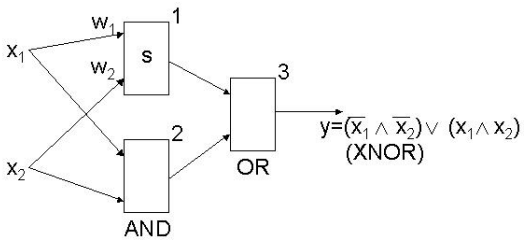
3058/GC26 Neural Computing and Artificial Intelligence, Coursework 1, 2011

Please hand in to 5th floor reception, MPEB, by **12pm on Friday 25 February**

1) The net to the right has been configured by the 'constructive' method to perform the XNOR function of its inputs x_1, x_2. Obtain a weight vector $\underline{w} = (w_1, w_2)$ and threshold s for node 1 that would enable this function to be carried out.



2) It is desired to store the two binary patterns (1,0,0) and (1,1,0) in a 3-node Hopfield net. Using the parameter setting rule than assigns non-zero values to the thresholds show that the energy function is in this case given by

$$H(x_1, x_2, x_3) = 2x_1x_3 - 2x_1 + 2x_3$$

and draw a state transition diagram for this system, labelling all transitions with their probabilities and showing the energy levels of the system.

3) Consider the reinforcement task for a single 2-input A_{RP} unit defined by the truth table

x_1	x_2	$q_0(\underline{x})$	$q_1(\underline{x})$
0	0	0.9	0.3
0	1	0.5	0.1
1	0	0.7	0.2
1	1	0.4	0.8

where $q_y(\underline{x})$ is the probability of the neuron receiving a reward for action y in input context $\underline{x}$ and the neuron has the initial parameter vector $\underline{w} = (0,\ 0,\ 0)$.

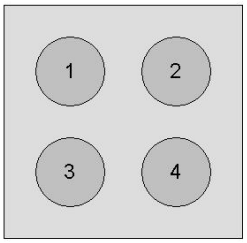
Assume that patterns (0,1), (1,0) and (1,1) are equally likely to be seen, and that the remaining pattern (0,0) is twice as likely to be seen as any of these three.

(i) What is the value of the initial performance measure M_{init}?

(ii) What is the value of the maximal performance measure M_{max}?

4) The Kohonen net to the right has weight vectors

$\underline{w}_1 = (-0.8, 0.7, -0.9)$, $\underline{w}_2 = (-0.9, 0.8, 0.9)$
$\underline{w}_3 = (0.8, -0.7, 0.8)$, $\underline{w}_4 = (0.9, 0.8, -0.7)$



having been partly-trained by exposure to a number of 3-dimensional pattern vectors. Consider now the presentation of the new training pattern $\underline{x} = (0.3, -0.4, 0.6)$.

(i) Calculate the Euclidean distance between $\underline{x}$ and each of the network's weight vectors. Which neuron is the 'winner' for pattern $\underline{x}$?

(ii) Assuming a current training rate of 0.1, perform one step of the Kohonen update rule on the weights of the winner only, and show how its weights are changed by the presentation of the new pattern.