Research on the Method of Machine Learning Algorithms in Ecological Construction

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Abstract. In the rapid development of modern artificial intelligence, for the development of ecological construction, how to rationally use machine learning to promote the development of agricultural economy has become a focus of practice and scientific research. This paper takes ecological image recognition as an example to analyze how to use support vector machine in image processing technology and machine learning in deep learning to conduct in-depth research, and to optimize and improve the algorithm to build an ecological image recognition model.

1. Introduction
In the rapid development of science and technology, ecological disease treatment has become the focus of ecological construction and development. In order to break through the situation of traditional artificial image recognition, researchers began to use multi-class algorithm to automatically detect and recognize ecological disease images. Before deep learning, traditional methods, such as support vector machine or decision tree, were mainly used for classification and recognition. By using deep learning algorithm to process images, the data set can be directly input into the model for training without obtaining the characteristic information in the sample. However, this method must reserve a large amount of data information, and it is very easy to produce the phenomenon of transition fitting. At the same time, as the model structure becomes more complex, the actual training speed slows down, which generally refers to the application in large-scale and complex model system. Nowadays, with the increasing application of machine learning in agriculture, more and more scientific research projects and achievements have been put forward by researchers from all over the world aiming at the development and changes of the market. For example, Zhang Yongling used salient segmentation algorithm to separate regions, and combined with SVM classifier to scientifically classify and identify different forms of diseases and insects, such as rice smok and rice plague, etc., and the actual recognition accuracy could reach 92.0%. Zhang Chao et al. built an embedded acquisition and diagnosis system, and completed the remote access design in the mobile phone client. Therefore, this article on the basis of the thorough understanding of the current ecological construction situation, based on the analysis of traditional machine learning algorithms, on the basis of reasonable improvement
optimization, scientific identification of different stages of ecological plant disease image information, and thus guarantee to build model to optimize application performance, at the same time also is added in the image recognition of natural language processing methods. This can automatically obtain the important content of the package.

2. Methods

2.1. Convolutional neural network
Convolutional neural network is a multi-layer artificial neural network, which has a structure similar to traditional neural network, including input layer, hidden layer and output layer. The biggest difference between the two is that the hidden layer of Convolutional Neural Network includes convolutional layer and pooled layer. With the increase of the convolutional layer, the learning ability of the actual neural network becomes stronger. The specific structure is shown in Figure 1 below:

![Structure analysis diagram of convolutional neural network](image)

**Fig. 1** Structure analysis diagram of convolutional neural network

From the perspective of training, error back propagation will be used to adjust network parameters to optimize the model, and this process is divided into two parts: on the one hand, it refers to forward propagation; on the other, it refers to back propagation. At the same time, since the pooling layer in the convolutional neural network currently used does not have weight and bias parameters, there is no need to learn the parameters of the pooling layer during network training[1-3].

For the forward propagation algorithm, the corresponding characteristic pixel calculation formula is:

\[ y_{pj}^{(1)} = f \left( \sum_{(u,v) \in K_{ij}} \sum_{c \in M_{ij}} W_{ij}^{(c)} \cdot X_{pj}^{(c-1)}(c+u,r+v)+b_{j}^{(1)} \right) \]

(1)

In the above formula, \( K \) satisfies \( K = \{(u,v) \in N^{2} | 0 \leq u \leq k_x, 0 \leq v \leq k_y \} \) And \( k_x \) and \( k_y \) represent the size of the \( l \)-layer convolution kernel \( W_{ij} \) (L); \( B_{j} \) (L) represents the bias of the JTH feature graph of the corresponding L layer. Variables \( c \) and \( r \) represent the current position of the pixel; \( U \) and \( V \) represent the positions where the convolution kernel moves to both sides; \( P \) represents the corresponding \( P \) training sample. \( F (.) \). Represents the activation function for layer \( l \)[4-5].

