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Agricultural Crop Recommendation Using Machine Learnong.

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A B S T R A C T

As a coastal state, Tamil Nadu faces uncertainty in agriculture which decreases its production. With more population and area, more productivity should be achieved but it cannot be reached. Farmers have words-of-mouth in past decades but now it cannot be used due to climatic factors. Agricultural factors and parameters make the data to get insights about the Agri-facts. Growth of IT world drives some highlights in Agriculture Sciences to help farmers with good agricultural information. Intelligence of applying modern technological methods in the field of agriculture is desirable in this current scenario. Machine Learning Techniques develops a well-defined model with the data and helps us to attain predictions. Agricultural issues like crop prediction, rotation, water requirement, fertilizer requirement and protection can be solved. Due to the variable climatic factors of the environment, there is a necessity to have a efficient technique to facilitate the crop cultivation and to lend a hand to the farmers in their production and management. This may help upcoming agriculturalists to have a better agriculture. A system of recommendations can be provided to a farmer to help them in crop cultivation with the help of data mining. To implement such an approach, crops are recommended based on its climatic factors and quantity. Data Analytics paves a way to evolve useful extraction from agricultural database. Crop Dataset has been analyzed and recommendation of crops is done based on productivity and season.

1. Introduction

Machine learning can help humans solve problems which are not easily solvable by humans. Machine learning can be used to solve tasks like classification, prediction, identification, etc. and can be applied to a wide range of other fields such as agriculture, sports, trade and business, and so on. This project aims at building a website focused on the agriculture sector, solving two significant issues crop recommendation and crop disease identification. The method used to solve these problems is by training models on datasets available over the internet and comparing them. Models with reasonable accuracy are embedded into the website, which can be then deployed on the cloud.

"The project" defines in its slogan, Farm = AI + Crop + Fertilizer + Pesticide, taking care of soil's health. The project honors the Indian farmer's love, hard work and character. Farmers help to feed a nation whose population is nearly 1.4 billion, however the productivity of farms is threatened by various natural factors that ruin the crops and farmer's livelihood. The project is a small initiative enhancing agriculture, making smart decisions to consider the demographics of the field, the factors affecting the crop, as well as how to keep the farm healthy for a super awesome yield. This will be implemented as a website providing features of Crop Recommendation, Fertilizer Recommendation and Pesticide Recommendation based on site specific parameters.

1.1 Description of the project

The project is a website made for farmers to help them with crop recommendations based on values of N, P, K, temperature, rainfall, relative humidity, and pH. Generally, soil gets degraded, and productivity is reduced if the right crop isn't chosen, but The project makes it really easy by using the ML model to make the real time prediction. The second feature is Fertilizer Prediction.

If the farmer opts not to change the crop as per land, he can go with the same crop but use fertilizer which will be recommended by The project based on N, P, K and crop values. Lastly, a very useful feature implemented is Pesticide Recommendation. Pests are a huge threat, but they can be stopped. Farmers simply need to upload a picture which clearly shows the pest and Irri great will identify the pest with the help of DL Model which is CNN and recommend the corresponding pesticide along with required dosage to get rid of pests and protect the crop. If the farmer already knows about the pest, then he/she can select the pest and corresponding pesticide will be recommended. Generally, it's seen that tests for soil are done by Indian government and results come within a few days, but farmers really do not know much on what to do next, so Irri great is sort of their next step. A simple, intuitive website will really help farmers to easily know the whereabouts of crops, thus helping every bit which Irri great can. Hence, the three modules: Crop, Fertilizer, Pesticide really come in handy and a boon for farmers.

1.2 Problem analysis

Agriculture is one of the biggest sources of earning for Indians. Though the Indian farmers really work hard in their fields, their productivity is threatened by natural factors. The fact cannot be changed that natural factors are uncontrollable, so the best way is to take most out of the field despite the natural factors. One of the major problems is soil degradation which can be prevented by growing the crop that is the most suitable as per the land. But even if the farmer chooses to grow a particular type of crop, then the appropriate dosage of fertilizers would help. Another major problem is the pest which can be only treated through suitable pesticides. This will help farmers. Various tests are conducted by the government in India which check the contents of soil, but farmers are unaware of what to do with the results of the soil test. Hence Irri great makes use of all the values of the tests and helps the farmers with crop recommendation, fertilizer recommendation and pesticide recommendation.

