

# An Efficient Crop Identification Using Deep Learning

Agila N, Senthil Kumar P

**Abstract:** In modern era, the deep neural network is the prominent tool in agricultural industry for providing support to farmers in monitoring crop yield based on the weather conditions. In this paper, the recurrent neural network is utilized for detecting the suitable crop for the observed environmental conditions from the field and also provides the suggestions about the desired crop can be grown in that field or not. The environmental parameters such as humidity, temperature, rain and moisture are obtained through the sensors and fed as input to recurrent neural network. Then, the recurrent neural network identifies the suitable crop by classifying the crop based on the climatic conditions. The experiment was conducted by using the Random Forest classifier, Decision Tree classifier, Logistic Regression, Support Vector Machine classifier (SVM), Multilayer Perceptron (MLP) and Recurrent Neural Network (RNN). The result shows that the recurrent neural network outperforms other methodologies.

**Index Terms:** Crop Identification, Decision Tree, Deep Learning, Logistic Regression, Multilayer Perceptron, Random Forest, Recurrent Neural Network, Support Vector Machine

## 1. INTRODUCTION

Now a days many researchers focusing on agricultural research for helping the farmers and improving the crop yield. However, farmer can visually handle the growth monitoring based on his knowledge where the farmers sometimes can face problems such as unknown harvesting time or plant diseases. Hence, a deep learning based system for efficient crop detection is important for providing a complete monitoring, notifying earlier for further control and supporting farmers. It helps us to increase the productivity and we can harvest more than what was planned thereby gaining more profit. Deep learning concepts were utilized for identifying the suitable crop that can be grown for the specific climatic conditions within a short span of time. The recurrent neural network takes the environmental conditions as an input and makes the classification of crops suitable for that climatic conditions easily.

## 2 RELATED WORKS

In recent years, the deep learning concepts was utilized in most of the agricultural research for providing solutions for improving the crop yield estimation, plant disease diagnosis, etc. In this paper, some of the deep learning related research papers was discussed. Dinh Ho Tong Minh et al., [1] presented a paper that describes about the challenge of remote sensing is the mapping vegetation quality coverage during winter season. The objective of this paper is to show how the capabilities of radar Sentinel-1 and deep learning can be used in mapping winter vegetation quality coverage. In this paper, two deep Recurrent Neural Network (RNN) based classifier methods were employed. It is clearly found that the performance of RNNs are much better than the performances of the classical machine learning algorithms such as random forest classifier and support vector machine classifier. Hence it can be proved that, for mapping winter vegetation quality

coverage, the time series sentinel-1 and RNNs can be employed. Dino Ienco et al., [2] proved that, remote sensing data can be suitably dealt with deep learning methods. In this research, the land cover classification was evaluated by using long short term memory. It was done from multi-temporal spacial data which is obtained from satellite images. Experiments were carried on two different datasets considering classification based on both pixel and object. The results show that, Recurrent Neural Networks are competitive when compared to the conventional classifiers, and can perform better than the well-known approaches in presence of lowly represented and highly mixed classes. It also shows that performances of standard classifiers can be improved by using alternative feature representation.

Nataliia Kussul et al., [3] suggested that image processing including remote sensing images can be easily done by using deep learning techniques. In this paper, a multilevel Deep Learning architecture was discussed that has its application in land cover and classification of crop type. For the combined experiment of assessing the crop and test site monitoring, experiments are carried out for crop classification in a varying environment. When compared with the performance of Multilayer perceptron, the architecture's performance with an ensemble of CNNs is much better. It also allows us to distinguish certain summer crop types. Andreas Kamilaris et al., [4] proved that deep learning is one of the recent, modern techniques for processing images and analysis of data with accurate results and great potential. In this study, 40 research efforts' survey which has deep learning techniques which has its application in various agricultural and food production challenges is performed. According to differences in the performance of classification and regression, deep learning techniques are compared with other popular existing techniques. Hence, it is proved that deep learning provides high accuracy and the performance of deep learning is much better when compared to existing commonly used image processing techniques. Kentaro Kuwata et al., [5] presented an estimation of Illinois crop yield by utilized deep learning, machine learning and SVR. From the food security perspective, it is very important that the accuracy must be very high in the estimation of crop yield. The crop model implementation in most of the regions is hard since every country prepare data in homogeneously. From the input data, it is feasible to extract the major features with the help of deep learning. So reduction in dependency of input data can be

