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Crop Recommendation System Using Machine Learning

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Abstract: Agricultural Crop Recommendation System relies on a multitude of input factors. This proposes a hybrid approach for suggesting suitable crops in specific areas, taking into account various attributes like soil type, rainfall levels, temperature value, Nitrogen value, Phosphorus value, Potassium value, humidity value and PH value of the soil. Utilizing technology to recommend crops for agriculture empowers farmers to enhance crop yields by suggesting the most suitable crops based on geographic and climatic conditions with respect to soil. The fundamental concept of this paper revolves around implementing a crop selection method to address numerous agricultural and farmer-related challenges.

Using a group of different machine learning models to make better predictions is like having a team of experts give you advice. Each expert has their own knowledge and experience, and by listening to all of them, you can make a better decision. Accuracy of different ML algorithms in crop recommendation system are such as that Support Vector Machine algorithm gives 99.54% accurate results, Neural networks algorithm gives 91% accurate results, Decision Tree algorithm gives us 87% of accuracy. While K-Nearest algorithm, Logistic Regression and Naive Bayes algorithm gives us 75%-85% accurate results.

We're gonna use machine learning algorithms to make the project more accurate and efficient enough to provide the real time results. In this crop recommendation system using machine learning Support Vector Classifier and Decision tree algorithms are being used as an expectation of most accurate outcomes of the model.

Keywords: Support Vector Machine, Feature selection, Crop suitability indices, Training dataset, Testing dataset, Model evaluation.

1. INTRODUCTION

Currently we are living in a world which is having a tremendous hunger of technology and that is what the requirement is.

Agriculture plays a vital role in feeding the world's population, and with the advent of technology, crop recommendation systems have become one of the most essential tools for optimizing agricultural practices. This system is going to help farmers make informed decisions about what crops to plant, when to plant them, and how to maximize their yield. In this article, we are outlining the main instructions for building the proposed system of Crop recommendation system.

The Scope and Purposes of the project is that it determine the scope crop recommendation system. We are targeting a specific region, soil type, pH level, crop type, or farming method so that we must have to clarify the purpose, such as increasing crop yield, reducing input costs, or improving sustainability.

And at the same time we are also Collecting the relevant data, including historical crop yields and production data, Soil quality and composition information, Weather data, including temperature, and humidity, Geographic data, such as elevation and topographical impacts, Crop-specific data, including growth requirements and pest/disease susceptibility, and Ensure data quality and accuracy.

Objective: It is using Support Vector Classifier aims to revolutionize modern agriculture by harnessing the power of data and machine learning. It has the potential to improve food security, reduce environmental impact, and enhance the livelihoods of farmers around the world. By providing precise and personalized crop recommendations, the project contributes to a more sustainable and resilient agricultural sector.

Maximize Crop Yield: This is the primary goal for most farmers. The system should recommend crops that are well-suited to the specific conditions of a farmer's land and climate, leading to higher yields and income.

Optimize Resource Utilization: By considering factors like water availability, soil nutrients, and labor requirements, the system can help farmers choose crops that can be grown using fewer resources, reducing cost and environmental impact.

Minimize Risk: Certain crops are more susceptible to pests, diseases, or weather events than others. The system can help farmers avoid such high-risk crops, increasing their chance of success and reducing financial losses.

Increase Farmer Autonomy: By providing data-driven insights and recommendations, the system can empower farmers to make informed decisions about their crops, reducing dependence on external advice and market fluctuations.

2. EXISTING SYSTEM

Traditional crop recommendation systems often relied on historical yield data, soil analysis, and weather records to make suggestions. While helpful, these systems have limitations:

Limited Granularity: Recommendations are often broad and regional, not specific to individual fields.

Inflexible to Change: They struggle to adapt to real-time variations like fluctuating weather or market trends.

Data Dependence: Their accuracy hinges on comprehensive and accurate historical data, which can be costly and time-consuming to collect.

DRAWBACKS OF EXISTING SYSTEM

Limited granularity: Recommendations often at regional, not field-level

Inflexibility: May not adapt to real-time variations or incorporate market trends, farmer preferences Data quality.

Dependency: Accuracy hinges on comprehensive, accurate historical data

3. PROPOSED SYSTEM

Advanced data analytics technology is deployed for monitoring and prognosticating alterations in agricultural output. These tools look at data to figure out which crops are best for different types of soil. With this info, farmers can make smart choices that lead to bigger harvests and more profit.

