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Review of Region based crop selection Using Deep learning

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Abstract

The agriculture yield mostly depends on climate factors. Any information associated with climatic factors will help farmers in foreordained farming. Choosing a right crop at right time is most important to get proper yield. To help the farmers in decision making process a classification model is built by considering the agro climatic parameters of a crop like Nitrogen, Phosphorous, Potassium, Ph Level, Rainfall, State, Season, Area and a recommendation system is built based on three factors namely crop, type of crop and the production. Predicting the state is the novel approach in which crop pattern of 28 states in India is marked and based on that classification model is built. Thorough analysis of Deep Learning algorithms incorporating preprocessing, data augmentation and comparison of optimizers and activation function of CNN & LSTM. The results shows that CNN is the best predictive model for classification of crops, crop type and Production based on agro meteorological climatic condition.

I. INTRODUCTION

Farming is the primary and most important occupation in India. Almost 50% of India's manpower has their occupation directly or indirectly linked to agriculture. India is hence rightfully called as an agricultural country. Agriculture provides almost 20% contributions to the Gross Domestic Product. India has exported agricultural goods worth $25 billion until November 2017. India is one of the leading countries worldwide in terms of farm output. Even after being a leading producer of agricultural products, India still lacks farm productivity. Farmers have very less income because of the lack of farm productivity. There needs to be an increase in productivity, to get more income for the farmers. To increase productivity, farmers should know which crop would suit the specific piece of land. If the right type of crop is cultivated in that piece of land, then automatically, the yield of the crop will increase.

Hence, crop recommendation systems can be very beneficial for farmers. Recommendation systems need to be very accurate and explicit. If not, it may result in vast amount of loss on the monetary and materialistic front. Various machine learning methods can be used to create recommendation systems. However, this paper proposes a system, which uses neural networks to build a powerful, accurate and an unambiguous recommendation system.

In this specific model of recommendation system, certain climatic parameters will be taken into consideration. These parameters would be temperature, soil moisture content and humidity. These mentioned parameters

would help the recommendation system to give an accurate prediction regarding the most suitable crop to be cultivated.

Naive Bayes, Support Vector Machine (SVM), Decision Tree, KNN, Multiplayer-layer Perceptron, ID3, J48, JRIP, BPN, Random Forest, ANN, Linear Regression, Neural Network, Chaid and Kohonen Self Organizing Map are the different kinds of supervised learning algorithms and unsupervised learning algorithms used in the systems. Various methods, such as Natural Language Processing, ensemble methods like majority voting, and others, are used to develop machine learning models. Ensemble technique is a type of machine learning methodology that helps integrate numerous base models to create the single best-fit predictive model. The predictions generated by the classification models are summed or use regression models that are averaged in a voting ensemble.

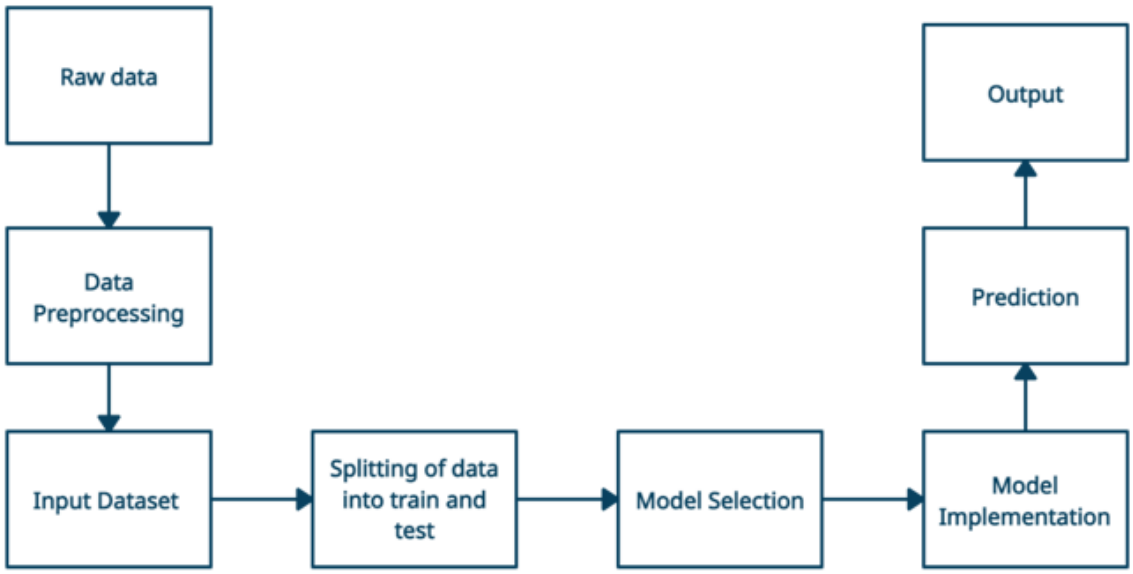

Figure 1. Block Diagram of Crop recommendation Model

The block diagram depicts the basic stages involved in creating the machine learning model above. The system's first stage involves cleaning and processing raw data. Crop data and fertilizer data are combined in this process to produce a final dataset. This dataset is then separated into training and testing data and utilized as input to the system. Model selection is the process of comparing various classification models in order to find the best appropriate one. The most suited crops are predicted, and the output is used for the following.