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expected. The significance and benefits of deep learning in the agricultural yield is also highlighted in this study. Guillermo L. Grinblat et al., [6] designed a deep Convolutional Neural Network (CNN) for identifying vein patterns of leaves which are affected. Three different legume species classification is considered specifically. The handcrafted feature extractors is avoided after the introduction of a CNN. After increasing the depth of the model, the reported accuracy was reached. The relevant vein patterns were unveiled with a simple visualization technique after analysing the resulting models. SUE HAN LEE ET AL., [7] PRESENTED A PAPER, IN WHICH AN UNSUPERVISED FEATURE REPRESENTATIONS ARE LEARNED BY USING CONVOLUTIONAL NEURAL NETWORKS (CNNs). DECONVOLUTIONAL NETWORKS (DN), A VISUALIZATION TECHNIQUE, IS UTILIZED FOR GETTING IDEA ON THE SELECTED FEATURES FROM THE DEEP CNN MODEL. FOR REPRESENTING EACH OF THE PLANT SPECIES UNIQUELY, VENATIONS OF DIFFERENT ORDER HAVE BEEN CHOSEN. WHEN COMPARED TO THE CONVENTIONAL SOLUTIONS, WHICH DEPEND ON THE FEATURES THAT ARE HAND-CRAFTED, CONSISTENCY AND SUPERIORITY ARE SHOWN IN THE EXPERIMENTAL RESULTS. YU SUN ET AL., [8] DESCRIBED THAT BOTH BOTANICAL TAXONOMY AND COMPUTER VISION, IDENTIFYING PLANT IMAGES HAS BECOME AN INTERDISCIPLINARY FOCUS. THE FIRST DATASET OF PLANT IMAGES WHICH CONSISTS OF 10,000 IMAGES COLLECTED BY MOBILE PHONE IN BEIJING FORESTRY UNIVERSITY CAMPUS IS PRESENTED. TO CLASSIFY PLANTS IN NATURAL ENVIRONMENT, A DEEP LEARNING MODEL WAS CONSTRUCTED. A HIGHER RECOGNITION RATE ON THE BJFU100 DATASET WAS ACHIEVED IN THE PROPOSED MODEL SHOWS THAT THE DEEP NEURAL NETWORK IS AN EFFICIENT TOOL FOR SMART FORESTRY. ANGIE K. REYES ET AL., [9] OF THE ECOUAN TEAM PARTICIPATED IN THE LIFE CLEF 2015 CHALLENGE AND UTILIZED A DEEP LEARNING APPROACH IN WHICH THE COMPLETE SYSTEM WAS LEARNED WITHOUT HAND-ENGINEERED COMPONENTS. A DATASET WITH 1.8 MILLION IMAGES ARE TRAINED BY USING CONVOLUTION NEURAL NETWORK. THE MODEL IS ALSO FINE TUNED BY UTILIZING THE TRANSFER LEARNING CONCEPTS FOR BETTER RECOGNITION. THE CLASSIFICATION ACCURACY WAS MORE THAN THE BEST RESULT OBTAINED IN 2014. Sue Han Lee et al. [10] proved that with the help of systems that identify plants recognition and identification of unknown plant species can be done more rapidly by botanists. In this paper, from the input data's raw representations, useful leaf features can be learned from Convolutional Neural Network (CNN) and based on Deconvolutional Neural Network (DN) approach, intuitions of the chosen features can be gained. Leaf characters' hierarchical botanical definitions fit these findings. From the new hybrid feature extraction models' design, plant classification systems' discriminative power can be improved. Chhaya Zala et al., [11] proposed deep learning model for processing big dataset in agricultural application. Data generated in agriculture is available in huge size nowadays. Deep learning models are useful to process a huge size of data because of their high efficiency and accuracy. In deep learning, huge sized and unstructured data can be effectively handled by more number of hidden layers. For many researchers, agricultural domain is the field of interest. In this paper, some recent works that has been carried out in the agricultural domain is summarized. Konstantinos P. Ferentinos [12] presented a paper, to detect plant diseases and to diagnose by using simple leaves images, convolutional neural network models were developed through deep learning methodologies. Many architectures are trained to identify the corresponding combination of the plant and the disease. The

