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Research Article

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Research on Intelligent Classification of Urban Trash Cans Based on Deep Learning

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Abstract In recent years, the problem of garbage classification has gradually entered our vision. More and more cities have begun to implement garbage classification policies. However, relying on citizens' manual classification has the problems of low efficiency and low accuracy. It is harmful to young children and older people. There are certain difficulties for the elderly in, and it is difficult for citizens to distinguish the types of rubbish when the light is low near the trash can. In response to this problem, this article combines deep learning and garbage classification, and uses the Inception-ResNet-v2 model in the convolutional network for modeling. The two thousand or so data sets are divided into training sets and test sets. Types of trash: plastic, glass, metal, waste cardboard, and paper have undergone in-depth learning. After multiple modeling, a model with relatively good accuracy has been obtained, and certain research has been conducted on the intelligent classification of urban trash cans. The intelligent classification of trash cans, which uses deep learning technology in machine learning, brings a certain improvement in efficiency and accuracy compared to manual recognition. Compared with traditional image recognition, deep learning has less impact on image quality, high concurrency, and too many types. It can recognize images better, which is the main direction of image recognition in recent years.

Keywords deep learning, garbage classification, image recognition, convolutional network

1. Introduction

In China, garbage classification is not widely implemented nationwide. Landfilling garbage or using in incineration sites for thermal power generation is a very common treatment method for many cities. This method is not only costly, but also air pollution. Seriously, there is no complete classification and recycling plan and route. At present, recyclable and non-recyclable are the two key points of garbage classification; the distribution of garbage bins in cities is small and uneven. These problems have led to people's garbage classification. Sometimes it is easy to confuse, and the purpose of garbage classification is not achieved.

There are many problems in the secondary utilization of waste and garbage in our country. Among them, the overall management of the industry is chaotic, there is no uniform standard, and the technology is far behind other countries. Take the iron and steel industry abroad as an example. Most countries use scrap steel as raw materials more than iron ore. Some developed countries have more than half of the scrap steel utilization rate, while European countries dominated by the European Union have reached more than 70%. In other common metals, the recovery rate of copper and aluminum in European and American countries exceeds half. Japan's demand for bauxite resources is extremely low. The recycling of waste aluminum products is the main thing, and no additional raw materials are basically needed. However, in our country, there is a lot of waste of renewable resources. This is especially obvious when the value of recycled items is low, such as batteries, glass, plastic packaging, and discarded clothes. There is a huge waste of resources.

Taking European countries as an example, their recycling rate for waste glass exceeds 90%, while in my country, the same number can only refer to the proportion of glass that is mixed in garbage and discarded. my country is extremely backward in the use of renewable resources in the world, especially the low-value recyclables are discarded in large quantities. If the landfill operation is only carried out, not only the accumulation of garbage will increase, but also the environmental pollution is very easy to cause [1].

In 2017 alone, excluding industrial waste, the amount of domestic waste produced in my country was about one million tons higher than the amount processed. Among them, the waste production volume of developed cities ranks in the forefront, from top to bottom, Beijing, Shanghai, Guangzhou, Shenzhen and Chengdu [2]. The consumption level of developed cities in my country has been in line with international standards, but the waste disposal has not reached the high level that it should be.

Since July last year, in response to this situation, my country has made great efforts in the national waste classification policy, but the waste classification is mainly based on manual screening by citizens, which is less efficient and accurate. Ordinary image recognition sometimes has high concurrency, the pictures increase sharply, and may be lost due to network problems, mistakes and omissions, etc., in addition to the problem of long recognition time [3]. In foreign countries, there are already large-scale garbage dumps that automatically classify garbage based on deep learning technology, which not only improves the efficiency of garbage classification, but also avoids the sanitary problems that may be caused by manual classification. my country produces a large amount of garbage, and garbage classification started late. Applying network technology to daily life is a very meaningful attempt.

2. Principle of Convolutional Neural Network CNN

Based on the complexity of the model and the performance of the model in the field of image recognition, CNN convolutional neural network is selected as the deep learning model.

The number of network layers and the accuracy of the training set cannot be completely unified. Under certain conditions, when the number of network layers increases, the accuracy of the training set will decrease instead. Because the gradient will propagate back to the upper layer, the multiplication effect may cause the gradient to tend to infinitesimal. This is not caused by the over-fitting of the model, because the increase in error is not only reflected in the test set, but also in the training set. In response to this situation, someone proposed a brand-new network, the Deep Residual Network (ResNet), whose core idea is to introduce "identical fast connection".

The deep residual network was first proposed by four Chinese from Microsoft Research. By using the Residual Unit to successfully train a 152-layer deep neural network, it won the championship in the ILSVRC 2015 competition, achieving a top5 error rate of 3.57%, while the amount of parameters is better. VGGNet is low and the effect is very outstanding. The structure of ResNet can accelerate the training of ultra-deep neural networks extremely quickly, and the accuracy of the model is also greatly improved.

The Google team released Inception-ResNet-v2, which achieved the best results in the ILSVRC image classification benchmark test. Inception-ResNet-v2 is a change from the early Inception V3 model, and got some inspiration from Microsoft's residual network (ResNet) paper.

