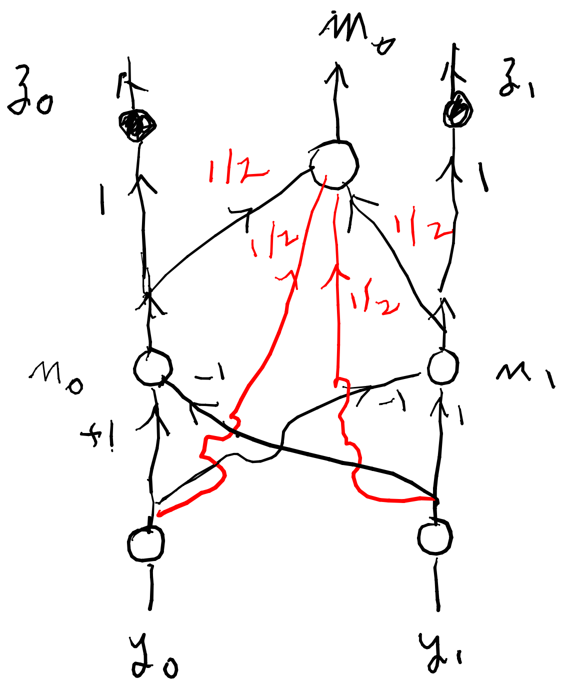
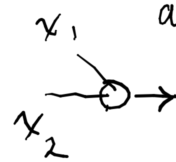
EE 434
03/13/06



analog threshold logic



$(x+x_2)\,1(x_1+x_2)$

$$m_0 = (y_0-y_1)\,1(y_0-y_1)$$

$$m_1 = (y_1-y_0)\,1(y_1-y_0)$$

$$M_0 = \frac{1}{2}(m_0+y_0+m_1+y_1)\,1\left(\frac{1}{2}[m_0+y_0+y_1+m_1]\right)$$

$$= \max(y_0, y_1)$$

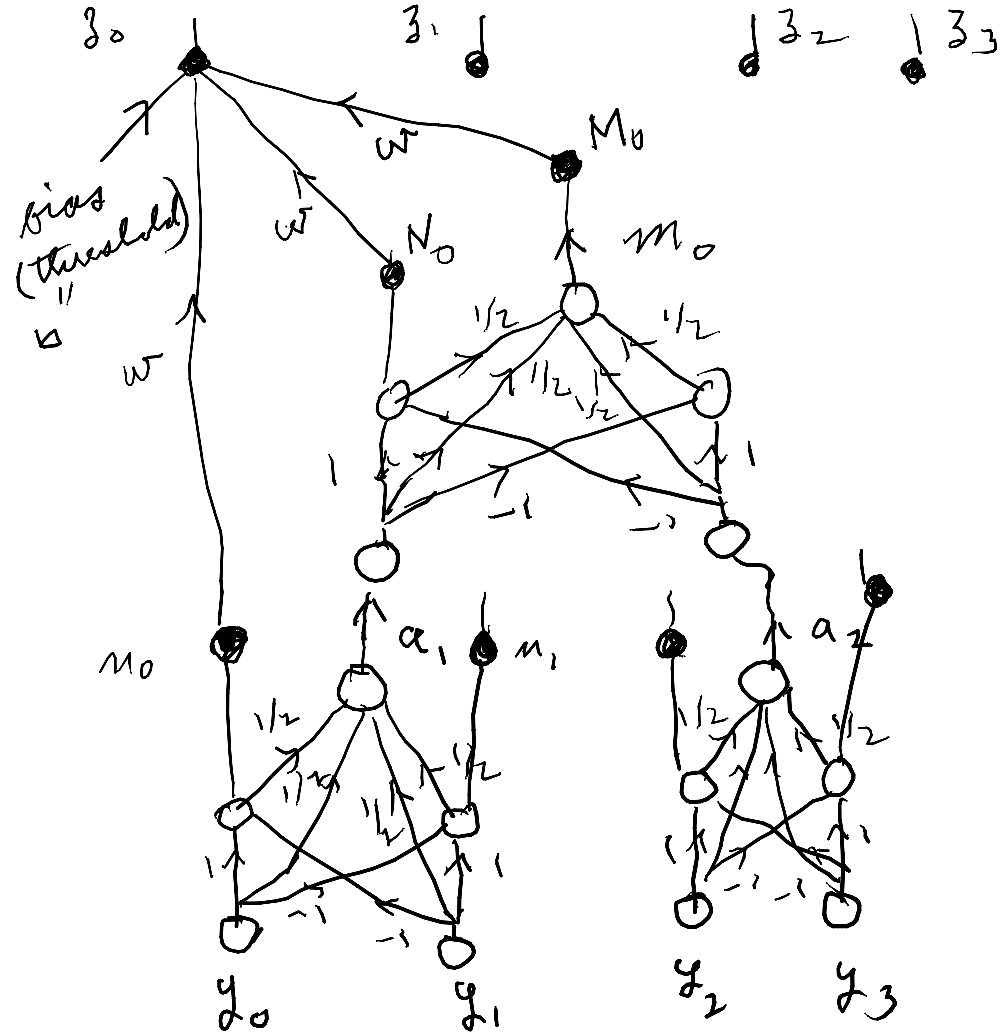
$$z_0 = 1(m_0) = \begin{cases} 1 & \text{if } y_0 \text{ is max} \\ 0 & \end{cases}$$