2. Literature survey

Agriculture is a major source of livelihood in India and Indian farmers put in their heart and soul to feed people. Farmers deal with crops, fertilizers, pests and pesticides. Hence, Irri great aims to serve Indian farmers via all three modules of Crop Recommendation, Fertilizer Recommendation and Pesticide Recommendation. Crop recommendation has been an area which is explored a lot, but all of the systems vary based on parameters that are fed into the ML model. Most of the ML models use Random Forest, some use Decision Tree, while others use Ensemble methods via Majority Voting Mechanism. Fertilizer Recommendation does not work much in AI. Main reason can be disintegrated data, but Irri great collected all the data from various sources and integrated it to have a well-formed dataset. A dictionary-based solution is implemented in Irri great. Thirdly, Pesticide Recommendation is not at all touched area, researchers have just restricted it to Pest Detection only, but The project extends the idea of identification of pest, along with a dictionary-based solution for the corresponding pesticide, available in India. Irri great uses ISO 9001, ISO 14001 and ISO 17025 standards for pesticide recommendation. Most of the pesticides are taken from biostudy site which is a popular site for farmers, but the problem is that search is not easy there and maximum pesticides recommended are not available in India. Following is discussed about various research papers pertaining to services offered by Irri great.

Rajak et al. 951-952) talks about crop prediction using various learners like SVM used as a classifier, Naive Bayes, Multilayer perceptron (ANN) and lastly Random Forest. The parameters used for crop prediction are: pH, depth, water holding capacity, drainage, erosion. The rule below demonstrates an example of the proposed recommendation system. IF ph is mild alkaline AND depth is above 90 AND water holding capacity is LOW AND drainage is moderate and erosion is low then paddy.

Dighe et al. 476-480) reviewed CHAID, KNN, K-means, Decision Tree, Neural Network, Naïve Bayes, C4.5, LAD, IBK and SVM algorithms and generated rules for recommendation system. Considering various factors like pH level of soil, month of cultivation, weather in the region, temperature, type of soil, etc. factors were considered to select maximum likely crops for plantation.

(Mokarrama and Arefin) discussed Location Detection, Data analysis and storage, Similar location detection and Recommendation generation module. Physiographic database, Thermal zone database, Crop growing period database, crop production rate database and seasonal crop database were used to get the final crop.

(Gandge and Sandhya) talks about Attribute selection, Multiple Linear Regression, Decision Tree using ID3, SVM, Neural Networks, C4.5, K-means and KNN. The proposed system consists of firstly Selection of agricultural field then Selection of crop previously planted, it takes input from user, preprocesses it, then in backend there is attribute selection followed by classification algorithm on data and then crop is recommended.

(Mishra et al.) uses J48, LAD Tree, LWL, IBK algorithm, firstly WEKA tool is used, LAD tree showed the lowest accuracy, though pruning the tree can minimize the errors, IBK gave good accuracy.

(Wu et al.) collects a large-scale dataset for insect pest identification called IP102, which contains over 75, 000 photographs of 102 insects. In comparison to previous datasets, the IP102 complies with a number of features of insect pest distribution in real-world settings . The findings show that existing handcrafted feature methods and deep feature methods are insufficient for pest identification

The results of the obtained deep features were then determined using SVM, ELM, and KNN classifiers. Deep models were then fine-tuned using pictures of plant disease and pests. In comparison to conventional approaches, deep learning models achieved better outcomes, according to the evaluation results. The findings of deep feature extraction surpassed those of transfer learning.

