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Self-organizing Map (SOM)

S-1 Initialize the weight w_{ij}, Random value may be ~~adjusted~~ assumed. Initialize the learning rate, "α".

S-2. Calculate square of the distance, i.e.

For each $j = 1$ to m.

$$O(j) = \sum_{i=1}^{n} \sum_{j=1}^{m} (x_i - w_{ij})^2$$

S-3 Find winning unit index j, so that $O(j)$ is minimum.

S-4. For all units j within a specific ~~xxi~~ neighbourhood of j & for all i, Calculate new weights.

$$w_{ij}(new) = w_{ij}(old) + \alpha [x_i w_{ij}(old)]$$

S-5. Update learning rate, α using the formula

$$\alpha(t+1) = 0.5 \times (t)$$

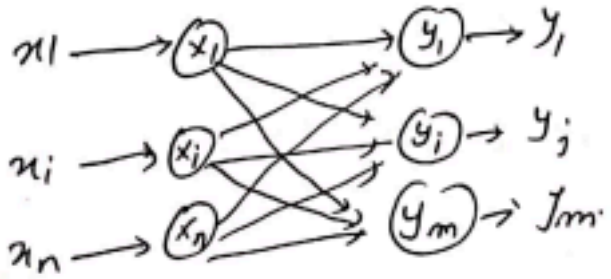


Fig. Architecture.

Ques Construct SOM to cluster four given vectors

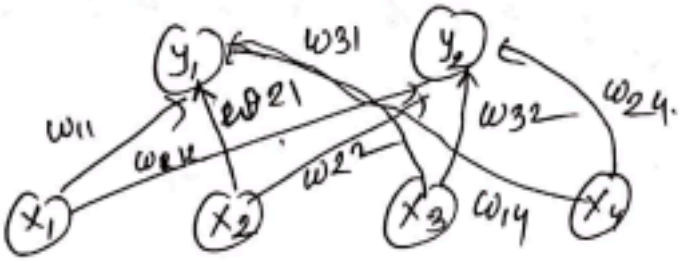
[0 0 1 1], [1 0 0 0], [0 1 1 0] & [0 0 0 1]

no. of cluster to be formed is 2. Assume an initial learning rate of 0.5

Soln

no of initial vectors, $n = 4$

no of cluster, $m = 2$



initialize the weight randomly 0 to 1

unit1 unit2

$$w_{ij} = \begin{bmatrix} 0.2 & 0.9 \\ 0.4 & 0.7 \\ 0.6 & 0.5 \\ 0.8 & 0.3 \end{bmatrix}$$

First input vector

$x = [0 \ 0 \ 1 \ 1]$

+

Calculate the dis:

$$D(J) = \sum_{i=1}^{n} (w_{iJ} - x_i)^2$$

$$D(1) = (0.2-0)^2 + (0.4-0)^2 + (0.6-1)^2 + (0.8-1)^2$$

$$= 0.4$$

$$D(2) = \sum_{i=1}^{n} (w_{iJ} - x_i)^2$$

$$= (0.9-0)^2 + (0.7-0)^2 + (0.5-0)^2 + (0.3-1)^2$$

$$= 2.04.$$

unit 1

$D(1) < D(2)$, Therefore winning cluster is $J = 1$.

Now update weights on winning cluster unit $j = 1$

$$w_{ij}(new) = w_{ij}(old) + \alpha [x_i - w_{iJ}(old)]$$

$$w_{11}(new) = w_{11}(old) + \alpha [x_i - w_{i1}(old)]$$

$$w_{11}(n) = w_{11}(0) + 0.5 [x_1 - w_{11}(0)]$$

$$= 0.2 + 0.5 [0 - 0.2) = 0.1$$

$$w_{21}(n) = 0.4 + 0.5[0 - 0.4]$$

$$= 0.2$$

$w_{31}(n) = 0.6 + 0.5[1 - 0.6]$

$= 0.8$

$w_{41}(n) = 0.8 + 5[1 - 0.8] = 0.9$

Update weight matrix

$$w_{ij} = \begin{bmatrix} 0.1 & 0.9 \\ 0.2 & 0.7 \\ 0.8 & 0.5 \\ 0.9 & 0.3 \end{bmatrix}$$

Second input vector $x = [1\ 0\ 0\ 0]$

Calculate Dist

$D(1) = (0.1-1)^2 + (0.2-0)^2 + (0.8-0)^2 + (0.9-0)^2$

$= 2.3$

$D(2) = (0.9-1)^2 + (0.7-0)^2 + (0.5-0)^2 + (0.3-0)^2$

$= 0.8$

$D(2) < D(1)$ $\boxed{J = 2}$

update weight

$$w_{12}(n) = 0.9 + 0.5[1 - 0.9]$$

$$= 0.95$$

$$w_{22}(n) = 0.7 + 0.5(0 - 0.1) = 0.35$$

$$w_{32}(n) = 0.5 + 0.5(0 - 0.5) = 0.25$$

$$w_{42}(n) = 0.3 + 0.5(0 - 0.3) = 0.15$$

$$w_{ij} = \begin{bmatrix} 0.1 & 0.95 \\ 0.2 & 0.35 \\ 0.8 & 0.25 \\ 0.9 & 0.15 \end{bmatrix}$$

Third input ~~for~~

$$D(1) = 1.5 \quad D(2) = 1.9$$

winning cluster $J = 1$

$$w_{11}(n) = 0.05$$

$$w_{21}(n) = 0.6$$

$$w_{31}(n) = 0.9$$

$$w_{41}(n) = 0.45$$

$$w_{ij} = \begin{bmatrix} 0.05 & 0.95 \\ 0.6 & 0.35 \\ 0.9 & 0.25 \\ 0.45 & 0.15 \end{bmatrix}$$

forth input vector

$$X = [0 \quad 0 \quad 0 \quad 1]$$

$D(1) = 1.475 \quad D(2) = 1.81$

Winning cluster, $J = 1$

$w_{11}(n) = 0.025$

$w_{21}(n) = 0.3$

$w_{31}(n) = 0.45$

$w_{41}(n) = 0.475$

$$w_{ij} = \begin{bmatrix} 0.025 & 0.95 \\ 0.3 & 0.35 \\ 0.45 & 0.25 \\ 0.475 & 0.15 \end{bmatrix}$$