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$$5 + 10 + 10 + 10 + 50 + 20 + 25 + 7 + 1$$

Thresholding

$$\min = 0 \quad \max = 7 \quad T = 4$$

0	0	0	0	0	0	9	0	0
0	1	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	1	1	1	1
0	1	1	0	1	1	1	1	1
0	1	1	0	0	1	1	1	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

0 9

0	0	0	0	0	0	0	0	0
0	4	0	0	0	0	0	0	0
0	5	4	0	0	0	0	0	0
0	6	5	0	0	7	7	0	0
0	7	6	0	7	7	7	7	0
0	7	7	0	0	7	7	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

$$S_1 \xrightarrow{\mu_1} \frac{43}{7}$$

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	2	2	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0



0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	2	2	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

↓ $\delta_{\text{OW}} 1$

$$S_2 \xrightarrow{\mu_2} \frac{56}{9}$$

$$S_1 = 6 \quad S_2 = 7$$

$$E_1 = 1 \quad E_2 = 3$$

0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	1	0	0	2	2	0	0	0
0	1	0	2	2	2	0	0	0
0	1	0	2	2	2	0	0	0
0	1	0	0	2	2	0	0	0
0	0	0	0	0	0	0	0	0

↑ $\delta_{\text{OW}} 2$

0	0	0	0	1	2	3	2
0	6	5	1	1	1	2	2
0	7	6	1	1	2	2	1
1	7	6	2	2	2	2	1
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

↓ $\delta_{\text{OW}} 2$

$$C_1 = 1.5 \quad 2$$

$$C_2 = 4.5 \quad 5$$

Sample

1	1	1
2	1.5	2
3	3	4
4	5	
5	4.5	7
6	4.5	5
7	4.5	9

Sample	Distance to mean of C ₁	Distance to mean of C ₂	Member G ₁	Member G ₂
1	(1 - 1.5) + (1 - 2)	(1 - 4.5) + (1 - 5)	↑	
	$\boxed{-1.5}$	$\boxed{7.5}$		

Sample	Distance to mean of C ₁	Distance to mean of C ₂	Member G ₁	Member G ₂
2	0	(1.5 - 4.5) + (2 - 5)	↓	
		$\boxed{6}$		

Sample	Distance to mean of C ₁	Distance to mean of C ₂	Member G ₁	Member G ₂
3	(3 - 1.5) + (4 - 2)	(3 - 4.5) + (4 - 5)	↓	1, 2
	$\boxed{3.5}$	$\boxed{2.5}$		

Sample	Distance to mean of C ₁	Distance to mean of C ₂	Member G ₁	Member G ₂
4	(5 - 1.5) + (7 - 2)	(5 - 4.5) + (7 - 5)	↓	1, 2
	$\boxed{8.5}$	$\boxed{2.5}$		

Sample	Distance to mean of C ₁	Distance to mean of C ₂	Member G ₁	Member G ₂
5	(3.5 - 1.5) + (5 - 2)	(3.5 - 4.5) + (5 - 5)	↓	1, 2
	$\boxed{2.5}$	$\boxed{2.5}$		

Sample	Distance to mean of C ₁	Distance to mean of C ₂	Member G ₁	Member G ₂
6	(4.5 - 1.5) + (9 - 2)	0	↓	1, 2
	$\boxed{16}$	$\boxed{2.5}$		

Sample	Distance to mean of C ₁	Distance to mean of C ₂	Member G ₁	Member G ₂
7	(3.0 - 1.5) + (4.5 - 2)	-0.5	A, B	A, B
	$\boxed{2.5}$	$\boxed{1.5}$		

$$\frac{3+5+3.0+4.5+3.5}{5} = \frac{19}{5}$$

$$\frac{4+7+5+5+4.5}{5} = \frac{27}{5}$$

19 27

$$\left(\frac{3.9}{G_1}, \frac{5.1}{G_2} \right)$$

1) Thresholding

$T=1$	$T=7$							
0 0 0 0 0 0 0 0 0								
0 1 1 0 0 0 0 0 0								
0 1 1 0 0 0 0 0 0								
0 1 1 0 0 2 2 0								
0 1 1 0 2 2 2 2								
0 1 1 0 0 2 2 0								
0 0 0 0 0 0 0 0 0								
0 0 0 0 0 0 0 0 0								

 $T=4$ $T=7$

2) Region Growing

round 1			
0 0 0 0	0 1 2 3 2	$m_1 = 43$	
0 4 3 1	1 1 2 2		
0 5 4 1	1 2 2 1		
0 6 5 1	2 7 7 1		
1 7 6 2	7 7 7 7		
1 7 7 2	1 7 7 0		
1 2 2 1	1 0 0 0		
2 2 1 1	0 0 0 0		

 $S_{1,2}^b$ $S_{2,2}^b$ $E_{1,2}^1$ $E_{2,2}^1$

round 2			
0 0 0 0	1 2 3 2		
0 4 3 1	1 1 2 9		
0 5 4 1	1 2 2 1		
0 6 5 1	2 7 7 1		
1 7 6 2	7 7 7 7		
1 7 7 2	1 7 7 0		
1 2 2 1	1 0 0 0		
2 2 1 1	0 0 0 0		

 $m_2 = 56$

0 0 0 0	0 0 0 0
0 1 1 0	0 0 0 0
0 1 1 0	0 0 0 0
0 1 1 0	0 2 2 0
0 1 1 0	2 2 2 2
0 1 1 0	0 2 2 0
0 0 0 0	0 0 0 0
0 0 0 0	0 0 0 0

Individual	Distance to mean (centroid) of cluster 1	Distance to mean (centroid) of cluster 2	Member C ₁	Member C ₂	Mean Vector (Centroid) Cluster		Mean Vector (Centroid) Cluster 2	
	A	B	A	B				
1			1	5	1	1	3.5	5
2	1.5-11+12-11=1.5	1.5-3.51+12-51=5	1,2	5				
3	13-11+14-11=5	13-3.51+12-51=3.5	1,2	5,3				
4	15-11+17-11=5	15-3.51+17-3.51=5	1,2	5,3,4				
5	13.5-11+15-11=6.5	13.5-3.51+15-3.51=5	1,2	3,4,5				
6	14.5-11+15-11=7.5	14.5-3.51+15-3.51=5	1,2	3,4,5,6				
7	13.5-11+14.5-11=6	13.5-3.51+14.5-3.51=5	1,2	3,4,5,6,7	1.25	1.5	3.9	5.1
		2.1						

