Plant Disease Identification by Using Deep Learning Models

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ABSTRACT

Normally agriculture is considered as one of the primary sources of income for the farmers and Indian economy greatly depends on agriculture growth and development for better production. As we all know that farmers have been facing with some continuous challenges for centuries, such as different plant diseases during their cultivation. If the disease is predicted in the early stage, it will be very helpful for the end users to save their plants and take necessary precautions to stop its further spread. This is very difficult for one to identify the disease in the early stage and take necessary steps on that plant or crop. In some cases we can able to identify the disease directly by observing the physical changes occurred on external portion of the plants and in some cases we cannot able to diagnose what exactly it is suffering with. Hence this motivated me to develop this current application by using deep learning concept and then try to figure out the disease which is present on those plants. Nevertheless, manual detection of disease costs a large amount of time and labor, so it is inevitably prudent to have an automated system to detect disease. To solve the above problem, we are developing a model by taking VGGNet on ImageNet and Inception module are selected in our approach. Instead of starting the training from scratch by randomly initializing the weights, we initialize the weights using the pre-trained networks on the large labeled dataset, ImageNet. The proposed approach presents a substantial performance improvement with respect to other state-of-the-art methods; it achieves a validation accuracy of no less than 91.83% on the public dataset. Even under complex background conditions, the average accuracy of the proposed approach reaches 92.00% for the class prediction of rice plant images. By conducting various experiments on our proposed model, we achieved a best accurate classification of plant diseases.

Key Words:

Deep Learning, ImageNet, Validation Accuracy, Vggnet, Inception Model, Plant Diseases.

1. INTRODUCTION

Normally there are several types of plant diseases in the real world environment and each and every disease is having some similar and some dis-similar qualities behind the classification. For some type of diseases we can detect the disease directly by observing the physical characteristics present on that infected plant images. For some diseases we cannot able to identify the problem immediately because some diseases are very minute and only predicted under microscopic observation. Hence for finding the problem we need to take the image of affected plant and then try to figure out the inner problem which is present on that plant

thoroughly to classify the disease type. In general we can see 7 common diseases which are found in plant based on their physical parameters such as :

1) Leaf Blast(LB)
2) Brown Spot(BS)
3) Sheath Blight(SB)
4) Leaf Scald(LS)
5) Bacterial Leaf Blight(BLB)
6) Rice Blast (RB)
7) Sheath Rot (SR)

Figure 1.Represents the Several Plant Diseases

From the above figure 1, we can figure out some set of diseases which are very common in most of the plants and some are easily identified and treated very easily. But some are very difficult to detect the problem due to its microscopic problem which is present inside the plant. Hence this motivated me to design the current application using deep learning models to detect the plant disease and its corresponding solution such as prevention and cure for that appropriate disease.

2. LITERATURE SURVEY

Literature survey is that the most vital step in the software development process. Before developing the new application or model, it's necessary to work out the time factor, economy,and company strength. Once all these factors are confirmed and got approval then we can start building the application. The literature survey is one that mainly deals with all the previous workwhich is done by several users and what are the advantages and limitations of those previous models. This literature survey is mainly used for identifying the list of resources to construct this proposed application.

MOTIVATION

1) Prediction of plant Diseases Using Convolutional Neural Network, Published In International Journal of Innovative Science and Research Technology at Volume 4, Issue 12, December – 2019.

AUTHORS: A. Sony

In this current work, the authors described the concept of diagnosis of plant diseases and its remedies. In general detection of any plant disease plays a prominent role for the control of infected plant and improves in growth. The authors also discussed that using the modern technologies like smart phones, farmers can able to detect and identify the pest present in the rice crop. For improving the accuracy in predicting the plant diseases, the author try to use CNN model using R Language to predict the diseases which are present in

rice plant by gathering images of disease leaves. In order to develop the model and train the model with more accurate results we try to collect the data from UCI Machine Learning Repository which contains only three 3 types of plant diseases like Bacterial Leaf Blight, Brown Spot, Leaf Smut.These authors are able to do detection on only three types of plant diseases rather than on all diseases.

