DEEP NEURAL NETWORK BASED CROP RECOMMENDATION SYSTEM

Bhavani R[1], Agalya V[2], Kiruthika N[3], Sugapriya C[4]

[1234]*Dept. of Computer Science and Engineering, Government College of Engineering Srirangam,TamilNadu, India*

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Abstract - *Agriculture is a critical sector that significantly relies on accurate and timely decision-making for optimal crop yield and resource utilization. This paper presents a novel approach to crop recommendation by leveraging the power of deep neural networks (DNNs) to analyze soil properties and climatic conditions. The proposed system aims to enhance the efficiency of crop selection, thereby contributing to sustainable and productive farming practices. The system utilizes a comprehensive dataset comprising soil characteristics and environmental characteristics. A deep neural network architecture is designed to process and learn complex relationships within a dataset, enabling the model to capture intricate patterns and dependencies that influence crop suitability.*

Key Words: Deep Neural Network, Crop recommendation System, Machine learning, Deep Learning.

1.INTRODUCTION

Crop recommendation systems are very useful technologies that help farmers choose crops that will maximize yields by providing them with information. To provide tailored suggestions, these systems make use of a multitude of data, such as past crop performance, soil properties, and weather patterns. The suggested technique will help farmers maximize agricultural productivity, reduce nutrient loss in crop fields, and use less fertilizers in crop production by using an artificial neural network to suggest a suitable crop based on various factors like the composition of phosphorus, potassium, and nitrogen in the soil, the pH value of the soil, rainfall, temperature, and humidity. Neural networks are used by Deep Learning to model and resolve complicated issues. An artificial neural network (ANN) having several layers between them is called a deep neural network (DNN). In the past, farmers have made crop selection decisions based on their own experiences, local expertise, and broad recommendations. But now that cutting-edge technologies, especially neural networks, emerged, accurate farming is entering a new phase. As we continue to innovate in agricultural technology, neural network-based crop recommendation systems represent a promising step towards a more resilient and sustainable future in farming.

2. RELATED WORKS

The recommender model is built as a hybrid model using classifier algorithms such as Naive Bayes, J48, and association rules. Based on the appropriate parameters, the system will recommend the crop. The paper aims to create a hybrid model for recommending crops to south Indian states by considering various attributes [1]. A crop recommendation system has been developed that employs machine learning algorithms to recommend the crop that can be harvested in that particular soil. There are several machine learning algorithms available in this system, including KNN, Decision Tree, Random Forest, Naive Bayes, and Gradient Boosting to recommend the crop.[2] Crop recommendation systems can help farmers and agricultural organizations make informed decisions about crop selection and maximize yields and profits. This technology is increasingly important as the world population continues to grow, and agricultural productivity needs to keep up with demand. To recommend the best crop to plant, the SVM algorithm is utilized [3]. The motive of the system is to enhance accuracy, so a hybrid approach using K-nearest neighbor (KNN) and Random Forest (RF) algorithms is employed. It introduces an accessible and user-friendly solution for crop recommendations and yield predictions. Users provide inputs such as temperature, humidity, soil pH, and rainfall [4]. The AI system helps precision agriculture improve overall crop harvest quality and accuracy. This research feature selection, Industry 4.0, proposes one solution, such as a recommendation system, using AI and a family of machine learning algorithms. Crop recommendation for an effective prediction system using machine learning is first to gather and preprocess the data from the relevant research institutions of Bangladesh and then propose an ensemble machine learning approach, called K-nearest Neighbour Random Forest Ridge Regression (KRR), to effectively predict the production of the major crops (three different kinds of rice, potato, and wheat). KRR is designed after investigating five existing traditional machine learning (Support Vector Regression, Naïve Bayes, and Ridge Regression) and ensemble learning (Random Forest and Cat Boost) algorithms.[5]

3. PROPOSED SYSTEM

The overall architecture of the proposed recommendation model is given in figure(1). This proposed approach utilizes classification approach in content based recommendation system.

