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Machine Learning for Sustainable Agriculture : Enhancing Resource Efficiency and Environmental Conservation

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ABSTRACT

Rainfall forecasting is crucial as far as our nation's civilization is concerned, and it occupies a significant part of the daily lives of people. It is the meteorology wing's obligation to anticipate the pattern of downpours considering any kind of uncertainties. Considering the ever-shifting weather patterns, correctly predicting downpours is difficult. This prediction routine becomes even more difficult whenever the season changes take place. Researchers from all around the world have created a variety of methods for forecasting rainfall, most of which use random values and generally are comparable with data on the climate of our nation. As a result of artificial climatic changes, food production and anticipating have declined which will harm the contribution of farming people to the economy by resulting in yields that are low and cause those farming people to become less comfortable with anticipating forthcoming crops. Therefore, in this research work, we are employing five distinct algorithms, namely, DT- Decision Tree, XG Boost, AdaBoost, RF- Random Forest, and SVM- Support Vector Machine for the purpose of predicting the rainfall effects, in turn, predict the yield of the crops for the betterment of the agricultural activities. Out of utilized 5 Machine learning approaches, the Decision Tree approach outperforms the others in terms of accuracy.

Keywords : SVM- Support Vector Machine, Agricultural Activities

I. INTRODUCTION

Rainfall forecasting is crucial in the civilization of our nation, and it takes on a significant part in the daily lives of people. It is the meteorology wing's obligation to anticipate the pattern of downpours considering any kind of uncertainties. Considering the ever-shifting weather patterns, correctly predicting downpours is difficult. Predicting downpours for both the rainfall as well as hot seasons seems difficult. Scientists from all around the globe have created a variety of methods to forecast downpours, the majority of which use values that are arbitrary and comparable to information about the climate. Agriculture has long been regarded as the primary provider of supplies to meet the everyday requirements of humans. It is additionally considered to be a core employment as well as one of our country's key industry fields. The farming persons should use conventional naked-eye inspection and produce nutritious crops avoiding the use of pesticides for faunas and their cultivated area for maintaining the healthful variety. However, climatic circumstances are rapidly shifting in opposition to the constituent-specific assets today, depleting nourishment as well as increasing safety. Meanwhile, the agricultural industry's GDP-Gross Domestic Product continues to fall, from over 17.2 per cent in the year 2005 to 11.1 per cent in the year 2012, five per cent in the year 2018 and two per cent in the initial part of the year 2020. Around eighty per cent of the farming population live in remote regions, and when the profitability of crop generation falls, their standard of living will be affected by fields at the industrial scale. It, therefore, makes it reasonable for Indian farming persons to be concerned about efficient and precise cultivation. In our nation, there are several methods for increasing crop profitability as well as improving crop quality in order to maintain growth in the economy in the agricultural sector. So, using a few of the most recent technological advancements, like machine learning, is one of the solutions for estimating the yields of crops in connection to meteorological and soil parameters related to farming in the field. Because meteorological circumstances are not quite foreseeable as they were years before. It is evolving daily as a result of globalization.

II. RELATED WORKS

[1] The agriculture industry has not yet received a CE (i.e., Circular Economy) framework adaptation. Filled this shortcoming in two ways: first, by tailoring the general CE framework to the unique characteristics of the agricultural sector, and second, by examining the range of the indicators available for gauging the performance of circularity in decision-making processes in agricultural production systems. As a result, the various components of the theoretical CE framework were modified for agricultural production systems. The definition of CE as it relates to agriculture was considered as a significant contribution of this work. Also defined were the CE techniques for agricultural activities as well as field adaptations of CE concepts. A thorough evaluation of the strengths and shortcomings of 41 circularity indicators for use in agricultural systems was also conducted.

[2] the most modern irrigation scheduling techniques were examined by using cutting-edge smart monitoring and control techniques. According to the literature study, closed-loop irrigation control techniques were more effective than open-loop systems that don't account for uncertainties. It was stated that greatly increasing water consumption efficiency may be achieved by integrating soil-based, plant-based, and weather-based monitoring techniques in a modelling context with model predictive control. This analysis aids in the selection of the most effective irrigation monitoring and management technique for open-field agricultural practices.

