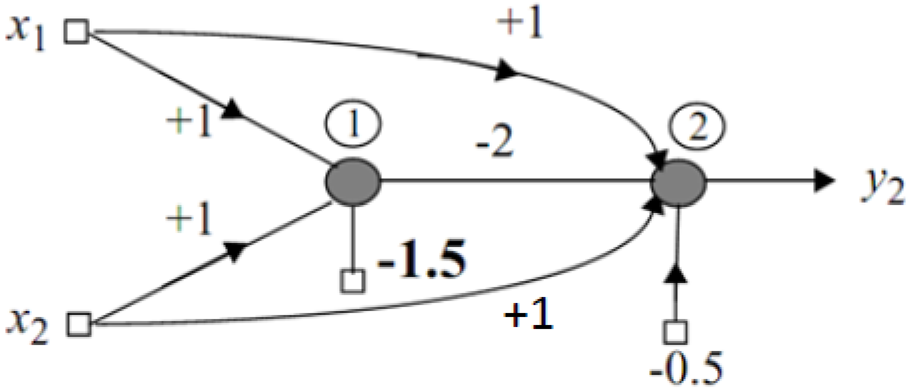
SysEng 5212/ EE 5370 Homomowork 3

February 15, 2018

Problem 1. Compute the induced local field (v) and the neuron output (y) for both neurons in the network given below. Assume a hardlimit activation function for both neurons. Show that this network solves the XOR problem.



(10 pts)

Problem 2. Implement back-propagation algorithm for following functions (**do not use matlab toolbox for this problem**)

$$f(x) = e^{-x} \text{ where } 1 \ \leq \ \text{x} \ \leq 10 \tag{1}$$

$$f(x,y) = sin(\pi x)cos(\pi y) \text{ where x } \in (-2,2) \text{ and y } \in (-2,2) \tag{2}$$

For each function, do the following:

1. Set up three sets of data: training, validation and testing (already provided in the code).

2. Use the training and validation data to compute the synaptic weights of the network, assumed to have a single hidden layer. The training data should be used to update the weights and validation data to calculate the MSE. Complete the code of **bp2.m** and **bp2val.m** files.

3. Evaluate the computation accuracy of the network by using the test data. Complete the code in last part of **q2p1.m** and **q2p2.m** files.

Use a single hidden layer, but with a variable number of hidden neurons. Investigate how the network performance is affected by varying the size of the hidden layer.

(40 pts)

Problem 3. Write a Matlab program to create and train a multilayer perceptron using the backpropagation learning algorithm with momentum (**use matlab toolbox for this problem**). Use your network to classify the Iris dataset (iris3class.mat) provided with this homework. Divide your data into a training set and testing set in a $2:1$ ratio. Perform the following experiments with your network:

1. Experiment with the following values of the learning rate (η) and momentum parameter (α) and comment on your results. Determine the values of η and α that yield best classification accuracy.

$$\eta \in [0.001, 0.01, 0.1, 0.25, 0.5]$$
$$\alpha \in [0, 0.1, 0.5, 0.8, 0.99]$$

2. Use the Levenberg-Marquardt variant of backpropagation to train your network and compare its performance with classical backpropagation.

3. Use the Nguyen-Widrow technique for weight initialization and compare the network's perfor- mance to that using random weight initialization.

4. Use 3-fold cross validation to test and train your network. Comment on the network's perfor- mance.

(50 pts)