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Crop Recommendation Using Machine Learning Algorithms

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Abstract: Agriculture plays an important role in the Indian economy and employment. The most common problem faced by farmers in India is that they do not choose products according to the needs of the soil and therefore they face serious problems in their productivity. This problem can be solved with precision agriculture. The decision-making process includes three parameters: land area, soil type, and crop information based on these parameters to show farmers the appropriate crop. Precision farming helps reduce unnecessary crops that increase profitability in addition to the following benefits such as better input and output efficiency and higher farming. This approach offers solutions such as suggestion from mixed model with majority voting, using random trees, using K- Nearest Neighbors as a learner, suggesting Crops suitable for soil for lack of accuracy and yield.

Keywords— Crop Recommendation, Machine Learning, Precision Agriculture, Random Forest.

INTRODUCTION

Despite being one of the largest agricultural producers, India still has very low farm productivity. Productivity must be increased so that farmers can earn more money from the same amount of land while doing less work. Precision agriculture is one method for accomplishing this. Precision farming, as the name implies, refers to the use of precise and correct aggregate comments such as fertilizers, soil, and so on, but the trend in agriculture has recently evolved dramatically due to globalization. Various factors have harmed India's agricultural health. Many new technologies have been developed to help people regain their health. Precision agriculture is one such technique, applied at the right time to the craw to increase productivity and yields. This method provides solutions such as proposing a recommendation system via an ensemble model based on majority voting techniques with a machine learning algorithm as the learner with high specific accuracy and efficiency, recommend a suitable crop based on soil parameters. Precision agriculture is one such technique, in which crops are planted at the optimal time to maximize productivity and yields. Not every precision agricultural system produces the optimum outcomes. Precision agriculture is a type of site-specific farming technology. However, in agriculture, it is critical that the recommendations made are accurate and precise because errors can result in significant material and capital loss. Crop recommendation is an important domain in precision agriculture.

LITERATURE SURVEY

Priyadarshini A, Aayush Kumar (2021). Intelligent Crop Recommendation System using Machine Learning. Farmers have occasionally made mistakes in crop selection depending on soil characteristics, sowing season, and geographical location. As a result, people commit suicide, abandon agriculture, and look for work in cities. This study developed a mechanism to aid farmers in crop selection by taking into consideration all elements such as sowing season, soil, and geographical location to address this issue.[1]

N. Priyadarshini and S. R. M. Prasanna Kumar. Crop Recommendation System using Data Mining Techniques. International Journal of Computer Science and Information Technologies, Vol. 6 (1) 2015, pp. 583-586. This paper presents a crop recommendation system that uses data mining techniques. The system takes inputs such as soil type, pH, temperature, rainfall, and crop type, and recommends the most suitable crop for cultivation. The results show that the system achieves an accuracy of 96.6%.[2]

A.V. Patel, and M. R. Patel. Crop Recommendation Using Machine Learning Techniques. International Journal of Advanced Research in Computer and Communication Engineering, Vol. 6 (2) 2017, pp. 200-204. The system considers soil pH, soil type, temperature, humidity, and rainfall as inputs and recommends the best crop for production. To identify the data and select the crop, the authors employ three machine learning algorithms: k-nearest neighbors (KNN), support vector machine (SVM), and decision tree (DT). It was reported that the system's performance was assessed using accuracy, precision, recall, and F-measure metrics. The results reveal that the KNN method outperforms the SVM and DT algorithms, with an accuracy of 97.14%. The authors suggest that the proposed method can be a useful crop recommendation tool, assisting farmers in increasing production and profitability. The research delves into the use of machine learning techniques in agriculture and crop recommendation.[3]

S. S. Shinde and S. B. Mane. Crop Recommendation System based on Machine Learning Algorithms. International Journal of Computer Applications, Vol. 179 (32) 2018, pp. 16-20. The system takes input from the user in the form of soil pH, temperature, humidity, rainfall, and type of soil, and uses these parameters to recommend the most suitable crop for cultivation. The authors claim that their system provides accurate recommendations and can help farmers maximize their yield and profits. [4]

