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Artificial Neural Network for Crop Recommendation

Dr. Deepika M P[1] and Greeshma Andrew[2]
[1-2]Cochin University of Science and Technology, Kochi, India
Email: deepikamp@cusat.ac.in, greeshmaandrew@cusat.ac.in

***Abstract*— Technologies are thriving nowadays. We can make use of the technologies in agricultural sectors too. Wrong choice of crop for cultivation will make the farmers life miserable. To get high yield on a crop, we need to take appropriate crop for cultivation that suits particular soil, humidity and PH etc. Failure of farmers to choose appropriate crop will lead them to financial crisis. Sometimes it may end upon suicidal activities. So, a crop recommendation system plays a crucial for the well-being of framers. If a system that suggests the crop based on soil, PH, humidity etc it would be beneficial for farmers. In this paper we are developing a crop recommendation system with the help of Multi Layer Perceptron. The model's performance is validated with the help of a dataset which is publically available and the proposed model is also compared with the traditional Machine Learning (ML) algorithms. Multi Layer Perceptron outraged the performance of other models with the accuracy of 97%.**

***Index Terms*— Agriculture, Crop recommendation.**

I. INTRODUCTION

In India's population one of the major sources of livelihood is agriculture [1]. Decline in agricultural productivity leads to the suicide of farmers [2]. If farmers are not aware of what type of crop has to be cultivated according to the factors temperature, rainfall, PH of the soil, ratio of Nitrogen, Potassium etc in the soil, their productivity will be drained and that may lead them to suicide attempts. If developing a system that recommend which type of crop that gives better yield by consider the above mentioned factors that will help the farmers to increase their yield. In the early days itself one of the several reasons of farmers suicidal is the reduction in yield [4]. If yield decreases their source of income will also fall down. Thus leads to the necessity of a system that predict which crop will be suited for some particular circumstances. To develop a system that predict the right crop, we used Artificial Neural Network (ANN). ANN are computational networks inspired from biological neural networks. It comprises of input, hidden and output layers. It can be referred as feed-forward neural networks as direction of the flow of information is one way. Weights and biases are the parameters learned by the networks during the training process. Multi Layer Perceptron (MLP) is widely used ANN that doesn't require any prior knowledge and hidden layers in MLP help to learn complex relationships in the dataset while training [5].

In our proposed work we are using the dataset which contains ratio of Nitrogen content in soil (N), ratio of Phosphorous content in soil (P), ratio of Potassium content in soil (K), temperature, humidity, ph, and rainfall as factors that affect the suggestion of crops. Deep learning performs better to distinguish crops [3]. The proposed system is implemented using Multi Layer Perceptron (MLP) and it compares with traditional Machine Learning (ML) algorithms, logistic regression, support vector machine, and K-Nearest neighbor. The performance of existing crop recommendation system using neural networks showing less accuracy, cause the necessity of a

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system that shows better performance than the existing ones. Multi Layer Perceptron gives better accuracy of 97% to recommend the crop.

II. Literature Studies

In [6] paper, authors proposed an Majority Voting technique as ensemble learning model with Chi-squared Automatic Interaction Detection (CHAID), Random tree, K-Nearset Neighbor and Naive bayes as base leaners. They were mainly focused on Madurai district and their dataset consists of soil specific attributes which were tested at soil testing lab located in Madurai itself, a district in Tamil Nadu, India. And they also used similar data from online sources. Accuracy of their model to recommend appropriate crop is 88%.
The paper [7] both soil and environmental characteristics are taken into consideration. Their dataset includes the attributes price of crop, yield, soil nutrients and rainfall temperature. They took datasets from Kaggle and government websites. They used Linear regression and Neural Networks for crop recommendation system. Neural Network shows 89.88% accuracy whereas Linear Regression shows accuracy of 88.26%. In terms of accuracy, Neural Networks performed better than Linear regression.
In [8], the authors presented an ensemble technique with the algorithms Random Forest, Naive Bayes and Linear Support Vector Machine(SVM) with the accuracy of 99.91% on the crops Kharif and Rabi only. Based on Majority voting technique, the best accuracy is provided. The dataset they have been used is taken from Government of India's data repository site. The data is a soil related dataset includes physical aspects and chemical properties of soil, it also contains climatic details. They suggests the best crop for cultivation.
In the paper [9] they provided an AgroConsultant system to suggest the best crop based on geographical specifications, soil and environmental factors. Also introduced Rainfall Predictor system which predicts the rainfall for next twelve months. The dataset which they have been used for their work is 'India Agriculture and Climate Dataset' and dataset from www.indiastat.com for their both systems. The algorithms applied Decision Tree, KNN, Random forest and Neural Network for crop recommendation. Neural Network shows highest accuracy of 91\%.

III. Methodology

In this section we discuss about the steps and methods that we followed to propose our work based on multi layer perceptron.

