Neural Network Approach for Flower Recognition

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Abstract

Flower recognition is a crucial task in horticulture, with over 250,000 types of flowers in nature, which makes it difficult for beginners to identify flowers. This project proposes a Convolutional Neural Network (CNN) model based on GoogLeNet to accurately recognize flower species using images. Besides, the primary objective of this project is to develop an efficient algorithm that can recognize flowers and provide their names to the audience.

The dataset used in this project consists of 4000 images of 5 types of flowers which are sunflower, daisy, tulip, rose, and dandelion which were obtained from the Kaggle repository. However, the limited number of flower species and the potential bias in the dataset are acknowledged as limitations of the project. In addition, the CNN model achieved a high training accuracy of approximately 90%, demonstrating the potential of CNN models in accurately identifying flower species by using images. Furthermore, the results of this project illustrate that the algorithms proposed in the project can quickly and efficiently recognize flowers for horticultural beginners and amateur horticulturists.

Introduction

Horticulture promotes the beauty of the human environment, and there are more than 250,000 known species of flowers [1]. Therefore, it could be time-consuming for horticultural beginners to research and recognize different types of flowers. Nowadays, technology innovates at a rapid pace, and with the advancement of Artificial Intelligence (AI) research, computers have been able to simulate human thinking and behavior such as learning, reasoning, etc. [2]. This project aims to assist horticultural beginners and amateur horticulturists to recognize flowers through Machine Learning (ML) and they will directly obtain the names of flowers from the Graphic User Interface (GUI) after they upload flower images to the system.

Methodology

The dataset that will be used in this project is obtained from the Kaggle repository and the dataset will be checked to ensure the proportion of the training dataset is 60% and that of the test dataset and validation dataset are 20% respectively. Besides, there are more than 4000 images of 5 different types of flowers in the dataset.

The processing of the data includes loading and preparing the dataset for the model, as well as generating batches of images and labels for training and evaluation. And TensorFlow's ImageDataGenerator class is used to automatically load and pre-process the data.

The optimizer used is Adaptive Moment Estimation (Adam) which uses gradient descent to update the model weights to minimize the loss function. Besides, Adam also uses moving averages of the parameters to provide running estimates of the second raw moments of the gradients. The loss function used in the training process is the categorical cross-entropy loss. Apart from that, TensorFlow's low-level API is used to manually control the training loop and update the model weights using gradient descent. After the model has been trained, the weights will be saved in the local file.

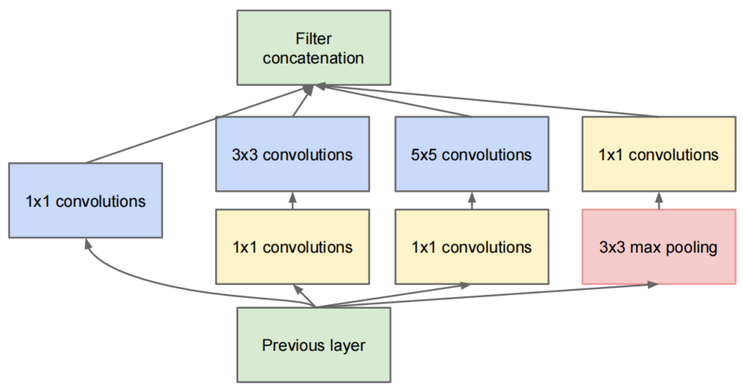
Load images from the test dataset to the previously trained model.

This project will use the Matplotlib library to illustrate the accuracy of the model in recognizing the images in the test dataset.

Model Design

The CNN model used in this project is GoogLeNet [3] and the version of this inception module is version 1 which is introduced by [3]. It consists of a series of parallel branches, each with a different type of layer. One branch may contain a 1x1 convolution followed by a 3x3 convolution, while another branch may contain a 1x1 convolution followed by a 5x5 convolution. The outputs of these branches are then concatenated, resulting in a single tensor that represents a composite feature map. The inception module is shown in Figure 1. Besides, GoogLeNet has 22 layers that consist of multiple inception modules that are stacked on top of each other, with the input image passing through several convolutional and max pooling layers before reaching the final classification layers. In addition, the GoogLeNet also uses global average pooling, which replaces the fully-connected layers at the top of the network with a global average pooling layer that takes the average of each feature map. This reduces the number of parameters in the model and helps to prevent overfitting.

