Plant Pathology 2021 - FGVC8

Devyani Barde

1 Introduction

Apples are one of the most important temperate fruit crops in the world. Foliar (leaf) diseases pose a major threat to the overall productivity and quality of apple orchards. The current process for disease diagnosis in apple orchards is based on manual scouting by humans, which is time-consuming and expensive.

Although computer vision-based models have shown promise for plant disease identification, there are some limitations that need to be addressed. Large variations in visual symptoms of a single disease across different apple cultivars, or new varieties that originated under cultivation, are major challenges for computer vision-based disease identification. These variations arise from differences in natural and image capturing environments, for example, leaf color and leaf morphology, the age of infected tissues, non-uniform image background, and different light illumination during imaging etc.

Plant Pathology 2020-FGVC7 challenge competition had a pilot dataset of 3,651 RGB images of foliar disease of apples. For Plant Pathology 2021-FGVC8, the number of foliar disease images has been increased and added additional disease categories. This year's dataset contains approximately 23,000 high-quality RGB images of apple foliar diseases, including a large expert-annotated disease dataset. This dataset reflects real field scenarios by representing non-homogeneous backgrounds of leaf images taken at different maturity stages and at different times of day under different focal camera settings.

The main objective is to develop machine learning-based model to accurately classify a given leaf image from the test dataset to a particular disease category, and to identify an individual disease from multiple disease symptoms on a single leaf image.

In this project, we will be using Convolutional Neural Networks to solve this multi-class classification problem. CNNs have defied expectations and risen to the throne as the most advanced computer vision technique. CNNs are by far the most common of the various forms of neural networks (others include recurrent neural networks (RNN), long short term memory (LSTM), artificial neural networks (ANN), and so on). The image data space is crowded with convolutional neural network models. They excel at image classification, object identification, and image recognition, among other computer vision activities.

Images are classified into different classes (classes being different types of diseases apple trees have) using Convolutional Neural Networks. Tensorflow, keras and cv2 libraries are used to implement Convolutional Neural Networks. Other libraries such as pandas and numpy are also used.

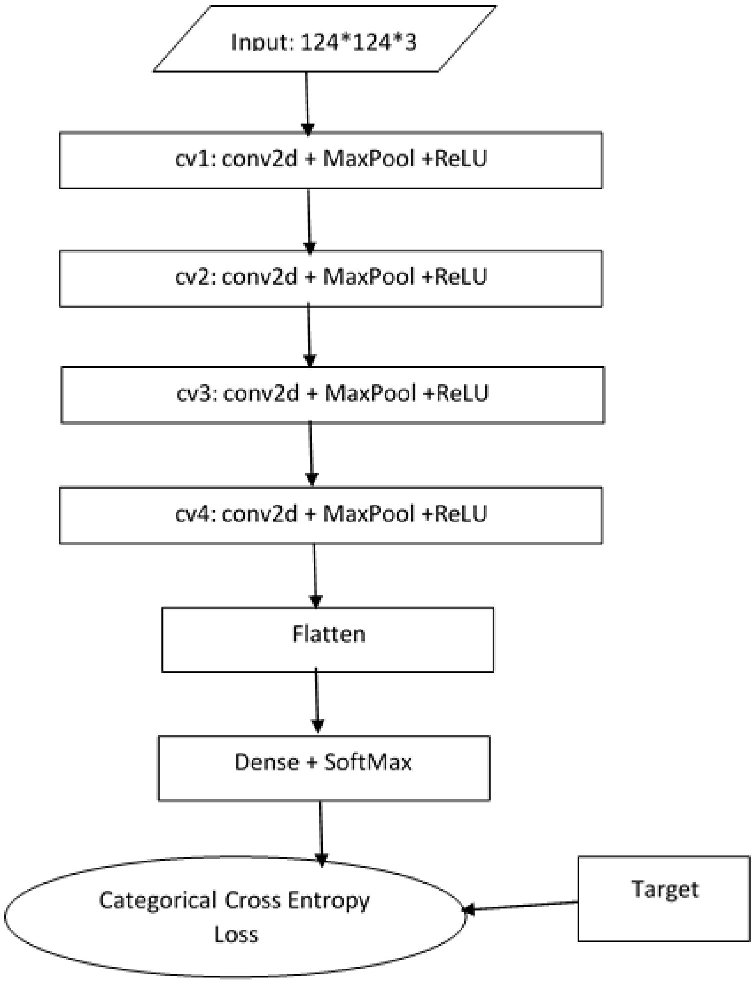

Figure 1: The architecture of Method.

2 Methods/Case Study

Convolutional Neural Networks are used in this project. Convolutional neural networks (CNNs), a form of artificial neural network that has become popular in computer vision, are gaining popularity in a number of fields, including biology. The Convolutional Neural Network consists of four layers with MaxPooling and ReLU function. A key component of the CNN architecture that performs feature extraction is the convolution layer. It usually consists of a mix of linear and nonlinear operations, such as convolution operation and activation functions.