2) Disease Detection Using Deep Learning, published in International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-5S3, February 2019

AUTHORS: V.Vanitha

In this paper, the authors mainly discussed the most prominent disease which is one kind of bacterial infection on most of the plants such as paddy, rice, corn and other plants. In this work the authors explained about the importance of early detection of such diseases can able to limit the spread of disease and we can ensure the plant quality. In this current work, the authors mainly described that if the automatic detection of plant diseases are introduced we can able to save a lot of work effort and can increase the ability of farming.Here the authors try to collect more than one thousand images of both healthy and infected paddy and other crops and they trained the model with all these images. Once the model is trained accurately now they try to verify the disease on test images which are collected from various resources. The experimental results clearly state that author's can able to detect and recognize 3 diseases accurately rather than all types of diseases with an accuracy of 99.6 % accuracy.

3) R. Bunescus and J. Platt, "Subsequence symptoms and causes for Several Plant Diseases," Advances in Neural Information Processing Systems, vol. 18, pp. 171-178, 2012.

AUTHORS: J. Platt

In this article the authors described about the paper having a detailed description on definition of disease, types of diseases, symptoms and causes of most commonly observed plant diseases. In general a research article was released by Michigan University[4] regarding the threats caused due to diseases. In this article several factors for disease development had been discussed and the authors discussed an overview of major disease-causing organisms great causes and effects for getting those diseases and what are the remedies and precautions to be taken is discussed clearly.

3. WORKING OF DEEP LEARNING MODEL

In this section, we mainly discuss about the importance of deep learning models and its working functionality for problem finding.

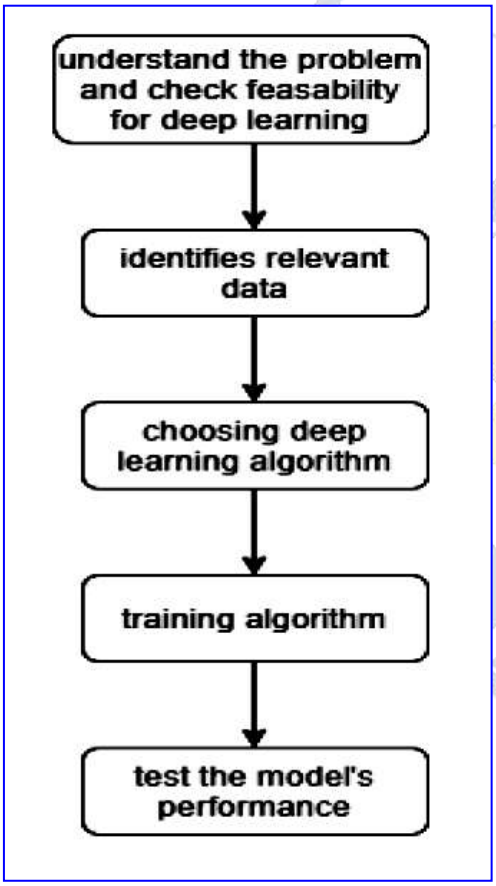
MAIN MOTIVATION

In deep learning, the convolutional neural network uses a complex architecture composed of stacked layers in which is

particularly well-adapted to classify the images. For multi-class classification, this architecture robust and sensitive to each feature present in the images.Common layers deployed in making Convolutional Neural Network architecture(CNN) are

Figure 2.Represents the CNN FLOW

1) CONVOLUTIONAL LAYER
2) POOLING LAYER



3) ReLU LAYER
4) DROPOUT LAYER
5) FULLY CONNEECTED LAYER
6) CLASSIFICATION LAYER

Now let us discuss about the stepwise procedure of deep learning models in several real world applications.

STEP1:

In the first step, we need to identify the exact problem what we are going to work and how to get solution for that problem. For this we need to have clear understanding about the problem and then we need to check how feasible to apply Deep learning model for this current problem.