[3] gave an overview of the development of the most important technological areas initially, including artificial intelligence, the Internet of Things, robotics, block chain, big data, etc. Then, to assist agri-cooperatives in their decision-making, an illustration of the technological method of innovation will be provided. Finally, a digital diagnostic tool will be provided to assess the level of digital innovation inside cooperatives. Two agri-cooperative examples from Spain served as the initial test cases for this technology. Everything said here helps to clarify how agri-cooperatives are becoming more digitalized within the setting of technologically advanced agricultural production.

[4] In order to estimate and forecast the Global Monthly Average Precipitation for 10368 Geographic Locations Worldwide for 468 Months, employed LSTM and Convent Architectures. Even with more hidden layers, it was still possible to accurately minimize RMSE and MAPE errors. For meteorological applications, the data

projected with extreme precision for the next months would be trustworthy. This study's application may be furthered by considering time-series datasets that are accessible for each individual nation and processing them using comparable methods to get precise forecasting outcomes.

III.Methodology

Proposed system:

In our research concerned with the usage of Machine Learning approaches, namely, DT- Decision Tree, XG Boost, AdaBoost, RF- Random Forest, and SVM- Support Vector Machine for the betterment of agricultural activities in India, we will anticipate rainfall along with the crop recommendations. For forecasting the rainfall, we will forecast whether or not it will rain in the intended region, and for crop suggestion, we will propose the name of the most favorable crop depending on the environmental conditions. For accomplishing both the prediction as well as the recommendation tasks, we are implementing all the said machine learning approaches. The utilized machine learning approaches will be detailed in brief below. The block diagram of our proposed scheme has been shown in the below.

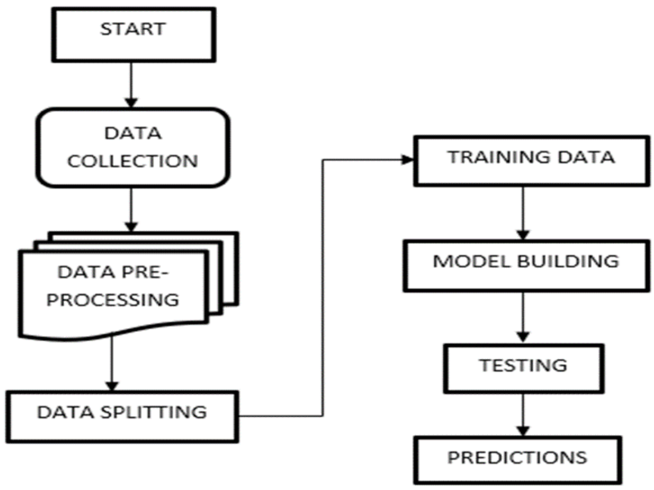

Fig1: Flow of the project

IV.Implementation

Decision Tree:

A DT is a tree-like arrangement that looks like a flow diagram, with a branch representing a ruling for the decision, an intrinsic node representing an attribute, and every node in the leaf structure representing the conclusion that was reached. The root node is the highest node in this tree concerned with the decision. DT learns to split by the magnitude of the feature. It divides the tree in a recursive manner, which is known as recursive splitting. This flow chart resembling arrangement aids anyone to arrive at decisions. It is an organizational graphic that effortlessly replicates human-level thought. As a result, DTs are simple to comprehend and comprehend.

XGBoost:

'Extreme Gradient Boosting' is what XGBoost refers to. It is a dispersed gradient boost package that has been optimized to be extremely effective, adaptable, and transportable. It uses the method known as Gradient Boosting for developing Machine Learning procedures. XGBoost uses concurrent tree strengthening for addressing a wide range of data science issues quickly as well as accurately. Boosting is a collaborative learning strategy for constructing a strong classifier from a sequence of poor ones. These kinds of approaches play an essential part in handling the trade-off with regard to bias-variance. Boosting approaches contrary to the bagging approaches, solely adjust for excessive variation in an algorithm. It also handles the two components (variance plus bias) and is seen to be effective.