1) Thresholding

$T = 3$ แบ่ง 2 ส่วน $T = 7$

0	0	0	0	0	1	2	3	2
0	4	3	1	1	1	1	2	2
0	5	4	1	1	2	2	1	1
0	6	5	1	2	7	7	7	1
1	7	6	2	7	7	7	7	1
1	7	7	2	1	7	7	7	0
2	2	2	1	1	0	0	0	0
2	2	1	1	0	0	0	0	0

$\therefore T > 3$ เป็นพื้นที่ในส่วนที่ 1 $\Rightarrow '1'$

$T = 7$ เป็นพื้นที่ในส่วนที่ 2 $\Rightarrow '2'$

ที่เหลือเป็นครา $\Rightarrow '0'$

0	0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	2	2	0	0
0	1	1	0	2	2	2	2	0
0	1	1	0	2	2	2	2	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

2) Splitting and Merging

0	0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2	2
0	5	4	1	1	2	2	1	1
0	6	5	1	2	7	7	7	1
1	7	6	2	7	7	7	7	1
1	7	7	2	1	7	7	7	0
2	2	2	1	1	0	0	0	0
2	2	1	1	0	0	0	0	0

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0	0	0	0	0	1	2	2	2
0	4	3	1	1	1	2	2	2
0	5	4	1	1	2	2	2	1
0	6	5	1	2	7	7	7	1
1	7	6	2	7	7	7	7	1
1	7	7	2	7	7	7	7	0
2	2	2	1	1	0	0	0	0
2	2	1	1	0	0	0	0	0



0 0 0 0	0 0 0 0
0 4 3 0	0 0 0 0
0 5 4 0	0 0 0 0
0 6 5 0	0 7 7 0
0 7 6 0	1 7 7 7
0 7 7 0	0 7 7 0
0 0 0 0	0 0 0 0
0 0 0 0	0 0 0 0

3.

Sample #1, 5

(1,1), (3.5, 5)

Sample	A	B
1	1	1
2	1.5	2
3	3	4
4	5	7
5	3.5	5
6	4.5	5
7	3.5	4.5

individual	Distance to mean (centroids) of Cluster 1	Distance to mean (centroids) of Cluster 2	Member G_1	Member G_2	Mean Vector (centroid) Cluster 1	Mean Vector (centroid) Cluster 2
1	$ 1-1 + 1-1 = 0$	$ 3.5-1 + 5-1 = 4.5$	{1}	{2}	(1, 1)	(3.5, 5)
2	$ 1-1.5 + 2-1 = 1.5$	$ 3.5-1.5 + 5-2 = 4.5$	{1, 2}	{3}	(1, 1)	(3.5, 5)
3	$ 1-3 + 1-4 = 5$	$ 3.5-3 + 5-4 = 2.5$	{1, 2, 3}	{3}		
4	$ 1-5 + 1-7 = 10$	$ 3.5-5 + 5-7 = 3.5$	{1, 2, 3}	{4}		
5	$ 1-3.5 + 1-5 = 6.5$	$ 3.5-3.5 + 5-5 = 0$	{1, 2, 5}	{4, 5}		
6	$ 1-4.5 + 1-5 = 7.5$	$ 3.5-4.5 + 5-5 = 1$	{1, 2}	{3, 4, 5, 6}		
7	$ 1-3.5 + 1-4.5 = 6$	$ 3.5-3.5 + 5-4.5 = 0.5$	{1, 2}	{3, 4, 5, 6, 7}		

$$G_1 \therefore (1.25, 2.5)$$

$$G_2 \therefore (4.75, 5.1)$$

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	1	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

$$\zeta_0 = 5$$

$$S_B = 7$$

E = 1

$$E = 0$$

individual

↳ mean 1

D to Mem 2

1	1			
1	1			
1	1			
1	1			
1	1			
1	1			

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$$\begin{array}{ll} S_1 = 5 & S_2 = 7 \\ E = 2 & E_2 \text{?} \end{array}$$

$$S_1 = 5 \rightarrow S = \frac{49}{8}$$

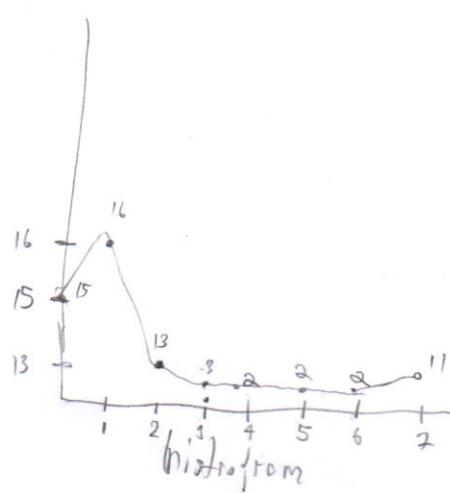
$$S_1 = \frac{59}{10}$$

	$E=1$	$E=0$	individual	D to mean 1	D to mem 2	member 1	member 2	mean 1	mean 2
								A	B
						4	7	57	3.5 4.5
1				5.2	18.5	4	7, 1		
2				37.25	10.25	4	7, 1, 2		
3				13	0.5	4	7, 1, 2, 3		
4				6.25	0.25	4	7, 1, 2, 3, 5		
5				4.25	1.25	4	7, 1, 2, 3, 5, 6		
							update mean	5	7
								2.83	3.55

$d(x,y) \neq 3d$

$d(y)$ use d_{\max}

1) រាយការការណើនា thresholding



$$f_o = \begin{cases} 0: 7 \\ 1: 3 \\ 3: 1 \\ 4: 0 \\ 5: 0 \\ 6: 1 \\ 7: 2 \end{cases} \rightarrow T_o$$

$$f_i = \begin{cases} 1: 6 \\ 2: 5 \\ 3: 1 \\ 4: 0 \\ 5: 0 \\ 6: 0 \\ 7: 2 \end{cases} \rightarrow T_i$$

