

Analysis and Visualization of Agricultural Data based on the impact of Climate Change through ETL process.



Project Description: Climate change is increasingly reshaping agricultural landscapes worldwide, posing significant challenges to food security and crop productivity. The effects of rising mean surface temperatures are particularly evident in countries with diverse agricultural practices and climatic conditions. The impact of climate change on crop yield varies by temperate regions, tropical and subtropical regions. For this purpose, the objective of this project is to build an ETL pipeline to assess the impact of climate change on agricultural data and provide necessary valuable insights. This framework will empower policymakers, and researchers on how to handle the difficulties arising from climate change in agriculture by providing them with well-informed decision-making capabilities.

Project Questions

- What impact has climate change based on mean surface temperature variation had on crop yield in countries with diverse climates like Pakistan, Germany, Turkey, and Australia in the last years?
- Have there been any trends or recurring patterns, in the yields of key crops such as maize, carrots, turnips, rice, and grapes?

Data Sources

DataSource-1: Crop Production

Metadata URL: [Link](#)

Data URL:

[Production_Crops_E_Africa.csv](#)
[Production_Crops_E_Americas.csv](#)
[Production_Crops_E_Asia.csv](#)
[Production_Crops_E_Europe.csv](#)
[Production_Crops_E_Oceania.csv](#)

Data Type: CSV

Licence: [CC BY-NC-SA](#)

Source:

This dataset is taken from Food and Agriculture Organization of the United Nations ([FAO](#)).

DataSource-2: All Countries Temperature Statistics

Metadata URL: [Link](#)

Data URL: [Temperature data globally](#)

Data Type: CSV

Licence: [CC0 1.0](#)

Acknowledgment:

This data is provided by [FAOSTAT](#) and is based on publicly available [GISTEMP](#) data from the [NASA GISS](#).

Source/Citation: International Monetary Fund. 2022. Climate Change Indicators Dashboard.

[Annual Surface Temperature Change](#). Accessed on [2024-05-23].

Note: This all work is purely non-commercial and is used for only semester project at FAU to implement the ETL pipeline and provide valuable insights.



DataSource-1 Description:

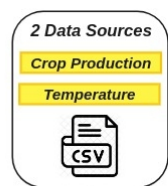
This FAO dataset provides an extensive overview of worldwide crop production statistics from 1961 to 2019. It includes 173 different products such as cereals, vegetables, fruits, tree nuts, fiber crops, oil crops, pulses, roots, and tubers. The dataset includes information on harvested areas, production quantities, and yields, offering a detailed picture of global primary crop production. This data is essential for examining agricultural productivity, food security, and related economic issues.

DataSource-2 Description:

This dataset provide details about mean surface temperature changes from 1970 to 2021 across countries around the world. It spans 51 years and compiles data from weather stations, satellites, and ocean buoys. The dataset enables analysis of temperature trends and identification of regions vulnerable to temperature changes, aiding in understanding climate change impacts and informing mitigation policies. Temperature is measured in degrees Celsius, with a +ve index indicating an increase and a -ve index indicating a decrease.

ETL Pipeline

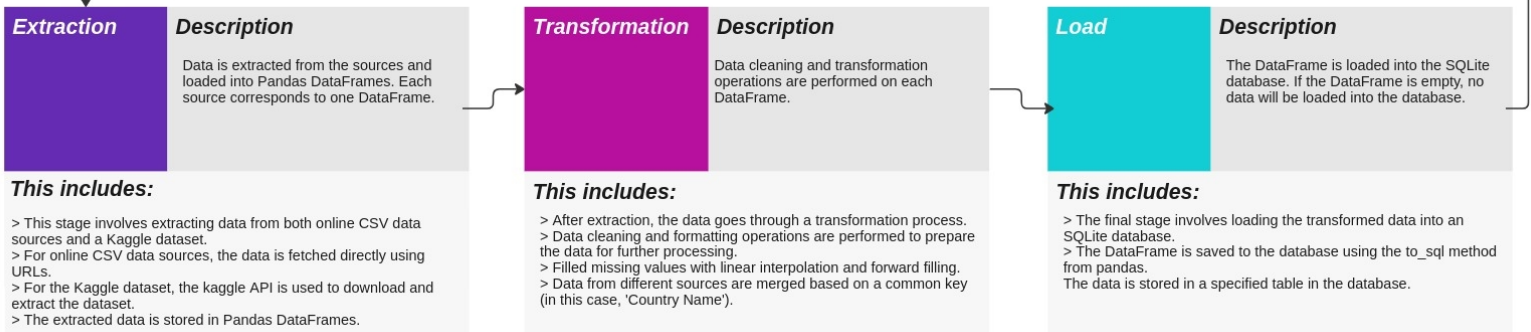
- The ETL pipeline is built with Python3 to extract publicly available datasets including crop production data from datasource-1 and historical temperature records from datasource-2.
- The extracted data undergoes transformations to standardize the formats, integrate relevant variables, and fill missing values using linear interpolation and forward filling.
- The "Country Name" is used as the key to merge dataframes, retaining only entries with matching country names, crops of interest, and temperature readings year-wise, focusing on the years 1970 to 2019.
- Logging is additionally configured in the ETL pipeline to capture the process flow and record errors, tracking successful steps and issues; try-except blocks handle exceptions, stopping the process, and logging critical errors as needed.
- Also ensured a clean environment by checking for and removing the Kaggle dataset file after reading.
- The loaded data will be analyzed to identify trends, correlations, and irregularities caused by climate change effects on crop yield variability.



Extract, Transform, and Load (ETL) Structure



ETL Pipeline.py



Results and Limitations

Output Data and Discussion:

The pipeline produces a merged dataset combining crop production data with mean surface temperature statistics across different countries globally, as shown in table 1. This ETL pipeline illustrate how even moderate increases in mean surface temperature can have substantial impacts on crop yield. The exact outcomes depend on various factors, including regional climate, specific crops, and the ability of farmers to adapt to changing conditions. It will provide policymakers and researchers with well-informed decision-making capabilities regarding climate change impacts on agriculture enables targeted adaptation strategies, efficient resource allocation, and proactive measures to mitigate economic and social impacts. This approach encourages innovation and international cooperation, enhancing agricultural resilience and contributing to food security and socio-economic stability.

Output Data Format:

Chose SQLite database format for flexibility, portability, integration with pandas, and scalability for medium-sized datasets.

Potential Issues:

- Data completeness issues with potential residual missing values.
- Data consistency challenges due to possible variations in source data.
- Dependency on the reliability of source data.
- Need for adjustments if input data structures or schemas change over time.

Table 1: Showing few rows of final transformed dataframe.

	Country Name	Item	Element	Unit_x	Y1970	...	Y2019	Unit_y	Change	1970	...	2019
0	Algeria	Carrots and turnips	Area harvested	ha	6700	...	43043	Degree Celsius	Surface Temperature Change	0.114	...	1.094
1	Algeria	Maize	Yield	hg/ha	4478	...	13292	Degree Celsius	Surface Temperature Change	0.114	...	1.094
2	Algeria	Rice, paddy	Production	tonnes	3000	...	57213	Degree Celsius	Surface Temperature Change	0.114	...	1.094
3	Pakistan	Grapes	Area harvested	ha	1820	...	19372	Degree Celsius	Surface Temperature Change	0.583	...	0.648
4	Pakistan	Sugar cane	Yield	hg/ha	104945	...	54069	Degree Celsius	Surface Temperature Change	0.583	...	0.648

