A Novel Method for Handwritten Digit Recognition System

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Abstract:

Character recognition plays an important role in the modern world. It can solve more complex problems and makes humans' job easier. An example is handwritten character recognition. This is a system widely used in the world to recognize zip code or postal code for mail sorting. There are different techniques that can be used to recognize handwritten characters. Two techniques researched in this paper are Pattern Recognition and Artificial Neural Network (ANN). Both techniques are defined and different methods for each technique is also discussed. Shape recognition, Chinese Character and Handwritten Digit recognition uses Neural Network to recognize them. Neural Network is used to train and identify written digits. After training and testing, the accuracy rate reached 99%. This accuracy rate is very high.

Keywords:

INTRODUCTION AND HISTORY

Character recognition is becoming more and more important in the modern world. It helps humans ease their jobs and solve more complex problems. An example is handwritten character recognition which is widely used in the world. This system is developed for zipcode or postal code recognition that can be employed in mail sorting. This can help humans to sort mails with postal codes that are difficult to identify. For more than thirty years, researchers have been working on handwriting recognition. Over the past few years, the number of companies involved in research on handwriting recognition has continually increased. The advance of handwriting processing results from a combination of various elements, for example: improvements in the recognition rates, the use of complex systems to integrate various kinds of information, and new technologies such as high quality high speed scanners and cheaper and more powerful CPUs. Some handwriting recognition system allows us to input our handwriting into the system. This can be done either by controlling a mouse or

using a third-party drawing tablet. The input can be converted into typed text or can be left as an "ink object" in our own handwriting. We can also enter the text we would like the system to recognize into any Microsoft Office program file by typing. We can do this by typing 1s and 0s. This works as a Boolean variable. Handwriting recognition is not a new technology, but it has not gained public attention until recently. The ultimate goal of designing a handwriting recognition system with an accuracy rate of 100% is quite illusionary, because even human beings are not able to recognize every handwritten text without any doubt. For example, most people can not even read their own notes. Therefore there is an obligation for a writer to write clearly. In this paper, both Pattern Recognition and Neural Networks will be defined. Examples of types of Pattern Recognition and Neural Networks will be discussed. The advantages of using Neural Networks to recognize handwritten characters will be listed. Finally, Artificial Neural Networks, using back-Propagation method will be used to train and identify handwritten digit

What is Neural Network

A Neural Network (NN) is a function with adjustable or tunable parameters. Let the input to a neural network be denoted by x. This is a real-valued or row vector of length and is typically referred to as input or input vector or regressor or sometimes pattern vector. The length of the vector x is the number of inputs to the network. So let the network output be denoted b Y. This is an approximation of the desired output y, which is also a real-valued vector having one or more components and the number of outputs from the network. The data sets often contain many input and output pairs. The x and y denote matrices with one input and one output vector on each row. A neural network is a structure involving weighted interconnections between neurons or units. They are often non-linear scalar transformations but can also be linear scalar transformation. The following figure shows an example of a one-hidden-layer neural network with three inputs, x = {x1 ,x2 ,x3}
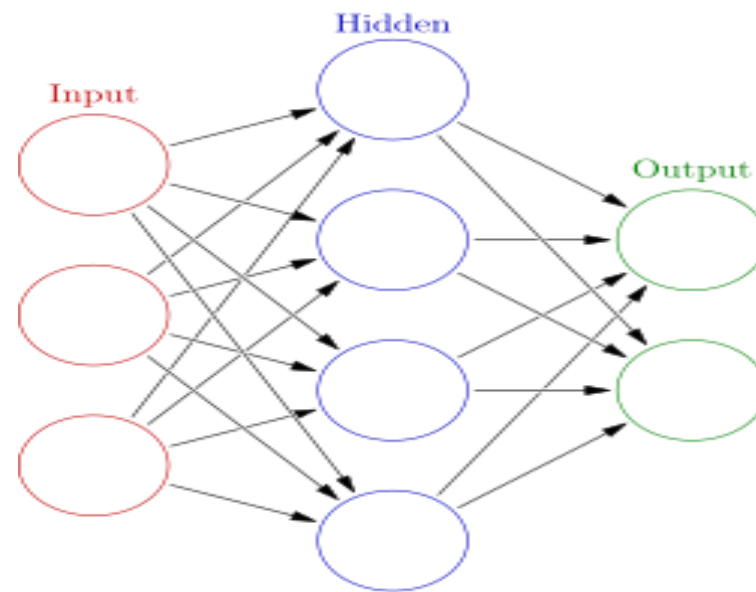
The three inputs, along with a unity bias input, are fed each of the two neurons into the hidden layer. The two outputs from this layer and from a unity bias are then fed into the single output layer neuron. This produces the scalar output Y.The layer of neurons is called hidden layer because the outputs are not directly seen in the data. Each arrow in the corresponds to a real-valued parameter, or a weight, of the network. The values of these parameters are tuned in the training network. A neuron is structured to process multiple inputs. This includes the unity bias in a non-linear way. Then, this produces a single output. All inputs to the neuron are first augmented by multiplicative weights. These weighted inputs are summed and then transformed via a non-linear activation function and as indicated from the above Figure the neurons in the first layer of the network are non-linear. The single output neuron is linear because no activation function is used. The information in an ANN is always stored in a number of parameters. These parameters can be pre-set by the operator or trained by presenting the ANN

Artificial Neural Network.