				①
0	0	0	0	1 2 3 2
0	4	3	1	1 1 2 2
0	5	4	1	1 2 2 1
0	6	5	1	2 7 7 1
1	7	6	2	7 7 7 7
1	7	7	2	1 7 7 0
1	2	2	1	1 0 0 0
2	2	1	1	0 0 0 0

$$f_2 = \begin{cases} 1: 6 \\ 2: 4 \\ 6: 1 \\ 7: 3 \end{cases} \rightarrow T_2$$

$$f_3 = \begin{cases} 0: 8 \\ 1: 2 \\ 7: 6 \end{cases} \rightarrow T_3$$

2) Region growing

0	0	0	0	1	2	3	2
0	4	3	1	1	7	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

$$S_1 = 5$$

$$B = 2$$

$$S_2 = 7$$

$$E_2 = 0$$

$$S_1 = 5 \rightarrow S_1 = 9$$

$$\downarrow$$

$$S_1 = \frac{5+9}{10}$$

$$S_1 = 5 \quad S_2 = 7$$

$$E_1 = 7 \quad E_2 = 0$$

$$S_1 = 5 \quad S_2 = 7$$

$$E_1 = 2 \quad E_2 = 0$$

thresholding

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	2	2	0
0	2	1	0	2	2	2	2
0	2	2	0	0	2	2	0
0	0	0	0	0	0	0	0
0	0	0	0	6	0	0	0

region growing

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	2	2	0
0	1	1	0	2	2	2	2
0	1	1	0	0	2	2	0
0	0	0	0	0	0	0	0
0	0	0	0	6	6	6	0

individual	D to mean	D to mean 2	member ₁	member ₂	mean 1		mean 2	
					A	B	A	B
1	5.2	18.5	4	7	5	2	3.5	9.5
2	37.25	10.25	4	7,1				
3	13	0.5	4	7,1,2				
5	6.25	6.25	4	7,1,2,2,5				
6	4.25	1.25	4	7,1,2,3,5,6	5	7	2.83	3.58

individual	D to mean 1	D to mean 2	member 1	member 2	mean 1		mem 2	
					A	B	A	B
1	5.2	18.5	4	7	5	7	3.5	4.5
2	39.25	10.25	4	7, 1				
3	13	0.5	4	7, 1, 2, 3				
5	6.25	0.25	4	7, 1, 2, 3, 5				
6	4.25	1.25	4	7, 1, 2, 3, 5, b				
				Update mean	5	7	2.83	3.58

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$S_1 = 5$ $S_2 = 7$
 $E_1 = 1$ $E_2 = 0$

Thresholding

0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	2	2	0
0	2	1	0	2	2	2	2
0	2	2	0	0	2	2	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Region Growing

$S_1 = 5$ $S_2 = 7$
 $E_1 = 2$ $E_2 = 0$

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	2	2	0
0	1	1	0	2	2	2	2
0	1	1	0	0	2	2	0
0	0	0	0	0	0	0	0
0	0	0	0	9	0	0	0
0	0	0	0	0	0	0	0

$$S_1 = 5 \rightarrow S_1 = \frac{40}{8}$$

$$S_1 = \frac{54}{10}$$

$$Seed_1 = 5$$

$$Err_1 = 2$$



$$Seed_2 = \frac{40}{8} = 5$$

$$\frac{40}{10}$$

$$\sqrt{\frac{(1-5)^2}{A_1 A_4} + (1-7)^2}$$

$$A = (1, 1)$$

$$12.25, 1$$

$$C_1 = (5, 7) 25$$

$$C_2 = (3.5, 4.5)$$

$$(14 + 21)$$

$$16$$

$$\begin{matrix} 0 & 0 & 0 & 0 & 1 & 2 & 3 & 2 \\ 0 & 4 & 3 & 1 & 1 & 1 & 2 & 2 \\ 0 & 5 & 4 & 1 & 1 & 2 & 2 & 1 \\ 0 & 6 & 5 & 1 & 2 & 1 & 7 & 7 \\ 1 & 7 & 6 & 2 & 7 & 7 & 7 & 7 \\ 1 & 7 & 7 & 3 & 1 & 7 & 7 & 0 \\ 1 & 2 & 2 & 1 & 1 & 0 & 0 & 0 \\ 2 & 2 & 1 & 1 & 0 & 0 & 0 & 0 \end{matrix}$$

$$Seed_3 = 7$$

$$Err_3 = 0$$

$$\frac{7 \times 8}{8}$$

$$dG_1, dG_2, M_1, M_2$$

$$16 + 36$$

$$1 \quad 5.2 \quad 18.5 \quad 4 \quad 1, 7$$

$$2 \quad 37.25 \quad 10.25 \quad 4 \quad 1, 2, 7$$

$$3 \quad 44.93 \quad 0.5 \quad 4 \quad 1, 2, 3, 7$$

$$4 \quad 4 \quad 1, 2, 3, 7$$

$$5 \quad 6.25 \quad 0.25 \quad 4 \quad 1, 2, 3, 5, 7$$

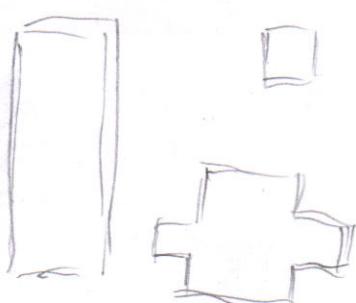
$$6 \quad 4.25 \quad 1.25 \quad 4 \quad 1, 2, 3, 5, 6, 7$$

$$4 \quad 1, 2, 3, 5, 6, 7$$

threshold

$$S_1 = 5 + S_2 = 7$$

$$E_1 = 2 + E_2 = 0$$



Mean 2

$$2.83 \quad 3.55$$

$$L_1 = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

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Thresholding

48 62 0610512 59010649

$$T_0 = 0.2$$

$$T_1 = 3 - 6$$

T_l = 7

splitting & Merging $T = 3 - 7$

0	0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2	2
0	5	4	1	1	2	2	1	
0	6	5	1	2	7	7	1	
1	7	6	2	7	7	7	7	7
1	7	7	2	1	7	7	0	
1	2	2	1	1	0	0	0	
2	2	1	1	0	0	0	0	



