to the impact of climate change on global agriculture. These actions have decreased soil fertility and water availability, making it harder for farmers to grow crops and support themselves.

6. How:

The emissions of greenhouse gases, changes in land use, and the deterioration of natural resources all play a role in the "how" of climate change and its impact on global agriculture. Human activities such as burning fossil fuels for energy and transportation, deforestation, and agricultural practices like animal rearing are the primary causes of greenhouse gas emissions.The capacity of forests and other natural ecosystems to absorb carbon dioxide from the atmosphere is diminished as a result of changes in land use, such as deforestation, which also contributes to climate change. The depletion of carbon stores is a major factor in the rise of atmospheric greenhouse gas concentrations. Another aspect that adds to climate change's effect on agriculture worldwide is the depletion of natural resources like soil and water. Soil erosion, decreased soil fertility, and decreased water availability are all problems that farmers face as a result of human activities including overfarming, overgrazing, and the use of chemical fertilizers and pesticides.

Chapter 2:

1. **WHO** After all the research we have gone through one particular data set called agri_data which consist of 25K rows of data and 6 columns those are Country, Crop_type, Season, Water_levels, Temperature_levels, Yield percentage.

2. **WHAT** We have observed some of the events through over data those are season, Crop_type these attributes are taken from the survey from the farmers, With the help of those event and behaviour mentioned we have taken these columns these for analysis Country, Crop_type, Season, Water_levels, Temperature_levels, Yield percentage.

3. **WHEN** The data is cross-sectional in nature and was gathered during the previous three years. Real-time data is not present in the dataset. The exact research question will determine how old the data is and how broadly generalizations can be drawn throughout time to guide.[4]

4. **WHERE** The dataset has a broad geographic scope because it was gathered from farmers all around the world. The dataset does not include geographic information (GIS), but it does contain data at the country level. Depending on the individual research issue, generalizations can be made across settings to varying degrees.[3]

5. **WHY** The information was gathered in order to research how different countries' crop yields are affected by water and temperature levels.

6. **HOW** A survey of farmers conducted over the previous three years led to the creation of the agri_data dataset. Researchers or volunteers visited farms in several nations as part of the survey and recorded data on the crops being cultivated, the water and temperature conditions, and the yield percentage. A dataset of 25,000 rows and 6 columns was created once the data had been collected and organized. The survey may have used digital or paper forms, and the information may have been recorded into a database or spreadsheet for analysis. Overall, a process of data gathering, organization, and analysis, probably including several people and tools, was used to build the dataset.

Chapter 3:

1. Who:

The Application can educate users on the severity and urgency of climate change by showing its effects on agriculture around the world. This can encourage people, groups, and governments to take action against climate change and support environmentally sound farming methods. A better understanding of the influence of climate change on agricultural production in different parts of the world can be gained with the aid of this application. Researchers, policymakers, and farmers can use this information to better prepare for the impacts of climate change on agriculture. Providing users with the data they need to make educated choices about agricultural practices, investments, and policymaking is one of the application's primary goals. As a result, food insecurity, economic losses, and environmental degradation can be avoided and farmers and policymakers can make more sustainable and climate-resilient decisions.

2. What:

After collecting and analyzing data, we built a web-based UI interface that provides easy data access and visualization for users. The user's landing page is where numerous UI elements are displayed. Another set of UI components is the feature component, which lets the user choose and choose among our features; upon clicking on a feature, a unique visualization is generated, And provides a stacked bar analysis of water levels versus countries, which is useful for visualizing the wide range of water and temperature conditions across regions. We have provided a geo chart analysis that will aid in learning the precise values of yield output.

3. When:

The user can use the application or visualization of climate change's effects on agriculture around the world whenever it's convenient for them. Also can be used by researchers and analysts to study and draw conclusions from the data. Moreover it can be used by students, teachers, and the general public to gain a better grasp of the science behind the effects of climate change on agriculture and to promote the value of environmentally responsible farming practices.

4. Where:

Several factors, including the intended audience, the visualization's features and functions, and the application's technological needs, can affect how widely the visualization of climate change's influence on global agriculture is implemented.

The visualization and application can be used in the following scenarios:

Via the web: The Application can be made available via the web, so it can be accessed from any device with an internet browser. With this method of deployment, changes can be made quickly and to a large audience.
Mobile app: The Application can be made into a mobile app that can be installed on a user's smartphone or tablet computer. Push alerts, geolocation services, and offline access are just some of the features that can be made available with this deployment method.
The use of VR and AR technology: The app may be used to function on VR and AR headsets, giving users access to more immersive and interactive experiences as they learn about the effects of climate change on agriculture around the world.

5. How:

By interacting with the visualization, users can gain insight into how global agriculture is being impacted by climate change. They may examine and analyze indicators over multiple countries and time periods, including crop yields, water availability, temperature, and precipitation patterns. The user can use this to better understand the effects of climate change on farming. The user can utilize the chart to keep tabs on their development. The user can observe how climate change is affecting agriculture through time and how different policies and practices are influencing results by comparing data from different time periods. This might show the user where they are succeeding and where they need to put in more effort.

Project Management

Implementation status report:

Work completed:

Description:

Visualising the impact of climate change in global agriculture

Responsibility:

- Data Gathering - VAMSHI SOLETI
- Data Transformation -SAIPRIYA AMBATI
- Data Migration to API -SRIRAM VORUGANTI
- Data Logics - PRAVALIKA TOGARU
- Java Script Graph Visualisation - SRIRAM VORUGANTI & PRAVALIKA TOGARU
- Web UI -VAMSHI SOLETI & SAIPRIYA AMBATI

Contributions:

- SRIRAM VORUGANTI - 11647099 (https://github.com/Sriram-Voruganti/Climate-change-project) - 25%
- PRAVALIKA TOGARU-11637604(https://github.com/TogaruPravalika/DV_Visualizing-the-impact-of-climate-change-on-global-agriculture) - 25%
- VAMSHI SOLETI - 11637574 (https://github.com/vamshisoletii/climate-change) - 25%
- SAIPRIYA AMBATI - 11664407 (https://github.com/Saiipriiya/dv-increment1) -25%

Project Management:

Work to be completed

Description:

Crop cultivation predict using the SVM Algorithm, And
Dashboard to represent the Different types of graph visualization

Responsibility:

- SVM Algorithm – PRAVALIKA TOGARU & SRIRAM VORUGANTI
- Dashboards Script – VAMSHI SOLETI & SAIPRIYA AMBATI

Contributions

- SRIRAM VORUGANTI - 11647099 - 25%
- PRAVALIKA TOGARU- 11637604-25%
- VAMSHI SOLETI - 11637574- 25%
- SAIPRIYA AMBATI - 11664407 -25%

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(https://www.sciencedirect.com/science/article/pii/S0040162506001417)

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