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Handwritten Number Recognition by Neural Networks

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Анотація

В даній роботі досліджено можливості підвищення ефективності застосування штучних нейронних мереж різних типів для розпізнавання цифр, проведено оптимізацію створених класифікаторів та досліджено якість їх роботи.

Ключові слова: *Штучна нейронна мережа, персептрон, навчання, образ, розпізнавання.*

Abstract

This work studies the ways of increasing the effectiveness of artificial neural networks used for different types of numbers recognition; it also optimizes the created classifications and investigates the quality of their work.

Keywords: *An artificial neural network, perceptron, learning (training), image, recognition.*

Neural Networks have recently started to be used in various kinds of pattern recognition. Handwritings of different people vary greatly; therefore, it is very difficult to recognize the handwritten characters. Handwritten character recognition is an area of pattern recognition that has become the subject of research during the last some decades. Neural network is playing an important role in handwritten character recognition. Many reports devoted to character recognition have been published, but still high recognition accuracy and minimum training time of handwritten characters using neural network is an open problem. Therefore, it is very important to develop an automatic handwritten character recognition system [1].

Early optical character recognition could be traced to activity around two issues: expanding telegraphy and creating reading devices for the blind. In 1914, Emanuel Goldberg developed a machine that read characters and converted them into standard telegraph code. In about 1965, Reader's Digest and RCA collaborated to build an OCR Document reader designed in 1965 [3].

Artificial neural networks are a family of models inspired by biological neural networks (the central nervous systems of animals, the brain in particular) and are used to estimate or approximate functions that can depend on a large number of inputs and are generally unknown.

Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the network function is determined largely by the connections between elements. We can train a neural network to perform a particular function by adjusting the values of the connections (weights) between elements. Commonly neural networks are trained, so that a particular input leads to a specific target output [2].

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 has been read.

The National Institute for Standards and Technology (NIST) has amassed a large database of digits, which is freely available, and has become somewhat of a benchmark for testing algorithms classification. The MNIST database is a modified set compiled of several NIST databases. It consists of 60,000 training examples and 10,000 test samples, each of which is a 28 x 28-pixel greyscale image. It is a good database for people who want to try learning techniques and pattern recognition methods on real-world data.

We convert these images into a standard resolution, let us say 16 x 16 pixels [4]. This will give us a standard size and resolution of the image so that we are able to apply neural network because the identity of the image through neural network is directly proportional to the resolution of the image. In other words if we use different resolution for these images then we will not be able to compare or standardize them as the input neurons will vary with the variation in resolution.

After receiving matrix entries in an array, a combined processing of the image, which came as an input for further recognition, should be done. The main goal of the task was to build a self-training model using artificial neural matrix scheme (with reverse spread).

The input can be submitted in the original image matrix vector form and one inner layer with a large number of neurons can be made. However, as the size of the images is generally very small, and the number of neurons in the inner layer should be large enough, the number of connections will grow to hundreds of millions. We will have to calculate a gradient error when training each of the links. Moreover, when turning images into a string of bytes, we will lose the topology of the image, i.e. the relationship between its individual parts. This loss will increase with each layer. In addition, the neural network must take out some of these invariants. The problem of recognition is the ability of the neural networks to be resistant to small changes, rotation and zoom.

An artificial self-organized neural network is constructed as follows: a bitmap character image is fed to the neural network input; the input can be represented as matrix receptors, and the image can be represented as a sequence of 0 and 1. The information from the matrix receptors is fed and transformed to the second level which is a class of neural matrixes representatives and assessment criteria for each image database. Then intermediate scales are calculated and the criteria of the elements selection are applied. They are also stated in the matrix form, forming the third level [5].

Output data is converted to the form in which they can be presented to the inputs of the network. Each entry in the data file is called steam or educational training vector. Training vector contains one value for every input of the network and another one for each output value of the network, which depends on the type of training (with or without a teacher).

The next step presupposes the weighing of the results obtained by calculating of the objective function from each matrix scheme, taking into account different criteria. The received results can be seen on the last stage, after calculating of all the weights. The most approximate image will correspond to the highest value.

In order to ensure maximum speed training priority there should be an optimal number of neurons in the hidden layer. We can achieve the perfect recognition of the input data by increasing the number of neurons. The re-training of the previously trained neural network will lead to the increase of the rate of proper recognition probability.

The results of the experimental research confirm the effectiveness of the new developed method of the synaptic weight ranges settings for artificial neural networks training. They have practical value and can be implemented in various fields of science and practice.

Our next goal is the optimization of the neural networks learning methods applying modern approaches based on the modified genetic algorithm. In addition, these methods can be used to reduce errors occurring at image recognition and which are connected with noises, and imply the application of the approximation and images filtering.

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