II. RELATED WORK

A. Crop recommendation using machine learning or deep learning

Crop Recommendation Systems use inputs of soil parameters like the ratio of Nitrogen, the ratio of Phosphorous, the ratio of Potassium and ph value of the soil, environmental factors such as humidity, rainfall, temperature, and many more.

The paper [3] displayed by Kiran Shinde, Jerrin Andrei, and Amey Oke proposes a crop recommendation system by comparing Naive Bayes, ID3, and Random Forest algorithms. The Random Forest algorithm is utilized to create the model, which is more accurate than the Naive Bayes and ID3 algorithms. The paper also proposes two more systems: fertilizer recommendation and crop rotation guidance. The crop rotation recommendation model is developed by using the FP algorithm. The fertilizer recommender calculates all of the fertilizer combinations that will suit the crop's needs at the lowest cost. Farmers can use the web and Android-based mobile devices to access the system.

S. Pudumalar , E.Ramanujam, R.Harine Rajashree?, C.Kavya?, T.Kiruthika?, J.Nisha? in paper [5] build a model using one of the most familiar ensembling techniques called the majority voting technique. Rather than using a single methodology, the ensemble method allows you to create a more accurate model by mixing several techniques. The technique uses different base learners such as Random Forest Tree, Chaid, K-Nearest Neighbor, and Naive Bayes, which makes a prediction model by combining the strengths of all the algorithms to bring out the best accuracy for building the model.

The architecture put forward by the paper [6] employs a majority voting technique which is the most common type of ensembling technique. Multi-layer Perceptron (Artificial Neural Network), Support Vector Machine, Random Forest, and Naive Bayes are the base learners used for creating the model. The base learners are selected in a manner that they are capable of and complimentary to one another, i.e., if one of the algorithms makes an error, the other algorithms will be able to rectify it.

Crop suitability and rainfall predictors make up the crop recommendation system developed by Zeel Doshi, Subhash Nadkarni, Rashi Agrawal, and Prof. Neepa Shah in their study [7]. The Linear Regression algorithm model helps predict the rainfall and displays rainfall of 12 months of a particular state. Supervised learning algorithms such as Random Forest, Decision Tree, Neural Network, and K-NN are compared against one another to get the most suitable algorithm with the highest accuracy score. The Neural Network approach, which has a 91 percent accuracy score, is then used to develop a model for the crop recommendation system. The month-wise rainfall prediction data is provided into the crop recommendation system's training model, which would then be combined to suggest the most suited crops.

Nidhi H Kulkarni, Dr. G N Srinivasan, Dr. B M Sagar, Dr .N K Cauvery in paper [8] provides a model for the crop recommendation system that uses a majority voting technique which is a kind of ensembling technique. The ensemble model has been brought forward using three independent base learners: Random Forest, Naive Bayes, and Linear SVM. Each of the samples from the data is trained and tested on the algorithms. The ensembling technique yielded a 98.91% accuracy score.

Rushika Ghadge, Juilee Kulkarni, Pooja More, Sachee Nene, and Priya R L in paper [9] proposed a system that checks soil quality to predict the crop suitable for cultivation based on soil type and maximize crop production by providing the right fertilizer. Unsupervised learning algorithms like Kohonen Self-Organizing Map are compared to supervised learning algorithms like Back Propagation Network. The algorithm with the highest accuracy is delivered to produce the model for the system.

Pavan Patil, Virendra Panpatil, Prof. Shrikant Kokate have used supervised learning algorithms such as Decision Tree, Naive Bayes, and KNN in paper [13]. The following are compared against each other, and the KNN algorithm seems to have the best precision, and the decision tree has the best accuracy. When a dataset has many variabilities, decision trees perform poorly, yet Naive Bayes performs better than decision trees in such cases. Combination classification algorithms, such as Naive Bayes and decision tree classifiers, outperform single classifier models.

Pradeepa Bandara, Thilini Weerasooriya, Ruchirawya T.H., W.J.M. Nanayakkara, Dimantha M.A.C., and Pabasara M.G.P. propose a system in which Arduino microcontrollers assist in the collection of environmental factors and supervised and unsupervised learning algorithms such as Naive Bayes, Support Vector Machine, and Natural Language Processing are implemented in paper [14]. Sunlight intensity sensor, soil moisture sensor, soil pH sensor, and humidity and temperature sensor are the sensors used in collecting the climate factors.