Random Forest Classifier:

RF is a kind of machine learning approach for resolving any kind of regression as well as classification issues. It employs ensemble learning, which is an approach that blends multiple classification algorithms to solve complicated issues. RF determines the result by considering the forecasting drawn out of DT. RF forecasts by averaging or averaging the final results from different trees. Raising the overall count of trees improves the accuracy of the end result.

Support Vector Machines:

The goal of the SVM technique is to identify the hyper plane in the N-dimensional space (N — the characteristics count) that clearly separates the input points. There are several hyper planes that might be used to split the 2 types of information pieces. In SVM, one discovers a plane with the greatest margin, that is, the distance that is largest among the information points from the two categories. Maximizing such distance of the margin gives considerable strengthening, allowing subsequent data points to be categorized with a greater level of certainty. Support vectors are information points which are nearer to the hyper plane and have an impact on its alignment as well as location. One could easily maximize the margins of the classifier by utilizing the applicable support vectors. The location of the hyper plane is going to differ if the support vectors are deleted. These constitute the details which will assist one in developing their SVM model.

ADABOOST:

The Adaptive Boosting which is popularly regarded as the 'AdaBoost' classifier is a method of ensemble learning which brings together numerous inadequate classifiers to produce a classifier that is powerful. The technique operates iteratively, with every poor classifier being taught upon the information and its forecasts being pooled to form the end forecast. To summarize, this classifier continually integrates many poor classifiers, delivering greater weight to incorrectly categorized observations with every iteration that follows. The AdaBoost approach generates a powerful combination of models capable of making precise forecasts on fresh or previously unknown information. Its versatility to concentrate on difficult observations, as well as its capacity to manage both multiple-class as well as binary classification issues, renders it an often-employed strategy in the field of machine learning.

V. Results and Discussion

The following images will visually depict the process of our project.

Home page: The screenshot of the home page of crop recommendation web application is represented in the below fig 2. Here, the user can able to view the home page of web application.

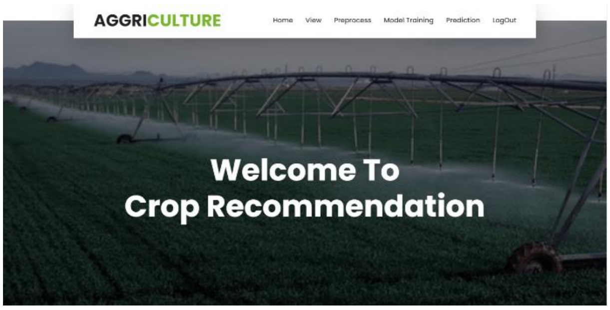

Fig2: Home Page

Rainfall Prediction Home page:

The screenshot of the rainfall prediction home page is denoted in the below fig. 3. Here, the user can able to view the rainfall prediction home page.

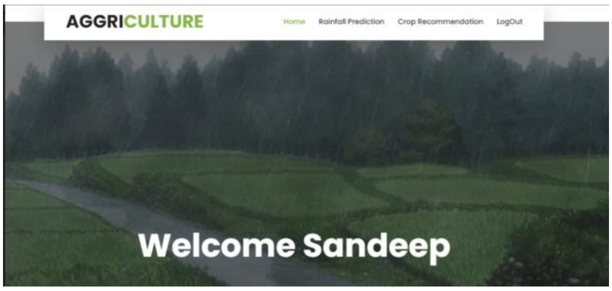

Fig3: Screenshot of the rainfall prediction home page

About Page:

The screenshot of the about page is indicated in the below fig. 4. The user can able to read more information regarding the application.

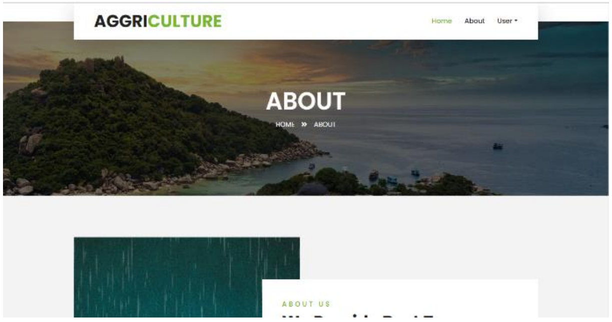

Fig. 4: Screenshot of the about page

Login Page:

The screenshot of the login page is specified in the below fig. 5. The user can login to the application by the providing the valid credentials provided during registration.

