Corn Leaf Disease Classification using CNN Project Report

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Abstract: The corn is a major food crops in many countries along with rice and wheat. It is one that is produced easily and used to feed millions of people. The production of corn is always affected by various diseases that might have different treatments. So incorrect classification of diseases may lead to incorrect remedial measures and reduced production efficiency also. The proposed model is formed with various convolutional layers and fully connected layers and predicts corn leaf disease correctly. The goal of this paper is to create a Disease Recognition Model that is supported by leaf image classification. To detect plant diseases, we are utilizing image processing with a Convolution neural network (CNN). A convolutional neural network (CNN) is a form of artificial neural network that is specifically intended to process pixel input and is used in image recognition.

Keywords Corn leaf disease, deep learning, convolution layers

INTRODUCTION

Agricultural production is a very old means of obtaining food. It is a vital source of income for people all around the world. No one can exist in our world without food. Plants are crucial not only for humans, but also for animals who rely on them for food, oxygen, and other necessities. The government and experts are taking significant initiatives to enhance food production, and they are working successfully in the real world. When a plant becomes afflicted with a disease, all living organisms in the environment are affected in some way. This plant disease can affect anywhere on the plant, including the stem, leaf, and branch. Even the types of illnesses that impact plants, such as bacterial and fungal diseases. etc. can differ. The illness that impacts the crops will be determined by factors such as climate. There are a large number of people that are food insecure. This occurs as a result of insufficient food crop output. Even significant climate changes will have an impact on plant development. This type of natural tragedy is unavoidable. Early detection of plant disease aids in the prevention of large-scale crop losses. Farmers must apply the appropriate insecticides for their crops. Too many pesticides are harmful to crops and farmland. Getting expert advice will help you avoid misusing chemicals on plants. Plants have been the focus of many researchers to aid farmers and others involved in agriculture. When a disease is visible to the naked eye, it is straightforward to detect. The illness may be discovered and treated early if the farmer has sufficient information and monitors the crops on a regular basis. However, this phase only exists when the disease is extreme or crop output is low. Then there are the different innovations. Farmers will benefit from the introduction of automated disease detection tools. This approach yields outcomes that are suitable for both little and large-scale agricultural cultivation. Importantly, the results are precise, and the disorders are detected in a very short amount of time. These technologies rely heavily on deep learning and neural networks to function. Deep Convolutional Neural Network is utilized in this study to identify infected and healthy leaves, as well as to detect illness in afflicted plants. The CNN model is designed to suit both healthy and sick leaves; photos are used to train the model, and the output is determined by the input leaf

Problem Statement

"Developing an accurate supervised learning classification model using Convolutional Neural Networks (CNN) for detecting and classifying corn leaf diseases based on leaf images." The objective of this project is to design and train a robust supervised learning classification model using CNN for accurately detecting and classifying different types of corn leaf diseases based on images of corn leaves. The model will be trained on a dataset consisting of labeled images of healthy corn leaves and various types of leaf diseases such as common rust, gray leaf spot, northern leaf blight, and others. The primary goal is to develop a model that can effectively learn the visual patterns and features associated with different corn leaf diseases, enabling it to classify new leaf images into appropriate disease categories. This model can assist farmers and agricultural experts in early detection and timely intervention to mitigate the impact of diseases on corn crops, thereby improving crop yield and reducing economic losses. The success of this project will be measured based on the model's accuracy, precision, recall, and F1-score in classifying the corn leaf diseases. The model's performance will be evaluated using appropriate evaluation metrics and compared against existing methods or baseline models to assess its effectiveness. By accurately classifying corn leaf diseases, this project aims to contribute to the field of precision agriculture, enabling farmers to make informed decisions about disease management strategies, optimize resource allocation, and improve overall crop health. Plant diseases pose a severe threat to global food security. Timely identification and treatment can significantly reduce these threats. Your challenge is to develop a model capable of identifying specific diseases affecting plant leaves. Your model should be able to analyze images of leaves and accurately classify the disease present (if any).