model is made a very supportive tool with the significantly high success rate. For supporting a system that identify plant diseases in natural environment, the approach could be further expanded. Srdjan Sladojevic et al., [13] proved that for classifying images, convolutional neural networks (CNNs) has achieved promising results. In this paper, a latest approach for developing plant disease recognition model using leaf images, is proposed. Beginning from image gathering for creating a database, all steps needed for disease recognition model implementation are explained in the paper, examined by experts of agriculture. A deep learning framework called caffe, was used to train CNN. The precision achieved were better in the experimental results. Jihen Amara et al., [14] developed a deep-learning based approach that automates classifying process of diseases in banana leaves. Specifically, to classify image data sets, the LeNet architecture is used as the convolutional neural network. The proposed approach's effectiveness is demonstrated by preliminary results under certain conditions like illumination, real scene images' orientation, complex background, size, pose and different resolution. Nuttakarn Kitpo et al., [15] presented a system with IoT for smart farming and a bot notification on growing stages of tomato for providing solutions related to smart farming. The deep learning based concept was utilized for finding the region of fruit proposal. After that, the regions found were classified into fruit growth stages using the wavelength that is visible, as a SVM classification's feature.

### 3 METHODOLOGY

#### 3.1 Logistic Regression

Logistic regression is one of the statistical models in which a logistic function is used by its base form for modelling a variable that is binary dependent. In analysis of regression, the logistic model's parameters are estimated by the logistic regression. The extension of binary logistic regression model may have more than two levels of dependent variable. The multinomial logistic regression models categorical outputs with more than two values. Here the different categories of outputs are the five types of crops namely, rice, wheat, barley, tomato and chile that are obtained based on the input values got from sensors such as temperature sensor, humidity sensor, rainfall sensor and moisture sensors.

#### 3.2 Random Forest Classifier

Random forests are a learning method for classification that functions by building multiple trees of decision during time of training and gives output as the classes' mode or individual trees' mean prediction. Random forests alter the habit of decision trees overfitting to their set of training. Decision tree is a famous classification methodology utilized in many machine learning tasks. The highly irregular patterns are learned efficiently by the fast growing trees with much deeper. The trees may get overfitted during training and have less bias and more variance. Random forests method averages more than one decision tree which is trained on multiple parts of the same set of training with an intention of obtaining reduction of the variance. Using random forest classifier the suitable crop can be grown in the region can be classified based on the values such as temperature sensor values, humidity sensor values, rainfall sensor values and moisture sensor values.

#### 3.3 Support Vector Machine

Support-vector machine is one of the powerful supervised learning method for analyzing data and to perform classification & regression task. From the training examples set, each and every sample is selected as belonging to any group, the SVM training algorithm develops a model which allocates new examples to a group or the other. Similarly, based on the trained values of temperature sensor, humidity sensor, rainfall sensor and moisture sensor, SVM can classify the crop and fine the suitable crop for the present weather conditions.

### 3.4 Decision Tree Classifier

Decision tree classifier constructs the tree from the data provided and classifies the data effectively in the field of computer science. It transforms the observations about an object to conclusions about the target value of the object. It is one of the statistics modelling approaches, machine learning and data mining for classification. The decision tree can construct the model in the form of tree where the target value takes the place of leaf node. The target value is the discrete set of value. While the target variable has the nominal values. Then, the classification can be done easily by constructing the decision tree. Whereas, for the continuous target values the regression trees are constructed. Using those values obtained from temperature sensor, humidity sensor, rainfall sensor and moisture sensor, we classify the suitable type of crop to be grown in that region.

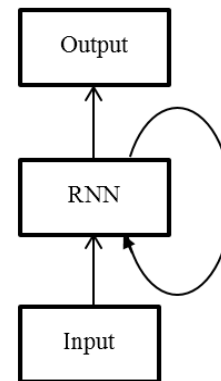
### 3.5 Multilayer Perceptron

A multilayer perceptron belongs to artificial neural network's feed forward class. A multilayer perceptron has minimum three layers of nodes: a layer of inputs, one or more hidden layer and a layer of outputs. Except input nodes, each and every node in the network is a neuron that is activated by the non-linear activation function. Multilayer perceptron can be differentiated from linear perceptron by its multiple layers along with non-linear activation. It also differentiate data that is linearly not separable. Giving the sensor values obtained from temperature sensor, humidity sensor, rainfall sensor and moisture sensor as the input values, we classify the type of crop that can be grown as the output using this technique.