Artificial Neural Network (ANN) has been around since the late 1950's. But it Was not until the mid-1980 that they became sophisticated enough for applications. Today, ANN is applied to a lot of real- world problems. These problems are considered complex problems. ANN's are also a good pattern recognition engines and robust classifiers. They have the ability to generalize by making decisions about imprecise input data. They also offer solutions to a variety of classification problems such as speech, character and signal recognition. Artificial Neural Network (ANN) is a collection of very simple and massively interconnected cells. The cells are arranged in a way that each cell derives its input from one or more other cells. It is linked through weighted connections to one or more other cells. This way, input to the ANN is distributed throughout the network so that an output is in the form of one or more activated cells. es of input and also possibly together with the desired output.

Back-propagation algorithm.

Back-propagation algorithm consists of two phases. First phase is the forward phase. This is the phase where the activations propagate from the input layer to the output layer. The second phase is the backward phase. This is the phase where then the observed actual value and the requested nominal value in the output layer are propagated backwards so it can modify the weights and bias values.

Handwritten Character Recognition.

There are many different types of recognitions in the modern time, which can really solve complex problems in the real world today. Examples of recognitions are: face recognition, shape recognition ,handwritten character recognition, such as handwritten Chinese character recognition and handwritten digit recognition.

NEURAL NETWORK BASED HANDWRITTEN DIGIT RECOGNITION.

Artificial Neural Network system is used to recognize ten different handwritten digits. These are digits from zero to nine. Here, back-propagation neural network is used to train all the data. The major problem is the digits are handwritten; therefore it is subject to enormous variability. Digits were written by different

people, using a great variety of sizes, styles, and instruments. Back-propagation can be applied to real image recognition problems without a complex pre-processing stage, which requires a detailed engineering. The learning network is fed directly with images rather than feature vectors. Before inputting the data into the network, the image has to be closed first so there would have no minor holes. Then the image is resized to 16 X 16 pixels. Afterwards, the image is thinned so only the skeleton remains. When the skeleton image is obtained, the horizontal, vertical, right diagonal, and left diagonal histogram of the image is determined. Then the histograms are concatenated into one large integer sequence. The integer sequence is the digit representation [6]. This is fed into the neural networkA three-layered neural network issued. This is 94 input units, 15 hidden units, and 10 output units (Appendix A for picture formateAn image, which contains 100 samples of number, is fed into the system to train and test. They are 100 samples of the same number with different writing styles. Then a net-file is created and can be used to create an imagefile. This image-file shows the recognized number.

Handwritten Digit Recognition With Neural Networks

Introduction.

Handwritten digit recognition is a created system that is used to recognize handwritten digits. The handwritten digit images get transformed into histograms and these histograms are fed into a neural network. This neural network outputs scores for matching the input digit against the ten possible digits (0-9). The data is trained and testedand it outputs the accuracy rate. The results can show us which numeral needs more training to reach high accuracies and which numeral the system had a difficulty to identify. Neural Network Digit Recognition System In order to have a learning task that is reasonably workable, a great amount of pre-processing of the digits is carried out using conventional Artificial Intelligence (AI) techniques. This is done before the digits are fed to the ANN. The difficult task is there are some handwritten digits that often run together or not fully connected. Numeral 5 is an example. But once these tasks have been carried out, the digits are available as individual items. But the digits are still in different sizes. Therefore a normalization step has to be performed so

we can have to have digits in equal sizes. After the digits are normalized, they are fed into the ANN. This is a feed-forward network with three hidden layers. The input is a 16 x 16 array that corresponds to the size of anormalized pixel image. The first hidden layer contains 12 groups of units with 64 units per group. Each unit in the group is connected to a 5 x 5 square in the input array and all 64 units in the group have the same 25 weight values. The second hidden layer consists of 12 groups of 16 units. This layer operates very similar to the first hidden layer, but now it seeks features in the first hidden layer. The third hidden layer consists of 30 units that are fully connected to the units in the previous layer

CONCLUSION:

Using Neural Network system, back-propagation learning, to recognize handwritten digits was very successful. An image, which contained 100 samples of each number, was trained and tested. The accuracy rate of recognizing the number was 99%. This accuracy rate is very high. From the training and testing results, it was concluded that the system had more trouble identifying numeral —5". This may be caused by the fact that the digit is running together or maybe it is not fully connected. The system was not stable. It gave different training and testing results every day for each numeral. It will need to take a close look at the system and should look for improvements for the future. From the net-file, the system was able to produce an image-file. The image-file produced showed the recognized number. This part will also need more improvements. Apart from the above problems and parts that need improvements, the overall recognition system was successful.

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