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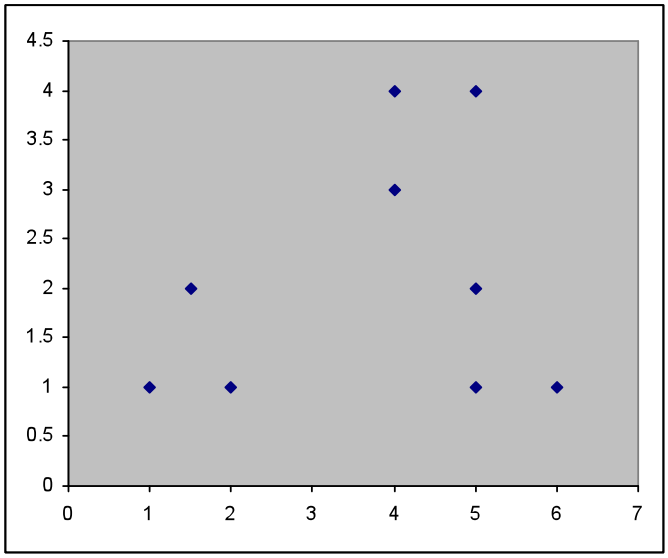


P_1 (1, 1)
P_2 (2, 1)
P_3 (1.5, 2)
P_4 (4, 4)
P_5 (5, 4)
P_6 (4, 3)
P_7 (5, 2)
P_8 (5, 1)
P_9 (6, 1)

Assume k = 3		
1st seeds		
m_1	m_2	m_3
p_2	p_8	p_9

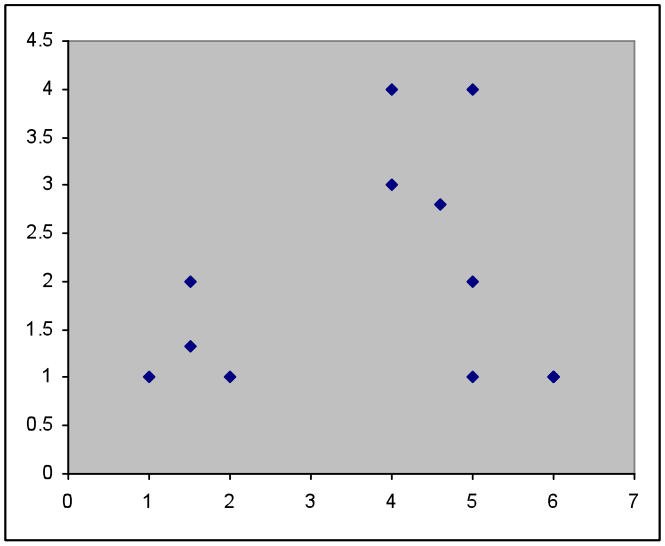
Assign objects to clusters

object	Cluster
P_1	1
P_2	1
P_3	1
P_4	2
P_5	2
P_6	2
P_7	2
P_8	2
P_9	3

Cluster membership based on Euclidean distance

Assume k = 3		
1st seeds		
m_1	m_2	m_3
p_2	p_8	p_9

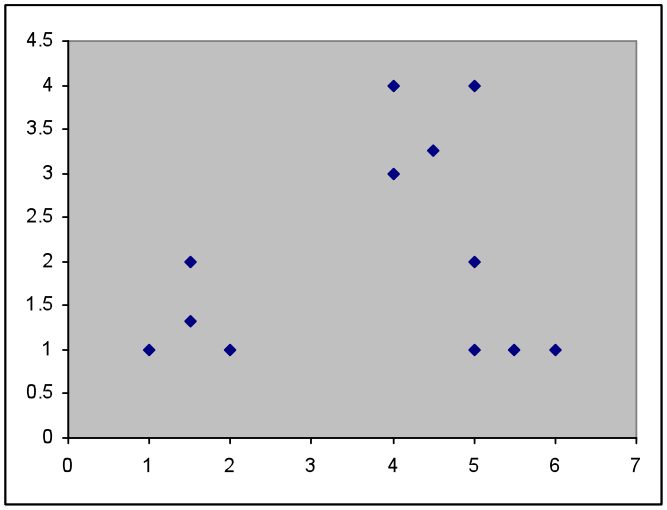
2nd seeds		
mc_1 :	x = (1+2+1.5) /(3) = 1.5	y = (1+1+2) / (3) = 1.33
mc_2 :	x = (4+5+4+5+5) / (5) = 4.6	y = (4+4+3+ 2+1) /(3) = 2.8
mc_3 :	x = 6	y = 1



