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Character recognition research based on artificial intelligence and maching learning

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ABSTRACT

In recent years, machine learning becomes a new research focus in the field of artificial intelligence. It has been successfully applied in the complex systems such as: machine vision, speech recognition, natural language processing, web search, recommendation system, intelligent robots etc. Especially, in the last two years the appears of the autopilot, deep QA system which based on artificial intelligence and machine learning technology make people began to rethink the word: machine is invented by human, it can never exceed the level of human intelligence. The Chinese character recognition has been a difficult problem in the field of character recognition. Different from the English text consisting of a small number of characters, it is difficult to use traditional algorithm to identify it automatically. But thanks to the further development of machine artificial intelligence, the automatic identification of Chinese characters has entered the practical stage. Although many domestic and foreign software vendors have launched a rate of Chinese characters automatic identification system which has a good recognition, there is still large room for improvement. In a large number of current domestic literatures, mainly papers aim at the research on automatic recognition of a small amount of characters. It is difficult to be applied to large character set recognition object. This is closely related to the structure of machine learning and learning algorithm. Satisficing votes of each classifier, which is trained previously to classify the characters feature vector, and taking the result of most votes as the final output is the current foreign mainstream solution.

KEYWORDS

Back propagation algorithm; Character recognition; Multi-layer perception; Supervised learning.

INTRODUCTION

"Neural network" redirects here. For networks of living neurons, see Biological neural network. For the journal, see Neural Networks (journal). In machine learning and related fields, artificial neural networks (ANNs) are computational models inspired by an animal's central nervous systems (in particular the brain) which is capable of machine learning as well as pattern recognition. Artificial neural networks are generally presented as systems of interconnected "neurons" which can compute values from inputs.

For example, a neural network for handwriting recognition is defined by a set of input neurons which may be activated by the pixels of an input image. After being weighted and transformed by a function (determined by the network's designer), the activations of these neurons are then passed on to other neurons. This process is repeated until finally, an output neuron is activated. This determines which character was read.

Like other machine learning methods - systems that learn from data - neural networks have been used to solve a wide variety of tasks that are hard to solve using ordinary rule-based programming, including computer vision and speech recognition. The study adopts BP network.

The paper is organized as follows. Section 1 introduces neural network. Section 2 describes the BP neural network, the simplified model and the training of BP. Section 3 describes how to realize character recognition by BP neural network. Section 4 mentions chinese characters recognition based on HALCON section 5 mentions progress of chinese characters recognition.

BP NETWORK

If we consider the human brain to be the 'ultimate' neural network, then ideally we would like to build a device which imitates the brain's functions. However, because of limits in our technology, we must settle for a much simpler design. The obvious approach is to design a small electronic device which has a transfer function similar to a biological neuron, and then connect each neuron to many other neurons, using RLC networks to imitate the dendrites, axons, and synapses. This type of electronic model is still rather complex to implement, and we may have difficulty 'teaching' the network to do anything useful. Further constraints are needed to make the design more manageable. First, we change the connectivity between the neurons so that they are in distinct layers, such that each neruon in one layer is connected to every neuron in the next layer. Further, we define that signals flow only in one direction across the network, and we simplify the neuron and synapse design to behave as analog comparators being driven by the other neurons through simple resistors. We now have a feed-forward neural network model that may actually be practical to build and use.

Referring to figures 1 and 2, the network functions as follows: Each neuron receives a signal from the neurons in the previous layer, and each of those signals is multiplied by a separate weight value. The weighted inputs are summed, and passed through a limiting function which scales the output to a fixed range of values. The output of the limiter is then broadcast to all of the neurons in the next layer. So, to use the network to solve a problem, we apply the input values to the inputs of the first layer, allow the signals to propagate through the network, and read the output values

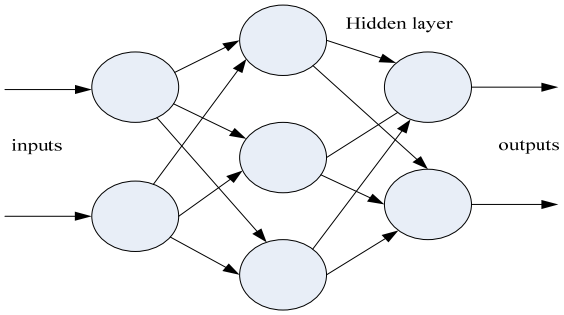

Figure 1 : A generalized network

Stimulation is applied to the inputs of the first layer, and signals propagate through the middle (hidden) layer (s) to the output layer. Each link between neurons has a unique weighting value.

