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Prediction of Crop, Fertilizer and Disease Detection for Precision Agriculture

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Abstract: ***The main walk of life of our Country is Agriculture. More than 70 % of the population's lives depend upon agriculture. It is also a great source of country's economy. In order to make this filed more profitable for farmers proper crops have to be grown in their fields. The prevalent problem among the farmers is Crop choice depending upon the soil in their farmlands. Another challenge faced by farmers is choosing the right fertilisers for their crops, which plays a very important role in getting a good and profitable yield. There is another major problem which they have to give more attention is the pest control or the diseases to which the plants may limit their growth. The above listed problems may solved using the advanced techniques of Precision Agriculture and data mining. Precision Agriculture is modern technique which can be used for farming. The main objective of is to solve above problems using data mining techniques and build a decision system which would help farmers to choose right crops for their farm , fertiliser recommendation for the crops grown and also to help the farmers in detecting the diseases by using the infected leaf images..***

Keywords*: *Precision Agriculture, Data Mining, Crop, fertilizer recommendation system, ML Algorithms

I. INTRODUCTION

India is the land of agriculture where the practice of agriculture predates to Indus valley civilization. When it comes to production of farm outputs India ranks seconds across worldwide. According to records of 2018 more than 50% of the Indian population employ in agriculture. It also contributes to country's GDP, 17-20 % of India's GDP is obtained from agriculture. The practice of agriculture in villages helps in rural development and also in decreasing the poverty and helps in up liftment of the farmer socially as well as economically. With all these and many more contributions of agriculture to the country it is necessary that proper care is taken for the growth of agriculture in the country. Proper guidance has to be given for farmers at different levels of farming right from the foundation of agriculture that is choosing crop grown in their farm according to the soil contents like the levels of nutrients, Once the crop is decided proper fertilizers have to be given for the proper and healthy growth of the crops otherwise the crops may suffer from deficiency of nutrients which results in decreasing of productivity. Even excess of fertilizer may cause soil pollution and may affect the inner development and growth of the crops. Hence proper advice has to be given when it comes to fertilizer as is it has direct link with crop growth, yield ,productivity and economy. Another barrier for the growth of crops is diseases to which plants gets exposed. The identification of the disease to which the plants are disclosed is very prominent in order to avoid the loss which may reflect in Yield productivity. The common method followed to detect the disease is by naked- eye surveillance which is a time consuming process and also a lot of proficiency is required which may sometimes lead to appropriate decision as proper care and more domain knowledge is required. An appropriate direction has to be given in recognizing the disease and pest control methods should be inculcated to avoid the disease and improve the yield. In providing a direction to the above problems of selecting the appropriate crops initially, making the choice of fertilizers and detecting the disease of the plants . Agriculture is practiced since ancient times in our country we have enormous amount of historic data which can be passed down to build a decision system in order to provide a direction to our farmers which would be beneficial both in terms of productivity and economy. Data Science and Data Mining are boon in terms of advancement technology for the field of agriculture. The enormous amount of historic data collected from the ancient agricultural practices can be passed down to process data and appropriate machine learning models are built to give proper advice regarding crop and fertilizer selection and in detection of the disease. Precision agriculture on the other hand is a modern concept of managing the farming activities. Precision Agriculture predominantly the third wave which follows initially by Mechanized farming and secondly Green Revolution of the modern agriculture. The main objective of the Precision agriculture is to determine a Decision support system to the whole agricultural practices by increasing the returns on inputs meanwhile retaining resources. Crop selection, Fertilizer recommendation and Plant disease detection are some of the systems of the precision agriculture.

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The paper substantially focuses on building an application which guides the farmers by recommending the type of the crops that can be grown in their farm according to the soil content , using data mining techniques and different machine learning models and the model which is highly efficient and high accuracy is preferred finally. The paper also aims at prescribing the fertilizers which can be given for the good growth of the plants by taking the inputs about the soil and the type of crop they are growing data mining techniques and machine learning models the model which has high accuracy is preferred finally Finally, it helps the farmers in detecting the disease to which the plants are exposed, it takes the image of disease infected leaf of the plants and tries to detect the disease using image recognition techniques.

II. LITERATURE SURVEY

The paper[1] focusses on the necessary required information and also outlines the need to establish a model of software precision agriculture explained. It profoundly analyses the foundation of the farming with pinpoint accuracy. Author starts explaining the precision farming from rudiments and proceeds in the direction of developing a model which provides a foundation for it. The paper clearly explains the software model which uses Precision agriculture to individual farmers who operate on a small farmland which helps at the crop level and it also has a hold to control the variability. The overall goal of the developed model is to provide guidance for every farmer irrespective of the crops they are growing whether the may grow in small or large farmland by using the most reachable e-services like SMS ,email. The author has developed the model which is restricted to the state of Kerala in India.