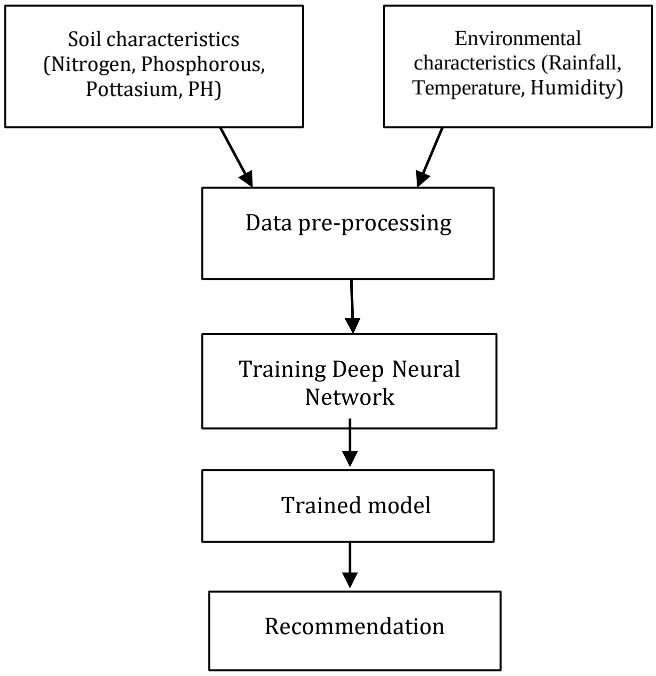

Fig -1: System architecture

The system first collects relevant data, preprocesses it and applies Deep neural network for making recommendations. Each phase is explained in the following sections.

3.1 Data Collection

Data collection is the most common approach for gathering and analyzing information from various sources. The data for this paper was downloaded from [7]. There are 2200 records of data represented with 7 features. Among them four features represent soil characteristics viz, Nitrogen, Phosphorus, Potassium, PH and three features represent environmental; characteristics viz, rainfall, temperature and humidity.

3.2. Data Preprocessing

The next step is pre-processing the data before the model can be trained. In this stage data is normalized using min-max normalization as given in (1).

$$x_{norm} = \frac{x - x_{min}}{x_{max} - x_{min}} \quad (1)$$

where x_{min} is the minimum value of the feature and x_{max} is the maximum value of the feature. Data normalization converts the features to [0,1] scale. Next the normalized data is split into training and testing data in the ratio of 80:20.

4.NEURAL NETWORK MODEL

The neural network architecture used in this paper for experimentation is given in figure (2). Input data is fed into the trained model, and the output layer produces predictions based on the learned parameters and computations performed during forward propagation.

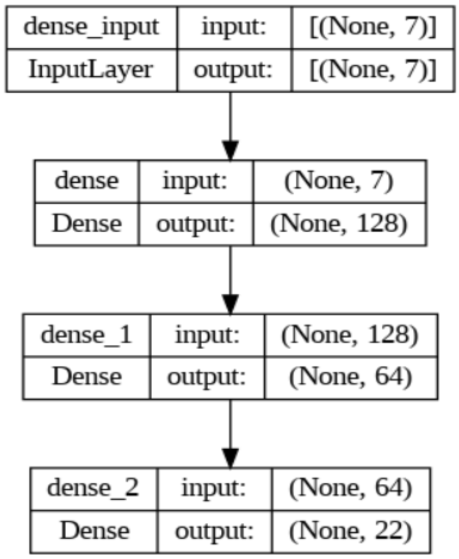

Fig -2: Proposed DNN model

4.1 Input Layer

The input layer is the initial layer where the raw data is fed into the network. It consists of nodes each of which represents a feature of the input data. In this architecture, there are 7 neurons in the input layer representing the seven features in the dataset. The seven features are Nitrogen, Phosphorus, Potassium, Rainfall, Temperature, PH, Humidity.

4.2 Hidden Layer

DNNs consist of one or more hidden layers sandwiched between the input and output layers. Each hidden layer is composed of multiple neurons. Neurons in each hidden layer receive input signals from the previous layer, perform computations, and pass the output to the next layer. there are 2 hidden layers in this architecture with x and y neurons in each layer respectively.

4.3 Activation Function

Activation functions introduce non-linearity into the network, enabling it to learn complex patterns in the data. ReLU is one of the most widely used activation functions in hidden layers due to its simplicity and effectiveness in mitigating the vanishing gradient problem and is given in (2).

$$RELU(X) = \{o \quad if \quad x < 0 \quad x \quad if \quad x \geq 0 \tag{2}$$

4.4 Output Layer

The output layer of the DNN produces the final predictions or outputs. The number of neurons in the output layer depends on the nature of the task. For example, in binary classification, there may be a single neuron with a sigmoid activation function, while in multi-class classification, there may be multiple neurons with softmax activation. Since this paper recommends among the 22 class of crops, it uses 22 neurons in the output layer with softmax activation function as given in (3).

$$s(x_i) = \frac{e^{x_i}}{\sum_{j=1}^{n} \quad e^{x_j}} \tag{3}$$

4.5 Recommendation Phase

The trained neural network provides recommendations to the users for the input features that they specify. The performance of the neural network model was then evaluated using the accuracy measures.