B. Crop Recommendation Using Natural Language Processing

NLP refers to the automatic processing of natural human language such as speech or text, and while the concept is intriguing, the real value of this technology is found in its applications. In essence, it generates an occurrence matrix for the sentence or text, ignoring syntax and word order. The frequency or occurrences of these words are subsequently employed as features in the training of a classifier.

C. Crop Recommendation Using Ensemble Technique

Ensemble methods are a machine learning method that helps combine multiple base models to produce a single best-predictive model. The majority voting ensemble, also known as voting ensemble, is one of the most often used ensemble algorithms for crop recommendation systems. It's a machine learning model that integrates predictions from a variety of other models. It is a strategy that can be used to increase model performance, to outperform any one model in the ensemble.

III. A COMPARATIVE STUDY OF CLASSIFICATION ALGORITHMS

A. Naive Bayes Algorithm

The Naive Bayes method is a type of supervised learning algorithm that is used for addressing classification issues that is based on the Bayes theorem. The simplest method you may use to analyse your data is Naive Bayes. This approach assumes that the dataset's variables are all "Naive", i.e., uncorrelated. It can be used to estimate the data distribution, but the Gaussian (or Normal) distribution is the simplest to deal with because all you have to do is estimate the mean and the standard deviation from the data being trained.

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Figure 2. Bayes' theorem

where,

P(A|B) is the Posterior probability: Probability of hypothesis A on the observed event B.

P(B|A) is the Likelihood probability: Probability of the evidence given that the probability of a hypothesis is true.

To understand the above equation in a simpler way, the above equation can be written as

$$\text{posterior} = \frac{\text{prior} \times \text{likelihood}}{\text{evidence}}$$

Figure 3. Simpler equation

4. Support Vector Machine

The Support Vector Machine (SVM) is a supervised learning approach widely used in text classification, picture classification, bioinformatics, and other fields. The problem space in Linear SVM must be linearly separable.

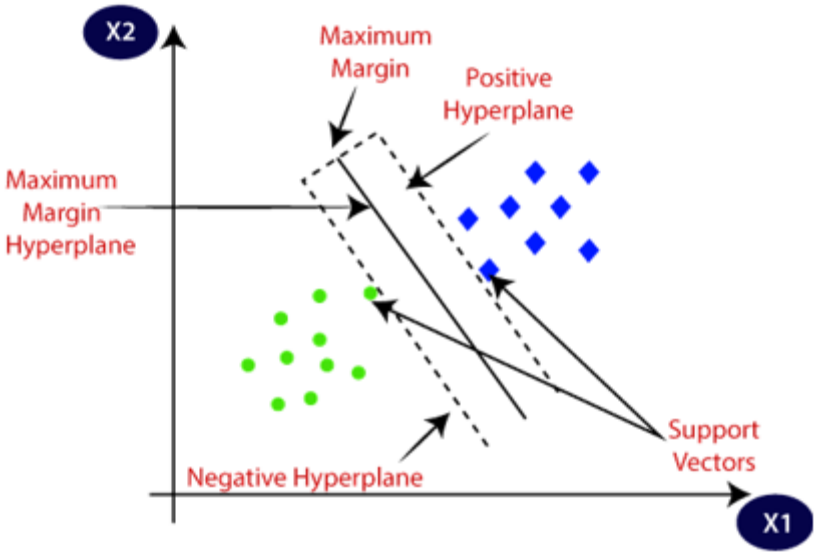

Figure 4. Support Vector Machine [15]

The model generates a hyperplane that maximizes the classification margin. In an n-dimensional Euclidean space, a hyperplane is a flat, n-1-dimensional subset that separates the space into two separate portions. Support vectors are the boundary nodes in the feature space. The greatest margin is calculated based on their relative positions, and an ideal hyperplane is drawn in the midpoint. When the dataset is not linearly separable, non-linear SVM is used. For all of the training data, a kernel function is utilized to generate a new hyperplane. Training data will be linearly separable due to the distribution of labels in the new hyperplane. Later, the labels in the hyperplane will be classified using a linear curve. We get a non-linear solution when we project the classification results back to the feature space.

C. Kohonen's SOM (Self-Organizing Map)

The fact that the entire learning takes place without supervision, i.e., the nodes self-organize, is a significant feature. They're also known as feature maps because they're essentially retraining the features of the incoming data and just grouping themselves based on their similarity. This is useful for visualizing complex or massive

amounts of high-dimensional data and displaying the relationships between them in a low-dimensional, usually two-dimensional, field to determine if the unlabeled data has any structure. The grid is the map that organizes itself at each iteration based on the input data.