In paper[2] emphasis on the importances of the selection of the crops initially to be grown and also the elements determining plant assortment like the rate of the product, fare in the market and the policies of the government are explained. This paper has come up with Crop Selection Method which provides a solution for the selection of the crops at the initial stage and also focuses on improving the net yield rate of the crop. It aims at providing the advice for the farmers by providing the series of crop that can be selected by keeping in mind various elements like weather, condition of the soil, water density and th crop type which the farmer would like to grow. The accuracy of the Crop Selection Method is considered finally.

In paper[3] intends in figuring out the imperative botheration of choosing Ensemble prototype learning classifiers. The ensemble model requires many classifier algorithms to be given, so there always lies a confusion as to which classifiers has to be chosen. This paper focus on getting a method which helps in choosing the best classifiers that can be given to a ensemble model. The classifiers chosen will have high accuracy. The classifier which are chosen should also have high performance rate. In context of high performance and high accuracy the author has proposed a method known as Selection by accuracy and Diversity. In order to choose significant and more accurate classifiers the author used Q- Statistics to compare between the relevant classifiers. The ensemble is developed by taking the classifiers. The author considered various algorithms .The SAD algorithm was superior to the others.

In paper[4] focused on building a system which aims at increasing the productivity rate of the crop by using sensors to analyze the soil condition. The soil in which the crops are grown is analyzed and a report is created based upon which the fertilizers to be given are advised. The author is proposing a system which adopts the predictive model type for the prediction of the fertilizers it also recommends the type of fertilizers. The author has embraced the IoT for shrewd and intelligent. The IoT technology also enhances the efficiency and also it reduces efforts the manpower strength which in turn reduces the time for the framer spent in farm. Thus the paper strictly hold on to the use of IoT to analyse the soil conditions and recommend fertilizer for the farmers according to the report thus helping the farmers to increase the productivity of their crops.

In paper [5] aims the usage of the pH electrodes, to persuade the pH element in the soil. The levels of pH p, central role in the growth crops. Hence authors take electrode method, finding pH by using the microcontroller. They preferred the use of the glass Ph electrode to determine the PH of the diluted acid soil. The values of the PH are used to classify the soil as alkaline ,acidic or neutral. The paper aims at building a model which in turn reduces the human intervention and also guides the farmer in selecting the crop based on the Ph levels of their soi

III. IMPLEMENTATION

In order to build a effective machine model following steps should be followed.

1) *Problem Framing:* From the description and problem statement, it can concluded that classification algorithms like below can be used to frame the problem.
2) Data collection: The initial stage once the problem is known is data collection or data gathering. Since we are building predictive models , they are only as strong as the data they're built on, good data collecting procedures are essential for creating high-performing models. The information taken from the data must always be a error-free and relevant to the task at hand. The data for the crop and fertilizer recommendation system can be directly collected from the respective soil. The dataset contains

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the values of the crops as outputs or labels and the respective nutrient levels required for the crop to be grown .Dataset also has the information regarding the rainfall for a particular area and also the levels of the pH required for the respective crop to be grown. Disease detection dataset ,it consists of healthy and unhealthy images of disease affected leaves which is categorized based on species and disease.

3) Data pre-processing: Data obtained is cleaned using various techniques .Some of which are involved are removing of the irrelevant values , elimination of the repeated values or duplicated values. Trying to eradicate some typing errors, getting rid of missing values, conversion of the data types. Using various techniques like mean ,median ,mode imputation will be applied for missing value treatment. Finally the scaled data which is obtained either by standardization or normalization is used for the training of the model as all the values will be in same scale.

4) Model Building : Dataset is divided into training and test data. machine learning algorithms' performance is estimated using the train-test split technique. Model is trained using the train data. Using various different machine learning algorithms and the model is built using appropriate machine learning algorithm. In this paper we are focussing on decision tree, Naïve Bayes, SVM, Regression, Random Forest, ResNet

5) Model Evaluation: Evaluating a learning method is the crucial. This often requires an estimation of the skill of the model when making predictions on data which is not seen during the training of the model. The planning of this process of training and evaluating a predictive model is called experimental design. In order to provide significant value to application, make predictions. Whether we're using machine learning to solve academic or business problems, it's becoming an increasingly important part of our life. The objective of model evaluation is to determine a model's accuracy on future. There are two types Hold out and cross-validation.