The analysis from the pooling layer will carry out sampling processing according to the output feature pixels of the previous layer, so it is also called the sampling layer. Generally speaking, two sampling methods will be selected, one refers to average pooling, and the other refers to maximum pooling. The average pooling formula is as follows:
In the above formula, \( S \) (1) Conform to the
\[
S^{(l)} = \{(i, j) \in N^2 | 0 \leq u \leq S_x^{(l)}; 0 \leq v \leq S_y^{(l)} \}
\]
This condition. \( S_x \) (L) and \( S_y \) (L) represent the sampling window under the L layer; \( U \) and \( v \) represent the length of each move of the pooled window.
At the same time, the corresponding maximum pooling will obtain the maximum value from the corresponding pixel in the pooling window. The specific calculation formula is as follows:
\[
\max \{ x^{(l-1)}_{p_l} (c + u, r + v) \}
\]
From the perspective of the full connection layer, the feature vectors obtained in the previous convolution operation will be input to the full connection layer and then transferred to the output layer through the mapping of activation function. The corresponding calculation formula of the full connection layer is as follows:
\[
y^{(l)}_{pj} = f \left( \sum_{i=0}^{N} x^{(l-1)}_{pi}, W^{(l)}_{pj} + b^{(l)}_j \right)
\]
In the above formula, \( N \) (L-1) represents the number of neurons in the L-1 layer; \( W_{ji} \) (l) represents the weight value between neuron i and j; \( B_j \) (L) stands for offset; \( F \) represents the activation function of layer L.
From the perspective of back propagation algorithm, the bias sensitivity error formula of the L layer is as follows:
\[
\delta^l = \frac{\partial E}{\partial b^l}
\]
The partial derivative of the training error in the L layer with respect to the weight value is as follows:
\[
\frac{\partial E}{\partial W^l} = x^{l-1} (\delta^l)^T
\]
Combined with the chain rule, it is clear that the relation formula between the sensitivity errors of the L +1 layer and the L layer is:
\[
\delta^l = \left( W^{l+1} \right)^T \delta^{l+1} \cdot f' \left( Z^l \right)
\]
It should be noted that, due to the difference in the connection mode selected by the hidden layer of the convolutional neural network, the calculation method of the error term will also be different in the process of error back propagation. Therefore, the error of each layer needs to be calculated and analyzed.

2.2. Ecological image recognition based on improved convolutional neural network
First, the overall structure of AlexNet Convolutional Neural Network. AlexNet studied in this paper mainly contains 8-layer network structure, and the corresponding network structure parameters are shown in the following Table1:

Table1. Network parameters
Meanwhile, local response normalization (LRN) needs to be followed by activation function to improve the generalization performance of the network. In this paper, the activation function of ReLU is selected, and the specific form is shown as follows:

\[
b_i^{j,y} = \alpha_{x,y} \left( \frac{a_{x,y}^{j}}{\kappa + \alpha \sum_{j=\max(0, j-1)}^{N-L+2} (a_{x,y}^{j})^2} \right)^{\beta}
\]

(8)

In the above formula, \(Ax, Yi\) represent the characteristic graph of convolution kernel \(I\) after the \((x, y)\) coordinate passes through the ReLu activation function, and the hyperparameters \(k=2, n=5, \alpha =10^{-4}, \beta =0.75, \) and \(n\) represents the number of convolution kernel.

In order to apply transfer learning to convolutional neural network model training faster, a DDC transfer learning optimization algorithm based on pre-training is proposed in this paper, and the method of minimizing the maximum mean difference is selected. This method integrates the deep features obtained in two task domains by Convolutional Neural Network.

2.3. Algorithm design and implementation

In this paper, AlexNet convolutional neural network is selected to implement training in the large data set ImageNet, because the data information contained is relatively large, which involves more than 20,000 categories and more than 14 million pictures. Assuming that it is regarded as the source domain of the research in this paper, the actual calculation quantity will bear a large burden. Therefore, only a subset is selected, from which 100,000 images of 800 categories are used as the training set. Meanwhile, the Keras deep learning framework is used for training, and the visualization tools under the TensorFlow framework are used for training processing. Finally, the corresponding training results are presented[5-7].