Figure 1. Inception Module



Results

Through iterative training, the most suitable training options found so far for this model include 35 training epochs with an optimizer of Adam and a learning rate of 0.003. Besides, the best training result of this model is around 95% training accuracy and 75% validation accuracy which is shown in Figure 3.

After training the model, the model is used to detect flower images and the UI is designed by using Gradio. The probability of the test image of each class will also be printed in the output line. A test result is shown in Figure 4.

Figure 3. Training and validation accuracy.

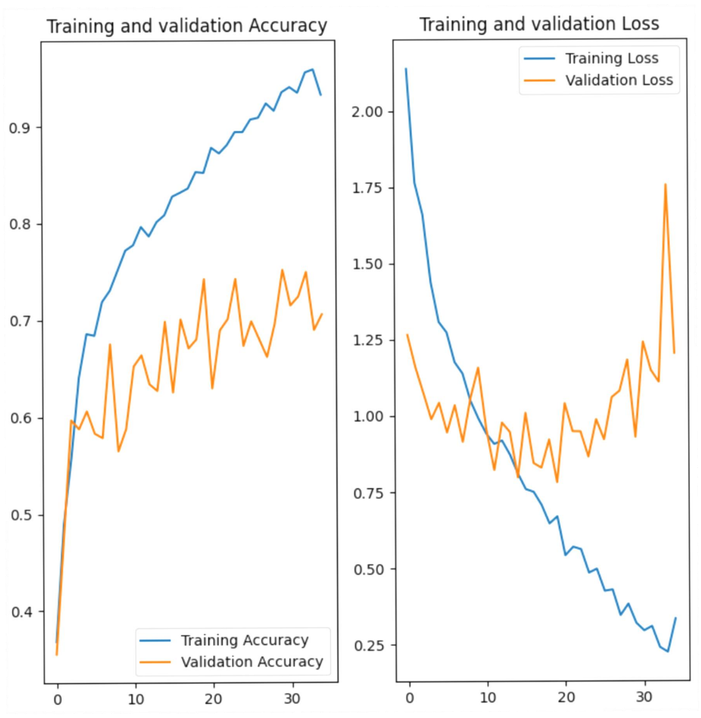
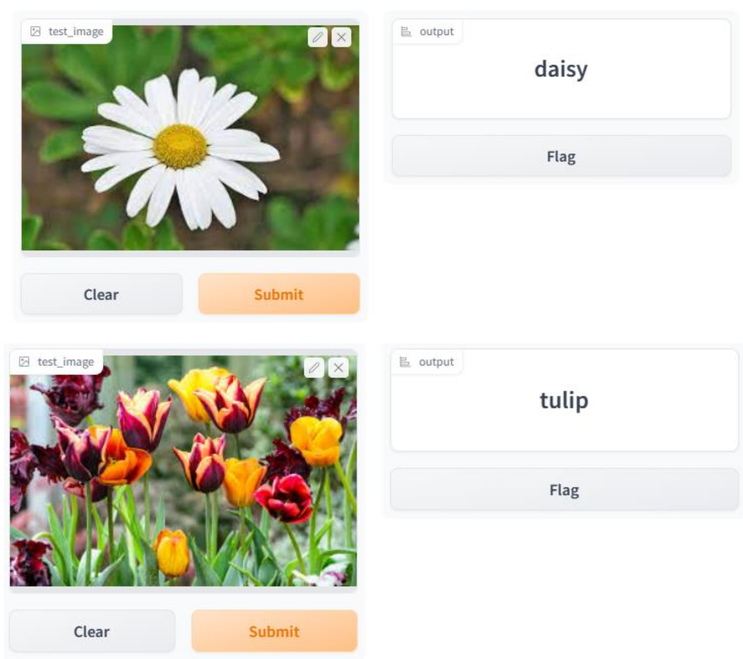


Figure 4. User Interface.



Conclusions

In conclusion, this project aimed to develop an efficient algorithm for flower recognition using a Deep Neural Network approach. The proposed Convolutional Neural Network (CNN) model based on GoogLeNet achieved a high training accuracy of approximately 90% in recognizing flower species using images. However, one limitation of the project was that the dataset used only contained five types of flowers. Despite this limitation, the results illustrate that the algorithms proposed in this project can quickly and efficiently recognize flowers for horticultural beginners and amateur horticulturists. For future research, it is recommended to use a larger dataset with more types of flowers to improve the ability of the model to recognize more flower species.

References

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