3. Future Scope

“The project” is not limited to current usage, it can be extended to many features as discussed below”:

1. The project currently supports 22 crops that are apple, banana, black gram, chickpea, coconut, coffee, cotton, grapes, jute, kidney beans, lentil, maize, mango, mothbeans, mungbean, muskmelon, orange, papaya, pigeon peas, pomegranate, rice, watermelon. Later on, the admin can add other crops. Moreover, in the future, fertilizers can also be added accordingly. The training was done on 10 pests: aphids, armyworm, beetle, bollworm, earthworm, grasshopper, mites, mosquito, sawfly and stem borer and with these pesticides are suggested.

2. In Crop Recommendation, values are manually entered by user of temperature, humidity, rainfall. Admin can also use some weather API to fetch the real time parameters by the city and state.
3. In Pesticide Recommendation, the uploaded image should be clear for correct results, otherwise with a blur image, the system sometimes gives wrong results so, further filters can be used to obtain better results. Also, the system can use better DL models.
4. In future pesticide code can be integrated with drone code so that it can take live pictures of pests and by email or by mobile the farmers would be notified about the pest along with the pesticides.

4. Recommended System

"Irri great" has three different modules. Methodology for all the modules will be discussed one by one.

4.1.1 Crop recommendation

This module can be implemented in four steps as discussed below

Step 1: Data Acquisition

Dataset can be acquired from Kaggle. Click here to have a look at the dataset.

Step 2: Values Input

Users are expected to input the site-specific parameters like: N, P, K (all of them in %), temperature (in °C), relative humidity (in %), rainfall (in mm) and pH.

Step 3: ML Model Training and creating .pkl file

The recommendation system is based on the ensemble model with majority voting technique. The constituent models are:

1. SVM
2. Random Forest
3. Naive Bayes
4. kNN

After the model is trained, a .pkl file is created.

Step 4: Crop Recommendation

.pkl file is loaded to recommend the crop based on input.

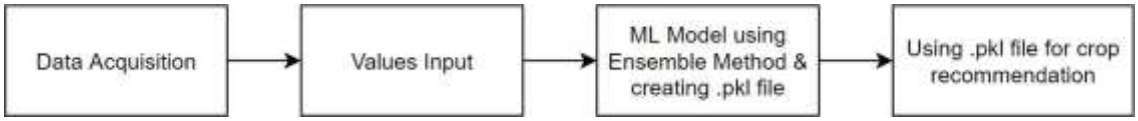

Fig. Methodology for Crop Recommendation

4.1.2 Fertilizer recommendation

This module can be implemented in four steps as discussed below and shown in Figure 2:

Step 1: Data Acquisition

Dataset will be created manually after collecting data from verified sources listed below:

1. The Fertilizer Association of India
2. Indian Institute of Water Management
3. Kaggle

The columns of the dataset are N, P, K (all of them in %) and crop.

Step 2: Values Input

Users are expected to input the site-specific parameters like: N, P, K (all of them in %), and crop (select from list - only 22 crops supported).

Step 3: Difference between desired and actual

Difference is calculated between desired value of N, P, K as per crop and the farm's actual value, based on it there are 3 outcomes possible for all three nutrients:

1. High
2. Low
3. Up to the mark

Step 4: Fertilizer Recommendation

Based on the outcomes from the above step, a dictionary-based solution (organic fertilizers) will be displayed.

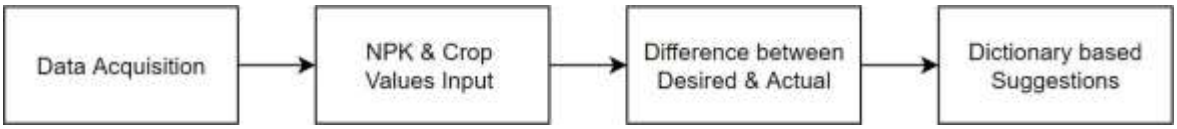

Fig. Methodology for Fertilizer Recommendation

5. System Architecture

The datasets for both the tasks were available online and were open sourced under open license to be used for anybody. The dataset for the first task consists of a CSV file which contains 2200 entries of the various factors such as soil condition, temperature, pH, humidity and rainfall and label output as the type of crop well produced in that type of conditions.