Convolutional neural networks were originally created by imitating the deep complex hierarchical structure of the connections between neurons and the brain in the human brain [11]. It is divided into three parts: convolutional layer, pooling layer and fully connected layer.

The convolution layer performs a convolution operation on the input image and the feature detector. The feature detector in the middle will randomly generate a variety of features. The random effect achieved is convenient to extract different features in the image and imitate the process of processing information in the brain.

After multiple convolution operations, the total feature map is used as the final output of this convolutional layer. In order to avoid the problem of overfitting, different filters are used in different operations to make the generated feature maps achieve differentiated results.

After the convolution operation, a pooling layer is usually added between the CNN layers. By reducing the dimensionality of the information, the parameters and calculation times in the network are reduced, and unnecessary calculation overhead is saved. Then input the obtained data into the fully connected layer, and get the most basic neural network after the data is flattened.

3. Model construction

Import the InceptionResNetV2 model from keras. Because the InceptionResNetV2 model is large, downloading the model through the python connection network is prone to download failure. Therefore, in this experiment, I downloaded the InceptionResNetV2 model from the keras official website in advance and placed it in the keras package. In the folder, you can directly call it later by importing the package. The effect of the experiment is no different from downloading the model directly through python code. When setting up the model, no longer use the last connection layer of the original InceptionResNetV2 model, reset the interface of the model and change it to the category required for garbage classification, namely cardboard, glass, metal, paper, plastic, trash. Category, corresponding to the six categories of data preprocessing.

3.1. Model training

The issues that need to be paid attention to in the training of the model are the selection of the number of batches and the number of iterations of the model. Batch processing is an important parameter in deep learning, which determines the direction of data set decline. After consulting the information and actual operation, it is found that when the data set is small, the number of batches and the number of training sets can be synchronized. The advantage of this is that the processing direction can better represent the overall sample. In addition, because the gradient values of different weights are quite different, it is difficult to select a global learning rate.

However, such an approach is not suitable for large data sets. Due to the computer's memory limitations, even if the GPU is used for calculation, it is still too difficult to load all the data at once. Moreover, the sampling difference between each batch of data will also disappear. When the batch number reaches a certain level, the direction of the data set decline basically does not change.

However, the number of batches is set to the lowest, that is, the number of batches is 1. In this way, the model is difficult to achieve convergence during training, and the automatic feature selection effect of the algorithm is very poor.

The number of model iterations is another important factor that affects the output of the neural network. When the number of iterations is very low, the accuracy of the model is much lower than other models, and when the number of model iterations exceeds a certain threshold, the model It is also easy to produce over-fitting problems, that is, the accuracy of the training set is very large, but the data set itself is different from the actual situation, resulting in the overall quality of the model is not high. In addition, the high number of iterations is also a burden on the performance of the computer.

Combining the above two parameters, the key to determining the quality of the model training, in addition to the model itself, there are also the number of batches and the number of iterations of the model. How to adjust the parameters to achieve the best effect of the model is the problem to be solved at this stage.

3.2. Save the model

Set the directory for saving the model and the path when saving the model. When setting the path (file name), write the number of iterations of the model and the accuracy of the test set in the name, and set the ModelCheckpoint to achieve the accuracy of the verification set. Save the effect.

Set up the model and call Kears' built-in evaluation function top_k_categorical_accuracy to make it an output of the custom evaluation function, which changes continuously with the training of the model.

In the model training, set the number of batches to 8 times, the number of training iterations to 5 times, and suffle to True to train the model.

In the actual training process, it was found that the excessively high batch processing times puts a great load on the computer's operation, and it is prone to crashes, so afterwards, the batch processing times were adjusted to 4 when adjusting the parameters.

```
                loss='categorical_crossentropy',
                metrics=['accuracy', acc_top3, acc_top5])
# 模型训练
model.fit(np.array(train_images), to_categorical(y_train),
          batch_size=8,
          epochs=5,
          shuffle=True,
          validation_data=(np.array(test_images), to_categorical(y_test)),
          callbacks=[checkpoint])

```

Figure 1: Model training

4. Use the model for analysis

After constant adjustment of parameters, five models with different accuracy rates were obtained in five iterations. The model with a 67% accuracy rate of the model generated in the last iteration was selected. Use this model to perform data on the 10th to 20th data in the test set.

```

model.load_weights('train_model/model_04-accuracy0.67.hdf5')

y_pred = model.predict(np.array(test_images))[10:20]
y_predx =np.argmax(y_pred,axis=-1)
print(y_predx)
print('-------------------------------------------------------')
print(y_test[10:20])

```

Figure 2: Model testing

The test results obtained are as follows:

```
In [42]: runfile('F:/shujubao/trashselect.py', wdir='F:/shujubao')
Jsing TensorFlow backend.
[3 1 4 5 0 1 1 3 0 5]
-------------------------------------------------------
[3, 0, 4, 4, 0, 1, 1, 3, 0, 2]
```

Figure 3: Test result

Among them, 0, 1, 2, 3, 4, and 5 respectively represent the categories of the test set: cardboard, glass, metal, paper, plastic, and trash. Among the 10 data tested, there are 7 correct test results. After that, I tested multiple sets of data and the accuracy rate obtained was around 70%.

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