Bidirectional Associate Memory

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Plan for Today

- Associate Memory
  - Auto-Associative Memory
  - Hetero-Associate Memory
    - **Bidirectional Associative Memory (BAM)**
    - **Application**

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Associate Memory

- Associate memory network are similar to human brain which associates similar pattern(set of input mapped to set of output) i.e one thing reminds us of other thing.
- It exhibits hebbian learning.
- Basically classified in two types
  1. Auto-Associative Memory
  2. Hetero-Associate Memory

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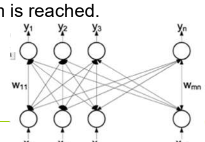
Bidirectional Associative Memory

- Bidirectional associative memory (BAM), first proposed by Bart Kosko(1988), is a hetero-associative network.It associates patterns from one set, set A, to patterns from another set, set B, and vice versa.
- BAM is a two-layer nonlinear neural network.
- Performs Forward and Backward search.
- Signal are sent back and Forth between both layers until equilibrim is reached.



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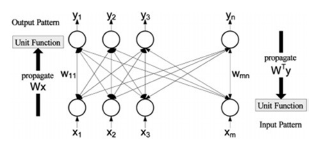
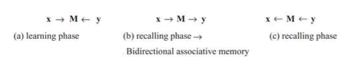
Bidirectional Associative Memory (BAM)

Network Model



x, y : row vectors
W : weight matrix
W^T : transpose of W
bipolar inputs 2 {-1,+1}



- fully connected
- bidirectional edges
- synchonized:

step t : data flow from x to y
step t + 1 : data flow from y to x

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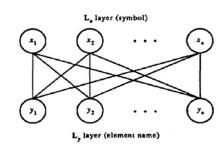
Application

Application of A bi-directional associative memory (bam) network in computer assisted learning in chemistry.

- We report a CAL system based on the BAM network (kosko, 1987a) to assist and guide students in associating the names of elements in the periodic table with their chemical symbols even though he/she may not be able to spell them correctly .



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Application

In the present study, the L_x , and L_y layers represent the chemical symbol and element name respectively.

Data can pass from one layer to another or vice versa.

Suppose there are m associated vector pair(s) of $\{(A_1, B_1), (A_2, B_2), \ldots, (A_m, B_m)\}$ where $A_i \in L_x$ and $B_i \in L_y$

Each vector element is coded in the ASCII binary format with

$A_i = \{a_i, \ldots, a_n\}$ or $B_i=\{b_i, \ldots, b_p\}$ with a_i and b_i having values of 1 or 0 only.

The connection weights between the L_x , and L_y layers are stored in a connection matrix **M** with dimension n x p.

But before that we,

$$a_k \in \{0, 1\} \leftrightarrow x_k \in \{-1, 1\} \qquad (1)$$

$$b_k \in \{0, 1\} \leftrightarrow y_k \in \{-1, 1\} \qquad (2)$$

binary bipolar

The connection matrix **M** is calculated as follows

$$\mathbf{M} = \sum_{i=1}^{m} \mathbf{X}_i^T \mathbf{Y}_i \qquad (3)$$

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Application

Steps

1. Define an initial vector, $\mathbf{Y}(j)$, with j denoting the number of iteration.
2. Proceed to the $(j+1)$ iteration using the following equations

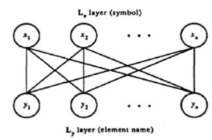
$$\mathbf{NETX}(j+1) = \mathbf{Y}(j)\mathbf{M}^T \qquad (4)$$

$$x_k(j+1) = \begin{cases} 1 \text{ if } netx_k(j+1) > 0 \\ 0 \text{ if } netx_k(j+1) = 0 \\ -1 \text{ if } netx_k(j+1) < 0 \end{cases} \qquad (5)$$

$$\mathbf{NETY}(j+1) = \mathbf{X}(j+1)\mathbf{M} \qquad (6)$$

$$y_k(j+1) = \begin{cases} 1 \text{ if } nety_k(j+1) > 0 \\ 0 \text{ if } nety_k(j+1) = 0 \\ -1 \text{ if } nety_k(j+1) < 0 \end{cases} \qquad (7)$$

3. Repeat equations (4)–(7) until there is no further significant change in **X** and **Y** in two successive iterations.
4. Convert the bipolar vectors **X** and **Y** to the corresponding binary vectors **A** and **B**.



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Application

Learning

Imagine we wish to store two associations, A1:B1 and A2:B2.

- A1 = (1, 0, 1, 0, 1, 0), B1 = (1, 1, 0, 0)
- A2 = (1, 1, 1, 0, 0, 0), B2 = (1, 0, 1, 0)

These are then transformed into the bipolar forms:

- X1 = (1, -1, 1, -1, 1, -1), Y1 = (1, 1, -1, -1)
- X2 = (1, 1, 1, -1, -1, -1), Y2 = (1, -1, 1, -1)

From there, we calculate $M = \sum X_i^T Y_i$ where X_i^T denotes the transpose. So,

$$M = \begin{bmatrix} 2 & 0 & 0 & -2 \\ 0 & -2 & 2 & 0 \\ 2 & 0 & 0 & -2 \\ -2 & 0 & 0 & 2 \\ 0 & 2 & -2 & 0 \\ -2 & 0 & 0 & 2 \end{bmatrix}$$

Recall

To retrieve the association A1, we multiply it by M to get (4, 2, -2, -4), which, when run through a threshold, yields (1, 1, 0, 0), which is B1. To find the reverse association, multiply this by the transpose of M.

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Application

Results

WHAT IS THE NAME OF THE ELEMENT WHICH HAS THE CHEMICAL SYMBOL H?

HYDROGEN

I

AB

WHAT IS THE NAME OF THE ELEMENT WHICH HAS THE CHEMICAL SYMBOL He?

HELIUM

Accuracy

Table 2. List of performance indicators generated by CHEM.PAS with nitrogen as an example to illustrate how the program works (see the text for definitions of symbols)

Input answer	AC (%)	Deviation	Length
NEUORON	67	Far away	Shorter
NETORGON	81	Not too far away	Same
NITORGON	84	Not too far away	Same
NITRIGON	97	Close	Same

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Reference

Application of a bi-directional associative memory (bam) network in computer assisted learning in chemistry.

F. T. Chau, b. Cheung, k. Y. Tam and l. K. Lr

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