The specific training steps are as follows: First, the target domain sample set is marked with pictures. By randomly dividing the image set constructed in this paper into training set and test set, and then marking all images, this data set can be called the main content of this paper. Second, 100,000 labeled images are selected from the ImageNet dataset to carry out transfer learning. Thirdly, the AlexNet convolutional neural network is trained with the source domain data set, and
the trained model is scientifically preserved. Fourth, adjust the pre-training model. Through network adjustment of the training model obtained in Step 3, network weight values, bias and output layer dimensions of the last three layers of the full connection layer were modified, and the first five layers of the network were frozen to ensure the actual parameters remained unchanged. Then Softmax classifier is added after the network output layer, and the final results are classified. Fifth, using DDC transfer learning method training model, oil painting network parameters. By integrating the target domain samples into the network model training, the probability distribution and classification difference between the source data and the target data were studied and analyzed. The network losses were analyzed according to the MMD algorithm, and then the network parameters were optimized according to the error back propagation algorithm. Sixth, carry out iterative training on the network until the network loss is below the threshold. The specific experimental process is shown in Figure 2:

![Experimental operation flow chart](image)

**Fig. 2** Experimental operation flow chart

### 3. Result analysis

#### 3.1. Accuracy of the algorithm

In this paper, Keras framework is used to implement network model training, in which the training set contains 1198 images and picture information related to ecological diseases, and the test set contains 493 images. When the number of iterations reaches 3000, the accuracy rate of time training and test set reaches 96.32% and 95.24% respectively. In order to better verify the application performance of the model, the data selected in this paper was trained into the original AlexNet convolutional neural network without transfer learning and DDC training. When we observe the results of 3000 iterations, it is found that the actual effect is not significant. The
accuracy rate of the training set is only 88.85%, and the accuracy rate of the test set is only 82.78%. Therefore, under the condition of too low training samples, it is very important to implement the model and train the processing in the big data system as early as possible, so as to improve the accuracy of actual identification in a certain sense. As shown in Figure 3 below, it is the accuracy analysis result of the training set domain test set of the two training methods selected in this study. Among them, (a) the training result of DDC deep transfer learning model based on pre-training, and (b) refers to the direct training result of AlexNet.

![Training results of DDC deep transfer learning model based on pre-training](image1)

![Results of direct training of AlexNet](image2)

**Fig. 3** Comparison results of the two algorithms

By comparing the loss values of the algorithm, it can be seen that (a) refers to the loss curve of DDC deep transfer learning model based on pre-training, and (b) refers to the loss curve of ordinary CNN network.
3.2. Performance analysis of classifier

The DDC deep migration model is processed by using the trained PSO-SVM classifier, and the model is labeled as DDC-SVM. The DDC model using the Softmax classifier is regarded as DDC-Softmax, and the AlexNet network is directly used to train the model. Ensure that the training set and test set are consistent with the experiment. The final classification results are as follows:

![Loss curve of DDC deep transfer learning model based on pre-training](image1)

(a) Loss curve of DDC deep transfer learning model based on pre-training

![The loss curve of the ordinary CNN network](image2)

(b) The loss curve of the ordinary CNN network

**Fig. 4** Comparison results of loss values of the two algorithms
According to the above analysis, whether the transfer learning model of DDC or the CNN model of direct training is selected, the classification accuracy of SVM classifier is always higher than that of Softmax classifier. It is also proved that the transfer learning pre-training network model proposed in this paper has a higher classification accuracy than the model which directly implements the training on the target data set.

Comparing the two experimental analysis, this paper study and put forward the DDC depth migration based on preliminary training learning mode in the construction of practice research is showed significance, and after learning algorithm of the model reference migration better application effect significantly, thus prove network after DDC training implement fine-tuning, to grasp some of the hidden image contains features. Therefore, it is necessary to increase the application and analysis of machine learning algorithms in future scientific research and exploration[8].

4. Conclusion
To sum up, through a deep understanding of the overall structure and calculation method of Convolutional Neural Network, the basic concept of transfer learning is clarified. Based on this, a DDC deep transfer learning network method based on pre-training is proposed to promote the AlexNet network to correctly recognize image information after the training of large database ImageNet. At the same time, in view of the difference of samples in different training domains, DDC was proposed to implement optimization treatment, and then the training results were compared and analyzed, and the effectiveness of the obtained algorithm was verified. Therefore, in the future ecological construction research, it is necessary to increase the application analysis of machine learning algorithms, and pay attention to the results provided by previous scientists for in-depth discussion. Only in this way can the application advantages of relevant algorithms be fully demonstrated.

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