STEP2:

In this step, we need to gather the relevant data from several sources and then try to mix all the corresponding data in order to get the actual solution for the current problem. In this stage we need to check the data correctly and then classify the relevant and un-relevant data separately.

STEP3:

Try to choose the best algorithm or deep learning model to solve the current problem. Here the algorithm selection plays a vital role to get accurate result in very efficient manner.

STEP4:

Here we need to train the algorithm with lot of training data and we need to check which data should be trained to get exact solution. In this step we can take small to large data depends on the appropriate task what we choose?

STEP5:

At this stage we try to apply the model and test some sample input. Once the sample data is given as input the current

model should check the input and tell what may the exact outcome for that test data.

4. PROPOSED PRE-TRAINED CNN MODELS

We used ResNet50, VGG19, Inception V3, Inception ResNet V2 models. Our approach resulted in F1 score, precision and recalls that were picked as the validation set.By using several types of CNN models,we are going to identify the plant diseases and classify one with other while predicting the plant disease.

1) VGG-19 MODEL

The ImageNet Large Scale Visual Recognition Challenge is an annual computer vision competition. Each year, teams compete on two tasks. The first is to detect objects within an image coming from *200* classes, which is called object localization. The second is to classify images, each labeled with one of *1000* categories, which is called image classification.

VGG 16 was proposed by Karen Simonyan and Andrew Zisserman of the Visual Geometry Group Lab of Oxford University in 2014 in the paper "VERY DEEP CONVOLUTIONAL NETWORKS FOR LARGE-SCALE IMAGE RECOGNITION". This model won the 1st and 2nd place on the above categories in 2014 ILSVRC challenge. This model achieves *92.7% top-5* test accuracy on ImageNet dataset which contains *14* million images belonging to 1000 classes. Both VGG 16 AND VGG 19 are same except only the difference in representation of layers count.

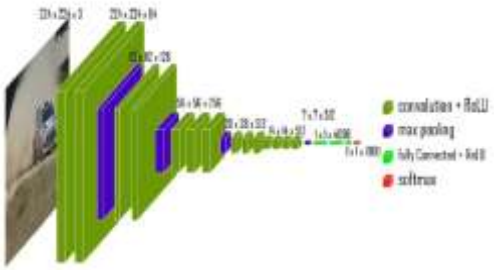


Figure 3.Represents the VGG-19 Model

2) INCEPTION-V3 MODEL

We deployed an Inception-v3 model using a SnapLogic Ultra Pipeline, a powerful, low-latency data pipeline. (More on how we built this demo.) The model was trained on an ImageNet dataset containing 1,000 types of objects. SnapLogic provides both horizontal and vertical scale to deep learning models and supports GPU acceleration.

type	patch size/stride or remarks	input size
conv	3×3/2	299×299×3
conv	3×3/1	149×149×32
conv padded	3×3/1	147×147×32
pool	3×3/2	147×147×64
conv	3×3/1	73×73×64
conv	3×3/2	71×71×80
conv	3×3/1	35×35×192
3×Inception	As in figure 5	35×35×288
5×Inception	As in figure 6	17×17×768
2×Inception	As in figure 7	8×8×1280
pool	8 × 8	8 × 8 × 2048
linear	logits	1 × 1 × 2048
softmax	classifier	1 × 1 × 1000

Figure 4.Represents the Path Size

3) INCEPTION RESNET V2

Inception V2 was introduced in combination with Inception-ResNet by thee researchers a Google in 2016. The main aim of the paper was to reduce the complexity of Inception V3 model which give the state-of-the-art accuracy on ILSVRC 2015 challenge. This paper also explores the

possibility of using residual networks on Inception model.

