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Soil Analysis for Crop Recommendation using Machine Learning Algorithms

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ABSTARCT: Soil analysis plays a crucial role in enhancing agricultural productivity by determining the suitability of soil for various crops. With the advent of machine learning (ML), it is now possible to automate and optimize crop recommendation processes based on soil characteristics. This study explores the application of machine learning algorithms to analyze soil parameters such as pH, nitrogen, phosphorus, potassium, moisture, and organic content to predict the most suitable crops for cultivation. Various supervised learning models, including Decision Trees, Random Forest, Support Vector Machines (SVM), and K-Nearest Neighbors (KNN), were trained and evaluated using soil datasets. The models were assessed based on accuracy, precision, recall, and F1-score to determine their effectiveness in crop recommendation. Among them, Random Forest demonstrated the highest performance due to its ensemble learning approach and robustness against overfitting. The implementation of such ML-based systems can greatly assist farmers in making informed decisions, leading to better crop yields, resource optimization, and sustainable agriculture. This approach not only reduces dependency on traditional trial-and-error methods but also integrates modern data-driven techniques into farming practices. Overall, the study demonstrates that machine learning offers a promising and scalable solution for intelligent crop recommendation based on soil analysis.

I. INTRODUCTION

1.1 OVERVIEW

Soil analysis plays a crucial role in enhancing agricultural productivity by determining the suitability of soil for various crops. With the advent of machine learning (ML), it is now possible to automate and optimize crop recommendation processes based on soil characteristics. This study explores the application of machine learning algorithms to analyze soil parameters such as pH, nitrogen, phosphorus, potassium, moisture, and organic content to predict the most suitable crops for cultivation. Various supervised learning models, including Decision Trees, Random Forest, Support Vector Machines (SVM), and K-Nearest Neighbors (KNN), were trained and evaluated using soil datasets. The models were assessed based on accuracy, precision, recall, and F1-score to determine their effectiveness in crop recommendation. Among them, Random Forest demonstrated the highest performance due to its ensemble learning approach and robustness against overfitting. The implementation of such ML-based systems can greatly assist farmers in making informed decisions, leading to better crop yields, resource optimization, and sustainable agriculture. This approach not only reduces dependency on traditional trial-and-error methods but also integrates modern data-driven techniques into farming practices. Overall, the study demonstrates that machine learning offers a promising and scalable solution for intelligent crop recommendation based on soil analysis.

II. LITERATURE SURVEY

1. SOIL ANALYSIS AND CROP RECOMMENDATION USING MACHINE LEARNING

Author- Patel et al. (2015)

Year-2015

In their 2015 study, Patel et al. proposed a decision support system for crop selection using Decision Tree algorithms, aiming to assist farmers in identifying the most suitable crops based on soil and environmental parameters. The model

utilized key soil features such as pH level, nitrogen, phosphorus, and potassium content, as well as environmental factors like temperature and rainfall. By applying the Decision Tree algorithm, the system was able to classify and recommend crops that matched the input conditions, providing a rule-based and interpretable decision-making framework.

2. Soil Analysis and Crop Recommendation using Machine Learning

Author- Banu and Praveena (2023)

Year-2023

In their 2023 review, Banu and Praveena conducted a comprehensive analysis of various machine learning techniques applied in the field of precision agriculture, with a particular focus on the role of soil data in enhancing predictive modeling and promoting sustainable farming practices. The study highlighted how advancements in machine learning have transformed traditional farming by enabling data-driven decisions, reducing dependency on manual methods, and improving resource efficiency. By examining a wide range of algorithms—including Decision Trees, Random Forest, Support Vector Machines (SVM), Artificial Neural Networks (ANN), and K-Nearest Neighbors (KNN)—the authors provided insights into how these models perform in tasks such as soil classification, crop recommendation, and yield prediction.

III. PROJECT DESCRIPTION

EXISTING SYSTEM

India is the land of agriculture and is among the top three global producers of many crops. The Indian farmer lies at the heart of the agricultural sector yet most Indian farmers remain at the bottom of the social strata. In addition, farmers find it difficult to decide which crop is best suitable and profitable for their soil, in spite of the few technological solutions that exist today, due to the variation in soil types across geographical regions. This paper proposes a crop recommendation system that uses a Convolutional Neural Network (CNN) and a Random Forest Model to predict the optimal crop to be grown by analyzing various parameters including the region, soil type, yield, selling price, etc. The CNN architecture gave an accuracy of 95.21 %, and the Random Forest Algorithm had an accuracy of 75%

DISADVANTAGES

- To gain a better understanding, the process of analysis involves disassembling complex elements into simpler bits.
- The primary function of the analysis is information collection. There is essentially more to the collection procedure than only asking customers about their needs and requirements through surveys.
- Due to the intricate structure of the applications, each piece of information has an own method.