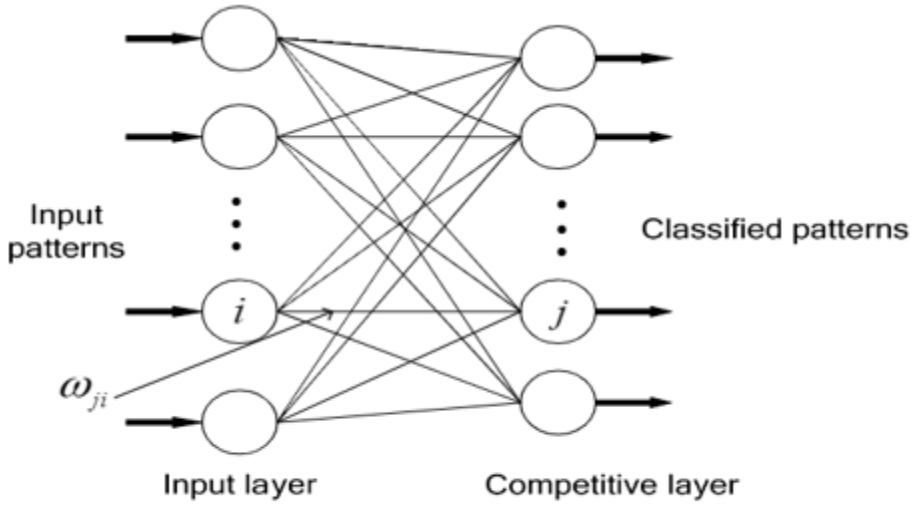

Figure 5. Kohonen's SOM [2]

Weight initialization is the first step to take place for the algorithm. Then a for loop from 1 to N number of epochs gets implemented. Selection of a training example takes place. The next few steps are computing and updating the winning vector. Repeat the last three steps for all training examples and cluster the test sample.

D. Neural Network

A neural network is a set of algorithms that attempts to recognise underlying relationships in a batch of data using a method that mimics how the human brain works. Because neural networks can modify input, they can produce the best possible outcome without requiring the output criteria to be redesigned.

A neural network is analogous to the neural network in the human brain. In a neural network, a "neuron" is a mathematical function that collects and categorizes data using a specified design. The two statistical procedures that the network closely resembles are the curve fitting and regression analysis.

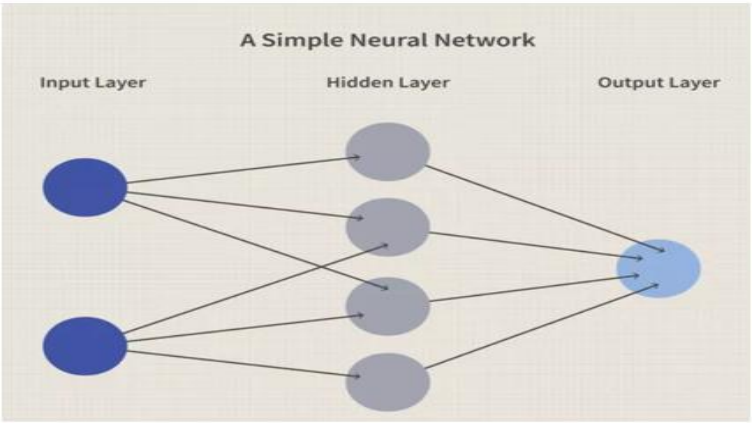

Figure 6. Neural Network [16]

E. BPN (Back-Propagation Neural Networks)

The core of neural network training is backpropagation. It's a method for fine-tuning the weights of a neural network based on the error rate of the previous epoch (i.e., iteration). You may reduce error rates and increase the model's generalization by fine-tuning the weights, making it more trustworthy. In data mining and machine learning, it's a crucial mathematical tool for boosting prediction accuracy. Backpropagation is a technique that is used to swiftly calculate derivatives.

The chain rule is used by the back propagation method in neural networks to determine the gradient of the loss function for a single weight. Unlike native direct computation, it efficiently computes one layer at a time. It computes the gradient but doesn't specify how it'll be used. It generalizes the delta rule's computation.

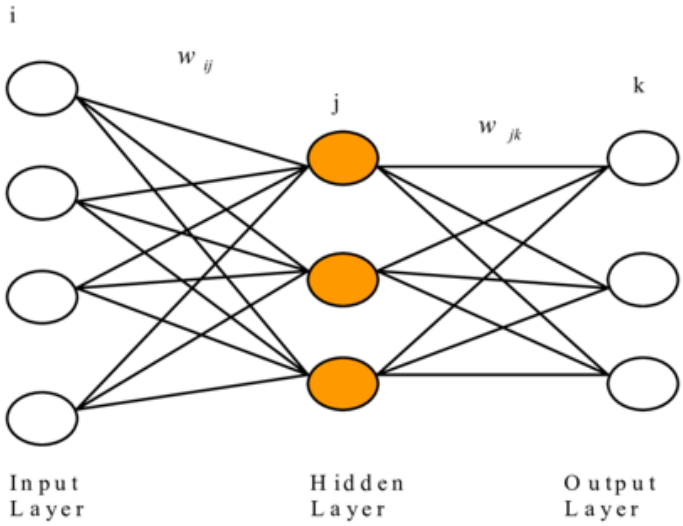

Figure 7. Back-Propagation Neural Networks [1]

The diagram above is an example to help understand Back propagation neural network:

1. X inputs arrive via a pre-connected path.
2. The randomly selected real weights W is used to input the model
3. We then calculate the output for each neuron, which starts from the input layer to the hidden layers, and the output layer.
4. Calculate the error present in the outputs.

