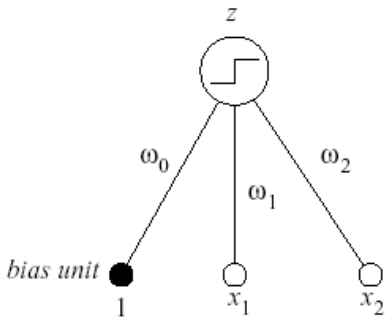
EEL5840: Machine Intelligence I: Homework #4

(Due Tuesday September 22, 2009)

Problem 1:

Consider the simple two-input perceptron below, where the activation function γ for z is the following threshc function:



$$\gamma(u) = \begin{cases} 0 & u \le 0 \\ 1 & u > 0 \end{cases}$$

(a) For each data set below, indicate whether or not a set of weights $\{\omega_0, \omega_1, \omega_2\}$ exists which would give the desired mapping.

#1			#2			#3			#4		
x_1	x_2	z	x_1	x_2	z	x_1	x_2	z	x_1	x_2	z
0	0	1	0	0	0	0	0	1	0	0	0
0	1	1	0	1	1	0	1	1	0	1	0
1	0	0	1	0	1	1	0	0	1	0	0
1	1	1	1	1	0	1	1	0	1	1	1

(b) Which (if any) of the data set(s) that is learnable in (a) cannot be learned if $\omega_0 = 0$?

(c) Which (if any) of the data set(s) that is learnable in (a) cannot be learned if $\omega_0 = -20$?

(d) Which (if any) of the data set(s) that is learnable in (a) cannot be learned if $\omega_0 = 20$?

Problem 2

Consider a one-hidden layer feedforward neural network, fully connected between layers, with 2 inputs, 2 hidden units in the first layer, and 1 output. Assume sigmoidal activation functions .

a. How many total independent weights are contained in this neural network? Show Work! No Work, No Credit.

Answer: ____ independent weights.

b. *Without any local variable*s, how many additions, multiplications, and function evaluations (γ,γ') are required to compute the output of the neural network in terms of the inputs and the weights of the neural network? Show Work! No Work, No Credit.

Additions:_____ Multiplications:_____ Function Evaluations:_____

c. Using the backpropagation algorithm, how much total computation is required [additions, multiplications and function evaluations (γ,γ')] to compute the error derivatives with respect to all the weights in the neural network, given a single training pattern $<x_1,x_2,y>$and the error measure $E=\frac{1}{2}(y-z)^2$? Show Work! No Work, No Credit.

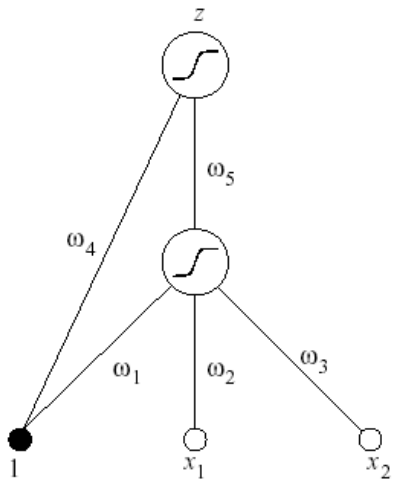
Forward Pass:

Additions:_____ Multiplications:_____ Function Evaluations:_____

Backward Pass:

Problem 3:

Consider the neural network with sigmoidal activation functions below:



Assuming initial values for the weights,

$\omega_i = 0.1$, $i \in \{1, 2, 3, 4, 5\}$,

a learning rate $\eta = 0.3$, pattern training, and the following training data set,

x_1	x_2	y
1	0	1
0	1	0

compute the value of the weights after two iterations of the backpropagation algorithm (one iteration per training pattern).