S. S. Sambare and S. S. Dhotre. Crop Recommendation System using Machine Learning Techniques. International Journal of Innovative Research in Computer and Communication Engineering, Vol. 5 (5) 2017, pp. 14169-14175. According to the authors, the approach is intended to assist farmers in increasing crop yields and profitability by making informed selections about which crops to grow. To provide crop suggestions, the system considers soil pH, temperature, humidity, rainfall, and crop history. The paper discusses the system architecture as well as the machine learning techniques that were utilized, such as the decision tree algorithm, the Naive Bayes algorithm, and the k-nearest neighbor algorithm. The accuracy and efficiency of these algorithms are compared by the authors.[5]

A. Summary of a Literature Review

With a knowledge cutoff of 2021-09, I can report that according to the source, there was a summary of the literature survey for crop recommendation using machine learning. One study was found that recommended crops based on soil type, climate, and other environmental factors using decision trees and a Bayesian network. The study reported that the system had an accuracy of more than 90%.

The system had an accuracy of more than 80%. Overall, these studies demonstrate the potential for machine learning to improve crop recommendations and help farmers make more informed decisions about what crops to plant. However, more research is needed to determine the best algorithms and data sources to use for this application.

SYSTEM DESIGN

A. Block Diagram

The following phases are commonly involved in crop recommendation using machine learning:

Data collection: Data collection include gathering information on agricultural yield, soil quality, climate, and other elements that can influence crop development and production.

Data Preparation: Data Preparation is the process of cleaning and pre-processing data to remove any missing values or outliers.

Feature Selection: Feature Selection Identifying the key traits or variables that can influence agricultural yield and production.

Model selection: Model selection is the process of selecting the best machine learning algorithm for the problem at hand. Crop recommendation systems include decision trees, random forests, support vector machines, and neural networks.

Model Training: Model Training is used as a subset of the data for training and the remainder for testing and validation, the machine learning model is trained on the prepared data.

Model Evaluation: Assessing the model's accuracy by comparing anticipated and actual values.

Deployment: Deployment is the process of deploying the trained model for crop recommendation and tracking its performance over time.

To maximize accuracy, a mix of feature selection, model selection should be used to optimize the performance of the machine learning algorithm.

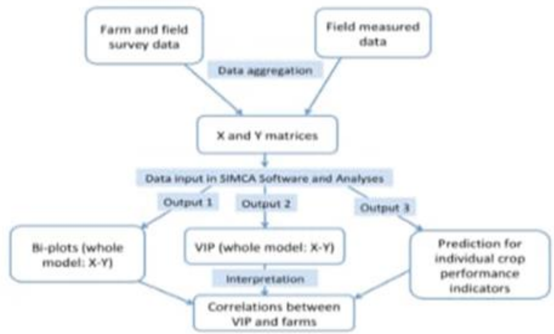


FIG 1 Architecture of Crop Recommendation Prediction

The above diagram depicts the crop recommendation system.

B. Flow Chart

FIG 2 Flow Chart for Crop Recommendation

TECHNOLOGIES

A machine learning model is nothing more than a piece of code; an engineer or data scientist does this smartly through training with data. So, if the model garbage was given in return got the garbage, i.e., the trained model will give false or wrong prediction.

Understanding the Machine Learning Workflow

The classification problem is when the target variable is categorical (i.e. the output could be classified into classes - it either belongs to class A or B or something else). The classification problem occurs when the output variable is a category, such as "red" or "blue," "disease" or "no disease," or "spam" or "not spam”

These are the most used classification algorithms:

1. Random Forest
2. Decision Trees
3. Support Vector Machine
4. Logistic Regression

A. Random Forest

Crop recommendation systems can make use of the machine learning method known as RF, or Random Forest. RF can be used to prioritize features from a big collection of crop-related variables, including soil type weather, and crop history. As a result, the dataset's dimensionality is decreased and the model's accuracy is increased. RF can be used to create forecasting models that suggest the optimal harvest for a specific set of circumstances.