We are using Support Vector Algorithm to achieve a new height of accuracy,

While implementing the project, the following steps were implemented in order to achieve the results. Data Cleaning and Preprocessing One of the first steps is to make sure that the dataset we are using is accurate. The dataset should not have any missing values and if the dataset does have missing values, they should be replaced by the appropriate values.

```
print('KNeighborsClassifier Accuracy:',KNN.score(Xtrain, Ytrain))

KNeighborsClassifier Accuracy: 0.9886363636363636

from sklearn.naive_bayes import GaussianNB
NB = GaussianNB()
NB.fit(Xtrain, Ytrain)

▾ GaussianNB
GaussianNB()

print('Accuracy:',NB.score(Xtrain, Ytrain))

Accuracy: 0.9840909090909091

from sklearn.svm import SVC # "Support vector classifier"
classifier = SVC(kernel='linear', random_state=0)
classifier.fit(Xtrain, Ytrain)

▾ SVC
SVC(kernel='linear', random_state=0)

print('Accuracy:',classifier.score(Xtrain, Ytrain))

Accuracy: 0.9954545454545455
```

Fig.1. Prediction Accuracy

The tools use special computer programs (like Decision Tree and Support vector classifier) to predict future trends. These programs learn from a lot of info, like past crop records and details about the land and weather. Once they learn, the programs can tell farmers how much they might grow and how much fertilizer they'll need in the future. In short, these tools are like a helpful guide for farmers who want to improve their crops and make more money.

4. IMPLEMENTATION

User Interface: We are creating a simple as well as user friendly user interface as it plays a huge role while providiting the data as an input.

Farmer-Friendly Design: Create an intuitive user interface, accessible via web app or mobile app.

Allow farmers to input field-specific information (location, soil type, irrigation, etc.

Well Trained Dataset: Training a dataset of crops with respect to Support Vector Classifier which is further going to throw outputs for the users.

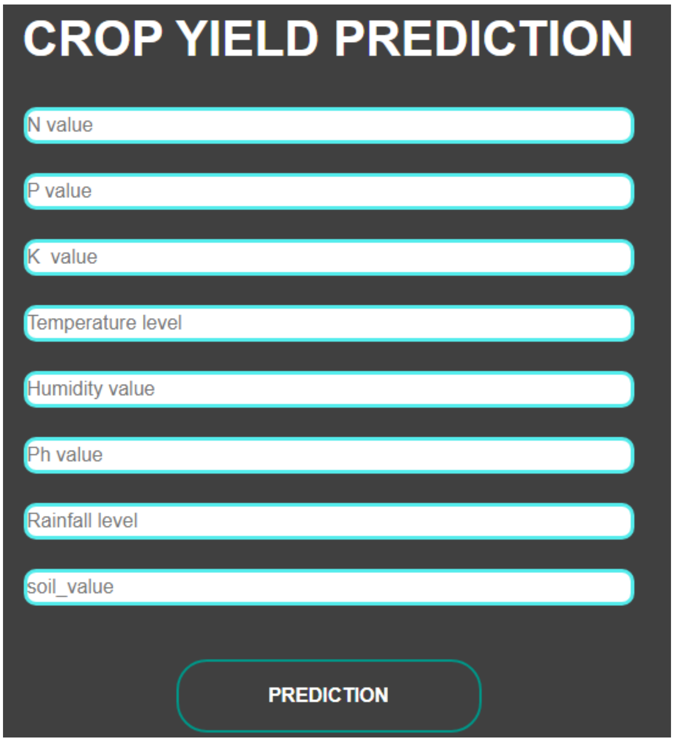

Fig.2. User-Interface design

Recommendation Generation:

Real-Time Processing: Process user input and real-time data streams efficiently.
Generate recommendations tailored to individual fields and current conditions.
Multi-Factorial Considerations: Account for yield potential, resource requirements, market demand, environmental impact, and farmer preferences.
Recommend crops that align with both economic and sustainability goals.

Data Integration:

Diverse Data Sources: Gather historical yield data, soil analysis, weather records, satellite imagery, sensor data, and market data.
Consider integrating farmer feedback for a more personalized approach.
Preprocessing and Cleaning: Ensure data quality through cleaning, handling missing values, and outlier detection.
Feature engineering extracts meaningful features for model training.
Model Development and Training: To give the instant and accurate information as a response to the users, the model must be trained with datasets.
Algorithm Selection: Choose machine learning algorithms based on the problem and data characteristics.
Consider CNNs for image analysis, decision trees for classification, and optimization algorithms for resource allocation.
Model Training: Split data into training and testing sets.
Train models on the training set to learn patterns and relationships.
Evaluate model performance on the testing set using appropriate metrics.

Unique Implementation Features:

Hyperlocal Focus: Analyze individual fields or sections within fields using high-resolution satellite imagery and sensor networks for granular recommendations.
Real-Time Adaptation: Integrate real-time weather forecasts and market data to dynamically adjust recommendations.
Human-in-the-Loop: Empower farmers with knowledge and control through interactive feedback mechanisms

5. METHODOLOGY

In the intricate process of our advanced agricultural technology, the primary actor is a user engaging with the system through a carefully designed user interface (UI). The UI serves as the gateway through which a farmer interacts with our innovative crop recommendation system. This interface is not merely a static display; it's a dynamic environment where the farmer provides specific inputs into the respective fields, shaping the nature of the inquiry.