ErrorB= Actual Output – Desired Output

5. After calculating the errors present, return from the output layer to the hidden layer to change the weights to reduce the error.

6. Repeat the technique until you get the desired result.

F. Multi-layer Perceptron (Artificial Neural Network)

Artificial neural networks are sometimes simply referred to as neural networks or multi-layer perceptrons, after the most useful type of neural network. A perceptron is a model of a single neuron that serves as a forerunner to larger neural networks. It's a branch of computer science that looks into how simple models of biological brains

may be utilized to address difficult computational problems like predictive modeling in machine learning. The goal is to construct strong algorithms and data structures that can be used to represent complex situations, rather than to produce realistic brain models.

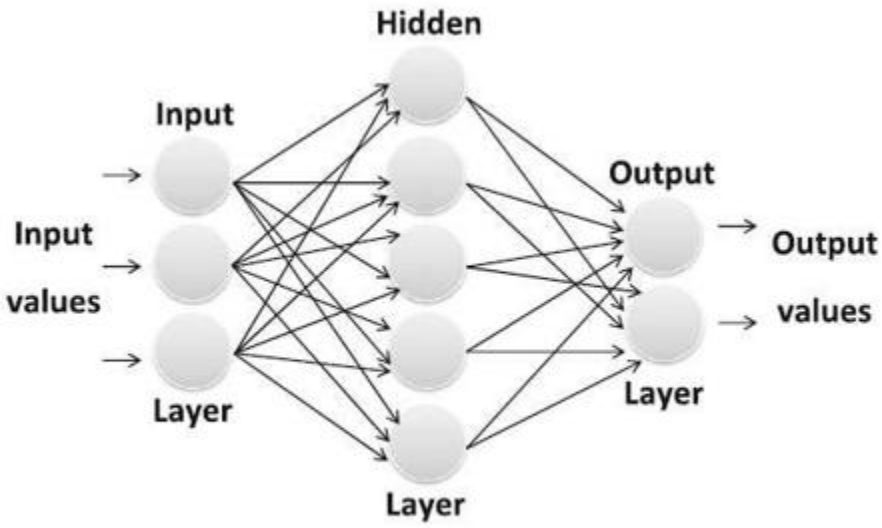

Figure 8. Multi-layer Perceptron [4]

G. Decision Tree

The independent variables are used to create a decision tree, with each node having a condition over a feature. The algorithm begins at the tree's root node to predict the class of the specified dataset. In layman's terms, decision trees are a series of if-else statements. It checks to see if the condition is satisfied, and if it is, it moves on to the next node in the decision chain. Based on the condition, the nodes pick which node to travel to next. Output is expected once the leaf node is reached. The tree is efficient when the conditions are in the appropriate order. The criterion for selecting conditions in nodes is entropy/information gain. The tree structure is derived using a recursive, greedy-based technique.

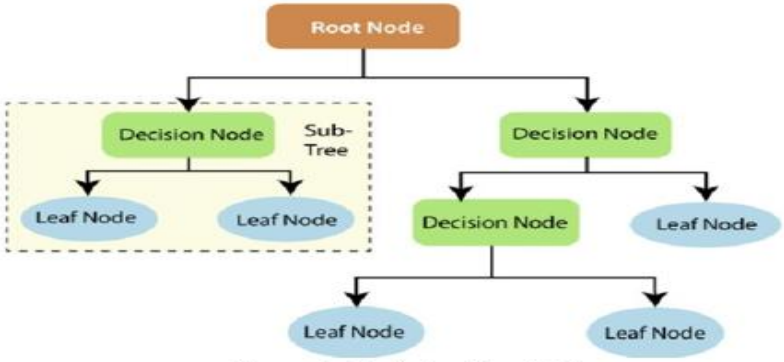

Figure 9. Decision Tree [17]

H. Random Forest Tree

To achieve classification and regression outputs, Random Forest uses a number of decision trees ensembled utilizing the "bagging approach". In classification, the result is derived using majority voting, whereas, in

regression, the output is calculated using the mean. Random Forest produces a reliable, accurate model that can handle a wide range of input data types including binary, categorical, and continuous characteristics. The following supervised learning model handles overfitting efficiently. It supports implicit feature selection and determines the relevance of importance.