5. PERFORMANCE EVALUATION

The accuracy metric is widely used in evaluating the performance of crop recommendation systems. Accuracy measures the proportion of correctly classified instances out of the total instances evaluated and is given in (4).

$$Accuracy = \frac{TP+TN}{P+N} \tag{4}$$

where TP is the number of true positives, TN is the number of true negatives, P is the number of positive samples and N is the number of negative samples. The accuracy score of various machine learning algorithms and the proposed model is tabulated in Table (1) and graphically represented in Figure (3). From the results it is observed that the proposed deep neural model outperforms all the other machine learning algorithms for crop recommendation.

Table 1. Accuracy of the models

Algorithm used	Accuracy
Logistic regression	85
SVM	87
K-NN	85
Decision tree	80
Random forest	88
Naïve Bayes	75
Deep Neural Network	97

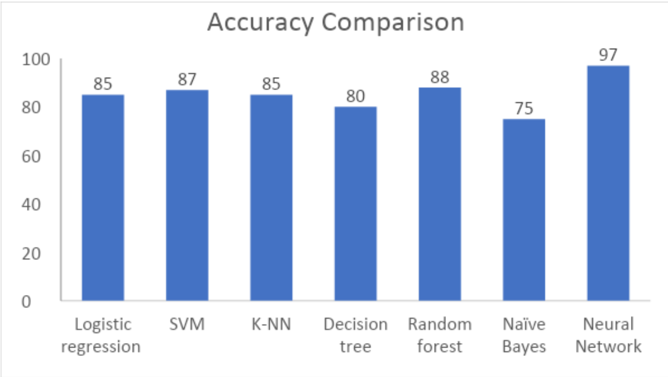

Fig -3: Accuracy Comparison

6. CONCLUSION

This system analyzes the soil characteristics and environmental characteristics to give better recommendations of crops to farmers. The performance of the Deep Neural Networks proposed for crop recommendation outperforms all the other machine learning algorithms. By utilizing DNNs, the system can handle complex patterns and relationships within the data, leading to more accurate predictions and recommendations. Further features related to crop yield prediction could be studied and incorporated to achieve greater impacts in agriculture. Also, user-friendly mobile applications could be designed for easy access of crop recommendations by the farmers. The adaptability of these systems is particularly crucial in agriculture, where environmental conditions can vary widely from season to season. As new data becomes available and conditions change, neural networks can update their algorithms to ensure that recommendations remain accurate and relevant.

7. REFERENCES

1. Tanmay Banavlikar,Aqsa mahir,Mayuresh Budukh,Soham Dhodapkar, “Crop recommendation system using machine learning”, Volume: 05 Issue: 05 | May-2018, Corpus ID: 231784031.

2. Viviliya B, Vaidhehi V, “The Design of Hybrid Crop Recommendation System using Machine Learning Algorithms ”, Volume-9 Issue-2, December 2019 9(2):4305-4311DOI: 10.35940/ijitee.B7219.129219.

3. Pushpa, Shwetha, Ramya, Pooja, “Crop recommendation system using machine learning”, CEI-2022, Volume-10 Issue-11, , DOI : 10.17577/IJERTCONV10IS11044.

4. Prasad Mane, Abhaysingh Rajpurohit, Ankeeta Ahire, "Crop recommendation system using machine learning", Volume 3, Issue 2, March 2023, DOI:10.48175/IJARSCT-8875 .

5. V. Nagesh, M. Moulika, K. Vaishnavi "Crop recommendation System using machine learning.", Volume 11, Issue 12 December 2023, Corpus ID: 268099127.

6. Mahmudul Hasan, Md Abu Marjan , "Crop recommendation for effective prediction system using machine learning" Original Research, 10 August 2023 DOI 10.3389/fpls.2023.1234555.

7. https://www.kaggle.com/code/vijay20213/crop-recommendation-with-99-45-accuracy.