0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

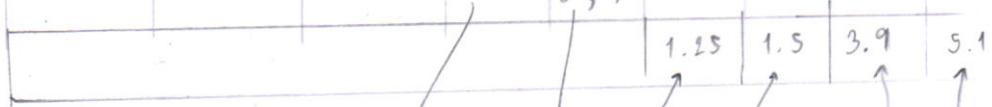
$$R_2 : \begin{matrix} C_1 & C_2 \\ 2 & 6 \end{matrix}$$

$$L_2 = \sqrt{\sum_{i=1}^N (f_i - c_1)^2}$$

$$L_1 = \sum_{i=1}^N |f_i - c_1|$$

Samples	A	B
1	1	1
2	1.5	2
3	3	4
4	5	7
5	3.5	5
6	4.5	5
7	3.5	4.5

Individual	Distance to mean (centroid) of cluster 1	Distance to mean (centroid) of Cluster 2	Member G1	Member G2	Mean Vector (centroid) cluster 1	Mean Vector (centroid) Cluster 2
1	$(1-1.5 + 1-2)$ = 1.5	$(1-4.5 + 1-5)$ = 7.5	1		A	B
2	0	6	1, 2			
3	3.5	2.5	1, 2	3		
4	8.5	2.5	1, 2	3, 4		
5	5	1	1, 2	3, 4, 5		
6	6	0	1, 2	3, 4, 5, 6		
7	4.5	1.5	1, 2	3, 4, 5, 6, 7		



$$\frac{1+1.5}{2}$$

$$\frac{1+2}{2}$$

$$\frac{3+5+3.5+4.5+3.5}{5}$$

$$\frac{4+7+5+5+4.5}{5}$$

Individual	Distance C ₁	Distance C ₂	Member G ₁	Member G ₂	Mean C ₁	Mean C ₂
1 (1,1)	10	6	4	7,1	5	3.5
2 (1.5,2)	$3.5 + 5 = 8.5$	$2 + 2.5 = 4.5$	4	1,2,7	5	3.5
3 (3,4)	$2 + 3 = 5$	$0.5 + 0.5 = 1$	4	1,2,3,7	5	3.5
4 (5,7)	0	$1.5 + 2.5 = 4$	4	1,2,3,7	5	3.5
5 (4.5,3)	$1.5 + 2 = 3.5$	$0 + 0.9 = 0.9$	4	1,2,3,5,7	5	3.5
6 (4.5,5)	$0.9 + 2 = 2.5$	$1 + 0.9 = 1.9$	4	1,2,3,5,7	5	3.5
7 (3.5,4.5)	$1.5 + 2.5 = 4$	0	4	1,2,3,5,7	5	3.5

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0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	1	7	7	2
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

$$S_1 = 5$$

$$S_2 = 7$$

$$E_1 = 2$$

$$E_2 = 2$$

Grow S_2
⇒

0	0	0	0	1	0	2	0	0
0	4	3	1	0	0	0	0	0
0	5	4	1	0	0	0	0	0
0	6	5	1	0	0	0	0	0
1	7	6	2	0	0	0	0	0
1	7	7	2	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

↓ Grow S_1

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	1	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

$$4+3+5+4+6+5+7+6/8$$

$$S_1 = \cancel{4} \cancel{3} \cancel{5} \cancel{4} \cancel{6} \cancel{5} \cancel{7} \cancel{6} 5$$

$$\cancel{2} \cancel{3} \cancel{4} \cancel{5} \cancel{6} \cancel{7} \cancel{8} \cancel{9}$$

$$3 \leq x \leq 7$$



↓
Grow S_1
⇒

0	0	0	0					
0	4	3	1					
0	5	4	1					
0	6	5	1					
1	7	6	2					
1	7	7	2					
1	2	2	1					
2	2	1	1					

↓

0	0	0	0					
0	4	3	1					
0	5	4	1					
0	6	5	1					
1	7	6	2					
1	7	7	2					
1	2	2	1					
2	2	1	1					

• Thresholding

$$T = 3$$

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

• k-mean

NO.	distance 1	distance 2	Mem 1	Mem 2	C1	C2
1	1.5	7.5	1		(1.5, 2)	
2	0	6	1, 2			
3	3.5	2.5		3		
4	8.5	2.5		3, 4		
5	5	1		3, 4, 5		
6	6	0		3, 4, 5, 6		
7	4.5	1.5		3, 4, 5, 6, 7		

• Splitting & Merging

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

• update centroid

$$\text{Group 1} \quad 1, 2$$

$$\left(\frac{1+1.5}{2}, \frac{1+2}{2} \right) \\ (1.25, 1.5)$$

$$\text{Group 2} \quad 3, 4, 5, 6, 7$$

$$(3.9, 5.1)$$

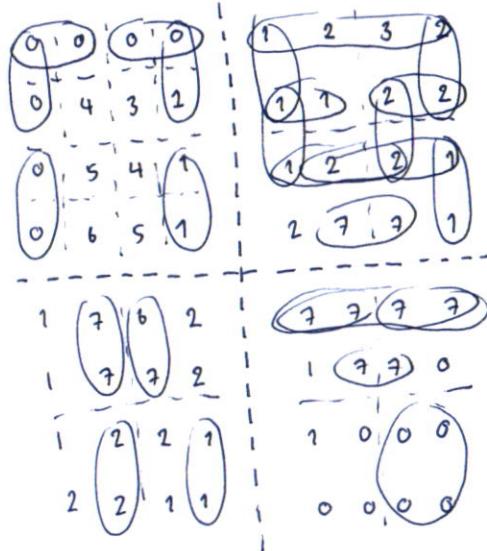
$$\frac{3+5+3.5+4.5+3.5}{5}$$

$$\frac{4+7+5+5+4.5}{5}$$

mn. no. 9

5mm \Rightarrow w/noise = 59010337- Threshold > 3

- split & merge

0 0 00
0 4 3 1

19.515

3+3

11.5

$$\begin{array}{l} 3 \\ (4+5) + 3.5 + 4.5 \\ \quad + 3.5 \end{array} \quad \begin{array}{l} 16 \\ 14 \end{array} = 4$$

