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Flower Recognition System Based on Deep Learning

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Abstract

This thesis reviews the research status and related applications of convolutional neural network technology in deep learning in flower recognition system. At the same time, this thesis explores the relevant architecture of CNN by building a simple convolutional neural network model. And through the related experiments, four kinds of flowers are classified, through the data set processing and network structure related parameters adjustment, the final recognition accuracy of the system reached 70%.

Keywords

Deep Learning, CNN, image recognition.

1. Introduction

As an important technology in image recognition, deep learning has important theoretical value and practical significance for promoting the development of flower image recognition system research. Traditional flower species recognition system mainly trains models according to the colors, shapes and textures of stems, leaves, flowers and other positions of plants. However, due to the high similarity between different kinds of flowers, the recognition accuracy of the model is low. At the same time, there are the challenges of flower image recognition system at present on the complex background content of flower images and the great differences between similar flowers in different growth cycles. Therefore, in this thesis, the high-precision recognition of flower species is realized by deep learning method of multi-layer neural network model built by Tensorflow framework. A flower recognition classifier with high accuracy is obtained after model training by Adam gradient descent algorithm. Compared with the traditional flower species recognition system, the accuracy is greatly improved.

2. Background

Flower recognition, in the current application environment, flower recognition can be used in agriculture, business and other fields, in agriculture can be used in the application of intelligent agriculture, can provide intelligent detection scheme and related planting suggestions for the planting of various cities, industrial parks. In the field of commercial application, it can identify the types of flowers in various gift-giving evaluation systems, and also provide users with more choices of flowers. However, compared with the more general plant recognition of flowers, its various applications should be a relatively unknown research field at present (referring to the academia, the industry has a lot of mature products, such as domestic flower partner and shape and color, foreign PlantSnap,

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etc.), and the relevant literature is relatively few. One of the main reasons restricting its development may be that the public data sets in this field are relatively few and the scale is not large, and the collection and processing of large-scale plant identification data sets is not only time-consuming and labor-intensive, but also requires professional skills in plant identification.

Deep learning technology has been developed for nearly 70 years at home and abroad. From the concept of artificial neural network and the mathematical model of artificial neurons proposed at the very beginning [6], to the birth of perceptron [7], namely neural network of single-layer computing unit, to the proof that perceptron cannot solve simple linear inseparable problems such as XOR [8], Then, the error back propagation algorithm of the multi-layer perceptron of nonlinear continuous transformation function is analyzed to see whether the multi-layer network structure can be realized. Finally, the error back propagation is turned into the birth of the back propagation algorithm [9], which starts the era of the rise of neural network.

Deep learning technology based on convolutional neural network is now mainly used in the field of image recognition. It was proposed by Professor Yann LeCun[10] of Canadian University and his colleagues in 1989. Convolutional Neural Network is a deep learning method with user participation and supervision that can be manually annotated. This is different from the deep signaling network (DBN) [7] composed of a limited Boltzmann machine (RBM) [11], which uses the unsupervised greedy training algorithm layer by layer to achieve excellent application effect display.

With the development and maturity of modern science and technology, the application of artificial intelligence in real life changes with each passing day.

Image recognition technology is an important field of artificial intelligence. It refers to the image object recognition, in order to identify a variety of different patterns of the target and the image of the technology. This study began as early as 1950.lt goes through three stages: word recognition, digital image recognition, and object recognition.

Image recognition technology as an important and complex technology, through this technology to process all kinds of information, not only can liberate manpower, but also more efficient, better quality. We hope to further study the image recognition technology through plant recognition, precisely flower recognition.

Although the image recognition technology is very complicated, its principle is not complicated. First, the technology stores large amounts of image data in one place. Then through comparative analysis, intuitionistic data information is obtained, and these datainformation is stored in the system. Finally, when people need data results, they can refer to them directly.

In recent years, with the attention of people to identify in various types of plants and other issues, flower recognition technology has gradually developed, among which, flower recognition technology mainly uses various types of flowers image features to carry out flower authentication.Flower recognition is the use of computer analysis of flower video or image, extract effective recognition information, and ultimately determine the type of the flower object technology,is one of the important applications in the field of image analysis.The application of image recognition technology in plants can monitor the growth of plants and identify species.By collecting and identifying information, fast, accurate and effective information can be obtained.

