1) Given $x_1 = (0,2)$, $x_2 = (0,0)$ / $x_3 = (1.5, 0)$

$x_4 = (5,0)$, $x_5 = (5,2)$ Given clusters

$C_1 = \{x_1, x_2, x_4\}$ $C_2 = \{x_3, x_5\}$

Sol Find the centroid.

$$M_K = \frac{1}{n_K} \sum_{i=1}^{n_K} x_{iK}$$

$$M_1 = \left(\frac{0+0+5}{3}, \frac{2+0+0}{3}\right)$$

$$= \left(\frac{5}{3}, \frac{2}{3}\right)$$

$$= (1.66, 0.66)$$

$$M_2 = \left(\frac{1.5+5}{2}, \frac{0+2}{2}\right)$$

$$= \left(\frac{6.5}{2}, \frac{2}{2}\right)$$

$$= (3.25, 1)$$

Step ②: Find the error

$$E_k^2 = \sum_{i=1} (x_{iK} - M_{iK})^2$$

$$E_1^2 = [(0-1.66)^2 + (2-0.66)^2 + (0-1.66)^2 + (0-0.66)^2 + (5-1.66)^2 + (0-0.66)^2]$$

$$= 2.756 + 1.796 + 2.756 + 0.436 + 11.156 + 0.436$$

$$= 19.336$$

$$E_2^2 = [(1.5-3.25)^2 + (0-1)^2 + (5-3.25)^2 + (2-1)^2]$$

$$= 3.063 + 1.00 + 3.063 + 1.00$$

$$= 8.126$$

$E_{1c}^2 = E_1^2 + E_2^2$

$= 19.336 + 80.126$

$= 27.462$

$m_1 = (1.166, 0.66)$ $\quad m_2 = (3.25, 2)$

$X_1 = (0, 2)$

$d(x_1, m_1) = \sqrt{(0 - 1.166)^2 + (2 - 0.66)^2}$

$= \sqrt{2.756 + 1.796}$

$= \sqrt{4.552} = 2.134$

$d(x_2, m_2)$

$= \sqrt{(0 - 3.25)^2 + (2 - 1)^2}$

$= \sqrt{10.563 + 1.00}$

$= \sqrt{11.563}$

$= 3.400$

$\therefore m_2 > m_1$

$X_2 = (0, 0)$

$d(x_2, m_1) = \sqrt{(0 - 1.66)^2 + (0 - 0.66)^2}$

$= \sqrt{2.756 + 0.436}$

$= \sqrt{3.192}$

$= 1.787$

$d(x_1, m_2)$

$= \sqrt{(0 - 3.25)^2 + (0 - 1)^2}$

$= \sqrt{10.563 + 1.00}$

$= \sqrt{11.563}$

$= 3.400$

$\therefore m_2 > m_1$

$X_3 = (1.5, 0)$

$d(x_3, m_1) = \sqrt{(1.5 - 1.66)^2 + (0 - 0.66)^2}$

$= \sqrt{0.026 + 0.436}$

$= \sqrt{0.462}$

$= 0.680$

$d(x_3, m_2) = \sqrt{(1.5 - 3.25)^2 + (0 - 1)^2}$

$= \sqrt{3.063 + 1.00}$

$= \sqrt{4.063}$

$= 2.016$

$\therefore m_2 > m_1$

$x_4 = (5, 0)$

$d(x_4, m_1) = \sqrt{(5-1.66)^2 + (0-0.66)^2}$

$= \sqrt{11.156 + 0.436}$

$= \sqrt{11.592}$

$= 3.405$

$d(x_4, m_2) = \sqrt{(5-3.25)^2 + (0-1)^2}$

$= \sqrt{3.063 + 1.000}$

$= \sqrt{4.063}$

$= 2.016$

$\therefore m_1 > m_2$

$\therefore m_1$ is $< m_2$ so it belongs to the cluster 2

$x_5 = (5, 2)$

$d(x_5, m_1) = \sqrt{(5-1.66)^2 + (2-0.66)^2}$

$= \sqrt{11.156 + 1.796}$

$= \sqrt{12.952}$

$= 3.599$

$d(x_5, m_2) = \sqrt{(5-3.25)^2 + (2-1)^2}$

$= \sqrt{3.063 + 1.00}$

$= \sqrt{4.063}$

$= 2.016$

$\therefore m_1 > m_2$

$\therefore m_1$ is $> m_2$ so it belongs to the cluster 2

$C_1 = \{(x_1, x_2, x_3)\}$ $C_2 = \{(x_4, x_5)\}$

Step ①:

$m_1 = \left\{\frac{0+0+1.5}{3}, \frac{2+0+0}{3}\right\}$

$= \left\{\frac{1.5}{3}, \frac{2}{3}\right\}$

$= \{0.500, 0.667\}$

$m_2 = \left(\frac{5+5}{2}, \frac{0+2}{2}\right)$

$= \left(\frac{10}{2}, \frac{2}{2}\right)$

$= (5, 1)$

Step 2:

$E_1^2 = \{$

$E_2^2 =$

$E_1 C^2$

We obs

with

$x_1 =$

$d(x_1$

Step 2: Find the error

$E_1^2 = \{(0-0.500)^2 + (2-0.667)^2 + (0-0.500)^2 + (0-0.667)^2 + (1.5-0.500)^2 + (0-0.667)^2\}$

$= 0.250 + 1.777 + 0.250 + 0.445 + 1.00 + 0.445$

$= 4.167$

$E_2^2 = \{(5-5)^2 + (0-1)^2 + (5-5)^2 + (2-1)^2\}$

$= \{0+1+0+1\}$

$= 2$

$E_{1c}^2 = E_1^2 + E_2^2$

$= 4.167 + 2$

$= 6.167$

Reassign all the ~~value~~ data objects to the cluster with the max distance.

$x_1 = (0,2)$ $m_1 = (0.500, 0.667)$ $m_2 = (5,2)$

$d(x_1, m_1) = \sqrt{(0-0.500)^2 + (2-0.667)^2}$

$= \sqrt{0.250 + 1.777}$

$= \sqrt{2.027}$

$= 1.424$

$d(x_1, m_2) = \sqrt{(0-5)^2 + (2-1)^2}$

$= \sqrt{25.00 + 1.00}$

$= \sqrt{26.00}$

$= 5.099$

$\therefore m_2 > m_1$

$x_2 = (0, 0)$

$d(x_2, m_1) = \sqrt{(0 - 0.500)^2 + (0 - 0.667)^2}$

$= \sqrt{(0.250) + 0.445}$

$= \sqrt{0.695}$

$= 0.834$

$d(x_2, m_2)$

$= \sqrt{(0 - 5)^2 + (0 - 1)^2}$

$= \sqrt{25.00 + 1.00}$

$= \sqrt{26.00}$

$= 5.099$

$\therefore m_2 > m_1$

$x_3 = (1.5, 0)$

$d(x_3, m_1) = \sqrt{(1.5 - 0.500)^2 + (0 - 0.667)^2}$

$= \sqrt{1.00 + 0.445}$

$= \sqrt{1.445}$

$= 1.202$

$d(x_3, m_2)$

$= \sqrt{(1.5 - 5)^2 + (0 - 1)^2}$

$= \sqrt{12.250 + 1.00}$

$= \sqrt{13.250}$

$= 3.640$

$\therefore m_2 > m_1$

$x_4 = (5, 0)$

$d(x_4, m_1) = \sqrt{(5 - 0.500)^2 + (0 - 0.667)^2}$

$= \sqrt{20.250 + 0.445}$

$= \sqrt{20.695}$

$= 4.549$

$d(x_4, m_2)$

$= \sqrt{(5 - 5)^2 + (0 - 1)^2}$

$= \sqrt{0 + 1.00}$

$= \sqrt{1.00}$

$= 1.00$

$x_5 = (5, 2)$

$m_1 > m_2$

Ans. $d(x_5, m_1) = \sqrt{(5 - 0.5)^2 + (2 - 0.33)^2}$

$= 4.548$

$d(x_5, m_2) = \sqrt{(5-5)^2 + (2-1)^2}$

$= 1.00$

$c_1 = (x_1, x_2, x_3)$

$c_2 = (x_4, x_5)$

The alteration steps here as we got the same set of clusters as the previous step.