$$\begin{array}{l} 4 + 7 + 5 + 5 \\ \quad + 1 \end{array} \quad \begin{array}{l} 10 \end{array}$$

$$\begin{array}{l} 21 \\ 14 \\ \quad + 5.25 \end{array} \quad \begin{array}{l} 21 \end{array}$$

$$\begin{array}{l} 3.9 \\ 19.5 \\ \quad + 5 \\ \hline 4 \end{array}$$



0.5 + 1

3.5 + 4

1.5 + 2

3 + 3

initial centroid

	A	B
2	1.5	2
6	4.5	5

2 + 3

1 + 0

3.5 + 5

0.5 + 2

Sample #	Distance to C1	Distance to C2	C1 Member	C2 Member
1	1.5	9.5	1	0
2	0	6	1, 2	0
3	3.5	2.5	1, 2	3
4	8.5	2.5	1, 2	3, 4
5	5	1	1, 2	3, 4, 5
6	6	0	1, 2	3, 4, 5, 6
7	4.5	1.5	1, 2	3, 4, 5, 6, 7

Finish

Cluster	Mean
Cluster 1 : 1, 2	1.25
Cluster 2 : 3, 4, 5, 6, 7	5.1

សំគាល់ ឯកតាំង 59010651

Thresholding $\rightarrow t_0 = [0-2]$

$$t_1 = [3-6]$$

0 0 0 0 0 0 1 0
0 4 1 0 0 0 0 0
0 1 4 0 0 0 0 0
0 1 5 0 0 1 1 0
0 2 1 0 2 2 2 2
0 2 2 0 0 2 2 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

$$t_2 = [7-9]$$

Splitting & merging $\rightarrow t = 3-7$

0 0 0 0 1 2 3 2
0 4 3 1 1 1 2 2
0 5 4 1 1 2 2 1
0 6 3 1 2 7 7 1

$t = 3-7$
 \Rightarrow

0 0	0 0	1 2	3 2
0 4	3 1	1 1	2 2
0 5	4 1	2 2	1 1
0 6	5 1	2 1	7 1
1 7	6 2	7 7	7 7
1 7	7 2	7 7	7 0
0 0	0 0	0 0	0 0
0 0	0 0	0 0	0 0

1 7 6 2 7 7 7 7
1 7 7 2 1 7 7 0
1 2 2 1 1 0 0 0
2 2 1 1 0 0 0 0



0 0	0 0	0 0	0 0
0 4	3 0	0 0	0 0
0 5	4 0	0 0	0 0
0 6	5 0	0 7	7 6
0 7	6 0	7 7	7 7
0 7	7 6	7 7	7 0
0 0	0 0	0 0	0 0
0 0	0 0	0 0	0 0

Sample	A	B
1	1	1
2	1.5	2
3	3	4
4	5	7
5	3.5	5
6	4.5	5
7	3.5	4.5
	2	2.5

$$C_1 = \textcircled{2}$$

$$C_2 = \textcircled{6}$$

$$\frac{1+1.5}{2} \quad \frac{1+2}{2}$$

individual	Dist to mem C1	Dist to mem C2	Mem		Mem C1		Mem C2	
			G1	G2	A	B	A	B
①	-1.5	7.5	1		1.25	1.5	3.9	5.1
②	0	6	1, 2		"	"	"	"
③	3.5	2.5	1, 2	3				
④	8.5	2.5	1, 2	3, 4				
⑤	5	1.5	1, 2	3, 4, 5				
⑥	6	0	1, 2	3, 4, 5, 6				
⑦	4.5	1.5	1, 2	3, 4, 5, 6	7	"	"	"
				1.5				

Region Thresholding

0 0 0 0 0 0 3 0 $T_0 = [0, 2]$
 0 4 3 0 0 0 0 0
 0 5 4 0 0 0 0 0
 0 6 5 0 0 7 7 0
 0 7 6 0 7 7 7 1
 0 7 7 0 0 7 7 0
 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0

 \downarrow

0 0 0 0 0 0 1 0 $T_1 = [3, 6]$
 0 1 1 0 0 0 0 0
 0 1 1 0 0 0 0 0
 0 1 1 0 0 2 2 0 $T_2 = [7, 7]$
 0 2 1 0 2 2 2 2
 0 2 2 0 0 2 2 0
 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0

Normal Intra Region Growing

0 0 0 0 0 0 0 0 0	$S_1 = 5$
0 1 1 0 0 0 0 0 0	$E_1 = 2$
0 1 1 0 0 0 0 0 0	
0 1 1 0 0 2 2 0 0	
0 1 1 0 2 2 2 0 0	$S_2 = 7$
0 1 1 0 2 2 2 0 0	$E_2 = 1$
0 0 0 0 0 0 0 0 0	
0 0 0 0 0 0 0 0 0	

k-Mean Clustering 3 7

Individual	Distance to	Distance to	Member	Member
	mean 1	mean 2	G1	G2
1	5	6	1	
2	3.5	4.5	1, 2	
3	0	1	1, 2, 3	
4	5	4	1, 2, 3	4
5	1.5	0.5	1, 2, 3	4, 5
6	2.5	1.5	1, 2, 3	4, 5, 6
7	1	0	1, 2, 3	4, 5, 6, 7

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	2	2	1
1	7	6	2	2	2	2	2
1	2	7	2	1	2	2	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

Region (Boundary)

$$S_1 = 5 \quad S_2 = 7$$

$$E_1 = 1 \quad E_2 = 1$$

0 0 0 0 1 2 3 2

1111 sum 1

0 1111 1 1 2 2

0 1111 1 1 2 2 1

0 1111 1 1 2 2 1

1 1111 2 1 1 2 2 1

1 1111 2 1 1 2 2 0

1 2 2 1 1 0 0 0

2 2 1 1 0 0 0 0

Thresholding

T = 3 - 7

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	1	0	0
0	1	1	0	1	1	1	1
0	1	1	0	0	0	1	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Subject	A	B
1	1	1
2	1.5	2
3	3	4
4	5	2
5	3.5	5
6	4.5	5
7	3.5	4.5