Assign objects to clusters

objects	Cluster
P_1	1
P_2	1
P_3	1
P_4	2
P_5	2
P_6	2
P_7	2
P_8	3
P_9	3

3rd seeds		
C_1 :	x = 1.5	y = 1.33 y = (same as before)
C_2 :	x = (4+5+4+5) / (4) = 4.5	y = (4+4+3+2) / (4) = 3.25
C_3 :	x = (5+6) / (2) = 5.5	y = (1+1) / (2) = 1



Assign objects to clusters

objects	cluster	
P_1	1	
P_2	1	
P_3	1	
P_4	2	
P_5	2	
P_6	2	
P_7	3?	{ d (??, C_2) = $\sqrt{(5-4.5)^2 + (2-3.25)^2} = \sqrt{(0.5)^2 + (1.25)^2}$ { d (??, C_3) = $\sqrt{(5-5.5)^2 + (2-1)^2} = \sqrt{(1.25)}$
P_8	3	
P_9	3	

New seeds		
C_1 :	same	
C_2 :	x = (4+5+4) / (3) = 4.25	y = (3+4+4) / (3) = 3.66
C_3 :	x = (5+5+6) / (3) = 5.33	y = (2+1+1) / (3) = 1.33

Assign objects to clusters

objects	cluster
P_1	1
P_2	1
P_3	1
P_4	2
P_5	2
P_6	2
P_7	3?
P_8	3
P_9	3

No change done →→→

Cluster results	
C_1 :	1.5 , 1.33
C_2 :	4.25 , 3.66
C_3 :	5.33 , 1.33

E = (mean squared error)

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

$= (P_{ix} - m_{ix})^2 + (P_{iy} - m_{iy})^2$ 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
+……..	
$+ (P_{9x} - m_{3x})^2 + (P_{9y} - m_{3y})^2$	

$$= \overset{.3589}{[(1 - 1.5)^2 + (1 - 1.33)^2]} + \overset{.3589}{[(2 - 1.5)^2 + (1 - 1.33)^2]} + \overset{.4489}{[(1.5 - 1.5)^2 + (2 - 1.33)^2]}$$

$$+ \overset{.1781}{[(4 - 4.25)^2 + (4 - 3.66)^2]} + \overset{.6781}{[(5 - 4.25)^2 + (4 - 3.66)^2]} + \overset{.4981}{[(4 - 4.25)^2 + (3 - 3.66)^2]}$$

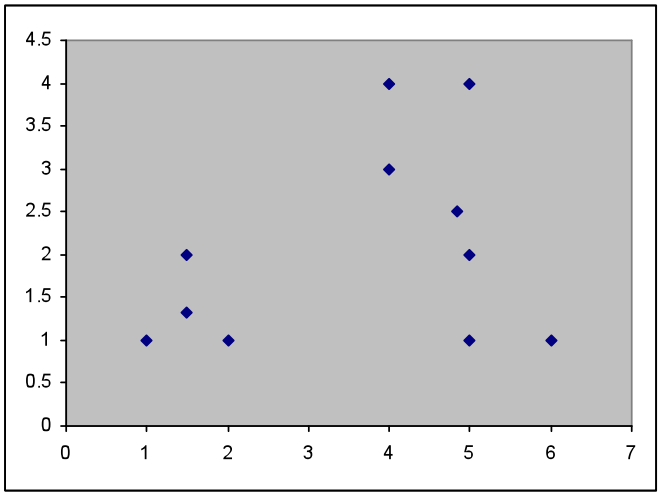
$$+ \overset{.5578}{[(5 - 5.33)^2 + (2 - 1.33)^2]} + \overset{.2178}{[(5 - 533)^2 + (1 - 1.33)^2]} + \overset{.5578}{[(6 - 5.33)^2 + (1 - 1.33)^2]}$$

= 3.8544

→ the choice of initial seed can be crucial !
see next example with K = 2

What if K = 2 in the previous case?

