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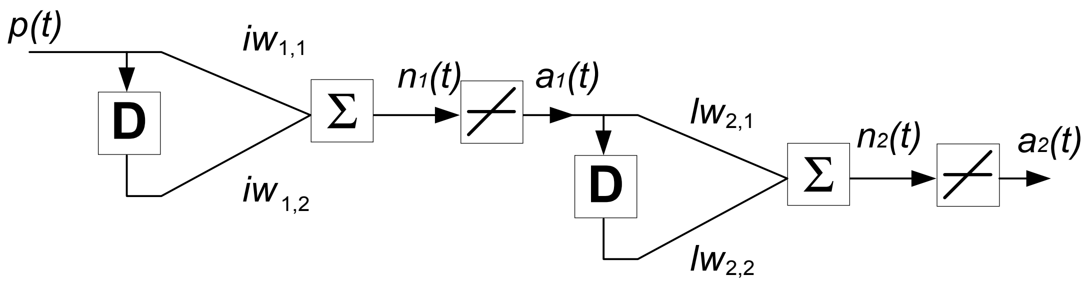
ENEE 434 Midterm Spring 2002

Work all problems and show your work for partial credit. 100 points. Your signature guarantees the work is your own - only signed papers will be graded.

Open book, open notes. Good luck.

1. [30 points, 15 minutes] In the following neural network let an input sequence be **p**(1) = [2], **p**(2) = [1], **p**(3) = [4], **p**(4) = [3] and let the weight matrix be $\mathbf{IW}^{1,1}$ = [2 1] and $\mathbf{LW}^{2,1}$ = [1 2], calculate $a_1(t)$ and $a_2(t)$ for t=0, 1, 2, 3, 4, 5; assume any unknown delay states to be zero and that the inputs are cyclicly repeated. Will the outputs ever cyclicly repeat,(explain your answer)?



2. [35 points, 25 minutes] A MatLab script for perceptron training is given as follow:

```
net = newp([-5 5; -5 5], 1);
net.trainParam.epochs = 3;
p = [[1;-2] [-3;2] [-2;1]];
t  = [0 1 1];
net = train(net, p, t)
```

Calculate weights and bias in each epoch. Is the performance goal met? If yes, what is the number of epochs that it takes to reach the goal? Calculate the error rate to train the perceptron and plot it.

3. [35 points, 25 minutes]

Thinking to increase the number of exemplars a student proposes a new class of Hopfield networks by changing the activation function from tanh(n). The jth new activation function, $a_j(n)$, is based upon the satlin(n) one, where

satlin(n) = n1(n)-(n-1)1(n-1) with 1(n) being the unit step function.

This (j+1)st activation function is defined as

$a_{j+1}(n) = \text{satlin}_j(n) + \text{satlin}_j(n-2(j+1)) = \text{satlin}_{j+1}(n) = a_j(n)+a_j(n-2(j+1))$
for j=0,1,2,..., with $a_0(n)=\text{satlin}(n) = \text{satlin}_0(n)$

a) Sketch the jth activation function versus the net input n for j=0,1, 2, and 3.

b) Using the kth one of these activation functions for each neuron of an m-neuron network, give the differential equation in the presence of resistors R and bias for the resulting Hopfield neural network.

c) Considering the network energy function covered in class and assuming the weight matrix is symmetric, $W=W^T$, if possible give the number of stable exemplars when $a_3(n)$ is used if there are N stable exemplars with $-1<n<1$ when tanh(n) is used for all neurons; if not possible explain why.

d) Discuss advantages and disadvantages of using these $a_j(n)$.