Member G₁Member G₂

Mean Vector

Cluster 1

Individual	R ₁	R ₂	Member G ₁	Member G ₂	Cluster 1
1	1.5	2.5	1	1	
2	0	6	1,2		
3	3.5	2.5	1,2	3	
4	3.5	2.5	1,2	3,4	
5	5	1	1,2	3,4,5	
6	6	0	1,2	3,4,5,6	
7	4.5	1.5	1,2	3,4,5,6,7	

$$\left(\frac{1+1.5}{2}, \frac{1+2}{2} \right) \rightarrow \left(\frac{1.25, 1.5}{2}, \frac{(3.9, 5.1)}{5} \right) \rightarrow \left(\frac{3+5+2.5+4.5+1.5}{5}, \frac{4+7+5+3+4.5}{5} \right)$$

$$S_1 = 5 \quad S_2 = 7$$

$$E_1 = 1 \quad f_2 = 0$$

thresholding

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	2	2	0
0	2	1	0	2	2	2	2
0	2	2	0	0	2	2	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

$$S_1 = 5$$

$$E_1 = 2$$

Region growing

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	2	2	0
0	1	1	0	2	2	2	2
0	1	1	0	0	2	2	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

0	0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2	
0	5	4	1	1	2	2	1	
0	6	5	1	2	7	7	1	
1	7	6	2	9	9	7	7	
1	7	7	2	7	7	2	0	
1	2	2	1	1	0	0	0	
2	2	1	1	0	0	0	0	

0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	2	2	0	
0	2	1	0	2	2	2	2	
0	2	2	0	0	2	2	0	
0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	

Region

$$S_1 = 5 \quad S_2 = 7$$

$$E_1 = 2 \quad E_2 = 1$$

0 0 0 0 1 2 3 2

0 4 3 1 1 1 2 2

0 5 4 1 1 2 2 1

0 6 5 1 1 2 7 9 1

1 7 6 2 1 2 7 7 7

1 7 7 2 1 2 7 2 0

1 2 2 1 1 0 0 0 0

2 2 1 1 0 0 0 0 0

$$u_1 = \frac{33}{7} \\ = 4.7 \approx 5$$

Trash

$$(0) \rightarrow 0-3$$

$$(1) \rightarrow 4-6$$

$$(2) \rightarrow >7$$

175/17 590(023)

Sample	A	B
1	1	1
2	1.8	2
3	3	4
4	5	7
5	3.5	5
6	4.5	5
7	3.5	4.5

a

c2.

$$1.8 + 1 - 2 = 1.5$$

$$2.1 \quad 0$$

$$|1-4.5| + |4-5| = 2.5$$

$$|9.5-4.5| + |2-5| = 6$$

$$3.5 + 1.5 + |4-2| = 3.5$$

$$|3-4.5| + |4-5| = 2.5$$

$$|5-1.5| + |17-2| = 8.5$$

$$|5-4.5| + |7-5| = 2.5$$

$$|3.5-1.5| + |5-2| = 5$$

$$|3.5-4.5| + |5-5| = 0$$

$$|4.5-1.5| + |15-2| = 6$$

$$|3.5-4.5| + |5-5| = 0$$

$$|3.5-1.5| + |4.5-2| = 4$$

$$|3.5-4.5| + |4.5-5| = 1.5$$

$$a \Rightarrow \begin{matrix} 1 & 2 \\ A & B \end{matrix}$$

$$\frac{2.5}{2}, \frac{3}{2}$$

$$(1.25, 1.5)$$

$$c2 \Rightarrow \begin{matrix} 3 & 4 & 5 & 6 \\ A & B \end{matrix}$$

$$(3.9, 5.1)$$

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	9	7	2	1	9	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

thresholding (0) → 0 - 2
 (1) → 3 - 6
 (2) → 7

0	0	0	0	0	1	0
0	1	1	0	0	0	0
0	1	1	0	0	0	0
0	1	1	0	0	2	2
0	2	1	0	2	2	2
0	2	2	0	0	2	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

- 1) 1 1 ✓
 2) 1.5 2 ✓
 3) 3 4 ✗
 4) 5 7
 5) 3.5 5
 6) 4.5 5 ✓
 7) 3.5 4.5 ✗

$$\begin{array}{ll}
 1) |1-1.5| + |1-2| = 1.5 & C_1 \\
 2) |1-0| & C_2 \\
 3) |3-1.5| + |4-2| = 3.5 & |1-4.5| + |1-5| = 7.5 \\
 4) |5-1.5| + |7-2| = 10.5 & |1.5-4.5| + |4-5| = 2.5 \\
 5) |3.5-1.5| + |5-2| = 5 & |3.5-4.5| + |5-5| = 1 \\
 6) |4.5-1.5| + |5-2| = 6 & |4.5-4.5| + |5-5| = 0 \\
 7) |3.5-1.5| + |4.5-2| = 4.5 & |3.5-4.5| + |4.5-5| = 2.5
 \end{array}$$

$$A_1, B_1$$

$$\frac{2.5}{2}, \frac{3}{2}$$

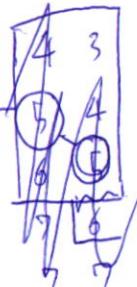
$$(1.25, 1.5)$$

$$A_2, B_2$$

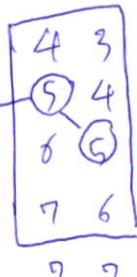
$$\frac{2.5}{5}, \frac{2.5}{5}$$

$$(3.9, 5.1)$$

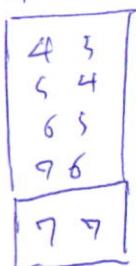
start



$S_1 - 1$



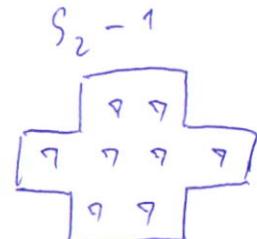
$S_1 - 2$



$$\mu = \frac{42}{8} = 5.25$$

Legion

$$s_1 = 5 \quad s_2 = 7 \\ e_1 = 2 \quad e_2 = 1$$



2nd May

HW74

54010099

Thresholding

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

 \Rightarrow

0	0	0	0	0	0	1	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	1	1	0
0	1	1	0	1	1	1	1
0	1	1	0	0	1	1	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

$$T = 3 - 7 ;$$

splitting and Merging

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

 \Rightarrow

0	0	0	0	1	2	3	2
0	4	3	1	1	2	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	6	5	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