### 3.6 Recurrent Neural Network

Recurrent neural network is type of artificial neural network that deals with sequence dependence among the data. It allows to express temporal dynamic behavior and utilized in various applications like text mining sentiment analysis and opinion mining [16]. The input at the input node is given as vector of the sequence to input layer, one vector at a time. The RNN is a neural network that organizes the neurons in a layer. The connections between the nodes of each adjacent layer form a directed graph. Each neuron is activated by using the activation function. Each connection has a weight which is passed to the next successive layer along with the input. For each timestep the neurons in the layer other than input layer calculates its present activation as nonlinear function that connect to it. Target activations given by supervisors could be supplied for units of outputs at particular time steps. Using values obtained from the sensors such as temperature sensor, humidity sensor, rainfall sensor and moisture sensor, The most suitable crop can be grown in the region for the present and future climatic conditions are classified. Deeper Recurrent Neural Networks provided exceptional results in a variety of

problems related to image classification. By adding more layers to the node, the features captured by the network could be improved. The structure of recurrent neural network is shown in figure 1.



**Fig. 1. Structure of Recurrent Neural Network**

In recurrent neural network the hidden state is updated by using the following recurrence relation

$$h_t = f_w(x_t, h_{t-1}) \quad (1)$$

Where  $h_t$  represents the new hidden state,  $h_{t-1}$  represents the old hidden state,  $x_t$  represents the current input, and the  $f_w$  represents the fixed function with the trainable weight. Let the weight at recurrence neuron is 'whh' and the weight at input neuron is 'wxh'. The recurrence relation by applying the activation function is as follows

$$h_t = \tanh(W_{hh}h_{t-1} + W_{xh}x_t) \quad (2)$$

The output is calculated by using the following formula

$$y_t = W_{hy}h_t \quad (3)$$

Where  $y_t$  represents the output and the  $W_{hy}$  represents the weight at output layer. Inputs are the data obtained from the sensors such as temperature sensor, humidity sensor and moisture sensor. The number of hidden layers present is directly proportional to level of accuracy. Output will be the decision of the choice of crops which is suitable to be grown in that area for the present and future climatic conditions

## 4 RESULT ANALYSIS

The dataset consists of 10000 records that are partitioned into training and testing data. Among 10000 records, 67% of records are utilized as training data and the remaining 33% of records are utilized as testing data. The experiment was conducted by giving the present weather conditions as the input values such as temperature sensor values, humidity sensor values, rain sensor values and moisture sensor values as input to the machine learning algorithms such as random forest, decision tree, logistic regression, support vector machine, multilayer perceptron and RNN. Then, suitable crop is identified by using above mentioned algorithms. Thus, the farmer wants to grow some other crop, the system will be able to suggest that the desired crop by the farmer can be grown or not. Since machine learning algorithms have less accuracy when compared to deep learning, we apply Recurrent Neural Network Algorithm to improve our accuracy and to classify the most suitable crop for the present and future climatic conditions. Deeper Recurrent Neural Networks provided



exceptional results in a variety of problems related to image classification. By adding more layers to the node, the features captured by the network could be improved. Even though, in practice it has been recorded that it is very difficult to train models that are deeper due to challenges like gradients that vanish and explode. It has also been found that by adding more layers, models' accuracy starts saturating after a certain point and then begins degrading. Using RNN, we can also classify the duration till which the desired crop can be grown by the farmer. Table 1 represents the accuracy of crop prediction.

**TABLE 1: ACCURACY OF CROP PREDICTION**

S.No	Algorithm	Predicted crop	Accuracy
1.	Logistic Regression	Wheat	95.5%
2.	Random Forest Classifier	Wheat	96.7%
3.	Support Vector Machine Classifier	Wheat	97.8%
4.	Decision Tree Classifier	Wheat	94.7%
5.	Multilayer Perceptron	Wheat	93.6%
6.	Recurrent Neural Network	Wheat	98.3%

## 5 CONCLUSION

The suitable crop can be grown based on the present weather conditions were detected accurately by using recurrent neural network. When the crop is planned to grown by the former, the probability of that desired crop was validated. Then it suggests that the desired crop can be grown or not in the based on the climatic conditions. The model also suggests that which crop can be grown in that field. Thus, the recurrent neural network model provides high accuracy in detecting the suitable crop identification compared to other methodologies.

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