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BIDIRECTIONAL ASSOCIATIVE MEMORY (BAM)

- A bidirectional associative memory stores a set of pattern associations by summing bipolar correlation matrices (an n by m outer product matrix for each pattern to be stored).
- The architecture of the net consists of two layers of neurons, connected by directional weighted connection paths.
- The net iterates, sending signals back and forth between the two layers until all neurons reach equilibrium (i.e., until each neuron's activation remains constant for several steps).
- Bidirectional associative memory neural nets can respond to input to either layer. Because the weights are bidirectional and the algorithm alternates between updating the activations for each layer, we shall refer to the layers as the X-layer and the Y-layer (rather than the input and output layers).

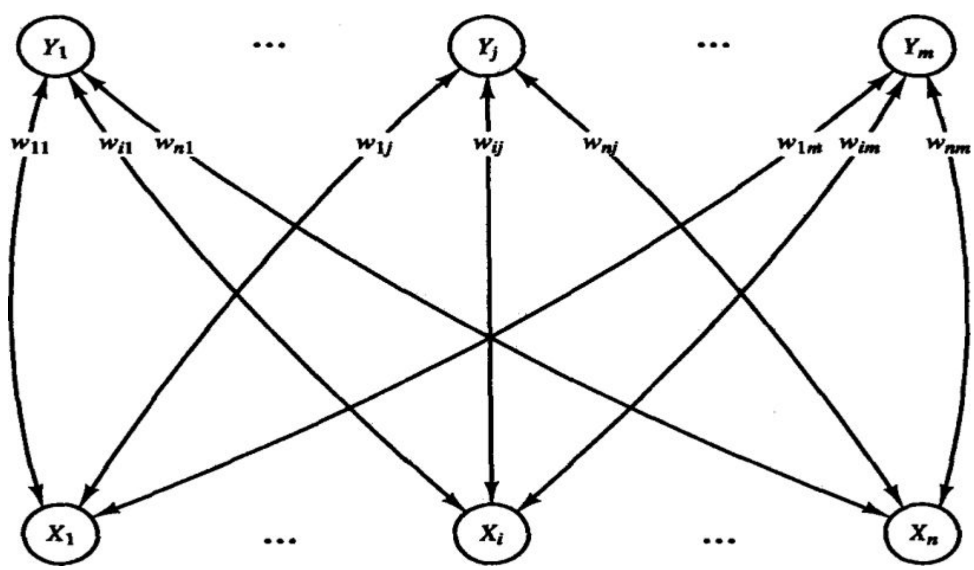

Figure: Bidirectional Associative Memory (BAM)

Architecture -

The single-layer nonlinear feedback BAM network (with heteroassociative content-addressable memory) has n units in its X-layer and m units in its Y-layer.
The connections between the layers are bidirectional; i.e., if the weight matrix for signals sent from the X-layer to the Y-layer is W, the weight matrix for signals sent from the Y-layer to the X-layer is W^T .

Algorithm

1. Initialize the weights to store a set of P vectors; initialize all activations to 0

2. For each testing input, do Steps 3 - 7.

3. a) Present input pattern x to the X-layer, (i.e., set activations of X-layer to current input pattern).
   b) Present input pattern y to the Y-layer, (Either of the input patterns may be the zero vector.)

4. While activations are not converged, do Steps 5 - 7.

5. Update activations of units in Y-layer:
   Compute net inputs:
   $y\_in_j = \sum w_{ij} x_i$
   Compute activations:
   $y_j = f(y\_in_j)$
   Send signal to X-layer.

6. Update activations of units in X-layer:
   Compute net inputs:
   $x\_in_i = \sum w_{ij} y_i$
   Compute activations:
   $x_i = f(x\_in_i)$
   Send signal to Y-layer.

7. Test for convergence: If the activation vectors x and y have reached equilibrium, then stop; otherwise, continue.

Analysis:

Input set: $X_1 = [1\ 1\ 1\ 1\ 1\ 1\ ]^T$, $X_2 = [-1\ -1\ -1\ -1\ -1\ -1\ ]^T$, $X_3 = [1\ -1\ -1\ 1\ 1\ 1\ ]^T$,
$X_4 = [1\ 1\ -1\ -1\ -1\ -1\ ]^T$

Target set: $Y_1 = [1\ 1\ 1]^T$, $Y_2 = [-1\ -1\ -1]^T$, $Y_3 = [-1\ 1\ 1]^T$, $Y_4 = [1\ -1\ 1]^T$

X_1, X_2, X_3 got converged in 1 epochs while X_4 got converged in 3 epochs.