2 A typical neural network for solving the MNIST database

Abstract

The MNIST database (Mixed National Institute of Standards and Technology database) is a large database of handwritten digits that is commonly used for training various image processing systems. The database contains 60,000 training images and 10,000 testing images. There have been a number of scientific papers on attempts to achieve the lowest error rate; one paper, using a hierarchical system of convolutional neural networks, manages to get an error rate on the MNIST database of 0.23 % (in a paper by the original creators of the database, they used a support vector machine to get an error rate of 0.8%).[1]

A typical neural network to solve the MNIST task might have

- ***784 inputs*** (pixels) connected to ***1,000 neurons***, which are in turn connected to ***10 output targets*** (one for each digit).
- Each layer is *fully connected* to the layer above (so each input pixel has a set of ***weights*** that is connected to every neuron in the layer above).

This architecture can do quite well on handwritten digit recognition, but is orders of magnitude smaller than the human brain.

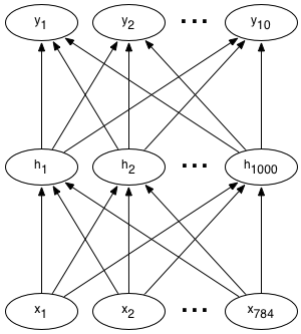

Figure 2.1: A graphical representation of the network described above, where x_i are the inputs, h_j are the hidden neurons and y_k are the output class variables. The arrows represent the weights; the first layer connects 784 pixels to $1,000$ hidden neurons (units) using $784 \times 1,000 = 784,000$ weights (typically represented as a $784 \times 1,000$ matrix). The next layer connects $1,000$ hidden units to 10 output labels using $10 \times 1,000 = 10,000$ weights; thus this network has a total of $10,000 + 784,000 = 794,000$ weights.

[1] Details from Wikipedia