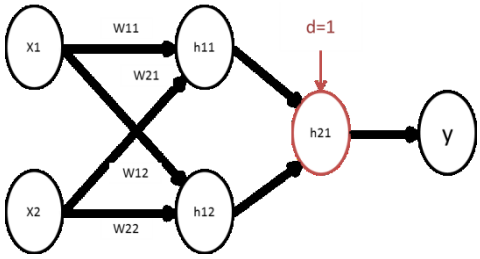
3.

3.1 XNOR function:

Activation Function: **RELU**

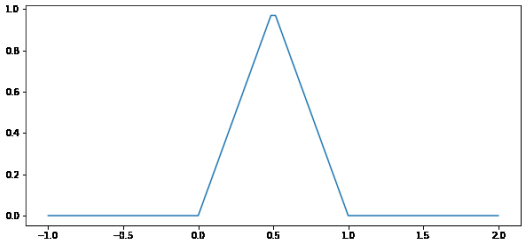



$f(x;W, c,w, b,\mathbf{d}) = \max\{0,(w^T * \max\{0,\mathbf{W}^T * x + c\} + b)+d)\}$

$\mathbf{W}=\begin{matrix}1 & 1\\ 1 & 1\end{matrix}$ $c=\begin{matrix}0\\ -1\end{matrix}$ $b=0$ $w=\begin{matrix}-2\\ 4\end{matrix}$ $d=1$

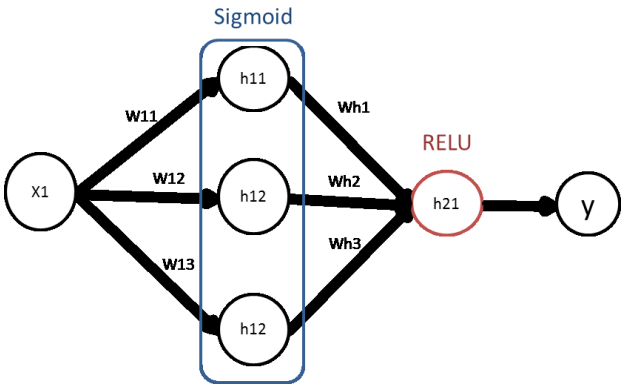
$$\begin{matrix}0 & 0\\ 0 & 1\\ 1 & 0\\ 1 & 1\end{matrix} * \begin{matrix}1 & 1\\ 1 & 1\end{matrix} = \begin{matrix}0 & 0\\ 1 & 1\\ 1 & 1\\ 2 & 2\end{matrix} + |0 \quad -1| \rightarrow RELU \begin{matrix}0 & -1\\ 1 & 0\\ 1 & 0\\ 2 & 1\end{matrix} = \begin{matrix}0 & 0\\ 1 & 0\\ 1 & 0\\ 2 & 1\end{matrix} * \begin{matrix}-2\\ 4\end{matrix} \rightarrow \begin{matrix}0\\ -2\\ -2\\ 0\end{matrix} + 1 \rightarrow RELU \begin{matrix}1\\ -1\\ -1\\ 1\end{matrix} = \begin{matrix}1\\ 0\\ 0\\ 1\end{matrix}$$

3.2 Function graph:

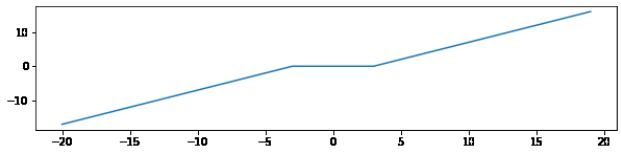



$f(x;W, c,w, b) = \max\{0,w^T * Sig(\mathbf{W}^T * x + c) + b\}$

$\mathbf{W}=\begin{matrix}1 & 0 & 1\\ 2 & 0 & 1\\ -2 & 2 & 1\end{matrix}$ $c=\begin{matrix}0\\ 0\\ 2\end{matrix}$ $b=0$ $w=\begin{matrix}1\\ 1\\ 1\end{matrix}$

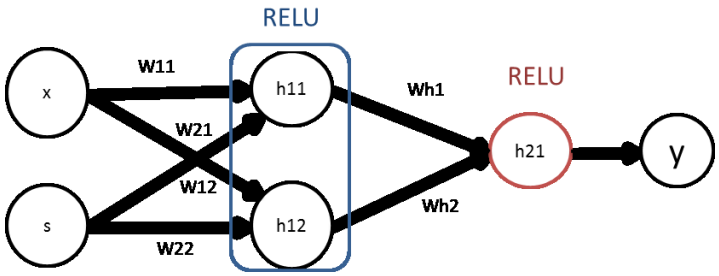


3.3 Function graph




$f(x;W, c,w, b) = \max\{0, w^T * \max\{\mathbf{W}^T * x + c, 0\} + b\}$

$\mathbf{W}= \begin{matrix} 1 & -1 \\ -1 & 1 \end{matrix}$ $c= \begin{matrix} 0 \\ 0 \end{matrix}$ b=0 $w= \begin{matrix} 1 \\ 1 \end{matrix}$



5.

A. $L(X;w;y) = \frac{1}{2}||Xw - y||^2 = \frac{1}{2}(Xw - y)^T(Xw - y) = \frac{1}{2}w^T X^T Xw + \frac{1}{2}y^T y - w^T X^T y.$

$\nabla L(X;w;y) = X^T Xw* - Xy = 0 \Rightarrow XT\ Xw* = XT\ y.$

$\arg\min_w L(X;w;y) = \arg\min \frac{1}{2}\sum_{i=1}^{N}(wTx(i) - y(i))^2 = \frac{1}{2}(X^T X)^{-1} X^T y$