Image recognition technology based on deep learning

Compared with other image recognition methods, the image recognition technology based on deep learning does not need to extract specific features, and only through iterative learning can find appropriate features, which can acquire global and contextual features of images, and has strong robustness and higher recognition accuracy.

Deep learning theory

The basic idea of deep learning is using neural network for data analysis and feature learning, data features are extracted by multiple hidden layers, each hidden layer can be regarded as a perceptron, the perceptron is used to extract low-level features, and then combine low-level features to obtain abstract high-level features, which can significantly alleviate the problem of local minimum. Deep learning overcomes the disadvantage that traditional algorithms rely on artificially designed features and has attracted more and more researchers' attention. It has now been successfully applied in computer vision, pattern recognition, speech recognition, natural language processing and recommendation systems. Traditional image classification and recognition methods of manual design features can only extract the underlying features, and it is difficult to extract the deep and complex image feature information [18]. And deep learning method can solve this bottleneck. It can directly conduct unsupervised learning from the original image to obtain multi-level image feature information such as low-level features, intermediate features and high-level semantic features. Traditional plant diseases and pests' detection algorithms mainly adopt the image recognition method of manual designed features, which is difficult and depends on experience and luck, and cannot automatically learn and extract features from the original image. On the contrary, deep learning can automatically learn features from large data without manual manipulation. The model is composed of multiple layers, which has good autonomous learning ability and feature expression ability, and can automatically extract image features for image classification and recognition. Therefore, deep learning can play a great role in the field of plant diseases and pests image recognition

Convolutional neural network

Convolutional Neural Networks, abbreviated as CNN, has a complex network structure and can perform con volution operations. As shown in Fig. 2, the convolutional neural network model is composed of input layer, convolution layer, pooling layer, full connection layer and output layer. In one model, the convolution layer and the pooling layer alternate several times, and when the neurons of the convolution layer are connected to the neurons of the pooling layer, no full connection is required. CNN is a popular model in the field of deep learning. The reason lies in the huge model capacity and complex information brought about by the basic structural characteristics of CNN, which enables CNN to play an advantage in image recognition. At the same time, the successes of CNN in computer vision tasks have boosted the growing popularity of deep learning.

In the convolution layer, a convolution core is defined first. The convolution core can be considered as a local receptive field, and the local receptive field is the greatest advantage of the convolution neural network. When processing data information, the convolution core slides on the feature map to extract part of the feature information. After the feature extraction of the convolution layer, the neurons are input into the pooling layer to extract the feature again. At present, the commonly used methods of pooling include calculating the mean, maximum and random values of all values in the local receptive field [20, 21]. After the data entering several convolution layers and pooling layers, they enter the full-connection layer, and the neurons in the full-connection layer are fully connected with the neurons in the upper layer. Finally, the data in the full-connection layer can be classified by the softmax method, and then the values are transmitted to the output layer for output results.

Image Preprocessing:

The dataset is divided into 80% for training and 10% for Validation and 10% for testing. First, augmentation settings are applied to the training data. These are generated 'on the fly', with each operation carrying a weighted probability of appearing in each epoch. 12712 images belonging to 10 classes are there in the dataset, 10 classes of diseases are labelled from 0 to 9 according to their diseases in a separate csv file. The code uses imagedatagenerator to augment the images so that the model is trained best and also reduces overfitting.

A Convolutional Neural Network has three layers: a convolutional layer, a pooling layer, and a fully connected layer. Fig 2 shows all layers together

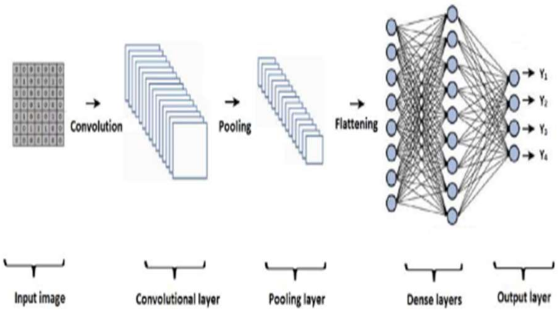


Fig. 2. CNN Architecture

Convolutional layer: produces an activation map by scanning the pictures several pixels at a time using a filter.
Fig 3 shows the internal working of the convolution layer.