The system can forecast the best crop for a given area by examining previous data on crop yield, weather, soil type, and other factors. RF can shed light on the elements that are most crucial for influencing agricultural productivity, which can assist farmers in making better decisions. The insights provided by RF can help farmers to make informed decisions about which crops to plant in a particular season, how much to invest in fertilizers and other inputs, and how to manage pests and diseases.

```
from sklearn.ensemble import RandomForestClassifier
RFModel = RandomForestClassifier(n_estimators=20)
RFModel.fit(X_train, y_train)
predRF = RFModel.predict(X_test)
accRF = accuracy_score(y_test, predRF)
accuracy.append(accRF)
modelName.append("Random Forest")
# Printing the metrics
print(classification_report(y_test, predRF))
```

FIG 3 Random Forest Coding

B. Decision Trees

Based on a variety of variables like soil type, climate, and access to irrigation, decision trees can be used to forecast which crops are most likely to thrive in a specific area.

In order to design a decision tree, it is necessary to analyze a dataset to determine the key variables that influence crop growth and production. These elements may consist of the type of soil, pH value, nutrients present, temperature, and the availability of irrigation.

Decision Trees

```
In [16]: from sklearn.tree import DecisionTreeClassifier

In [17]: dTree = DecisionTreeClassifier(criterion="entropy", max_depth=5)
         dTree.fit(X_train, y_train)
         predDT = dTree.predict(X_test)
         accDT = accuracy_score(y_test, predDT)
         accuracy.append(accDT)
         modelName.append("Decision Trees")
         # Printing the metrics
         print(classification_report(y_test, predDT))
```

FIG 4 Decision Trees Coding

C. Support Vector Machine

Finding the hyperplane that best divides various classes of data points in a high-dimensional feature space is the basic goal of SVM. SVM can be used to categorize various crops according to their production potential, growth requirements, soil type, weather conditions, and other environmental parameters in the context of crop recommendation. The initial step is to gather information about various crops, including information about yield, growth requirements, soil type, weather, and other environmental elements. Preprocessing is necessary to eliminate any inconsistent or missing values and to normalize the acquired data.

```
from sklearn.svm import SVC

SVMModel = SVC()
SVMModel.fit(X_train, y_train)
predSVM = SVMModel.predict(X_test)
accSVM = accuracy_score(y_test, predSVM)
accuracy.append(accSVM)
modelName.append("SVM")
# Printing the metrics
print(classification_report(y_test, predSVM))
```

FIG 5 Support Vector Machine Coding

D. Logistic Regression

Logistic regression can be used in crop recommendation to forecast the likelihood that a crop will succeed depending on variables including soil quality, climate, and resource availability. A logistic regression model can be trained to generate predictions on fresh data by examining past data and determining which factors are most important for crop performance. Using data from farms with diverse soil types and climate conditions, for instance, a logistic regression model may be trained to detect which crops are most likely to thrive under certain conditions. Based on this analysis, the model can then make

recommendations to farmers on which crops to plant in their specific region or plot of land.
Engagement levels decline as length of service increases

```python
from sklearn.linear_model import LogisticRegression
```

```python
logisticReg = LogisticRegression()
logisticReg.fit(X_train, y_train)

# Making predictions and printing metrics:
logisticReg.fit(X_train, y_train)
predLogistic = logisticReg.predict(X_test)
from sklearn.metrics import accuracy_score, classification_report, confusion_matrix
accLR = accuracy_score(y_test, predLogistic)
accuracy.append(accLR)
modelName.append("Logistic Regression")
print(classification_report(y_test, predLogistic))
```

FIG 6 Logistic Regression

RESULTS

The implementation of a crop recommendation system was useful to all the farmers across India can utilize right away. Based on factors like nitrogen, phosphorus, potassium, PH value, humidity, temperature, and rainfall, this method will assist farmers in making an educated choice regarding which crop to cultivate. It was suggested that the research can be utilized to enhance national productivity and generate profits by implementing this strategy. By doing this, farmers are able to grow the crops that will increase their production and the nation's overall profitability. This study used a variety of machine learning techniques, including Decision Tree, Naive Bayes, Support Vector Machine, Logistic Regression, and Random Forest, to convey its recommendations for diverse Indian crops.