Flower recognition technology is widely used in Smart agriculture, urban planning, business identification and other aspects.Applying flower identification technology to the field of urban planning can improve the management efficiency of urban flower cultivation by government or other institutions. Applying flower identification technology to the field of urban planning can improve the management efficiency of urban flower cultivation by government or other institutions. For example, in different parts of the city on the road planting different flowers or plant identification, flower identification technology can quickly identify different kinds of flowers and provide the best matching scheme for the use of relevant institutions, but also can return the relevant decision-making structure to the system for relevant in-depth learning, for subsequent urban planning recommendations to update the system. Through a comprehensive analysis of the image recognition

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of plants and flowers, the coordination of urban planning can be improved, and the convenience of residents' living experience can be improved. The study of flower identification system is not only beneficial to the development of urban planning by relevant institutions, but also can obtain reliable and relevant flower information in time in the process of identifying toxic and harmful flowers, so as to ensure the safety of residents in urban areas.

The combination of image recognition technology and security technology can more quickly carry out image collection and processing work, intelligent analysis of image information, from which to obtain more effective information, so that the security work can be carried out smoothly, can obtain timely and effective information support from the image recognition technology.

In the process of carrying out flower-related commercial transactions, non-professionals often can not correctly distinguish the type of flowers, so that in the transaction is very likely to be misled, fraud.With the help of artificial intelligence image recognition technology, doctors can accurately and clearly observe the image, and then obtain effective image information.

In the field of agricultural production, people can use image recognition technology to display the process of plant growth in a pictorial form, which can provide relatively reliable data for agricultural production and ensure the improvement of agricultural production level. In addition, artificial intelligence image recognition technology can carry out panoramic image monitoring on the growth process of plants, and can do a good job in the quality inspection of agricultural products.

In the comprehensive and sustainable development of social science and technology,the importance of image recognition technology is gradually highlighted, and it has developed into a new technology. While popularizing and applying this technology in an all-round way, its application fields are gradually expanding. To this end, the image recognition technology will also achieve a new development, can take into account the users personalized needs of continuous innovation and progress, give full play to the value and role of the technology itself.

To sum up, image recognition technology has a broad prospect in the future development and can be applied in various fields. Its development space and application value are significant, which should be paid attention to and studied in depth.

3. Research

3.1 Computation Environment

The hardware configuration of the computer is tabulated as follow:

Table 1. Computation Environment

CPU	2.9GHz intel Core i7
GPU	Radeon Pro 560 Intel HD Graphics 630
Memory	16G
OS	Mac OS
Deep Learning Framework	tensorflow.keras
CUDA	10.1
CPU	i7 10750H
GPU	RTX 2070s
Memory	32G
OS	Windows 10
Deep Learning Framework	tensorflow.keras
CUDA	10.1

3.2 Data Collection:

Based on Focused Crawler, the image data needed by the project are obtained by taking Baidu image as the data source, and retrieving according to the keyword of the flower name. The requests is used

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to obtain the page information, and the Beautiful Soup 4 is used to analyze and crawl the page data. A total of more than 3000 pieces of data are crawled, including three kinds of flowers. It is necessary to clean the data before use because the obtained data is mixed.

3.3 Data Processing

First of all, the picture data needs to be cleaned to eliminate some completely irrelevant pictures. Because the original data of the picture is small, the picture is roughly screened by manual screening. Secondly, these complex backgrounds would disturb during feature extraction because the background of flower images is generally complex, so it is necessary to further clean the data set before training the model. After the above operations, a relatively clean picture data set is obtained.

After data cleaning, the number of pictures would be less than 3000. We know that abundant high-quality data is the key to train a good model. In order to train a better model, it is necessary to expand the picture data. The image data is further expanded by flipping, rotating and adding Gauss Noise. Finally, it is expanded to more than 90,000 pictures.

After the expansion is completed, in order to ensure the effectiveness of subsequent model training, it is necessary to unify the size of the picture. OpenCV is used to adjust the size of the picture in batches, and the size of the image is set to 32*32*3.

Finally, data encapsulation should be carried out on the image data. It uses the Pillow to read the image data, convert it into an array, and match its corresponding tags. Computer programs can only read data through 0 and 1, but can't read pictures through eyes to get information like people. In data encapsulation, this thesis divides the data into train set and test set by 4: 1 ratio, and adopts one-hot encoding method. Finally, the read data is transferred to MAT format for storage, which is convenient for the subsequent operation of the experiment.

