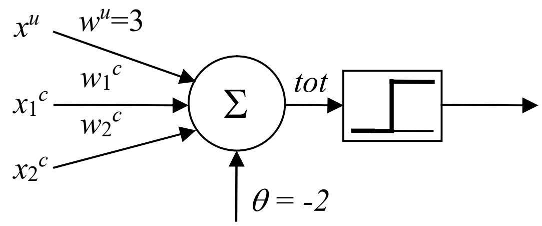
ECE 449 In-class exercise #14 **Fall 2019**

Consider following instar network



The training sequence will consist of the following two inputs, presented repeatedly (i.e. 1,2,1,2,...):

$x^u(1)=0, x^c(1)=\begin{bmatrix}-1\\1\end{bmatrix}$, and $x^u(2)=1, x^c(2)=\begin{bmatrix}-1\\1\end{bmatrix}$

a) Perform first four iterations of the instar rule using learning rate η = 0.5. Assume that initial weight matrix for conditioned input $\mathbf{w}^c(0)$ is set to all zeros.

<u>Iteration 1:</u> The neuron did not respond; thus its weights are not altered by the instar rule

$$o(1)=f_{hlu}\left(w^u x^u(1)+w^c x^c(1)+\theta\right)=f_{hlu}\left(3\cdot 0+\begin{bmatrix}0 & 0\end{bmatrix}\begin{bmatrix}-1\\1\end{bmatrix}-2\right)=0$$

$$w^c(1)=w^c(0)+0.5o(1)\left[x^c(1)-w^c(0)\right]=\begin{bmatrix}0\\0\end{bmatrix}+0\left(\begin{bmatrix}-1\\1\end{bmatrix}-\begin{bmatrix}0\\0\end{bmatrix}\right)=\begin{bmatrix}0\\0\end{bmatrix}$$

<u>Iteration 2:</u> Unconditioned stimulus appears on the second iteration, the instar did respond

$$o(2)=f_{hlu}\left(w^u x^u(2)+w^c x^c(2)+\theta\right)=f_{hlu}\left(3\cdot 1+\begin{bmatrix}0 & 0\end{bmatrix}\begin{bmatrix}-1\\1\end{bmatrix}-2\right)=1$$

$$w^c(2)=w^c(1)+0.5o(2)\left[x^c(2)-w^c(1)\right]=\begin{bmatrix}0\\0\end{bmatrix}+0.5\left(\begin{bmatrix}-1\\1\end{bmatrix}-\begin{bmatrix}0\\0\end{bmatrix}\right)=\begin{bmatrix}-0.5\\0.5\end{bmatrix}$$

<u>Iteration 3:</u> Unconditioned stimulus is not present, and the instar did not respond

$$o(3)=f_{hlu}\left(w^u x^u(3)+w^c x^c(3)+\theta\right)=f_{hlu}\left(3\cdot 0+\begin{bmatrix}-0.5 & 0.5\end{bmatrix}\begin{bmatrix}-1\\1\end{bmatrix}-2\right)=0$$

$$w^c(3)=w^c(2)+0.5o(2)\left[x^c(3)-w^c(2)\right]=\begin{bmatrix}-0.5\\0.5\end{bmatrix}+0\left(\begin{bmatrix}-1\\1\end{bmatrix}-\begin{bmatrix}-0.5\\0.5\end{bmatrix}\right)=\begin{bmatrix}-0.5\\0.5\end{bmatrix}$$

Iteration 4: Unconditioned stimulus is present again and the instar does respond

$$o(4)=f_{hlu}\left(w^u x^u(4)+w^c x^c(4)+\theta\right)=f_{hlu}\left(3\cdot 1+\begin{bmatrix}-0.5 & 0.5\end{bmatrix}\begin{bmatrix}-1\\1\end{bmatrix}-2\right)=1$$

$$w^c(4)=w^c(3)+0.5o(4)\left[x^c(4)-w^c(3)\right]=\begin{bmatrix}-0.5\\0.5\end{bmatrix}+0.5\left(\begin{bmatrix}-1\\1\end{bmatrix}-\begin{bmatrix}-0.5\\0.5\end{bmatrix}\right)=\begin{bmatrix}-0.75\\0.75\end{bmatrix}$$

This completes the fourth iteration. If we continue this process, **w** will converge to **x**, and the instar neuron will be responding to conditioned input without presence of the unconditional input.

b) Display results of each iteration in a graphical form.