6) Model Selection: The process of selecting one method as a solution is called as model selection. Two classes of statistical methods can be used to intrepret the estimated skill of different models for the purpose of model selection.

7) Model deployment: Once the model is developed it can be deployed using python web application frame work i.e., Flask. Flask is a micro-framework. Since it is lightweight and only includes elements that are necessary. It only consists of parts required for web development, which including routing, request handling, sessions, and so forth. Other functions, such as data handling, can be handled by the developer through the creation of a custom module or the use of an enhancement.

IV. ALGORITHMS

In this paper we are focussing on decision tree, Naïve Bayes, SVM, Regression, Random Forest, ResNet

Decision tree is model is kin of supervised learning hierarchy. The process starts from intervening the root node to forecast a output label. It’s usage can be paradigmed in regression and classification. Decision tree make us of the concepts of entropy, information gain, attribution selection. It can be used in the field of marketing, withholding of customers, interpretation of diseases.

Naïve Bayes is affines to supervised learning which holds the bedrock from Bayes therm. It is authentic in clearing up classification problem. This really is amongst the most basic and precise Classifiers. It's still a probabilistic classifier because it creates predictions based upon on probability distribution function of the incidents. It can be fit in NLP, classification ,sentimental amnalysis and so on.

Support vector machine abbreviated as SVM also affines to supervised technique popular for Bi-classification contention. It takes the help of vectors referred as support vectors. The intention of SVM is creation of outline called hyperplane. It includes both classification , prediction of numeric. Whilst in two dimension it identifies contour sundering two class.

Logistic Regression is to adumbrate likelihood of output.It can be binary or mutlinominal. Model forsees the probability interlinked with individual dependent variable. It works by finding the linear relativity between independent variables and chooses link function. Whichever has the best link-function will be fitted for data preferred. Logistic regression methods can be depicted as shown below.

Random forest affines to ensemble techniques, in this the randomization of selecting the root nodes is done.It also indulges the bagging method. It is a bag of decision trees. Terminolgy “forest” depicts it is provoked by algorithm getting trained by bagging or boosting. The outcome is determined by algorithm which is based on the forecasts of the decision trees.

ResNet is abbreviated as Residual Network, to elucidate complex problem by adding much more layer for a DNN for raising the performance. Network is built be piling the block of residuals

For the crop guidance and fertilizer recommendation system the model is trained on the algorithms of Decision tree,Naïve Bayes, SVM, Logistic Regression ,Random Forest , however finally the accuracy and performance of each algorithm is measured and finally the model with better accuracy and performance is selected.

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However for the disease detection Resnet is used for image classification. When some of the parameters are tweaked and techniques such as scheduling learning rate, gradient clipping, and weight decay are used, ResNets perform significantly better for image classification.classification tasks. It's also known as a lazy learner algorithm because it doesn't learn from the training set right away; instead, it saves the dataset and performs an operation on it when it comes time to classify it.

V. RESULTS AND DISCUSSION

The accuracy and performance of each algorithm is measured and finally the model with better accuracy and performance is selected. The comparison of accuracy for the algorithms is given in the Table 1. It shows that the Random forest has higher accuracy for the data given. However the model accuracy varies from data provided.

Algorithm	Accuracy
Decision Tree	90
SVM	87
Logistic Regressiom	91
Random Forest	96
XGBoost	89
Naïve Bayes	90

Table 1: Accuracy Comparison

The Resnet algorithm is used for the image classification for disease detection application. We use learning rate scheduling instead of fixed learning rate because the learning rate keeps changing for every batch of training. Weight decay is used as it is a regularization technique. In order to limit the values of gradients to a small range to prevent undesirable changes in parameters due to large gradient values we can use Gradient Clipping.

Epoch	Training loss	Validation loss	Validation accuracy
1	0.7556	0.5978	0.8256
2	0.1135	0.0256	0.9278

Table 2: Learning Rate for batches

Table 2 depicts the learning rate in terms of training loss, validation loss and validation accuracy.It can be observed that model performed well in the epoch 2.