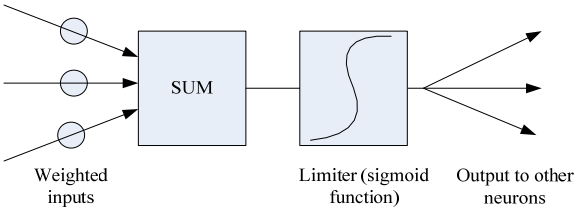

Figure 2 : The structure of a neuron

Inputs from one or more previous neurons are individually weighted, then summed. The result is non-linearly scaled between 0 and +1, and the output value is passed on to the neurons in the next layer.

Since the real uniqueness or 'intelligence' of the network exists in the values of the weights between neurons, we need a method of adjusting the weights to solve a particular problem. For this type of network, the most common learning algorithm is called Back Propagation (BP). A BP network learns by example, that is, we must provide a learning set that consists of some input examples and the known-correct output for each case. So, we use these input-output examples to show the network what type of behavior is expected, and the BP algorithm allows the network to adapt.

The BP learning process works in small iterative steps: one of the example cases is applied to the network, and the network produces some output based on the current state of it's synaptic weights (initially, the output will be random). This output is compared to the known-good output, and a mean-squared error signal is calculated. The error value is then propagated backwards through the network, and small changes are made to the weights in each layer. The weight changes are calculated to reduce the error signal for the case in question. The whole process is repeated for each of the example cases, then back to the first case again, and so on. The cycle is repeated until the overall error value drops below some pre-determined threshold. At this point we say that the network has learned the problem "well enough" - the network will never exactly learn the ideal function, but rather it will asymptotically approach the ideal function.

When a document is put to visual recognition, it is expected to be consisting of printed (or handwritten) characters pertaining to one or more scripts or fonts. This document however, may contain information besides optical characters alone. For example, it may contain pictures and colors that do not provide any useful information in the instant sense of character recognition. In addition, characters which need to be singly analyzed may exist as word clusters or may be located at various points in the document. Such an image is usually processed for noise-reduction and separation of individual characters from the document. It is convenient or comprehension to assume that the submitted image is freed from noise and that individual characters have already been located (using for example, a suitable clustering algorithm). This situation is synonymous to the one in which a single noise-free character has been submitted to the system for recognition.

The process of digitization is important for the neural network used in the system. In this process, the input image is sampled into a binary window which forms the input to the recognition system. In the above figure, the alphabet A has been digitized into 6X8=48 digital cells, each having a single color, either black or white. It becomes important for us to encode this information in a form meaningful to a computer. For this, we assign a value +1 to each black pixel and 0 to each white pixel and create the binary image matrix I which is shown in the. So much of conversion is enough for neural networking which is described next. Digitization of an image into a binary matrix of specified dimensions makes the input image invariant of its actual dimensions. Hence an image of whatever size gets transformed into a binary matrix of fixed pre-determined dimensions. This establishes uniformity in the dimensions of the input and stored patterns as they move through the recognition system.