$$z_1 = 1(m_1) = \begin{cases} 1 & \text{if } y_1 \text{ is max} \\ 0 & \end{cases}$$

$x \longrightarrow 1(x)$ = hard limit

$$1(x) = \begin{cases} 1 & \text{if } x \geq 0 \\ 0 & \text{if } x < 0 \end{cases}$$

To get the max of 4 numbers



$m_0 = \max(a_1, a_2)$

$a_1 = \max(y_0, y_1)$
$a_2 = \max(y_2, y_3)$

desire only one of $z_i = 1$, all others $= 0$, desire the "1" for the max y_i

$$z_0 = 1(b + w\overbrace{(n_0 + N_0 + M_0)}^{\max = 3}) = \begin{cases} = 1 \text{ if } b + w \times 3 > 0 \\ = 0 \text{ if } b + w\begin{pmatrix} 2 \\ 1 \\ 0 \end{pmatrix} < 0 \end{cases}$$

(max) $\equiv 1 = M_0$

any of these numbers

$3w > -b$; $b + 2w < 0$

if $w = 1$, $3 > -b$; $b < -2$ choose $b = -2.5$

allows to get the maximum of 4 positive numbers

Hopfield net:

$$C\frac{dn}{dt} = W a(n) - Gn + I_B \; ; \quad a(n) = f(n)$$

$\uparrow$ S-vector of activation

$\hat{t} = \Omega t; \quad t = \hat{t}/\Omega$

$$C\frac{dn}{d\hat{t}/\Omega} = \Omega C \frac{dn}{d\hat{t}} \; ; \quad C \text{ is } S\times S, \; \Omega \text{ is } 1\times 1$$

can normalize to 1 one of the C_{ii}

$$C = \begin{bmatrix} C_{11} & & 0 \\ & C_{22} & \\ 0 & & \ddots \; C_{SS} \end{bmatrix} = \operatorname{diag}(C_{ii})$$

an alternate to get all $C_{ii} = 1$ is to multiply by C^{-1}

$$\frac{dn}{dt} = \underbrace{C^{-1}W}_{\hat{W}} a(n) - \underbrace{C^{-1}G}_{\hat{G}} n + \underbrace{C^{-1}I_B}_{\hat{I}_B}$$

$T \times T^{-1}$

but $\hat{W}^T \neq \hat{W}$ if

$W^T = W$

$\hat{W} = C^{-1}W$

$\hat{W}^T = W^T C^{-1}$

$$\frac{dx}{dt} = (C^{-1} W T)(T^{-1} a(x)) - \hat{G} x + \hat{I}_B$$

we want $(C^{-1} W T)^T = C^{-1} W T$

desire T so that $\quad T^T W^T C^{-1} \overset{?}{=}$ desire to choose T so that

$$T^T W^T C^{-1} = C^{-1} W T$$

$$T^T W C^{-1} \overset{?}{=} C^{-1} W T$$

$\therefore$ choose $T = C^{-1} \Rightarrow (C^{-1})^T W C^{-1} = C^{-1} W C^{-1}$

$\therefore$ can preserve the Lyapunov symmetry of $\hat{W}$ by $T = C^{-1}$, $\quad \hat{W} = C^{-1} W C^{-1}$, $\; C = \text{diag}[c_{ii}]$

$c_{ii} > 0$

$$\frac{dx}{dt} = \hat{W} \underbrace{(c\,a(x))}_{\hat{a}(x)} - \hat{G} x + \hat{I}_B, \quad \hat{a} = C\,a(x)$$

allows for stability of the $\hat{a}$'s going to equilibria