Option 1	
Initial seeds	
C_1	P_3
C_2	P_6



Assign objects to clusters

object	Cluster
P_1	1
P_2	1
P_3	1
P_4	2
P_5	2
P_6	2
P_7	2
P_8	2
P_9	2

2nd set of seed
m_1 : x = 1.5 y = 1.33
m_2 : x = (4+5+4+5+5+6) / (6) = 4.83 y = (4+4+3+ 2+1+1) /(6) = 2.5

object	Cluster
P_1	1
P_2	1
P_3	1
P_4	2
P_5	2
P_6	2
P_7	2
P_8	2
P_9	2

Stop

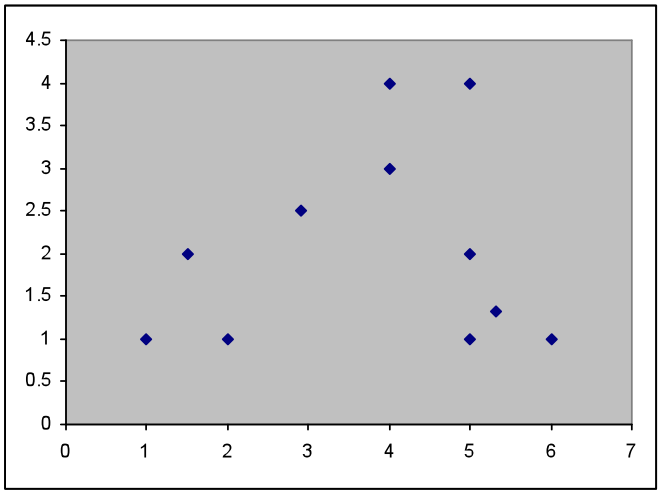
$$= [(1-1.5)^2 + (1-1.33)^2] + [(2-1.5)^2 + (1-1.33)^2] + [(1.5-1.5)^2 + (2-1.33)^2] = 1.1667$$
(.25 .1089 .25 .1089 0.4489)

$$+ [(4-4.83)^2 + (4-2.5)^2] + [(5-4.83)^2 + (4-2.5)^2] + [(4-4.83)^2 + (3-2.5)^2]$$
(.6889 2.25 .028 2.25 0.6889)

$$+ [(5-4.83)^2 + (2-2.5)^2] + [(5-4.83)^2 + (1-2.5)^2] + [(6-4.83)^2 + (1-2.5)^2]$$
(0.0289 0.25 0.0289 2.25 1.3689 2.25)

$$= \mathbf{13.50}$$

Option 2	
Initial seeds	
C_1	P_6
C_2	P_9



Assign objects to clusters

object	Cluster
P_1	1
P_2	1
P_3	1
P_4	1
P_5	1
P_6	1
P_7	2
P_8	2
P_9	2

m_1 :	x = (1+2+1.5+4+5+4) / (6) = 2.91	y = () / () = 2.5
m_2 :	x = 5.33	y = 1.33

2nd round object distribution

objects	cluster	
P_1	1	
P_2	1	
P_3	1	
P_4	1	
P_5	?	$\{ d_{51}) = \sqrt{(5 - 2.91)^2 + (4 - 2.5)^2} = \sqrt{(2.09)^2 + (1.5)^2} = \sqrt{(6.61)}$ $\{ d_{52}) = \sqrt{(5 - 5.33)^2 + (4 - 1.33)^2} = \sqrt{(0.33)^2 + (2.67)^2} = \sqrt{(7.2389)}$
P_6	1	
P_7	2	
P_8	2	
P_9	2	

Stop

$= [(1 - 2.91)^2 + (1 - 2.5)^2] + [(2 - 2.91)^2 + (1 - 1.2.5)^2] + [(1.5 - 2.91)^2 + (2 - 2.5)^2]$
$+ [(4 - 2.91)^2 + (4 - 2.5)^2] + [(5 - 2.91)^2 + (4 - 2.5)^2] + [(4 - 2.91)^2 + (3 - 2.5)^2]$
$+ [(5 - 5.33)^2 + (2 - 1.33)^2] + [(5 - 5.33)^2 + (1 - 1.33)^2] + [(6 - 5.33)^2 + (1 - 1.33)^2]$

$=$ **24.042**