PROPOSED SYSTEM

Crop prediction is a task that involves using deep learning algorithms to predict crop yields and other relevant metrics based on a variety of factors, such as weather conditions, soil data, and historical crop data. The goal of this task is to provide farmers and other stakeholders with accurate and reliable information about expected crop yields, which can help them to make better decisions about planting, harvesting, and other aspects of agricultural management. The problem of crop prediction involves several challenges, including the need for accurate and timely data, the selection of relevant features and parameters for analysis, and the development of suitable machine learning models for prediction. By addressing these challenges, crop prediction has the potential to improve agricultural productivity and sustainability, and to support the development of more efficient and effective farming practices.

ADVANTAGES

- Agriculture has historically been and remains to this day one of the main pillars of the Indian economy as two thirds of the Indian population is directly dependent on agriculture for their livelihood.
- An equally important fact is that it contributes to 58% of India's Global Domestic Product (GDP).
- Dismally low profits that farmers earn for their produce because of the 'farm to market' mechanism which involves hundreds of middlemen who eat up most of the profits by transporting and selling crops.

IV. MODULES DESCRIPTION

DATASETS ACQUISITION

In this module, we can upload the crop yield datasets in the form of CSV file format. And also store the data in database for future purpose. The dataset includes the temperature, rain fall, pH value, nitrogen, phosphorus, potassium values. These values are extracted from Kaggle website and values are stored the integer values. And also upload the soil datasets that are collected from KAGGLE sources in terms of image format.

PREPROCESSING

Data pre-processing is an important step in the data mining process. The phrase "garbage in, garbage out" is particularly applicable to data mining and machine learning projects. Data preparation and filtering steps can take considerable amount of processing time. In this module, we can eliminate the irrelevant values and also estimate the missing values of data. Finally provide structured datasets. Then in soil image, we can analyze the noises and remove the noises using Median filtering algorithm. Median filtering is a widely used technique for removing noise from images, including soil images. It works by replacing each pixel in an image with the median value of its neighbouring pixels. In the case of salt and pepper noise, which is common in soil images, median filtering can be particularly effective at removing the noise while preserving the edges and details of the image.

FEATURES EXTRACTION

Feature selection refers to the process of reducing the inputs for processing and analysis, or of finding the most meaningful inputs. In this module, select the multiple features from uploaded datasets. And train the datasets with various crop labels with multiple attribute values. We can train the datasets to multiple crops such as rice, maize and so on. Features are collected from soil image datasets such as color, shape and texture datasets. Build a CNN architecture that is appropriate for the task of soil feature extraction. This can involve choosing the number and the size of convolutional and pooling layers, selecting an activation function, and deciding on the loss function and optimizer.

MODEL TRAINING

In this module, we can implement multi-layer perceptron algorithm to classify the uploaded datasets. MLP algorithm is one of the most popular Supervised Learning algorithms, as well as Regression problems. Crop prediction using MLP (Multilayer Perceptron) algorithm is a machine learning technique that involves the use of artificial neural networks to predict crop yields based on environmental data. The MLP algorithm is a type of feedforward neural network that is capable of learning complex relationships between input variables and output predictions.

V.RESULT

India's agriculture sector is significant. It is necessary for the Indian economy's survival and expansion. India is a significant producer of many different agricultural goods. In the process of cultivating crops, soil is crucial. A non-renewable, dynamic natural resource required for life is soil. The selection of the right crop based on the needs of the soil is a common issue faced by young Indian farmers. They experience a significant decline in productivity as a result. Earlier crop cultivation used to be done by farmers with practical experience. Based on the qualities and properties of the soil, farmers are no longer able to select the ideal crop. Therefore, a recommendation system that uses a machine learning algorithm to suggest the crop that can be harvested in that specific soil has been developed. In the proposed system, we process the user-supplied image of the soil and classify it into one of four classifications of soil: Red, Alluvial, Black, and Clay. A MobileNetV2 Architecture model accomplishes this. Several crops that can be grown in that soil type are recommended when the soil type is forecasted. In order to anticipate the list of crops that would grow well in a given soil, our suggested system maps the soil and crop data. As a result, the farmers will find our proposed method useful in helping them choose the right crops for their soil and in educating inexperienced farmers. Our proposed system achieved Training accuracy of 97.34% and validation accuracy of 99.21%.

VI. CONCLUSION

Yield optimization in farming is very crucial for countries whose agricultural sector plays an important and significant role in the economy. Better yields could be achieved if farmers knew what to grow based on their location. In this study we implement precision agriculture to develop a crop recommendation system that can help farmers increase crop yield. We use various machine learning algorithms for the classification of soil which allows our system to be able to

recommend crops to grow based on the attributes of the particular soil. The only soil attributes we consider in this study are three main soil nutrients, namely, nitrogen, potassium, and phosphorus; as well as soil pH level. This means that our solution is more accessible to most farmers and thus would have a greater impact on the agricultural sector of South Africa, because this type of soil data is more accessible. Our contribution to the literature is that we are able to develop a highly accurate crop recommendation system using soil attribute data that is more accessible. We also managed to establish which algorithm is best suited for the task of soil classification. **Keywords:** Agriculture Precision Agriculture Crop Recommendation Machine learning Kernel-based support vector machines Random forests South Africa

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