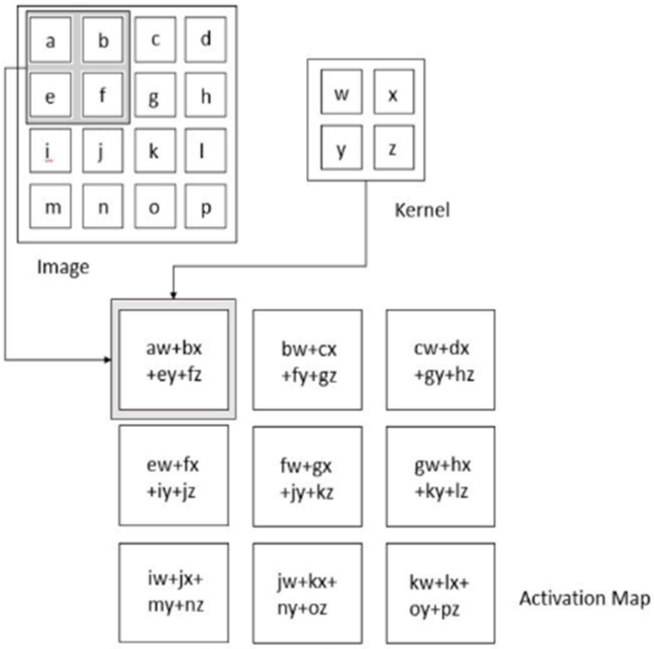


Fig. 3. Convolution Layer

Pooling Layer
Pooling layer: reduces the amount of data created by the convolutional layer so that it is stored more efficiently.
Fig 4 shows the internal working of the pooling layer

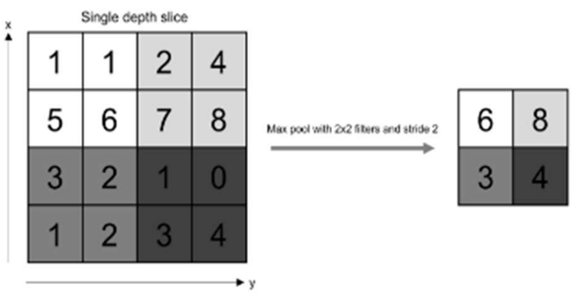


Fig. 4. Pooling Layer

Fully Connected Layer
Fully connected input layer – The preceding layers' output is "flattened" and turned into a single vector which is used as an input for the next stage. The first fully connected layer – adds weights to the inputs from the feature analysis to anticipate the proper label. Fully connected output layer – offers the probability for each label in the end.
Fig 5 shows the internal working of fully connected layer

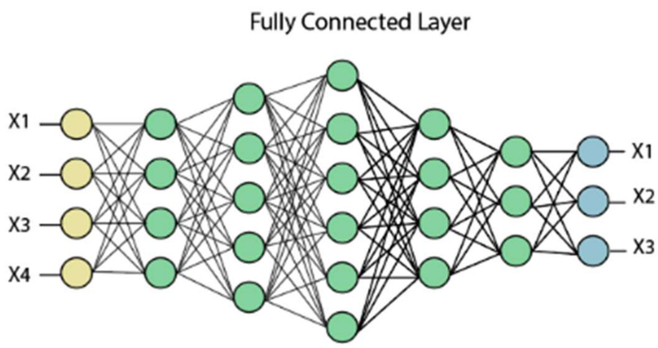
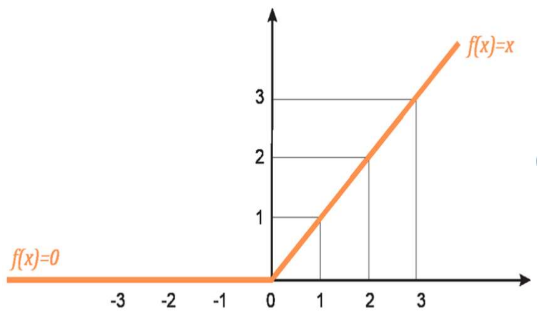