A. Decision Tree Algorithm

A decision tree algorithm plays a crucial role in powering crop recommendation systems by analyzing factors and recommending suitable crops based on user input. The first step involves gathering data from various sources like past agricultural records, soil maps, weather data, and crop characteristics.

This data is then cleaned, preprocessed, and organized into a format suitable for training the decision tree model.

The algorithm starts with a single root node representing the entire dataset.

At each node, the algorithm chooses the most relevant factor (e.g., soil pH, etc) to split the data into further branches.

Each branch represents a subset of the data with similar characteristics.

This branching process continues until each leaf node contains data with similar optimal crop choices

B. Anaconda Navigator

We are going to use the Anaconda navigator for this project. Because Anaconda is designed specifically for scientific computing, data science, machine learning applications, large-scale data processing and most importantly predictive analytics.

Anaconda includes a number of pre-installed packages, such as

Pandas, and NumPy which we are also going to ude while going ahead. These packages are used in scientific computing. It is also designed to work seamlessly with Jupyter Notebooks which is going to be helpful for use.

C. SVM (Support Vector Machine)

SVM uses information about successful crops planted in various locations, including environmental factors like soil properties, climate data (temperature, rainfall, humidity), and historical yields. These factors serve as features in the SVM model. When presented with data for a new field, SVM predicts the most suitable crop .

Here in this project, SVM is being used to achieve high accuracy in crop prediction, providing reliable recommendations for farmers.

Herein, the model, endowed with the capability to make sense of complex datasets, not only processes the user's input but also reaches out to the database to fetch additional pertinent data. This fusion of user-provided information and database-derived insights empowers the model to make predictions tailored to the unique characteristics of the user's land and soil.

Once the support vector classifier completes its computations, it promptly relays the results back to the controller. The controller, acting as a conduit between the user interface and the model, efficiently channels the crop recommendations back to the UI. This responsive feedback loop ensures that the user interface is promptly updated with the latest and most relevant information.

Finally, the user interface takes center stage, presenting the meticulously calculated crop recommendations to the user. In a visually intuitive manner, the recommended crops are displayed on the screen, providing the user with a clear and actionable insight into the optimal crops for their specific agricultural context. This harmonious interplay of user interaction, machine learning prowess, and database-driven insights culminates in a seamless and informed decision-making process for the farmer, enhancing overall agricultural productivity and efficiency.

Target Users: individual farmers, agricultural organizations, or both.

Specify geographic coverage: local, regional, or global.

Identify crops of interest and relevant constraints.

Gather and Prepare Data: Data sources: Historical yield data, Soil analysis Weather records

Data preprocessing: Clean and format data for consistency.

Handle missing values and outliers.

prediction as a response to the users.

Feature engineering: extract relevant features for model training.

6. SYSTEM ARCHITECTURE

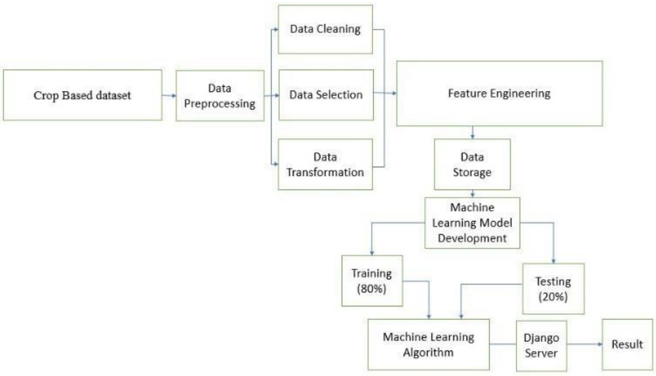

Fig.2 architectural diagram

Data training: The data must be trained to provide accurate

7. CONCLUSION

In the realm of farming intelligence, there's a shift from the old-fashioned way of choosing crops based on experience and limited information. Now, we're entering a new era where machine learning is combined with advanced technologies, such as real-time environmental data, bringing forth hyper-local dynamic crop recommendation systems. These systems have the potential to transform agriculture by customizing recommendations for each plot, leading to increased yields and profits. This tailored approach allows farmers to optimize their harvests, boosting income and improving their livelihoods.

The integration of real-time data and adaptable algorithms not only helps farmers respond promptly to changing weather patterns but also minimizes risks associated with climate fluctuations, contributing to sustainable farming practices. This innovation enables precise water management, optimized fertilizer application, and reduced energy consumption, conserving resources for future generations. This crop recommendation system, driven by the power of machine learning and real-time data, empowers farmers to make informed decisions, optimize resource usage, and achieve unparalleled levels of productivity and profitability.

This marks just the beginning of a transformative journey in agriculture. As technology continues to advance, we can anticipate even more sophisticated, data-driven solutions, paving the way for a future where every farm thrives, and every farmer flourishes, all while safeguarding the environment for generations to come.

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