Classification Model of Wheat Grain based on Autoencoder

Song Wentao
Anhui University School of Internet, Hefei, Anhui, 230039

***Abstract*—Deep learning technology is the latest hot technology in the fields of machine learning, artificial intelligence, data mining, and pattern recognition in recent years; it is based on the hierarchical structure of the human brain and achieves the purpose of automatic parameter adjustment through training mechanisms, enabling some complex tasks to be performed. Simplified or implemented by deep learning technology. This article comprehensively describes the typical structure of deep learning models, introduces popular deep learning models such as autoencoders, and uses this model to classify and identify diseased wheat in the wheat particle database. Experiments quantitative statistical results show that by adjusting the parameters of deep learning during the training of the autoencoder network, the training error of the training sample will be smaller, and the error of the test sample will be reduced.**

Keywords—Deep Learning; Autoencoder; Image Classification

I. INTRODUCTION

Deep learning is the latest research boom in the field of machine learning. Since 2006, deep learning has attracted special attention from the academic community. Until now, deep learning has become one of the most popular research technologies in the field of big data companies and artificial intelligence. And also made significant progress in image search, speech recognition, image recognition, natural language processing, online advertising, etc. It can be said that deep learning is a research direction that has attracted widespread attention in the field of machine learning in recent years. The essence of deep learning is Construct a machine learning model with multiple hidden layers to learn the abstract expression of large-scale training data, with the goal of ultimately improving the accuracy of classification. It can also be understood as follows: "Deep model" is a means of deep learning theory, and "feature learning" It is the purpose of deep learning theory. Compared with traditional shallow learning, deep learning focuses on two points: (1) deep learning emphasizes the depth of the model structure; (2) deep learning highlights the importance of feature learning, Each layer in the model is transformed by features, and finally gets more abstract features at the top layer, which solves artificial design problem levy consumption of time and resources.

II. TYPICAL STRUCTURE OF DEEP LEARNING MODEL

The purpose of deep learning is to build an artificial neural network that can learn objective things like the human brain. Its concept is derived from human research on artificial neural networks, and its typical structure is shown in Figure 1:

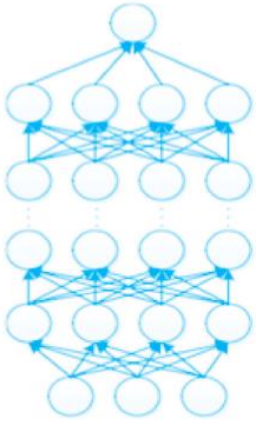

Figure 1 Typical structure of a deep learning model

As can be seen from the figure, the deep learning model is mainly composed of three parts, namely the input layer, the hidden layer and the output layer. Deep learning is to analyze and learn the low-level features to form more abstract high-level features to build the deep level of the data Feature representation. Deep learning is also divided into two types, namely supervised and unsupervised learning. For example, convolutional neural networks belong to supervised deep learning models, and deep belief networks belong to unsupervised deep learning models. 20th century At the end of the 1980s, the implementation of the back-propagation algorithm in the category of artificial neural networks brought dawn to machine learning. The idea of the bp algorithm is this: at the beginning, the required cost is defined on the training sample set. Function, and then solve the gradient of the cost function for each parameter. In the knowledge theory of artificial neural networks, if you know the residuals of the upper neurons, you can find the gradients of the lower neurons, but the bp algorithm uses this A little knowledge. The specific calculation and solution process of the bp algorithm is also top-down, and it continues until we get the gradient of each parameter. In addition, its model for machine learning based on statistical methods, it can help to learn statistical rules from a large number of training sample sets to achieve the goal of data prediction or classification. However, there are still a series of problems in the application of the bp algorithm in the training process of deep learning. For example, the gradient will It becomes more and more sparse, and the error correction signal will become smaller and smaller from the top to the bottom. In the case of random initialization, the initial value will converge to a local minimum, especially in the area far from the optimal area. In addition, in the sample data training process, the bp algorithm can only be trained using labeled sample data sets, and often

978-1-7281-7005-3/20/$31.00 ©2020 IEEE

Dalian, China
June 27-29, 2020

some samples are unlabeled. Humans have found that using the bp algorithm can make an artificial nerve Network models learn statistical rules from a large number of training sets to make predictions of unknown events. This type of statistical machine learning methods shows many advantages compared to past artificial rule-based systems.