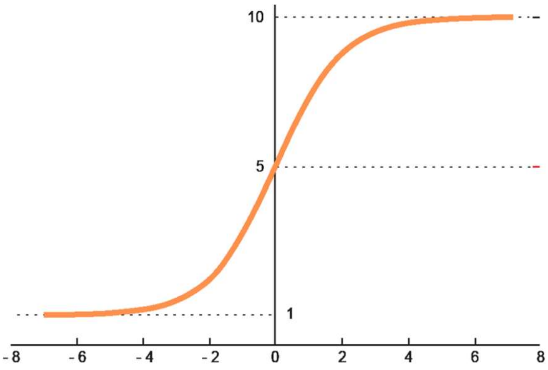
Fig. 5. Fully Connected Layer

A activation function that introduces the property of non-linearity to a deep learning model. ReLU solves the vanishing gradients issue. "It interprets the positive part of its argument. It is one of the most popular activation functions in deep learning. The rectified linear activation function or ReLU for short is a piecewise linear function that will output the input directly if it is positive, otherwise, it will output zero. It has become the default activation function for many types of neural networks because a model that uses it is easier to train and often achieves better performance.



Graphic representation of the ReLU activation function

Softmax is a mathematical function that converts a vector of numbers into a vector of probabilities, where the probabilities of each value are proportional to the relative scale of each value in the vector.



Graphic representation of the softmax activation function

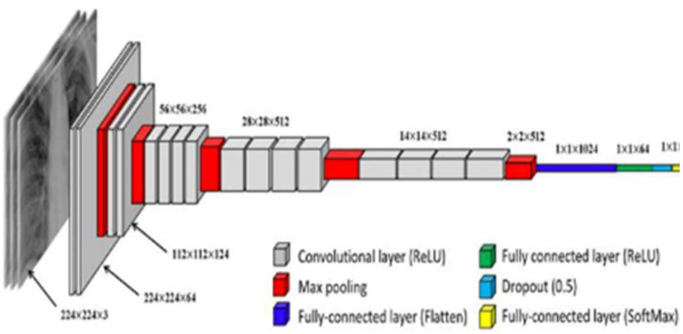
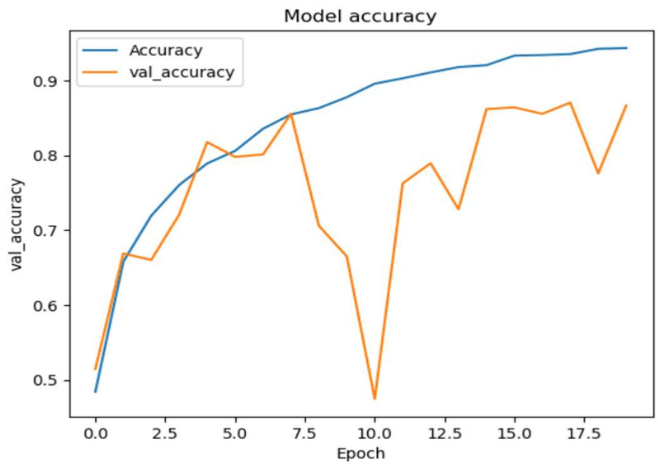
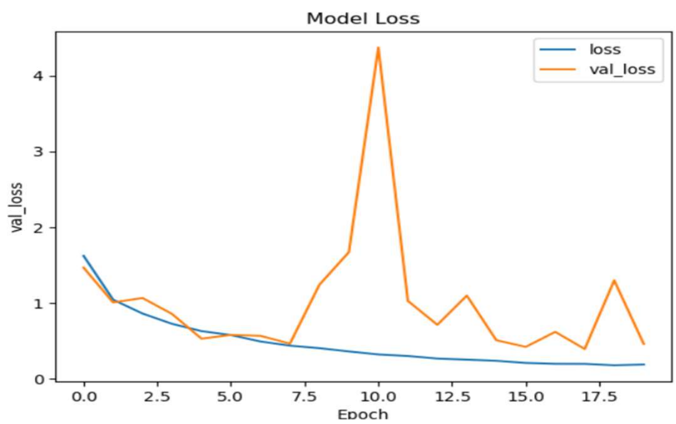


