

P <sub>1</sub> (1, 1)
P <sub>2</sub> (2, 1)
P <sub>3</sub> (1.5, 2)
P <sub>4</sub> (4, 4)
P <sub>5</sub> (5, 4)
P <sub>6</sub> (4, 3)
P <sub>7</sub> (5, 2)
P <sub>8</sub> (5, 1)
P <sub>9</sub> (6, 1)

Assume $k = 3$		
<b>1<sup>st</sup> seeds</b>		
$m_1$	$m_2$	$m_3$
$p_2$	$p_8$	$p_9$

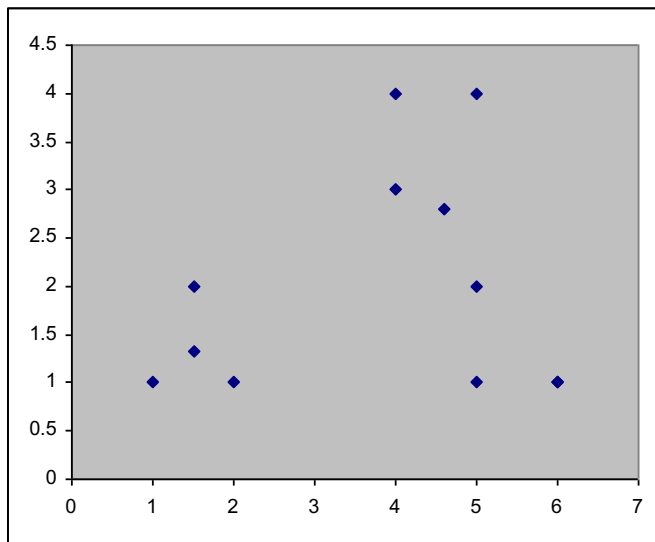
### Assign objects to clusters

object	Cluster
P <sub>1</sub>	1
P <sub>2</sub>	1
P <sub>3</sub>	1
P <sub>4</sub>	2
P <sub>5</sub>	2
P <sub>6</sub>	2
P <sub>7</sub>	2
P <sub>8</sub>	2
P <sub>9</sub>	3

### Cluster membership based on Euclidean distance

Assume $k = 3$		
1 <sup>st</sup> seeds		
$m_1$	$m_2$	$m_3$
$p_2$	$p_8$	$p_9$

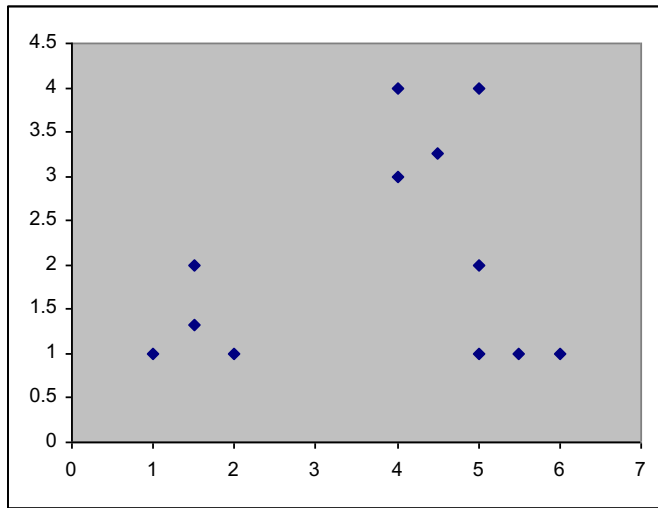
<b>2<sup>nd</sup> seeds</b>	
mc <sub>1</sub> :    x = (1+2+1.5) / ( 3) = 1.5	y = (1+1+2 ) / (3) = 1.33
mc <sub>2</sub> :    x = (4+5+4+5+5) / (5) = 4.6	y = (4+4+3+ 2+1) / ( 3) = 2.8
mc <sub>3</sub> :    x = 6	y = 1



### Assign objects to clusters

objects	Cluster
P <sub>1</sub>	1
P <sub>2</sub>	1
P <sub>3</sub>	1
P <sub>4</sub>	2
P <sub>5</sub>	2
P <sub>6</sub>	2
P <sub>7</sub>	2
P <sub>8</sub>	3
P <sub>9</sub>	3