III. AUTOENCODER

The automatic encoder is based on the characteristics of artificial neural networks and is the simplest method of deep learning. Assume that a neural network and input data are given. By training and adjusting its parameters, the input and output are equal (or (Very close), so that we can get the weight of each layer. At the same time, we also get the representation of the input in each layer, which is the feature. The autoencoder is such a way to reproduce the input data as much as possible. Neural network. In order to achieve the purpose of reproducing the input data, the autoencoder needs to extract the information representing the input data.

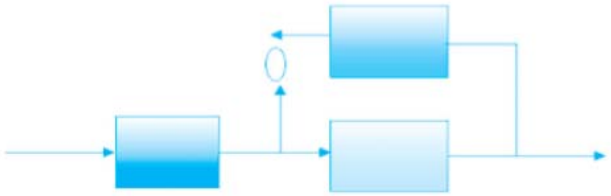

Figure 2 Schematic diagram of the reconstruction error of training the second layer

From the first step we can get the code of the first layer, which is a good representation of the first layer of the original input signal. The training method of the second layer and the first layer is the same, as shown in Figure 2, we output the first layer The code of the second layer is used as the input signal of the second layer, and the parameters of the second layer are also adjusted to minimize the reconstruction error. The second layer of expression. By analogy, other layers are trained in this way, and the parameters of this layer are adjusted for each training, the parameters of the previous layer are fixed, and their decoder decoders are already no need.

IV. EXPERIMENTAL ANALYSIS

This experiment uses a wheat particle data set obtained in practice, including normal wheat particles and diseased wheat particles, where the number of samples of each type is not exactly the same. Each sample is image data of wheat particles of 256 * 256 pixels. The data set contains 4 files, which are the images of the training samples, the labels of the training samples, the images of the test samples, and the labels of the test samples.

This experiment is based on the MATLAB R2015a operating platform, using a wheat particle recognition database, and using Matlab's Deep Learning learning toolbox. It has 2 hidden layers, each of which has 100 nodes. The overall network structure is: 784 -100-100-10. The experiment compares the recognition error rate when using denoise (noise reduction) technology and the feature map learned in both cases. Figure 3 shows the feature map when denoise autoencoder is not used:

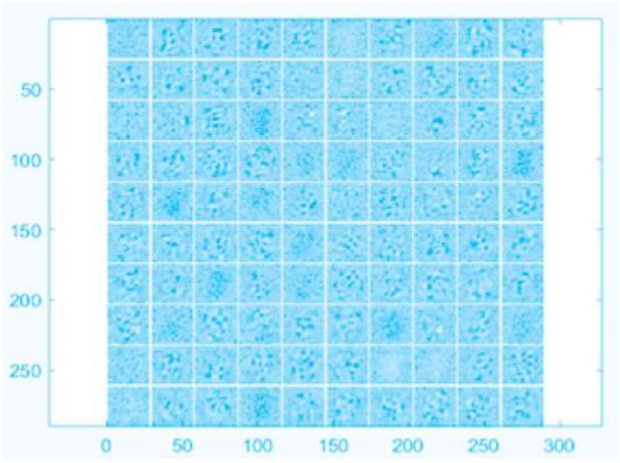

Figure 3 Feature map display when denoise autoencoder is not used

The sample mean squared error of the first layer of the training of the autoencoder network is 8.1786, the training error of the entire sample is 4.333766, the sample mean squared error of the second layer is 1.0469, and the training error of the entire sample is 0.304765. The feature map shows:

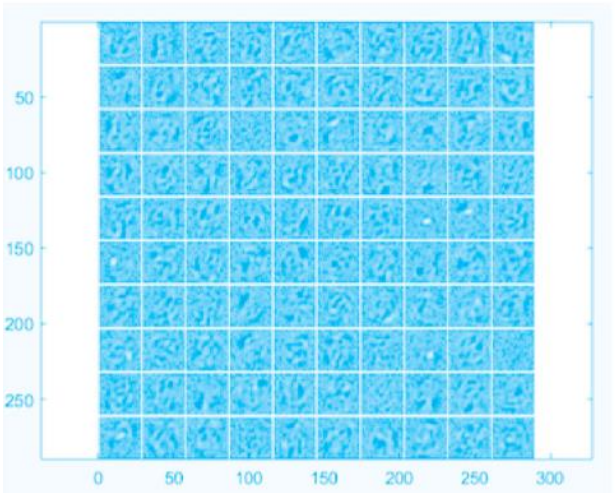

Figure 4 Feature map display when denoise autoencoder is used

It can be seen that the sample mean squared error of the first layer training of the autoencoder network is 10.7232, the training error of the entire sample is 10.35352602, the sample mean squared error of the second layer training is 3.6673, and the training error of the entire sample is 1.715745. In addition, by comparing Figure 4 With Figure 5, it can be easily seen that the features learned by the autoencoder after adding the noise are slightly better. That is to say, random noise is introduced into the visible layer of the network (that is, the data input layer), that is, when using DAE, the original data can be reconstructed with the corrupted input data, and the features it trains will be more robust. From the operating results, the training error of the second layer of the autoencoder network is smaller than the training error of the first layer, and if the weight obtained by training the autoencoder network is assigned to the FFNN network, the training error of the FFNN network is significantly smaller than the training error of the SAE network, and the error rate of the test sample is also reduced from 10.17 to 8.13%. That is to say, adding parameters that pass learning during network training will make the training sample training error smaller, and will also reduce the test sample error.

V. Conclusion

Deep learning is one of the most successful research directions in the field of machine learning in the past ten years. It has become a boom in research in big data Internet companies and artificial intelligence, and has been used in speech recognition, image search, image recognition, natural language processing, online Significant progress has been made in advertising and other fields. This article comprehensively describes the typical structure of deep learning models, introduces popular deep learning models such as autoencoders, and uses this model to classify and identify diseased wheat images in the wheat particle database. Experiments quantitative statistical results show that by adjusting the parameters of deep learning during the training of the autoencoder network, the training error of the training samples will be smaller, and the error of the test samples will be reduced, which will improve the correct classification and recognition of diseased wheat images.

References

[1] Shang Li. Research on sparse coding algorithm and its application [D]. University of Science and Technology of China. 2006.

[2] Behnke S. Hebbian learning and competition in the neural abstraction pyramid[C]. In: Proceedings of international joint conference on neural networks (IJCNN), Washington, DC, USA, 1999, vol 2,pp 1356–1361.

[3] Bengio Y, Lamblin P, Popovici D, Larochelle H. Greedy layer-wise training of deep networks[J]. In: Advances in neural information processing systems (NIPS), Vancouverr, Canada, 2006, pp 153–160.

[4] Yu Kai, Jia Lei, Chen Yuqiang, Xu Wei. Yesterday, today and tomorrow of deep learning [J]. Computer Research and Development, 2013, 50 (9): 1799-1804.

[5] Lu Na. Research on large-scale image classification based on deep hierarchical feature learning [D]. University of Electronic Science and Technology of China. 2015.

[6] Feng Xiaoxia. Research on image recognition algorithms based on deep learning [D]. Taiyuan University of Technology. 2015.

[7] Liu Jianwei, Liu Yuan, Luo Xionglin. Progress in Deep Learning Research [J]. Applied Computer Research, 2014, 31 (7).

[8] Sun Zhijun, Xue Lei, Xu Yangming, Wang Zheng. Review of Deep Learning Research [J]. Journal of Computer Applications, 2012, 29 (8): 2806-2810.

[9] Coates A,Lee H,Ng AY. An analysis of single-layer networks in unsupervised feature learning[C]. In: Proceedings of international conference on artificial intelligence and statistics (AISTATS), Chia, Laguna, Italy, 2010.

[10] Behnke S. Hebbian learning and competition in the neural abstraction pyramid[C]. In: Proceedings of international joint conference on neural networks (IJCNN),Washington,DC,USA, 1999,vol 2,pp 1356–1361.