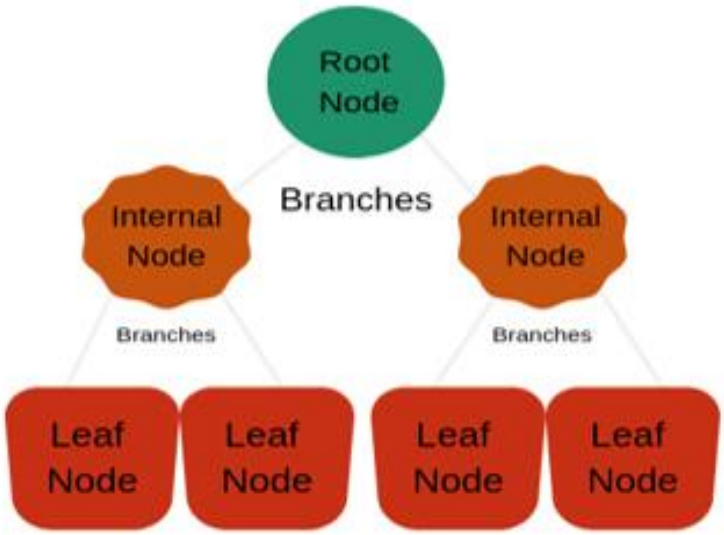

Figure 10. Random Forest Algorithm [18]

The initial step is the selection of random K data points from the training set. Then create decision trees for the data points chosen, i.e., the subsets. Decide on the number N for the decision trees you wish to generate. Replicate the two initial steps. Find the forecasts of each decision tree for new data points and allocate the up to the minute data points to the category with the most votes.

I. K-Nearest Neighbors

K-nearest neighbors is a non-parametric classification and regression technique. It's one of the most basic machine learning techniques. KNN's basic concept is to look at your neighborhood, suppose the test data point is comparable to them, and derive the result. We look for k neighbors and make a forecast using KNN. KNN classification uses majority voting over the k closest data points, whereas KNN regression uses the mean of the k closest data points as the output. The K value and distance function are the two hyperparameters that makeup KNN. The K parameter indicates how many neighbors should be included in the KNN algorithm. According to the validation error, the value of k should be modified. The most common similarity function used is Euclidean distance. Different possibilities include the Manhattan distance, Hamming distance, and Minkowski distance.

Assume there are two categories, Category A and Category B, and a new data item x1 is received. Which of the following categories does this data point belong in? This type of challenge necessitates the use of a K-NN method. We can determine the category or class of a dataset with the help of K-NN. Consider the diagram below:

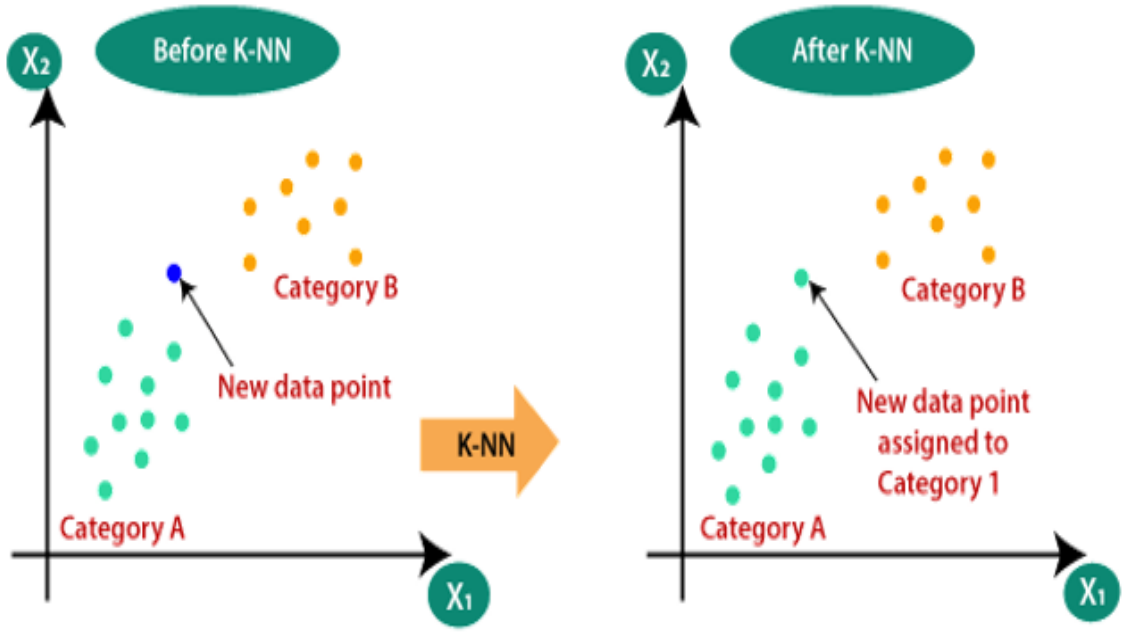

Figure 11: K-Nearest Neighbors [19]

The initial step is to decide the number of neighbors (K). Then determination of the Euclidean distance between K neighbors takes place. Finding the K nearest neighbors using the Euclidean distance is the next step to be followed. Tally the number of data points in each category among these K neighbors. Assigning the new data points with the greatest number of neighbors to the category. We've completed our model.