individual	Distance 1	Distance 2	Mean of 1	Mean of 2	Mean 1	Mean 2
1	1.	1.	2	6	1.5, 2	4.5, 5
2	1.5	7.5	2, 1	6		
3	3.5	2.5	2, 1, 3	6, 3		
4	8.5	2.5	2, 1, 3	6, 4, 3		
5	5	2.5	2, 1, 3	6, 4, 5, 3		
6	6	1	2, 1, 3	6, 4, 5, 3		
7	4.5	1.5	2, 1, 3	6, 4, 7, 5, 3	1 9.25, 1.5	1 3.9, 5.1

non overlapping windows

59010093

Watershed Thresholding

$$f(x,y) \geq 3 = 0$$

0	0	0	0	0	0	1	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	2	2	0
0	2	1	0	2	2	2	2
0	2	2	0	0	2	2	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

$$T_0 = [0, 2]$$

$$T_1 = [3, 6]$$

$$T_2 = [7, 7]$$

3, 4

3, 5, 4, 5

Region Growing

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	2	2	0
0	1	1	0	2	2	2	2
0	1	1	0	2	2	2	2
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

ID	Distance 1	Distance 2	G1	G2	3	7
1	5	6	1, 3	7		
2	3.5	9.5	1, 2, 3	7		
3	0	1	1, 2, 3	7		
4	5	4	1, 2, 3	4, 7		
5	2.5	0.5	1, 2, 3	4, 5, 7		
6	2.5	1.5	1, 2, 3	4, 5, 6, 7		
7	1	0	1, 2, 3	4, 5, 6, 7		

$$\delta_1 = 5 \quad \delta_2 = 7$$

$$E_1 = 2 \quad E_2 = 0$$

670 03/05/2018 59011194

0	0	0	0	1	2	3	4	1
0	4	3	1	1	1	2	2	
0	5	4	1	1	2	2	1	
0	6	5	1	1	2	2	1	
1	2	6	2	2	7	7	7	
1	7	7	2	1	7	7	7	
1	2	2	1	1	0	0	0	
2	2	1	1	0	0	0	0	

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	2	7	2	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

Thresholding

$$S_1 = 5$$

$$S_2 = 7$$

$$E_1 = 1$$

$$E_2 = 0$$

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	2	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

Region grouping

$$S_1 = 5$$

$$S_2 = 7$$

$$E_1 = 2$$

$$E_2 = 0$$

Individual	D to mean 1	D to mean 2	mentor 1	mentor 2	mean 1		mean 2	
	A	B	A	B				
1	52	18.5	4	2,1	5	7	3.5	4.5
2	39.25	10.95	4	2,1,2				
3	13	0.5	4	2,1,2,3				
4	6.25	0.95	4	2,1,2,3,5				
5	4.25	1.25	4	2,1,2,3,5,6				
				Update mean	5	7	2.93	3.58

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

Thresholding

$$S_1 = 5 \quad S_2 = 7$$

$$E_1 = 1 \quad E_2 = 0$$

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

Region growing

$$S_1 = 5 \quad S_2 = 7$$

$$E_1 = 2 \quad E_2 = 0$$

 S_1

individual	D to mem 1	D to mem 2	member	member	mean 1	mean 2		
			1 4	2 7 9, 1	A 5	B 7	A 3.5	B 4.5
1	5.2	16.5	4	7 9, 1				
2	37.25	10.25	4	9, 1, 2				
3	13	0.5	4	9, 1, 2, 3				
5	6.25	0.25	4	9, 1, 2, 3, 5				
6	4.25	1.25	4	9, 1, 2, 3, 5, 6				
				update mem	5 * 7		2.83	3.58

Thresholding

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	1	1	0
0	1	1	0	1	1	1	1
0	1	1	0	0	1	1	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Splitting and Merging

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

	Distance 1	Distance 2	Members	62	Cluster 1		Cluster 2		A	B	
					A	B	A	B			
1	1.118	5.315	1,2	6	1.5	2	4.5	3	1	1	
2	1.416	—	1,2	6	1.5	2	4.5	3	1.5	2	
3	2.5	1.803	1,2	3,6	1.5	2	4.5	3	3	4	
4	6.103	2.062	1,2	3,4,6	1.5	2	4.5	3	5	7	
5	9.606	1	1,2	3,4,5,6	1.5	2	4.5	3	3.5	5	
6	—	—	1,2	3,4,5,6	1.5	2	4.5	3	4.5	5	
7	9.202	11.18	1,2	3,4,5,6,7	1.5	2	4.5	3	3.5	4.5	
				1.25	1.5	3.0	5.1				
<u>New</u>						3,9					

1) Thresholding ; $T = 3$ $T = 4$

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	2	2	0
0	1	1	0	2	2	2	2
0	1	1	0	0	2	2	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