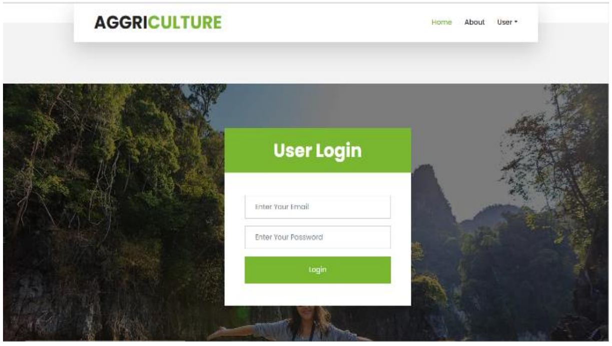

Fig5: Screenshot of the login page

User Home Page:

The screenshot of the user home page is expressed in the below fig. 6. The user is redirected to the user home page after logging into the application successfully.

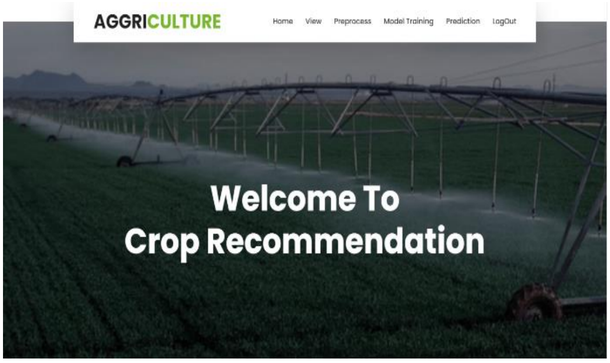

Fig6: Screenshot of the user home page

View:

The screenshot of the view page is demonstrated in the below fig. 7. The dataset which is uploaded into the application can be viewed by the user through this page.

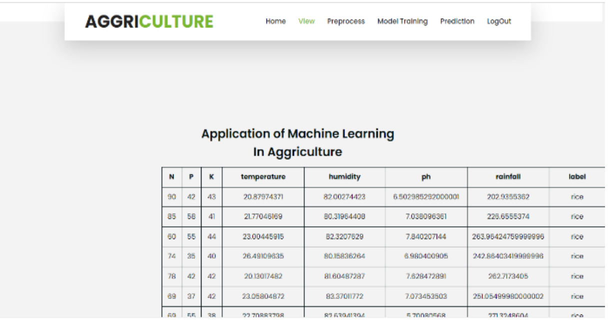

Fig7: Screenshot of the view page

Model:

The screenshot of the model page is shown in the below fig. 8. The dataset can be trained by the user in this page after selecting the appropriate algorithm.

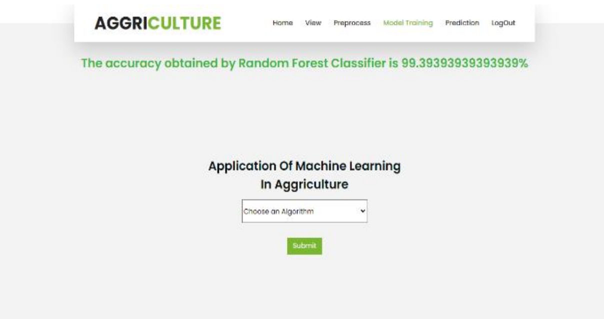

Fig8: Screenshot of the model page

Prediction:

The screenshot of the prediction page is displayed in the below fig. 9The outcome result of the crop recommended by the application is shown in this page based on the rainfall data.

Fig9: Screenshot of the prediction page

VI. Conclusion

Prediction of future rainfall is crucial for agricultural output. The amount of rainfall determines how quickly agricultural crops grow. In order to help farmers with their agriculture, it is therefore required to forecast the amount of rainfall for a season. With enhanced outcomes by means of accuracy, MSE, and correlation, the suggested technique uses multiple linear regression to forecast rainfall for the Indian dataset.

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