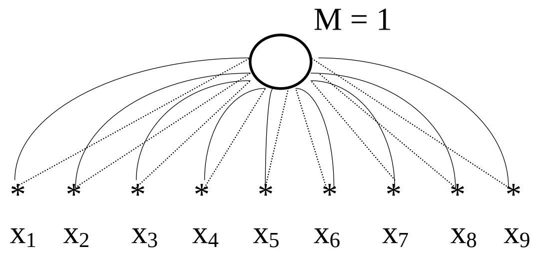
FIT5186 Examples from Lecture 7

ART1 Example



$\mathbf{x}_1 = (1\,0\,0\,0\,1\,0\,0\,0\,1)$
$\mathbf{x}_2 = (1\,1\,0\,0\,1\,0\,0\,1\,1)$
$\mathbf{x}_3 = (1\,0\,1\,0\,1\,0\,1\,0\,1)$

Assume a vigilance factor of $\rho = 0.7$.

Initialise weights as $w_{ij} = \frac{1}{10}$; $v_{ij} = 1$ for all $i = 1, 2, ..., 9$ and $j = 1$.

N = 9
w_{ij} bottom up weights (dotted)
v_{ij} top down weights (solid)

Present input 1 $\mathbf{x}_1 = (1\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 1)$ $\quad y_1 = \sum_{i=1}^{9} w_{ij} x_i = \frac{1}{10} + \frac{1}{10} + \frac{1}{10} = 0.3$

neuron 1 is the winner (only choice)

Vigilance Test: Is $\frac{1}{||\mathbf{x}_1||} ||\mathbf{v}_1 \mathbf{x}_1|| > \rho$? $\quad \frac{1}{3} \times 3 = 1 > 0.7 \quad$ So the test is passed.

Update Weights: $\mathrm{w}_{ij} = \frac{v_{ij} x_i}{0.5 + \sum v_{ij} x_i}$ $\quad$ so $\mathrm{w}_{11} = w_{51} = w_{91} = \frac{1}{0.5+3} = \frac{2}{7}$

all other weights $w_{i1} = 0.1$ as initialised

$v_{ij} \leftarrow x_i v_{ij}$ $\quad$ so $v_{11} = v_{51} = v_{91} = 1$ and all others are equal to zero

So $\mathbf{w} = [\frac{2}{7}\ 0.1\ 0.1\ 0.1\ \frac{2}{7}\ 0.1\ 0.1\ 0.1\ \frac{2}{7}\ ]^{\mathrm{T}}$ (long term memory)

and $\mathbf{v} = [1\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 1]^{\mathrm{T}}$ (short term memory)

Present input 2 $\mathbf{x}_2 = (1\ 1\ 0\ 0\ 1\ 0\ 0\ 1\ 1)$ $\quad y_1 = \sum_{i=1}^{9} w_{ij} x_i \cong 1.057$

neuron 1 is the winner (again, it's the only choice)

Vigilance Test: Is $\frac{1}{||\mathbf{x}_2||} ||\mathbf{v}_1 \mathbf{x}_2|| > \rho$? $\quad \frac{1}{5} \times 3 = 0.6 < 0.7 \quad$ So the test is failed.

There are no more neurons to test, so we create a new neuron, $w_{i2} = 0.1$, $v_{i2} = 1\ \forall i$

Update Weights: $\mathrm{w}_{ij} = \frac{v_{ij} x_i}{0.5 + \sum v_{ij} x_i}$ so $\mathrm{w}_{12} = w_{22} = w_{52} = w_{82} = w_{92} = \frac{1}{0.5+5} = \frac{2}{11}$

all other weights $w_{i2} = 0.1$ as initialised

$v_{ij} \leftarrow x_i v_{ij}$ $\quad$ so $v_{12} = v_{22} = v_{52} = v_{82} = v_{92} = 1$ and all others are equal to zero

$$\text{So } \mathbf{w} = \begin{pmatrix} \frac{2}{7} & 0.1 & 0.1 & 0.1 & \frac{2}{7} & 0.1 & 0.1 & 0.1 & \frac{2}{7} \\ \frac{2}{11} & \frac{2}{11} & 0.1 & 0.1 & \frac{2}{11} & 0.1 & 0.1 & \frac{2}{11} & \frac{2}{11} \end{pmatrix}^{\mathrm{T}} \quad \text{and } \mathbf{v} = \begin{pmatrix} 1\,0\,0\,0\,1\,0\,0\,0\,1 \\ 1\,1\,0\,0\,1\,0\,0\,1\,1 \end{pmatrix}^{\mathrm{T}}$$

