# Bidirectional associative memory (BAM)

— Proposed by Bart Kosko in 1985.

— It is a hetro-associative memory network.

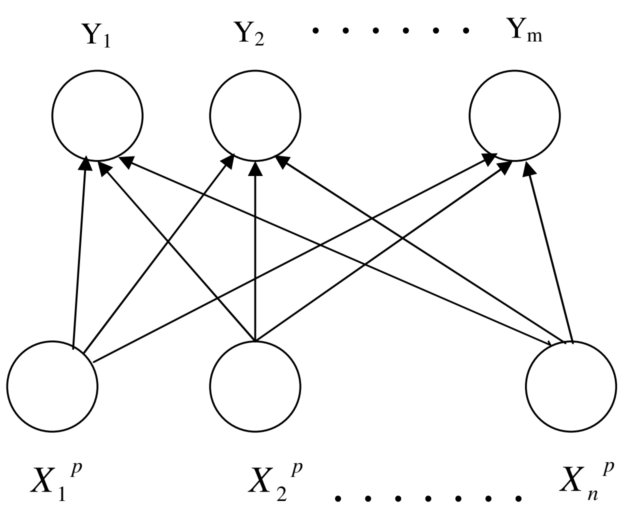
— Architecture：

① Input layer ： $X_i^{\ p} \in \{-1,+1\}$

② Output layer： $Y_j \in \{-1,1\}$

③ Weights ： $W_{ij} = \sum_p X_i^{\ p} Y_j^{\ p}$

④ Connection：

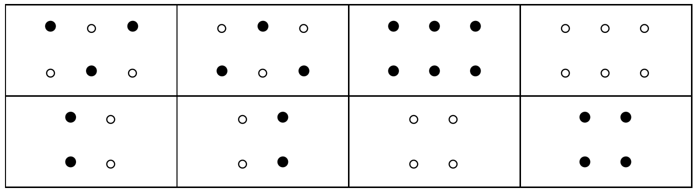



It's a 2-layer fully connected feed forward & feed back network.

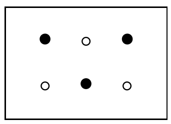
⑤ Transfer function：

$$X_i^{\ new} = \begin{cases} +1 & net_j > 0 \\ X_i \quad if & net_j = 0 \\ -1 & net_j < 0 \end{cases} \qquad where \qquad net_j = \sum_i W_{ij} \cdot X_i$$

$$Y_j^{new} = \begin{cases} +1 & net_j > 0 \\ X_i & \text{if} \quad net_j = 0 \\ -1 & net_j < 0 \end{cases} \qquad \text{where} \qquad net_j = \sum_j Y_j \cdot W_{ij}$$



Test pattern



| $X_1$ | $X2$ | $X3$ | $X4$ | $X5$ | $X6$ | $Y_1$ | $Y_2$ | $Y_3$ | $Y_4$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -1 | 1 | -1 | 1 | -1 | 1 | -1 | 1 | -1 |
| -1 | 1 | -1 | 1 | -1 | 1 | -1 | 1 | -1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | -1 | -1 | -1 | 1-1 |
| -1 | -1 | -1 | -1 | -1 | -1 | 1 | 1 | 1 | 1 |

1. Learning
   a. Set up network
   b. Setup weights

$$W_{ij} = \sum_p X_i^{\,p} Y_j^{\,p}$$

$$W_{12}\,(1,-1,1,-1)\begin{pmatrix} 1 \\ -1 \\ 1 \\ -1 \end{pmatrix} = -4$$

$$W_{13}\,(1,-1,1,-1)\begin{pmatrix}1\\-1\\-1\\1\end{pmatrix}=0$$

$$W=\begin{pmatrix}0&-4&0&-4\\-4&0&-4&0\\0&-4&0&-4\\-4&0&-4&0\\0&-4&0&-4\\-4&0&-4&0\end{pmatrix}_{6*4}$$

2. Recall

① Read network weights

② Read test pattern

③ Compute Y

$$net_j=\sum_i W_{ij}X_i$$

$$Y_j^{new}=\begin{cases}+1 & net_j>0\\ Y_j \quad if & net_j=0\\ -1 & net_j<0\end{cases}$$

④ Compute X

$$net_j=\sum_{\mathrm{j}} Y_jW_{ij}$$

$$X_i^{new}=\begin{cases}+1 & net_i>0\\ X_i \quad if & net_i=0\\ -1 & net_i<0\end{cases}$$

⑤ Repeat ③ & ④

until converge

聚類之 Application

$\because \quad test \quad pattern \quad (1\ 1\ 1-1\ 1-1)_{1*6}$

No1 ① $(111-11-1)\cdot\begin{pmatrix}\overset{6*4}{W}\end{pmatrix}=(4,-12,4,-12)=(1-11-1)$

No2 ② $(1,-1,1,-1)\cdot\begin{pmatrix}\overset{6*4}{W}\end{pmatrix}=\begin{pmatrix}4\\-12\\4\\-12\end{pmatrix}=\begin{pmatrix}1\\-1\\1\\-1\end{pmatrix}$ 二次都相同