3 <sup>rd</sup> seeds		
C <sub>1</sub> :	$x = 1.5$	$y = 1.33$ $y = (\text{same as before})$
C <sub>2</sub> :	$x = (4+5+4+5) / (4) = 4.5$	$y = (4+4+3+2) / (4) = 3.25$
C <sub>3</sub> :	$x = (5+6) / (2) = 5.5$	$y = (1+1) / (2) = 1$



**Assign objects to clusters**

objects	cluster	
P <sub>1</sub>	1	
P <sub>2</sub>	1	
P <sub>3</sub>	1	
P <sub>4</sub>	2	
P <sub>5</sub>	2	
P <sub>6</sub>	2	
P <sub>7</sub>	3?	$\{ d(P_7, C_2) = \sqrt{(5 - 4.5)^2 + (2 - 3.25)^2} = \sqrt{(0.5)^2 + (1.25)^2}$ $\{ d(P_7, C_3) = \sqrt{(5 - 5.5)^2 + (2 - 1)^2} = \sqrt{(1.25)^2}$
P <sub>8</sub>	3	
P <sub>9</sub>	3	

New seeds	
C <sub>1</sub> :	same
C <sub>2</sub> :	$x = (4+5+4) / (3) = 4.25$ $y = (3+4+4) / (3) = 3.66$
C <sub>3</sub> :	$x = (5+5+6) / (3) = 5.33$ $y = (2+1+1) / (3) = 1.33$

**Assign objects to clusters**

objects	cluster
P <sub>1</sub>	1
P <sub>2</sub>	1
P <sub>3</sub>	1
P <sub>4</sub>	2
P <sub>5</sub>	2
P <sub>6</sub>	2
P <sub>7</sub>	3?
P <sub>8</sub>	3
P <sub>9</sub>	3

No change done →→→

Cluster results	
C <sub>1</sub> :	1.5 , 1.33
C <sub>2</sub> :	4.25 , 3.66
C <sub>3</sub> :	5.33 , 1.33

**E = (mean squared error)**

$$E = \sum_{I=1}^k \sum_{P_i C_i} |P - m_i|^2$$

$$= (P_{ix} - m_{ix})^2 + (P_{iy} - m_{iy})^2 \quad \text{squared distance from } P_i + m_i$$

=	$(P_{ix} - m_{ix})^2 + (P_{iy} - m_{iy})^2$	--squared distance from $P_i + m_i$
	$+ (P_{2x} - m_{1x})^2 + (P_{2y} - m_{1y})^2$	Cluster 1
	$+ (P_{3x} - m_{1x})^2 + (P_{3y} - m_{1y})^2$	

	$+ (P_{4x} - m_{2x})^2 + (P_{4y} - m_{2y})^2$	Cluster 2
	+.....	
	$+ (P_{6x} - m_{2x})^2 + (P_{6y} - m_{2y})^2$	

	$+ (P_{7x} - m_{3x})^2 + (P_{7y} - m_{3y})^2$	Cluster 3
	+.....	
	$+ (P_{9x} - m_{3x})^2 + (P_{9y} - m_{3y})^2$	

$$= \begin{matrix} .3589 & .3589 & .4489 \\ [(1 - 1.5)^2 + (1 - 1.33)^2] + [(2 - 1.5)^2 + (1 - 1.33)^2] + [(1.5 - 1.5)^2 + (2 - 1.33)^2] \\ \\ .1781 & .6781 & .4981 \\ + [(4 - 4.25)^2 + (4 - 3.66)^2] + [(5 - 4.25)^2 + (4 - 3.66)^2] + [(4 - 4.25)^2 + (3 - 3.66)^2] \\ \\ .5578 & .2178 & .5578 \\ + [(5 - 5.33)^2 + (2 - 1.33)^2] + [(5 - 5.33)^2 + (1 - 1.33)^2] + [(6 - 5.33)^2 + (1 - 1.33)^2] \\ \\ = & \mathbf{3.8544} \end{matrix}$$