Pooling layer is used as it provides an approach to down sampling feature maps by summarizing the presence of features in patches of the feature map. The type of pooling used in our model is Max pooling. Max pooling calculates the maximum value for each patch of the feature map.

The aim of using the rectified Linear Unit (ReLU) function is to make our images more non-linear. The explanation for this is that images are non-linear by nature. The rectified Linear Unit (ReLU) is used to break up the linearity even further in order to compensate for any linearity that might be imposed on an image during the convolution process. The activation function applied to the last fully connected layer is different from the other, that is ReLU is not used as an activation function for the last layer. As we are dealing with a multi-class classification problem, softmax activation function is used.

Softmax function normalizes output real values to target class probabilities, that is why softmax activation function is the proper choice for multi-class classification problems. Softargmax, or multi-class logistic regression, is another name for the softmax algorithm. This is because the softmax is a multi-class classification generalization of logistic regression, and its formula is very similar to the sigmoid function used in logistic regression. Only when the groups are mutually exclusive can the softmax function be used in a classifier. Many multi-layer neural networks conclude with a penultimate layer that produces real-valued scores that are difficult to scale and manipulate. The softmax is particularly useful in this situation because it converts the scores to a normalized probability distribution that can be presented to users or used as feedback to other systems. As a result, it's common to add a softmax feature as the neural network's final layer.

Here, we are using a larger input size, this helps with the accuracy. In our problem, a small pigment on the apple tree leaf and its color can change the disease the tree has. Hence, to give a fine grained image as input, the input size is larger.

Figure 1 showes the architecture of CNN model. In this project, categorical cross entropy loss function is used as it is well suited for classification tasks, since one example can be considered to belong to a specific category with probability 1, and to other categories with probability 0.

The training dataset consists of 18,632 images of apple tree leaves, each image is associated with a label. The label is the name of disease the apple tree has or the label is 'healthy' if the tree is free from diseases. In this project, this data is split into training and validation data. 80 percent, that is 14,906 data samples, of the data is used for training and the remaining 20 percent, that is 3,726 data samples, is used for validation.

3 Results and Discussion

From figure 2 we can see that the model never overfit the data. Splitting the data as 80 percent training data and 20 percent validation data was a good idea as a lot of data was used for training, this also helped with the overfitting problem. Overfitting is more likely to happen if a small amount of data is available for training.

MaxPooling layer reduces the number of parameters to learn and the amount of computation performed in the network. The features present in a region of the feature map created by a convolution layer are summed up by the pooling layer. As a result, rather than precisely positioned features created by the convolution layer, further operations are performed on summarised features. As a result, the model is more resistant to changes in the location of features in the input image. As MaxPooling is used, it selects the maximum element from the region of the feature map covered by the filter. As a result, the performance of the max-pooling layer will

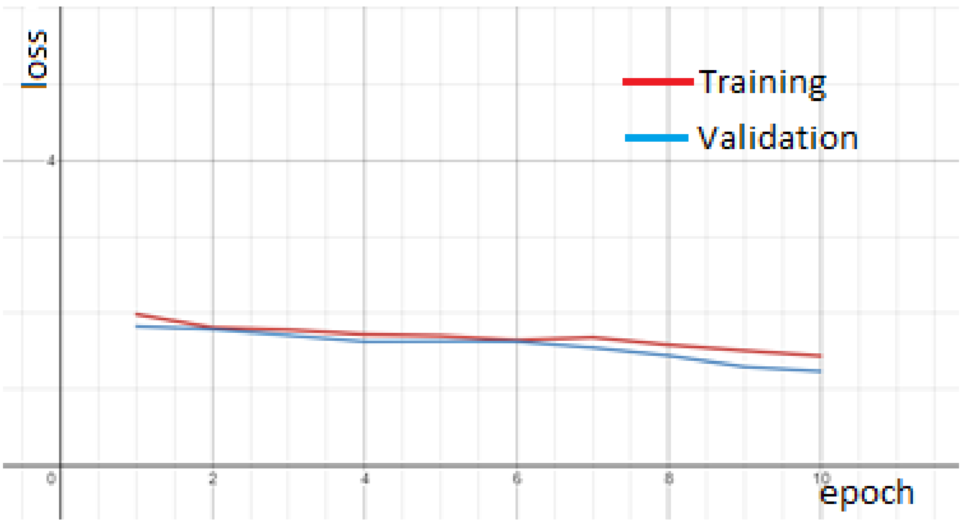

Figure 2: Training/Validation Loss

be a feature map with the most popular features from the previous feature map.

In our model, four convolution layers are used, which seems to be the right choice as adding any more layers to the model might have lead to overfitting. Using less number of convolution layers would mean extraction of less number of features, due to which our model would not have performed well.

4 Conclusion

Apple tree leaves images were successfully classified based on the different types of diseases they have. Convolutional Neural Networks (CNNs) were used to complete this task. Convolutional Neural Networks (CNNs) have worked efficiently for this multi-class classification problem. The choice of type of pooling layer(i.e. MaxPooling) and activation functions(i.e. Rectified Linear Unit (ReLU) and SoftMax for last layer) have also worked properly for this problem.

Reference

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