There are in total 22 types of crops available in the dataset and they are 'rice' 'maize', 'chickpea', 'kidneybeans', 'pigeonpeas', 'mothbeans', 'mungbean', 'black- gram', 'lentil', 'pomegranate', 'banana', 'mango', 'grapes', 'watermelon', 'muskmelon', 'apple', 'orange', 'papaya', 'coconut', 'cotton', 'jute' and 'coffee'.

The second dataset consists of 70,000 plant images having various diseases. It was a 5GB data from resolution 256x256. There are 38 classes available where there are 14 different plants and 26 diseases to be identified. Refer figure: 10 for peak into dataset.

These datasets were used to train all the further mentioned ML algorithms and the one with best accuracy was chosen.

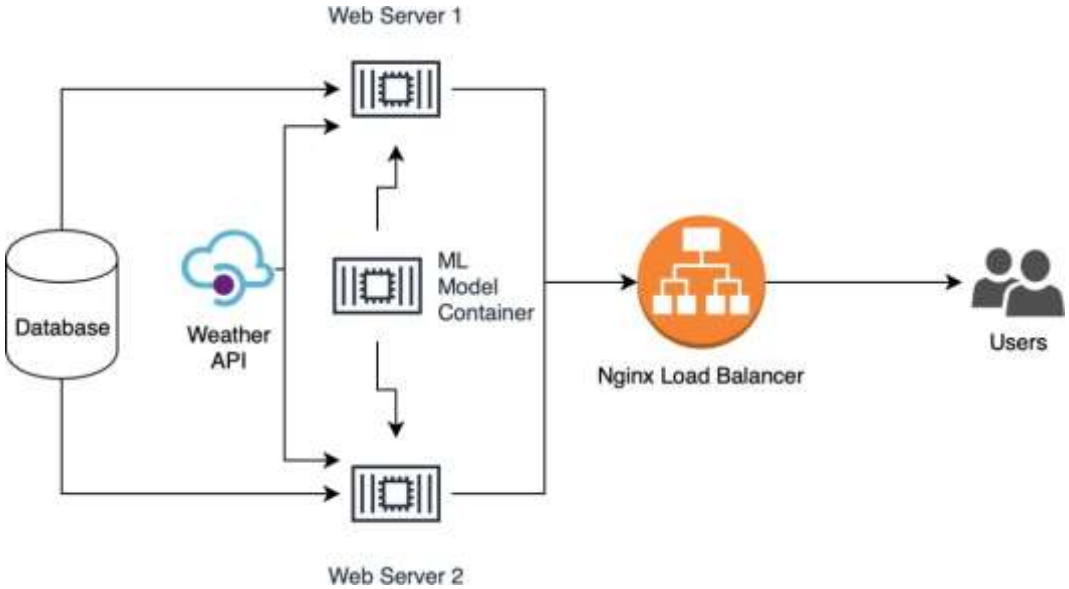

Fig. System Architecture

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Conclusion

India's farmers are hard at work. They help to feed a nation whose population is nearly 1.4 billion. However, their productivity is threatened by some natural factors that can ruin their crops and their livelihoods.

So, this solution (The project) will benefit farmers to maximize productivity in agriculture, reduce soil degradation in cultivated fields, and have informed advice on organic fertilizers/ other fertilizers and also know about the right crop by considering various attributes. This would provide a comprehensive prediction and hence benefit both farmers and the environment. Not only this, but pest control would also be a major issue to be solved via this project.

This project solves the problem of agricultural industry by providing the solution to a major problem of harvesting. We studied 5 different algorithms for the task 1 and reached to a conclusion that Random Forest is the best suited for the seleced dataset. Random Forest achieved an overall accuracy of 99.3%. For the task 2 a comparative study was shown between VGG16, ResNet50 and EfficientNetV2S. Ef- ficientNetV2 outperformed VGG16 and ResNet50 by achieving an overall accuracy of 96.06%. ResNet50 performed better than VGG16 gaining an overall accuracy of 95.53%. These two models were then deployed on web to be accessed by people.

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