(long term memory) (short term memory)

Present input 3 $\mathbf{x}_3 = (1\ 0\ 1\ 0\ 1\ 0\ 1\ 0\ 1)$ $\quad y_1 = \sum_{i=1}^{9} w_{i1}x_i \cong 1.057 \quad y_2 = \sum_{i=1}^{9} w_{i2}x_i \cong 0.745$

neuron 1 is the winner

Vigilance Test: Is $\frac{1}{||\mathbf{x}_3||}||\mathbf{v}_1\mathbf{x}_3|| > \rho$? $\quad \frac{1}{5}\times 3 = 0.6 < 0.7$ $\quad$ So the test is failed.

neuron 2 is the next winner (only other choice)

Vigilance Test: Is $\frac{1}{||\mathbf{x}_3||}||\mathbf{v}_2\mathbf{x}_3|| > \rho$? $\quad \frac{1}{5}\times 3 = 0.6 < 0.7$ $\quad$ So the test is failed.

There are no more neurons to test, so we create a new neuron, $w_{i3} = 0.1,\ v_{i3} = 1\ \forall i$

Update Weights: $\mathrm{w}_{\mathrm{ij}} = \frac{v_{ij}x_i}{0.5 + \sum v_{ij}x_i}$ so $\mathrm{w}_{13} = w_{33} = w_{53} = w_{73} = w_{93} = \frac{1}{0.5+5} = \frac{2}{11}$

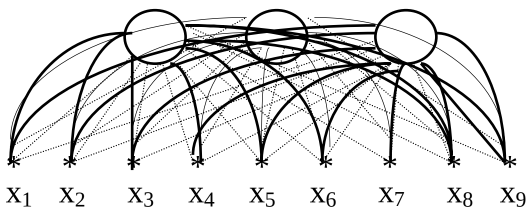
all other weights $w_{i3} = 0.1$ as initialised

$v_{ij} \leftarrow x_i v_{ij}$ $\quad$ so $v_{13} = v_{33} = v_{53} = v_{73} = v_{93} = 1$ and all others are equal to zero

FINALWEIGHTS:

So $\mathbf{w} = \begin{pmatrix} \frac{2}{7} & 0.1 & 0.1 & 0.1 & \frac{2}{7} & 0.1 & 0.1 & 0.1 & \frac{2}{7} \\ \frac{2}{11} & \frac{2}{11} & 0.1 & 0.1 & \frac{2}{11} & 0.1 & 0.1 & \frac{2}{11} & \frac{2}{11} \\ \frac{2}{11} & 0.1 & \frac{2}{11} & 0.1 & \frac{2}{11} & 0.1 & \frac{2}{11} & 0.1 & \frac{2}{11} \end{pmatrix}^{\mathrm{T}}$ $\quad$ and $\mathbf{v} = \begin{pmatrix} 1\ 0\ 0\ 0\ 1\ 0\ 0\ 0\ 1 \\ 1\ 1\ 0\ 0\ 1\ 0\ 0\ 1\ 1 \\ 1\ 0\ 1\ 0\ 1\ 0\ 1\ 0\ 1 \end{pmatrix}^{\mathrm{T}}$

M=3



N=9

A vigilance factor of ρ = 0.7 has caused all three input patterns to be separately classified. In fact, ρ = 0.6 would have achieved the same result, since all 3 vigilance tests would still have failed.

If ρ = 0.5 is used, the second and third input patterns would have been classified in the 1st cluster with the 1st input pattern. This is because the second and third input patterns are regarded as being close enough to the1st input pattern, resulting from the relaxation of vigilance.