Fig. 1. Original image crawled from Internet

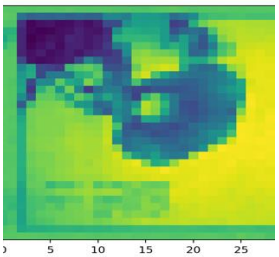

Fig. 2. Processed images

3.4 Design and Construction of CNN Model

CNN is mainly used to classify and recognize flower images. Its network structure is shown in Table II.

Table 2. Computation Environment

Network layer	Parameters
Input	32*32
Conv1	32*32
Conv2	32*32

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MaxPooling	16*16
Conv3	16*16
Conv4	16*16
MaxPooling	8*8
Fc1	2048
Dropout	90%
Fc2	128
Dropout	90%
Output	Softmax

Set the size of the pictures to 32*32*3 in the input layer. The model is composed of four Conv2D layer, two MaxPooling 2D layer, two Dropout[6] layer and two Fully Connected layer. Except the output layer uses softmax activation function, other layers all use relu activation function. The convolution layer mainly extracts and scans the image data, and 64 convolution kernels are used in the input layer to operate; MaxPooling is used in this thesis, which can effectively reduce the size of parameter matrix, speed up the calculation and prevent overfitting. When overfitting appears in the model, the model chooses to add Dropout layer to randomly discard some data. Finally, the data is processed and trained through the full connection layer. In the output layer, the probability corresponding to each item is obtained by using Softmax activation function, and then the item with the highest probability is selected as the prediction result.

In terms of parameters, the parameters of the model are mainly set according to the size of the data set and previous training experience because the parameters of the model are not available at the beginning. Through adjusting learning rate, dropout rate, epochs, batch size and other parameters many times, a higher accuracy is finally obtained.

3.5 Programming and Optimization method

Technically, all the programming is done in Python. Python and TensorFlow are versions 3.6 and 2.3.1, respectively. Two separate Python files are created: one for loading data and data preprocessing, and one for CNN model building and serving data. In the data load file, the imported packages are "numpy" and "scipy". The first step is to use the "load" function in "scipy. IO" to load the MAT files of the training set and test set. The second step is to normalize the image set, and the processed data set will be input into the CNN model in the second Python file. When we use TensorFlow, we create various nodes in the diagram, and Tensor circulates in those nodes. Tensorflow also needs the following knowledge reserves: 1. The meaning of the scale: The scale represents the specific value, the vector represents the position (a point in space), and the amount of the sheet represents the entire space. One-dimensional arrays are vectors, multidimensional arrays are tensor, and matrices are tensor. That is, the tensile is actually an n-dimensional array. 2. Order and shape of tensents: Order refers to dimensions, and shapes are the number of elements in each dimension that people can see. 3. Four important tensor data type types: Variable: Variable: Variable in the calculated map, Tensor: a multidimensional matrix with many methods for developers to use, Graph: a calculated map, Session: used to run a calculated map, interpretation: calculating the map, data flow map essence is chained together functions. 4. Three important data functions: Variable:tf.Variable: init.. Used for initialization, Constant: Constant, Placeholder: A temporary variable, i.e. the warrior does not assign it a value and needs time to assign. 5. In the method of error reverse propagation, tensorflow encodes the weights (weights) and deviations of the edges to the next layer instead of the previous layer.

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3.6 E1. Optimization method

In terms of data processing, the image is digitized by the tensor of OpenCVpackage in Python, and it is cut to the size of 32*32. Then, all the images with labels are packaged into "mat" files by calling the "saveMat" method in the package "scipy. IO". The "mat" file is essentially a Python dictionary, where "x" holds image tensors and "y" holds image labels

Convolutional neural network is a feed-forward neural network consisting of input layer, hidden layer, output layer structure, plus three different dimensions (width, hight, depth) with three dimensions of neurons, the three dimensions here are not to describe neural networks but to describe neurons, such as the input picture size of 32 x 32 x 2 (rgb), then the input neurons and pictures of the same size, These artificial-based neural units can also influence surrounding elements for functional purposes, i.e. to adjust the learnable weights and biases of neurons, which perform well for large image processing.

