Homework 4 - Artificial Intelligence - 153COSI-101A-1

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Deadline: Monday, November 2, 2015, 11:55 PM

Assignment: You are given a training set containing the handwritten images of three digits (3, 5, 8). Train a feedforward neural network with one hidden layer of size 3 to learn representations of those digits. Try using (a) Linear transform function and (b) Sigmoid transform function for the hidden layer. Change the size of hidden layer to 6 and 9, and retrain the networks.

Submit:
(1) Your codes
(2) The image visualization of the input weights of every neuron in the hidden layer in the trained neural networks. Put all images in one document (PDF or Word) and submit the document. Please clearly label every image.

Answers:

Linear hidden layer with 3 hidden neurons:

As you can see, the numbers are barely visible with a linear hidden layer. However, if the digits are trained separately, you can achieve slightly better results:

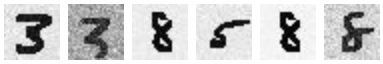
Nevertheless, this was by far the word performing option with the pybrain library. This may be a limitation of the pybrain implementation as I remember seeing better results in class.

Sigmoid hidden layer with 3 hidden neurons:

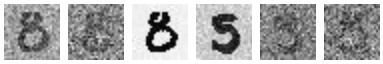
This network had highly variable results with each training session. It typically captured at least one digit well and sometimes it also captured a second digit less well. The network did quite well when trained on one digit at a time as seen below:

However, this is “cheating” with respect to this task as it required me to break up the numbers and train separate networks

Sigmoid hidden layer with 6 hidden neurons:



This 6 hidden neuron network was at times very successful with representations of all numbers in the above set of images. However, other runs were far less successful. Take this one for example:



This is the exact same setup as the previous set of images, however, no hidden neuron takes on a solid representation of 3.

Sigmoid hidden layer with 9 hidden neurons:

The more neurons we add, the more likely we are to have at least one good representation of each number. The above set demonstrates this. However, we also occasionally see something like this:

I would note, however, that getting all of one digit as in the above was rare.

Sigmoid hidden layer with 30 hidden neurons:

I trained a network with 30 neurons to see if the pattern held:

Indeed, the more hidden layer neurons, the more likely I was to see at least one solid representation of each digit. Furthermore, I also saw that the error reported by the train function, more consistently converged to the same value with larger networks.

Sigmoid hidden layer with 50 hidden neurons:

Here is one final example with the 50 neuron network, which converged to the same low error as the 30 neuron network and has a great set of hidden neurons representing all digits.