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Midterm Exam

ENEE 434 Spring 2004

Open book, open notes, 100 points, 75 minutes (15 minutes for checking); if stuck go on to the next problem. Your signature guarantees the work is your own - only signed exams will be graded. "May the most you wish for be the least you get [St. Patrick saying]"

1. (30 points, 20 minutes)

A neural network, called nnetest, has 3-vector inputs and 2-vector outputs, all in the range [-2 ,+3] of the inputs to 5 neurons that are hyperbolic tangents and from them to the purely linear output neurons; all weights are +1 and biases are -1.

a) Give the newff command to set up nnetex.

b) Give the outputs for the inputs $[1, 1/2, -1]^T$ and $[-1, ½, 1]^T$.

2. (35 points, 20 minutes)

An autoassociative neural network using +1 or -1 signals has

$$p_1 = [1 \quad 1 \quad 1 \quad 1]^T, \quad p_2 = [1 \quad 1 \quad -1 \quad -1]^T$$

a) Set up and draw a suitable neural network using, as in Exercise E7.5,

$W=PP^T-QI$

b) Considering that this network is not designed to handle

$$p_3 = [1 \quad -1 \quad -1 \quad 1]^T$$

Show: b1) what the output is with this input

b2) what the W would be if this were incorporated from the start.

c) Determine all the other independent p's which can be used to form W along with the three above. Use all of these to form W using the formula of a) and determine what outputs will result.

d) Given a positive integer k extend the result of c) to determine how many (2k-1)-vectors and how many 2^k-vectors can be auto-associated in this class of neural networks.

3. (35 points, 20 minutes)

For the logsig activation function f, y=f(x), the derivative can be found from $df(x)/dx = g_o(y)=(1-y)y$

a) Determine the same type of formula for the derivative of tansig, that is find $g_1(y)$ for $df(x)/dx=g_1(y)$.

b) A neural network has one layer with two inputs, a weight matrix W (with no biases) and two output logsig neurons. By attempting to minimize the squared output error $e=(t-a)^T(t-a)$ for an exemplar pair (p,t), develop an equation in terms of t and p, using the result above part a), for updating the ij entry W_{ij} of the weight matrix W from k=0 to k=1 assuming W(0)=I using equation (11.27)

$$W^m(k+1) = W^m(k) - \alpha s^m(k)(a^{m-1}(k))^T$$

4. Extra credit - a much research type of problem: extend Problem 2d) to 2k-vectors.