J. Long short-term memory (LSTM) is an artificial recurrent neural network (RNN) architecture[1] used in the field of deep learning. Unlike standard feedforward neural networks, LSTM has feedback connections. It can not only process single data points (such as images), but also entire sequences of data (such as speech or video). For example, LSTM is applicable to tasks such as unsegmented, connected handwriting recognition, speech recognition and anomaly detection in network traffic or IDSs (intrusion detection systems).

A common LSTM unit is composed of a cell, an input gate, an output gate and a forget gate. The cell remembers values over arbitrary time intervals and the three gates regulate the flow of information into and out of the cell.

LSTM networks are well-suited to classifying, processing and making predictions based on time series data, since there can be lags of unknown duration between important events in a time series. LSTMs were developed to deal with the vanishing gradient problem that can be encountered when training traditional RNNs. Relative insensitivity to gap length is an advantage of LSTM over RNNs, hidden Markov models and other sequence learning methods in numerous applications

TABLE
1
Application of Machine Learning Algorithms in Crop Recommendation System

Year	Study	Application	Techniques/Algorithms	Performance Results
2015	Kiran Shinde, Jerrin Andrei, Amey Oke [3]	Web Based Recommendation System for Farmers	1. Random Forest Tree 2. Crop Recommendation 3. Crop rotation recommendation 4. Fertilizer Recommendation	The study recommends that Random Forest Tree be used to make recommendations to farmers for crops, crop rotation, and fertilizer selection.
2016	S.Pudumalar, E.Ramanujam, R.Harine Rajashree?, C.Kavya?, T.Kiruthika?, J.Nisha? [5]	Crop Recommendation System for Precision Agriculture	1. Random Forest 2. Chaid 3. K-Nearest Neighbor 4. Naive Bayes	The model has an accuracy of 88% in terms of prediction.
2017	Rohit Kumar Rajak, Ankit Pawar, Mitalee Pendke, Pooja Shinde, Suresh Rathod,AvinashDevare [6]	Crop Recommendation System to Maximize Crop Yield using Machine Learning Technique	1. Support Vector Machine 2. Naive Bayes 3. Random Forest Tree 4. Multi-layer Perceptron (Artificial Neural Network)	The following system helps recommend crops on the basis ofEnsembling Technique which uses base learners such as SVM, Naive Bayes, Random Forest Tree and Multi-layer Perceptron algorithms.

2018	Zeel Doshi, Subhash Nadkarni, Rashi Agrawal, Prof. Neepa Shah [7]	AgroConsultant: Intelligent Crop Recommendation System Using Machine Learning Algorithms	1. Decision Tree 2. K-NN 3. Random Forest 4. Neural Network 1. Rainfall Prediction 2. Crop Recommendation	The system in the following paper provides a model made by the Neural Network which gives the best accuracy of 91% compared to the other algorithms.
2018	Nidhi H Kulkarni, Dr. G N Srinivasan, Dr. B M Sagar, Dr.N K Cauvery [8]	Improving Crop Productivity Through A Crop Recommendation System Using Ensembling Technique	1. Random Forest 2. Linear SVM 3. Naive Bayes	The system in the following paper uses Ensembling Technique to recommend crops to the users, which uses base learners such as Linear SVM, Naive Bayes and Random Forest Tree algorithms.
2018	Rushika Ghadge, Juilee Kulkarni, Pooja More, Sachee Nene, Priya R L [9]	Prediction of Crop Yield using Machine Learning	1. Kohonen's SOM (Self-Organizing Map), 2. BPN (Back-Propagation Neural Networks), 3. API (Application Programming Interface).	Kohonen's Self-Organizing Map and Back-Propagation Neural Networks are compared against each other, the algorithm with the best accuracy is used to recommend crops to increase crop yield.

2020	Annapoorna.S, Apoorva Herle, C M Sushma, Neha.Y.Jain, Mr.VijayKumar.S [11]	CRAPCSS-Crop Recommendation and Pest Control Suggestion System	1. Support Vector Machine 2. Logistic Regression 3. Crop Recommendation 4. Pest Control Suggestion	After performing feature selection based on different attributes, integration of the SVM model takes place. SVM in comparison to Logistic Regression provides a better accuracy of 97%.
2020	Dr.A.K.Mariappan, Ms C. Madhumitha, Ms P. Nishitha and Ms S. Nivedhitha [12]	Crop Recommendation System through Soil Analysis Using Classification in Machine Learning	1. K-Nearest Neighbors 2. Crop Recommendation on the basis of region/location 3. Crop Recommendation based on soil nutrients 4. Soil Recommendation	The accuracy provided by the KNN algorithm is 89% which is better than SVM as it provides an accuracy of 80%.
2020	Pavan Patil, Virendra Panpatil, Prof. Shrikant Kokate [13]	Crop Prediction System using Machine Learning Algorithms	1. K-Nearest Neighbors 2. Decision Tree 3. Rainfall prediction 4. Crop Recommendation	The K- Nearest Neighbor model gives the best accuracy compared to Decision Tree Algorithm is 89.4%
2020	Pradeepa Bandara, Thilini Weerasooriya,	Crop Recommendation	1. Naive Bayes 2. Support Vector	It is clear from the data collected by