CHARACTER RECOGNITION BY BP NEURAL NETWORK

To realize character recognition by computer, BP algorithm will be correspondingly simplified. The node function can be defined by the following formulas:

$$f(x)=\frac{1}{1+e^{-x}} \quad \textbf{(1)}$$

where x is input value, e is constant. Suppose there is random network which includes many nodes that the number of nodes is n, and each node's feature is Sigmoid. For simplicity there is only a output value named y in whole network. The output value of each node is Ok and the network includes N samples expressed as $(x_i, y_i)(i=1,2,...,N)$ To one input named by x_i, the output of neural network is y_i. The equations of node (j) isdescribed by the following.

$$net_{ji}=\sum_k W_{kj} O_{ki} \quad \textbf{(2)}$$

Square-type error function is determined by the following equations.

$$E_k=\frac{1}{2}\sum_{i=1}^{n}(y_k-\hat{y}_k)^2 \quad \textbf{(3)}$$

Where y_k is actual output of BP.

$$E_k=(y_k-\hat{y}_k)^2 \quad \textbf{(4)}$$

$$net_{ji} = \sum_{k} W_{kj} O_{ki} \quad (5)$$

$$\delta_{ji} = \frac{\partial E_i}{\partial net_{jk}} \quad (6)$$

Then the following equations is deduced.

$$\frac{\partial E_i}{\partial W_{kj}} = \frac{\partial E_i}{\partial net_{ji}} \frac{\partial net_{ji}}{\partial net_{ji}} \quad (7)$$

Suppose that there are L layers in BP network, the L layer includes only output nodes and the first layer is input nodes. Thus the algorithm of BP is simplified as follows.

(1) Select initial Weights.

(2) Following process is repeated until the output value is convergent.

When value of i is from one to N, if there is fore propagation process, the value of Oki net ji yi are calculated. If there is back propagation process, the value of is calculated in each layer from the M layer to the 2 layer.

The simplified BP algorithm is to turn a group of samples of input and output problem into a nonlinear optimization problem and use gradient descent method that is the most universal optimization method. The more accurate solution can be attained through adding hidden nodes to BP network which increases adjustable parameter in optimization problem.

TRAINING BP NEURAL NETWORK

It is a key problem to select the amount of data in complex character recognition, because the relationship between input and output is included the samples selected. Thus, the amount of data used is more and the result of learning and training more exactly reflect the relationship of input and output. However, too much data will crease the expense of gathering data, analyzing data and training BP. Of course, exact result will not be attained if there is too little data. In fact the amount of data is decided by many factors such as network scale, the need of network test and the distribute of input and output. An experiential rule of confirming network scale is that the number of training samples is five times to ten times as that of connective samples.

According to the rule, training will be implemented between standard character and practical character abstracted from image, especially the confused character. Detailed steps are as follows.

Step 1: Select a pair of training samples from cases set being trained and use input vectors as network input.

Step 2: Calculate output vectors of network.

Step 3: Compare error between network output vectors and objective vectors being trained.

Step 4:Adjust network weights in the direct of reducing error from output t layer to the first middle layer.

Step 5:Repeat above steps for every case of case gather being trained until the error of the whole of case gather is minimum. parameter in optimization problem.

The calculation of the first step and the second step is implemented layer by layer. The end of learning is that error between actual output vectors and objective vectors is so little that it is acceptable and the weights do not need to be adjusted. As a result, when neural network trained is used to recognize character, the process only need to use the first step and the second step. The third step and the forth step begins from output layer and iteration method is used. Topological Structure is shown as figure 3.