The model accuracy always varies with respect to the input data given

VI. CONCLUSION AND FUTURE ENHANCEMENT

India is a country where agriculture is very important. The prosperity of the farmers leads to the prosperity of the nation. As a result, our efforts might well result in assist growers who are trying to plant the appropriate premised upon this harvest, their needs. To make this field more profitable for farmers, appropriate crops must be grown in their fields. The most common issue among farmers is crop selection based on the soil in their farmlands is solved using this system. The problem of choosing the fertilizers is also solved using the system. It also reduces the time of the farmer while detecting the disease of the crop to which they are exposed to. As a result, farmers can plant the appropriate crop, appropriate fertilizer, and detects the disease to which the diseases the exposed, increasing their yield and the nation's overall productivity. Along with expertise of precision agriculture and drilling of information collected system was able to give benefits to our farmers. Our future work will focus on creating a more comprehensive data can be selected with more than just a large range of values and algorithms.

In future this system could be integrated to know the market value of the crops grown by the farmers.It currently takes all external conditions as inputs to the system, but as an added feature, a methodology can be enforced to identify the one factor using some other two variables

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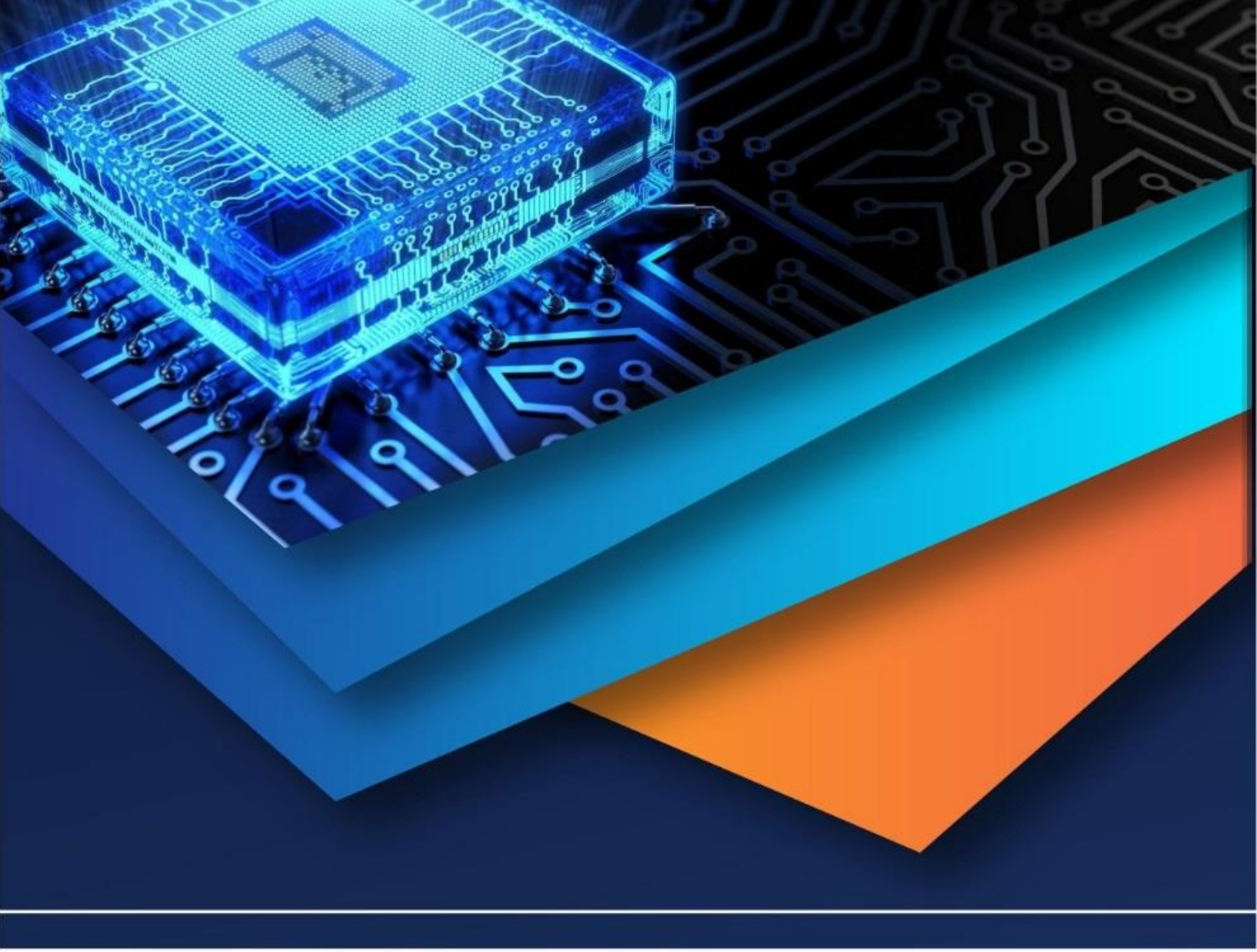

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