We obtained the following accounting reports after running the Decision tree, SVM, Random Forest, and Logistic regression algorithms.

1. Accuracy Report of SVM

	precision	recall	f1-score	support
apple	1.00	1.00	1.00	37
banana	1.00	1.00	1.00	32
blackgram	1.00	1.00	1.00	36
chickpea	1.00	1.00	1.00	32
coconut	1.00	1.00	1.00	23
coffee	1.00	1.00	1.00	31
cotton	0.91	1.00	0.95	29
grapes	1.00	1.00	1.00	41
jute	0.79	1.00	0.89	27
kidneybeans	0.97	1.00	0.98	30
lentil	0.97	0.97	0.97	29
maize	1.00	0.91	0.95	34
mango	1.00	1.00	1.00	33
mothbeans	0.96	0.96	0.96	25
mungbean	1.00	1.00	1.00	28
muskmelon	1.00	1.00	1.00	26
orange	1.00	1.00	1.00	29
papaya	1.00	0.96	0.98	24
pigeonpeas	1.00	0.96	0.98	25
pomegranate	1.00	1.00	1.00	24
rice	0.96	0.78	0.86	32
watermelon	1.00	1.00	1.00	33
accuracy			0.98	660
macro avg	0.98	0.98	0.98	660
weighted avg	0.98	0.98	0.98	660

The total accuracy of the Support Vector Machine is about 98%.

2. Accuracy Report of Random Forest

	precision	recall	f1-score	support
apple	1.00	1.00	1.00	37
banana	1.00	1.00	1.00	32
blackgram	1.00	1.00	1.00	36
chickpea	1.00	1.00	1.00	32
coconut	1.00	1.00	1.00	23
coffee	1.00	1.00	1.00	31
cotton	1.00	1.00	1.00	29
grapes	1.00	1.00	1.00	41
jute	0.96	0.96	0.96	27
kidneybeans	1.00	1.00	1.00	30
lentil	1.00	1.00	1.00	29
maize	1.00	1.00	1.00	34
mango	1.00	1.00	1.00	33
mothbeans	1.00	1.00	1.00	25
mungbean	1.00	1.00	1.00	28
muskmelon	1.00	1.00	1.00	26
orange	1.00	1.00	1.00	29
papaya	1.00	1.00	1.00	24
pigeonpeas	1.00	1.00	1.00	25
pomegranate	1.00	1.00	1.00	24
rice	0.97	0.97	0.97	32
watermelon	1.00	1.00	1.00	33
accuracy			1.00	660
macro avg	1.00	1.00	1.00	660
weighted avg	1.00	1.00	1.00	660

The total accuracy of the Random Forest is about 100%

3. Accuracy Report of Logistic Regression

	precision	recall	f1-score	support
apple	1.00	1.00	1.00	37
banana	1.00	1.00	1.00	32
blackgram	0.91	0.86	0.89	36
chickpea	1.00	1.00	1.00	32
coconut	1.00	1.00	1.00	23
coffee	0.97	1.00	0.98	31
cotton	0.85	0.97	0.90	29
grapes	1.00	1.00	1.00	41
jute	0.85	0.85	0.85	27
kidneybeans	1.00	1.00	1.00	30
lentil	1.00	1.00	1.00	29
maize	0.96	0.79	0.87	34
mango	1.00	1.00	1.00	33
mothbeans	0.81	0.88	0.85	25
mungbean	1.00	1.00	1.00	28
muskmelon	1.00	1.00	1.00	26

orange	1.00	1.00	1.00	29
papaya	1.00	0.92	0.96	24
pigeonpeas	0.93	1.00	0.96	25
pomegranate	1.00	1.00	1.00	24
rice	0.88	0.91	0.89	32
watermelon	1.00	1.00	1.00	33
accuracy			0.96	660
macro avg	0.96	0.96	0.96	660
weighted avg	0.96	0.96	0.96	660

The total accuracy of the Logistic Regression is about 96%.