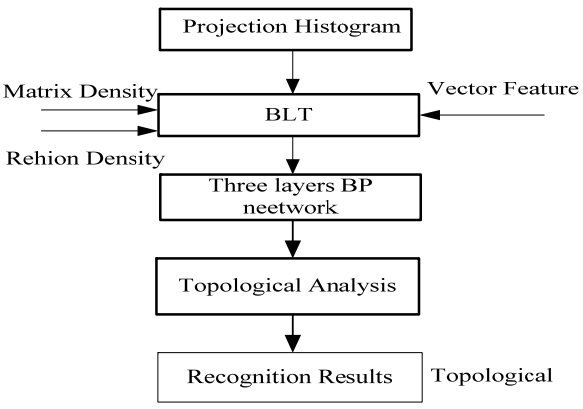

Figure 3 : Topological structure

CHINESE CHARACTERS RECOGNITION BASED ON HALCON

Commonly used Chinese character segmentation methods include the projection method, template matching and domain connecting method. Projection method and the traditional domain connecting method is not a better solution of the Chinese characters disconnected problem, the template matching is too dependent on a priori knowledge when producing templates. To solve these problems, dynamic threshold segmentation method combined with region morphology and connected region segmentation method is proposed in this paper, a better way to solve the problem of Chinese characters disconnected. After segmenting Chinese characters and extracting characters features, improved artificial neural network classifier is used to classify and identify characters. The artificial neural network classifier is fast at classification, a good choice if the training can be applied offline and thus is not time critical.

Image processing software HALCON is comprehensive standard software for machine vision developed by the German MVTec company. It is a set of image processing library with more than 1600 operators for Blob Analysis, Morphology, Pattern Recognition, Matching, Measuring, Identification, and 3D vision, to name just a few. The interactive programming environment can be used for rapid development of machine vision applications, or new operator can be added to integrate their visual function. Introduce with HALCON's powerful computational analysis capability, Chinese characters recognition is greatly simplified, and produces good results.

Chinese character recognition consists of two main tasks: segmentation and classification. Character segmentation is a main pre-processing step. In this paper dynamic threshold segmentation method combined with region morphology method is put forward to solve the disconnected problem in. Characters Recognition Progress is shown as figure 4.

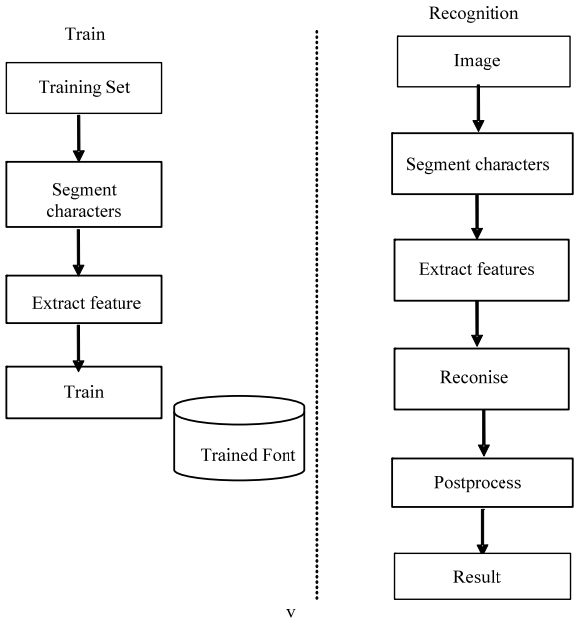

Figure 4 : Characters recognition progress

Chinese characters segmentation. Improved artificial neural network classifier in HALCON is applied in classification.

PROGRESS OF CHINESE CHARACTERS RECOGNITION

As shown in Fig.5, the character recognition process consists of training stage and recognition process. In the learning process, known as the offline process, comprises the training of the font, i.e., regions that represent Chinese characters (in the following just called characters) are extracted and stored together with the corresponding character names in training files, making it easy to find the errors that occurred during the training on the one hand and the other one hand, you can reuse the contained information for the case that you want to apply a similar application in the future. Now the training files are used to train the font.

CONCLUSION

The important feature of thisANN training is that the learning rates are dynamically computed each epoch by an interpolation map. The ANN error function is transformed into a lower dimensional error space and the reduced error function is employed to identify the variable learning rates. As the training progresses the geometry of the ANN error

function constantly changes and therefore the interpolation map always identifies variable learning rates that gradually reduce to a lower magnitude. As a result the error function also reduces to a smaller terminal function value. The result of structure analysis shows that if the number of hidden nodes increases the number of epochs taken to recognize the handwritten character is also increases. A lot of efforts have been made to get higher accuracy but still there are tremendous scopes of improving recognition accuracy.

From the results shown above, these proposed methods are actually experimentally proved to be fast and efficient. But How to identify Chinese characters having noise interference and distortion, such as hand writing with HALCON should be our further study task.

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