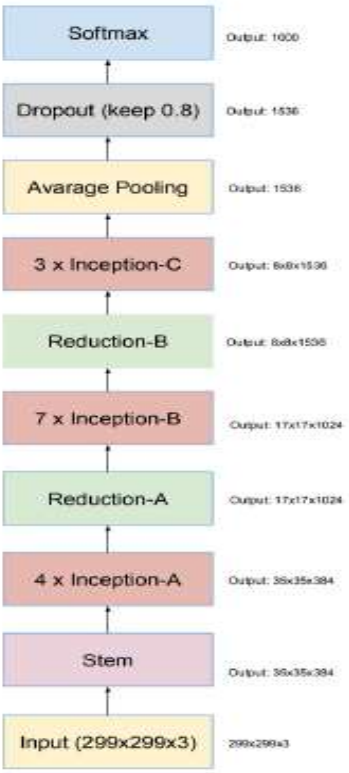


Figure 5. Represents the RESNET V2 Model

5. EXPERIMENTAL RESULTS

Accuracy of the constructed classifier model can be calculation using the following equation.

TP+TN

$$\text{Accuracy} = \frac{(TP+TN)}{(TP+FP+FN+TN)}$$

Where,

TP = Observation is positive an predicted is also positive

TN=Observation is negative and predicted is also negative

FP = Observation is negative but predicted is positive

FN = Observation is positive but predicted is negative.

PERFORMANCE METRICS

Network	Crops	Top-1 Error	Top-5 Error
ResNet-151 [5]	dense	19.4%	4.5%
Inception-v3 [15]	144	18.9%	4.3%
Inception-ResNet-v1	144	18.8%	4.3%
Inception-v4	144	17.7%	3.8%
Inception-ResNet-v2	144	17.8%	3.7%

From the above table we can see several models and its corresponding error rate on several crop datasets.

GRAPH FOR VGG19 LOSS

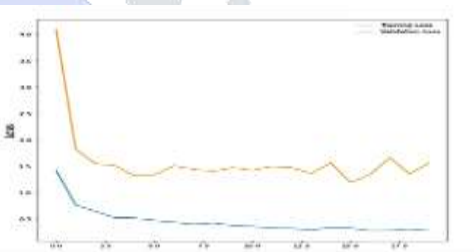


Figure 6. Represents the VGG19 Loss

Figure 7. Represents the VGG19 Accuracy

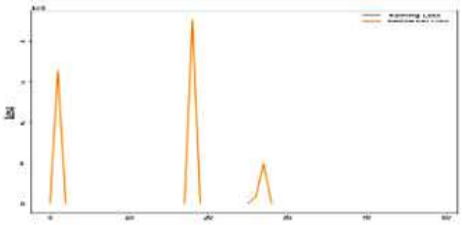


Figure 8. Represents the Inception V3 Loss

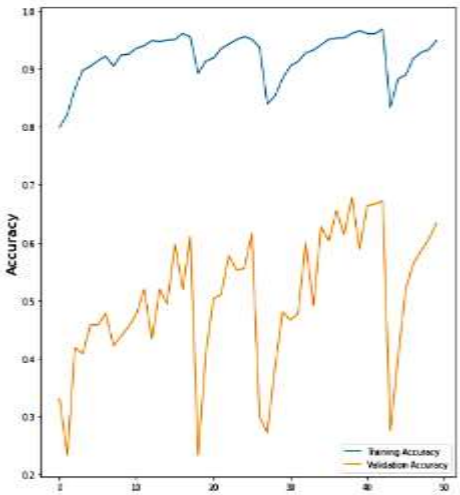


Figure 9. Represents the Inception V3 Accuracy

6. CONCLUSION

In this current work we for the first time designed and implemented an application using PRE-TRAINED DEEP LEARNING (CNN) models in the agriculture field for plant disease prediction and to guide the farmers or agriculture experts about the plant disease. We try to design an application which can able to identify the plant disease from the affected part of crop image and then find out remedies for that disease. At present, it is very interesting to design the deep intricate neural network (CNN) is the latest image recognition solution. Here we try to gather several infected plant images and apply CNN models to identify the disease name and also find out the necessary preventive measures for that plant. To solve the above problem, we used ResNet50, VGG19, Inception V3, Inception ResNet V2 models. Our approach resulted in F1 score, precision and recalls that were picked as the validation set.By using several types of CNN models, we are going to identify the plant diseases and classify one with other while predicting the plant disease.

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