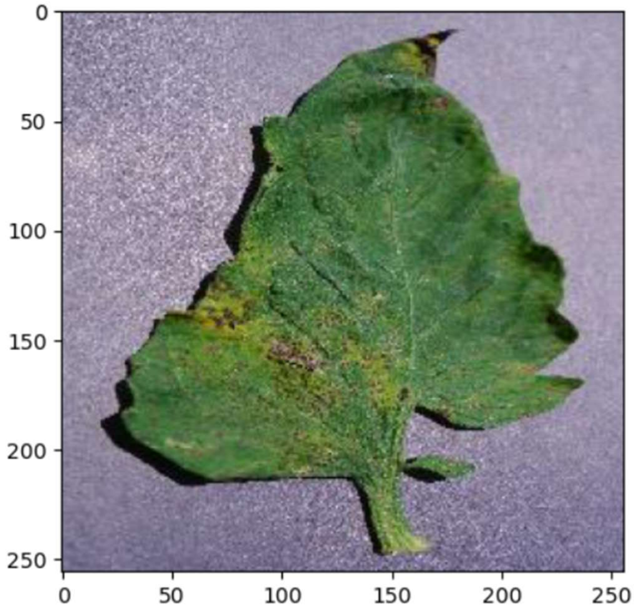
Fig. 6. CNN

Model was build using keras sequential added conv2d, maxpooling2d, averagepooling2d, flatten, dense and dropout layers, model was trained with 20 epochs which yielded a train accuracy of 0.9431 and validation of accuracy of 0.8662. with a training loss of 0.1858 and validation loss 0.4585.

```
model.summary()
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv0 (Conv2D)               (None, 122, 122, 32)      4736
_________________________________________________________________
bn0 (BatchNormalization)     (None, 122, 122, 32)      128
_________________________________________________________________
activation (Activation)      (None, 122, 122, 32)      0
_________________________________________________________________
max_pool (MaxPooling2D)      (None, 61, 61, 32)        0
_________________________________________________________________
conv1 (Conv2D)               (None, 59, 59, 64)        18496
_________________________________________________________________
activation_1 (Activation)    (None, 59, 59, 64)        0
_________________________________________________________________
avg_pool (AveragePooling2D)  (None, 19, 19, 64)        0
_________________________________________________________________
flatten (Flatten)            (None, 23104)             0
_________________________________________________________________
rl (Dense)                   (None, 500)               11552500
_________________________________________________________________
dropout (Dropout)            (None, 500)               0
_________________________________________________________________
sm (Dense)                   (None, 10)                5010
=================================================================
Total params: 11,580,870
Trainable params: 11,580,806
Non-trainable params: 64
```







Conclusion

It focused how image from given dataset in field and past data set used predict the pattern of plant diseases using CNN model. This brings some of the following insights about plant leaf disease prediction. As maximum types of plant leaves will be covered under this system, farmer may get to know about the leaf which may never have been cultivated and lists out all possible plant leaves, it helps the farmer in decision making of which crop to cultivate. Also, this system takes into consideration the past production of data which will help the farmer get insight into the demand and the cost of various plants in market. While evaluating model accuracy on test set is 87.175452709198 %.

References

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