	Ruchirawya T.H., W.J.M. Nanayakkara, Dimantha M.A.C and Pabasara M.G.P [14]	System	Machine 3. IoT to collect data	sensors that the suggested system has a high level of accuracy and is suited for both rural and urban locations.
2021	Palaniraj A, Balamurugan A S, Durga Prasad R,Pradeep P [20]	Crop and Fertilizer Recommendation System using Machine Learning	1. Support Vector Machine	The model made using Support Vector Machine gives an accuracy of 90.01%, which helps in predicting the crops based on different N, P, K values, rainfall, temperature and location.

TABLE III

Comparison between advantages and disadvantages of classifiers

Classifiers	Advantages	Disadvantages
Naive Bayes	1. Suitable for huge datasets 2. Fast, simple and easy to handle 3. Can be quickly and easily updated on the go 4. Helps in solving multi-class prediction problems as it's quite useful with them.	1. Naive Bayes assumes that all features are independent or uncorrelated, so it cannot learn the relationship between features. 2. If a categorical variable in the test data set has a category that was not included in the training data set, the model will assign a probability of 0 (zero) and will be unable to generate a prediction. This is commonly referred to as Zero Frequency.
Support Vector	1. Even if enough information is not	1. It doesn't support large datasets. 2. It will underperform if the number of

Machine	provided about the data, it produces good results. Works well with both the structured and unstructured data. 2. More productive in the high dimensional spaces. 3. When there is a visible margin of dissociation between classes, the support vector machine performs admirably.	features for each data point exceeds the number of training data samples. 3. It will underperform when the number of attributes for each data point exceeds the number of training data specimens.
Decision Tree	1. It is easy to comprehend because it follows the identical steps that a human would use while making a decision in the actual world. 2. It can be incredibly beneficial in resolving challenges with decision-making. 3. In comparison to other methods, data cleaning is not required as much.	1. The decision tree is complicated as it contains several tiers. 2. The training period is typically longer for a decision tree. 3. Due to the increased complexity and time required, decision tree training is relatively costly.
K-Nearest Neighbors	1. It is simple to put into action. 2. It can withstand noisy training data. 3. It may be more successful if the training data is vast.	1. It is always a compulsion to identify the value of K, which could be difficult at times. 2. Since the distance between the data points for all of the training samples must be calculated, the calculation cost is considerable.
Random	1. The Random Forest	1. A little change in the data can cause

Forest	algorithm, unlike Decision Tree and other algorithms, is less prone to overfitting. 2. The Random Forest algorithm returns the relative relevance of characteristics, which is quite valuable.	the Random Forest algorithm to change significantly. 2. The computations of the Random Forest algorithm can be significantly more complex than those of other algorithms.
Neural Network	1. Instead of using a database, the input data is saved in its own networks. As a result, data loss has no impact on how it functions. 2. The network can detect the defect and generate the output even if the neuron does not respond or information is lost. 3. Has the ability to tolerate mistakes.	1. Traditional algorithms typically require hundreds, if not millions, of labeled samples, whereas neural networks typically require much more data. 2. In terms of computing, neural networks are also more complicated than traditional algorithms. The neural network's lifespan is uncertain.

Conclusion

The review of research papers on the use of machine learning and deep learning algorithms showed that these techniques can be useful to assist farmers. Crop Recommendation, Crop rotation recommendation, Fertilizer Recommendation, and Rainfall Prediction were the most common systems created using the mentioned algorithms. Study [5] gives the prediction accuracy of 88% for the model. Neural Network provides the best accuracy of 91% compared to the other algorithms in study [7]. Study [11] shows the Support Vector Machine algorithm to be having a better accuracy than Logistic Regression of 97%. The K-Nearest Neighbors algorithm in Study [12] provides an accuracy of 89%, which is better in comparison to the Support Vector Machine algorithm which has an accuracy of 80%. Study [13] after comparison between different algorithms, shows that K-Nearest Neighbors has the best accuracy of 89.4%. This paper mainly reviews the advantages of each classifier and compares their compatibility for a crop recommendation system, from gathering the parameters required for the system to making the model that helps predict the most suitable crops. The inquiry demonstrates the abilities of various computations in predicting a few climate wonders, such as temperature, rainstorms, and

precipitation, and concludes that real systems are capable of doing so. Based on the findings of this work, we believe that more research is needed in the agricultural industry to improve precision. Using group approaches is a good way to ensure that the framework is more precise.

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