4. Accuracy Report of Decision Tree

	precision	recall	f1-score	support
apple	1.00	1.00	1.00	37
banana	1.00	1.00	1.00	32
blackgram	0.69	0.94	0.80	36
chickpea	1.00	1.00	1.00	32
coconut	1.00	1.00	1.00	23
coffee	1.00	0.87	0.93	31
cotton	0.97	1.00	0.98	29
grapes	1.00	1.00	1.00	41
jute	1.00	0.33	0.50	27
kidneybeans	1.00	0.73	0.85	30
lentil	0.88	1.00	0.94	29
maize	0.89	0.97	0.93	34
mango	1.00	1.00	1.00	33
mothbeans	1.00	0.56	0.72	25
mungbean	1.00	1.00	1.00	28
muskmelon	0.96	1.00	0.98	26
orange	1.00	1.00	1.00	29
papaya	1.00	1.00	1.00	24
pigeonpeas	0.93	1.00	0.96	25
pomegranate	1.00	1.00	1.00	24
rice	0.64	1.00	0.78	32
watermelon	1.00	0.97	0.98	33
accuracy			0.93	660
macro avg	0.95	0.93	0.93	660
weighted avg	0.95	0.93	0.93	660

The total accuracy of the Decision Tree is about 93%.

As a result of assessing all of the algorithms' accuracies, the Random Forest received 100% accuracy. As a result, the RF Model will be used as a web application for crop suggestion.

ALGORITHM	ACCURACY (%)
Decision Tree	93
SVM	98
Random Forest	100
Logistic Regression	96

Table 1 Accuracy in percentage

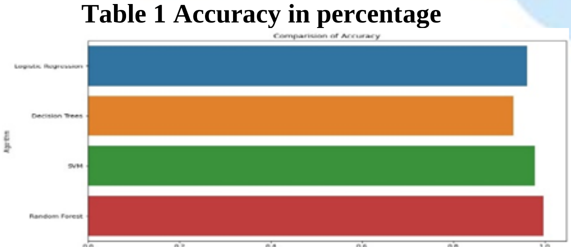


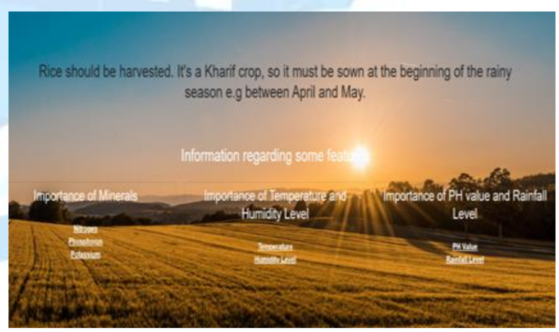
FIG 7 Comparison of Accuracy

Now it shows the best algorithm with the highest accuracy, Random Forest. Random forest is the algorithm in which used to develop a web application.

FIG 8 URL for the Executed Code

First, the code is executed and generates a URL, which we must paste into a Chrome page.

By providing input data, it will execute the code and display the output screen, which will show which crop needs to be cultivated.



CONCLUSION

Farmers in India will benefit greatly from the suggested crop recommendation system. The goal is to raise farmers' awareness of contemporary tools and infrastructure, as well as to promote precision farming. A well-informed selection can have a direct impact on their profitability. A method like this is especially beneficial for rookie farmers who are unfamiliar with soil and crop characteristics. More research into this system will allow it to provide more accurate recommendations. This system is safe and does not require any special gear to get started.

With machine learning, such a system can continue to evolve to support a wide range of crops and identify a wide range of weather patterns. The Random Forest's accuracy was 100 percent, and the linear regression model's accuracy was 96 percent. Random Forest was chosen as the finest machine learning algorithm after assessing all of their accuracies.

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