A. Dataset and Preprocessing

The dataset that we have used for the implementation of our work is from kaggle site.This dataset contains the factors that affect the crop prediction as independent variable and the dependent variable contain the name of 22 crops. Such type of a dataset is used for train the model. Before that we have to preprocess the data for better performance. Check for the null values and duplicate rows in the dataset and the dependent variable is encoded into numbers from labels. In the next step the dataset is split into training and testing in the ratio 8:2 and we have done normalizing and scaling with the help of Minmax scaler and Standard scaler.

B. Proposed model

To implement this experiment we choose Google Colaboratory as Integrated Development Environment (IDE) and the programming language was Python 3. The other software used to implement this experiment was Numpy, Pandas, Keras, Tensorflow and Scikit-learn.
Our proposed model is a multilayer perceptron. In the context of deep learning we have to reshape the input values and for model we used 3 dense layers with 64, 32 and, 22 units with activation function relu except for the last layer. Softmax activation function is used for the last layer as this is a multiclassification problem.
And for compile the model the optimizer we have used is 'adam'. Here the dependent variable or target variable is converted to integers as it simplifies the training process and reduces the memory requirements. Hence we used sparse categorical cross-entropy as the loss function.
Fig. 1 shows the architecture of our work.

C. Evaluation metrics

Model's performance is measure using some statistical ground truth values are required. In our work we used the metrics accuracy, precision, recall and F1-score.

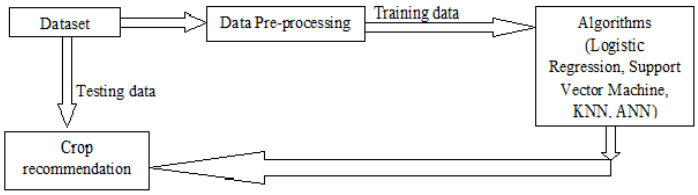

Figure 1. Architecture of the model

IV. Performance Analysis And Discussion

In this section we are going to discuss the results of our proposed multi layer perceptron using the evaluation matrix. The result shows that our model provide better suggestions for the crop cultivation.

To assess the efficiency of the model we used the evaluation metrics such as accuracy, precision, recall and F1-score as this is a classification problem. Accuracy, precision, recall and f1-score is all around 97%. Accuracy is 0.977, precision is 0.976, recall is 0.978 and f1-score is 0.975.

Each time model learns differently due to its stochastic nature.

Fig. 2 and Fig. 3 shows the model is not overfitted.

Fig. 4 and fig. 5 shows the input and predicted output of multi layer perceptron model. From the result it is very evident that our model predicts the right crop based on the attributes N, P, K, temperature, humidity, ph and rainfall.

Performance of the model is compared with traditional machine learning (ML) algorithms logistic regression, support vector machine, and K-Nearest neighbors. The multi layer perceptron gives better result than the traditional machine learning algorithms. Table I shows the comparison between our model and traditional ML algorithms. MLPs are well-suited for capturing non-linear relationships and making accurate crop recommendations based on diverse environmental and soil data. By learning from historical data on crop and environmental conditions, these models can uncover complex patterns and relationships that traditional linear approaches might overlook. MLPs can be beneficial in developing effective crop recommendation systems that take into account the complex interactions between environmental factors and crop suitability.

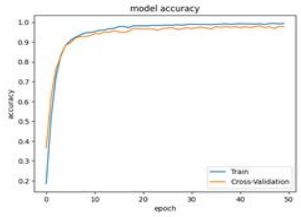

Figure 2. Accuracy of the model

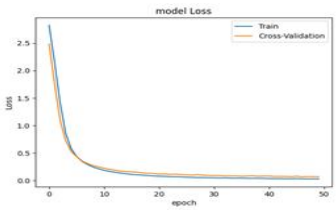

Figure 3. Loss of the model

```
[17]  N = 63
      P = 41
      k = 44
      temperature = 25.29
      humidity = 86.88
      ph = 7.1
      rainfall = 196.62
```

Figure 4. Inputs for the model

```
    print("Suggested crop is {}".format(crop))
else:
    print("No crop is recommended")
```

```
Suggested crop is Jute
```

Figure 5. Output of the model

TABLE I. Accuracy Of Algorithms

Algorithms	Accuracy
Logistic Regression	0.96
Support Vector Machine	0.96
K-Nearest Neighbors	0.95
Our model	0.97

V. CONCLUSION

In this paper we proposed a multi layer perceptron model for suggesting crop based on ratio of Nitrogen content in soil (N), ratio of Phosphorous content in soil (P), ratio of Potassium content in soil (K), temperature, humidity, ph, and rainfall. To evaluate the performance of the proposed model we used the crop recommendation dataset from kaggle. From this experiment we have realized that the proposed model possess high accuracy and it also gives better precison, recall and f1-score. Overall the proposed model performs better for crop recommendation. Our future work intends to develop an application that can implement in real world scenarios including yield prediction based on specific areas.

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