Two methods: error back propagation and stochastic gradient descent. And since it's essentially a chain function, which you can think of as multiplying matrices, and the way you get rid of the error mathematically is by taking the derivative or differentiating, so stochastic gradient descent is just taking the derivative of the error, and error back propagation is just using the derivative to modify the weight, and that gives you a better model. Tips: The matrices are constantly multiplied, that is, all nodes at the same layer exist in a large matrix, not each node exists alone. The reason for this is that it is convenient for parallel computing of the GPU. If the activation function of each layer is the same, GPU can also be parallel.

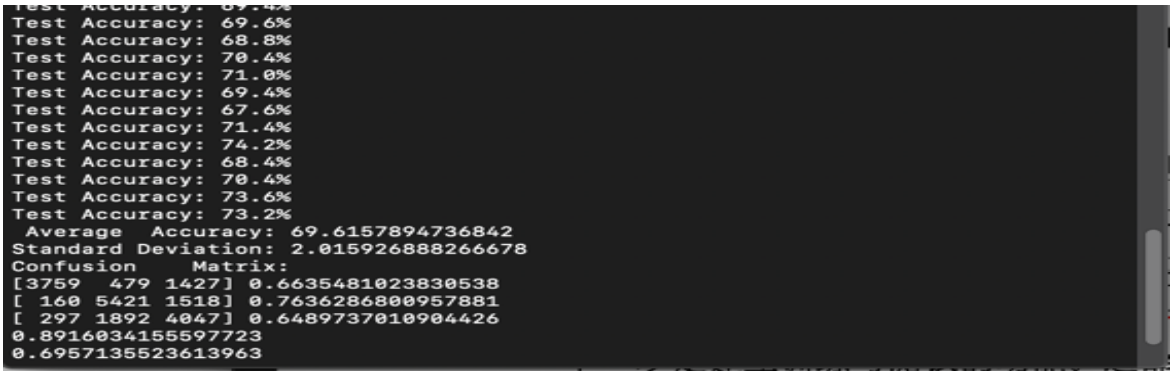

Fig. 3. Example of training and testing

3.7 E2. CNN Modeling

After network design, and the maximum design sequence of pooling layer have been adjusted, because after the first and the second convolution of pooling layer after layer of the effect of reducing dimension, lead to the final output results did not reach the desired effect, the final design the structure of the CNN model for convolution, activation function, pooling layer and the total layer. The convolution layer of the model is used to extract the features of the image. Activation functions are used to increase nonlinearity and simulate the activity of neurons on nonlinearity. To simplify the calculation, the ReLU function is used in the activation function. The pooling layer of the model is used to reduce the dimension of the images in the data set while preserving the important information of the images in the data set. Finally, the fully connected layer makes the final classification according to the features extracted in the previous training process [4].

When building the CNN architecture, the functions, including conv2D, maxpooling2D, Flatten, Dense, and Dropout, L2 are regularized as parameters from 'tensorflow.keras. Call layer ', 'numpy', and import the processed data. In the model, in order to avoid overfitting, the dropout strategy is adopted. The number of some nodes is set to 0 and the dropout rate is set to 0.5[5]. Similarly, kernel regularization (L2 regularization) is used. Flatten turns multidimensional input into one dimension and is often used for converting the convolutional layer to the fully connected layer. The laminate does not affect the size of the batch. The second step is to compile the previously created model,

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defining the optimizer and the loss function. After tuning, the learning rate is set to 0.001 and the loss function uses' SPARSE_SORTING 'to match the format of one of our integer labels.

The results of this project is shown in fig.3.

4. Conclusion

Three similar flower image data are input into the above CNN structure, and then the probability vector is obtained after Softmax logistic regression processing, which respectively represents the probability that the current image is of each species. The final recognition probability is determined by the maximum probability. After many parameter adjustments, the accuracy rate of the flower recognition system based on deep learning gradually increased from 40% to 70.77%. It can be seen that parameters are important to the model, but now it seems to have reached a bottleneck. If you want to continue to improve the accuracy, you need to clean the image data further——because data is the key to model training.

There are many types of flowers, which always influences the distinguishing efficiency of people or oganizations negatively when they need to send presents or bulid an urban garden environment. This report designs and constructs a new CNN model to identify flowers, which can reduce the unnecessary time on flower identification after applying. The future research should be on identification of pictures with high similarity, aiming for similar in appearance but different flowers. Also, the accuracy could be further improved. Flower identification has great prospects with the development of artificial intelligence. Under this situation, how to apply it in the real life effectively is the main research directions.

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