file: e:\courses\spring2002\434\Hopfield_ex1_simp.mcd RWN 03/05/02

$G1 := 2 \qquad G2 := 2 \qquad C1 := 5 \qquad C2 := 5$

$$G := \begin{bmatrix} G1 & 0 \\ 0 & G2 \end{bmatrix} \qquad C := \begin{bmatrix} C1 & 0 \\ 0 & C2 \end{bmatrix} \qquad G = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \qquad C = \begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$$

$$y(v) := \begin{bmatrix} \tanh\left(v_1\right) \\ \tanh\left(v_2\right) \end{bmatrix} \qquad v1 := \begin{bmatrix} 0.5 \\ 0.25 \end{bmatrix} \qquad v2 := \begin{bmatrix} -0.5 \\ 0.5 \end{bmatrix}$$

$$y1 := y(v1) \qquad y2 := y(v2)$$

$$y1 = \begin{bmatrix} 0.462117 \\ 0.244919 \end{bmatrix} \qquad y2 = \begin{bmatrix} -0.462117 \\ 0.462117 \end{bmatrix}$$

Now need to let v3 be variable and choose it to give a symmetric W
Define an unknow v3 as vx

$$vx(x1, x2) := \begin{bmatrix} x1 \\ x2 \end{bmatrix} \qquad yx(x1, x2) := \begin{bmatrix} \tanh(x1) \\ \tanh(x2) \end{bmatrix}$$

The equation to solve is W(y1-yx,y2-yx)=G(v1-vx,v2-vx)

$$Y(x1, x2) := \begin{bmatrix} y1_1 - yx(x1, x2)_1 & y2_1 - yx(x1, x2)_1 \\ y1_2 - yx(x1, x2)_2 & y2_2 - yx(x1, x2)_2 \end{bmatrix} \qquad V(x1, x2) := \begin{bmatrix} v1_1 - vx(x1, x2)_1 & v2_1 - vx(x1, x2)_1 \\ v1_2 - vx(x1, x2)_2 & v2_2 - vx(x1, x2)_2 \end{bmatrix}$$

setup for solving for x1 given x2 to make W symmetric W=GVY^-1

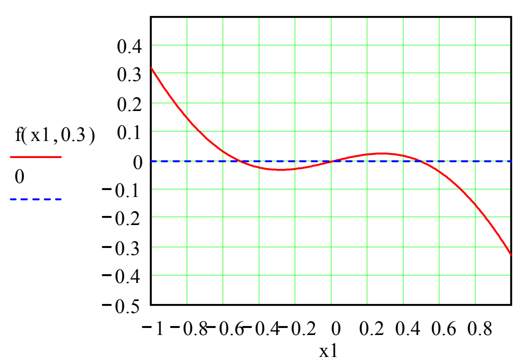
$$f1(x1) := G1 \cdot \left(v2_1 - x1\right) \cdot \left(y1_1 - \tanh(x1)\right) - G1 \cdot \left(v1_1 - x1\right) \cdot \left(y2_1 - \tanh(x1)\right)$$

$$f2(x2) := G2 \cdot \left(v1_2 - x2\right) \cdot \left(y2_2 - \tanh(x2)\right) - G2 \cdot \left(v2_2 - x2\right) \cdot \left(y1_2 - \tanh(x2)\right)$$

$$f(x1, x2) := f1(x1) - f2(x2)$$

$x1min := -1 \qquad x1max := 1 \qquad x1inc := 0.01$

$x1 := x1min, x1min + x1inc .. x1max$



Solve block to determine x1 given x2

Guess value: $x2 := 0.3$

$x1 := 0.5$

Given:

$x10 := \mathrm{root}(f(x1, 0.3), x1)$

$x1 := x10$ $x10 = 0.494563$

Form weight matrix which should be symmetric

$W(x1, x2) := G \cdot V(x1, x2) \cdot \left(Y(x1, x2)^{-1}\right)$

$V(x1, x2) = \begin{bmatrix} 5.436955 \cdot 10^{-3} & -0.994563 \\ -0.05 & 0.2 \end{bmatrix}$ $Y(x1, x2) = \begin{bmatrix} 4.286609 \cdot 10^{-3} & -0.919948 \\ -0.046394 & 0.170805 \end{bmatrix}$

$W = \begin{bmatrix} 2.15568 & -0.035206 \\ -0.035213 & 2.1522 \end{bmatrix}$ $W := W(x1, x2)$

$v3 := \begin{bmatrix} x1 \\ x2 \end{bmatrix}$ $v3 = \begin{bmatrix} 0.494563 \\ 0.3 \end{bmatrix}$

$y3 := \begin{bmatrix} \tanh(x1) \\ \tanh(x2) \end{bmatrix}$ $y3 = \begin{bmatrix} 0.457831 \\ 0.291313 \end{bmatrix}$

$I := -W \cdot y3 + G \cdot v3$ $I = \begin{bmatrix} 0.012446 \\ -0.010841 \end{bmatrix}$

As a check we should get zero for Wy-Gv+I for the equilibrium (v,,y) pair

$W \cdot y2 - G \cdot v2 + I = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ $W \cdot y1 - G \cdot v1 + I = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ $W \cdot y3 - G \cdot v3 + I = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$

Also of interest for Wy-Gv+I=0 is the inverse function for x=tanh(z).
This is z(x)=-0.5ln((1-x)/(1+x))

$z(x) := -0.5 \cdot \ln\left[\frac{(1-x)}{(1+x)}\right]$ $n(y1) := \begin{bmatrix} z(y1_1) \\ z(y1_2) \end{bmatrix}$ $n(y2) := \begin{bmatrix} z(y2_1) \\ z(y2_2) \end{bmatrix}$

$n(y1) = \begin{bmatrix} 0.5 \\ 0.25 \end{bmatrix}$ $n(y2) = \begin{bmatrix} -0.5 \\ 0.5 \end{bmatrix}$