input

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

2) Region Growing

$S_1 = 10 \quad S_2 = 6$

$E_1 = 13 \quad E_2 = 8$

0	0	0	0
0	4	3	1
0	5	4	1
0	(6)	5	1
1	7	(6)	2
1	7	7	2
1	2	2	1
2	2	1	1

0	0	0	0
0	4	3	1
0	5	4	1
0	(6)	5	1
1	7	(6)	2
1	7	7	2
1	2	2	1
2	2	1	1



1st iteration

$S_1 = M = \frac{19}{18} = 1.05$

0	0	0	0
0	4	3	1
0	5	4	1
0	(6)	5	1
1	7	(6)	2
1	7	7	2
1	2	2	1
2	2	1	1

2nd iteration

0	0	0	0
0	(4)	3	1
0	(5)	4	1
0	(6)	5	1
1	(7)	(6)	2
1	(7)	(7)	2
1	2	2	1
2	2	1	1

$S_2 = M = \frac{43}{10} = 4.3$

0	0	0	0
0	4	3	1
0	(5)	4	1
0	(6)	5	1
1	(7)	(6)	2
1	(7)	(7)	2
1	2	2	1
2	2	1	1

1st iteration

2nd iteration

1	2	3	2
1	1	2	2
1	2	2	1
2	7	7	1
7	7	7	7
1	7	7	0
1	0	0	0
0	0	0	0

$$S_1 = 1 \quad S_2 = 7$$

$$E_1 = 2 \quad E_2 = 0$$

1st iteration

$$S_1 = M = \frac{23}{22} = 1.045$$

1	2	3	2
1	1	2	2
1	2	2	1
2	7	7	1
7	7	7	7
1	7	7	0
1	0	0	0
0	0	0	0

9th iteration

$$S_1 = M = \frac{23}{20} = 1.15$$

1	2	3	2
1	1	2	2
1	2	2	1
2	7	7	1
7	7	7	7
1	7	7	0
1	0	0	0
0	0	0	0

3rd iteration

$$S_1 = M = \frac{16}{15} = 1.067$$

1	2	3	2
1	1	2	2
1	2	2	1
2	7	7	1
7	7	7	7
1	7	7	0
1	0	0	0
0	0	0	0

2nd iteration

Step	Distance to mean (centriod) of cluster 1	Distance to mean (centriod) of cluster 2	Member		Mean vector (centriod) of cluster 1	Mean vector (centriod) of cluster 2
	G ₁	G ₂	A	B	A	B
1			1	5	1	1
2	1.5	5	1, 2	5	1.25	2
3	5	1.5	1, 2	5, 3		
4	10	3.5	1, 2	5, 3, 4		
5	7.5	1	1, 2	5, 3, 4, 6, 7	1.25	1.5
6	6	0.5	1, 2	5, 3, 4, 6, 7	3.9	5.1

1. Thresholding

วิชา ภาพ ที่ 3 บล็อก ความต้องการ
ผู้สอน ดร. สมชาย วงศ์สุวรรณ 59011382

T=3				T=7				
0	0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2	2
0	5	4	1	1	1	2	2	1
0	6	5	1	2	4	7	1	1
1	7	6	2	7	7	7	7	7
1	7	7	2	1	7	7	0	0
1	2	2	1	1	0	0	0	0
2	2	1	1	0	0	0	0	0

1. ห้าม 2 block

2. กำหนดค่า T

$$N_{\text{row}} = 1$$

$$N_7 = 2$$

$$N_{\text{col}} = 0$$



0	0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	2	2	0	0
0	1	1	0	2	2	2	2	2
0	1	1	0	0	2	2	2	0
0	0	0	0	0	0	0	0	0
0	0	6	0	0	0	0	0	0

2. Splitting & Merging

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

⇒

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

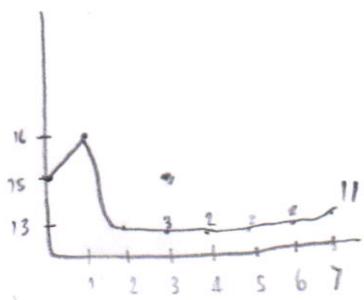
individual	Distance to Mean of Cluster 1	Distance to Mean of Cluster 2	Member		Mean Vector		Mean Vector	
			G1	G2	Cluster 1	Cluster 2	A	B
1			1	4	1	1	3.5	5
2	1.5	5	{1, 2}	4				
3	5	1.5	{1, 2}	{3, 4}				
4	10	3.5	{1, 2}	{3, 4}				
5	6.5	0	{1, 2}	{3, 4, 5}				
6	7.5	1	{1, 2}	{3, 4, 5, 6}				
7	6	1	{1, 2}	{3, 4, 5, 6}				

Sample	A	B
1	1	1
2	1.5	2
3	3	4
4	5	7
5	3.5	5
6	4.5	5
7	3.5	6.5

$$\begin{aligned}
 & C_1 (1, 1) & C_2 (3.5, 5) \\
 \#2 & |1-1| + |2-1| & |1.5-3.5| + |2-5| \\
 & = 1.5 & = 5 \\
 \#3 & |3-1| + |4-1| & |3-3.5| + |4-5| \\
 & = 5 & = 1.5 \\
 \#4 & |5-1| + |7-1| & |5-3.5| + |7-5| \\
 & = 10 & = 3.5 \\
 \#5 & |3.5-1| + |5-1| & |3.5-3.5| + |5-5| \\
 & = 6.5 & = 0 \\
 \#6 & |4.5-1| + |5-1| & |4.5-3.5| + |5-5| \\
 & = 9.5 & = 1 \\
 \#7 & |3.5-1| + |4.5-1| & |3.5-3.5| + |4.5-5| \\
 & = 6 & = 4
 \end{aligned}$$

ເລືອກຕົວ ຕົວພິບໃຫຍ່ 59011345
ກົດມາດ ດາວໂຫຼວ 59010444

1) Minimax noise Thresholding



Theodos
73

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	6	2	1	7	2	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

Splitting and Merging

$$R_3 : \begin{matrix} G_1 & G_2 \\ 3 & 7 \end{matrix}$$

Individual	Distance to mean (centroid) of cluster1	Distance to mean (centroid) of cluster2	Member G1	Member G2	Mean Vector		Mean Vector	
					(Centroid) A	(Cluster) B	(Centroid) A	(Cluster) B
1	5	6	1	7	3	4	3.5	4.5
2	3.5	4.5	1,2	-	3	4	3.5	4.5
3	0	7	1,2,3	-	3	4	3.5	4.5
4	5	4	1,2,3	4	3	4	3.5	4.5
5	1.5	0.5	1,2,3	4,5	3	4	3.5	4.5
6	2.5	1.5	1,2,3	4,5,6	3	4	3.5	4.5
7	1	0	1,2,3	4,5,6,7	1.83	2.33	4.125	5.375

Samples	A	B
1	1	1
2	1.5	2
3	3	4
4	5	7
5	3.5	5
6	4.5	5
7	3.5	4.5

0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	2	1	0	0	2	2	0
0	2	2	0	2	2	2	2
0	0	0	0	0	2	2	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Thresholding

$$S_1 = 5 \quad S_2 = 7$$

$$E_1 = 1 \quad E_2 = 0$$

Threshold (4 to 6) Threshold (7)

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	2	2	0
0	1	1	0	2	2	2	2
0	1	1	0	0	2	2	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Region Growing

$$S_1 = 5 \quad S_2 = 7$$

$$E_1 = 2 \quad E_2 = 3$$

$$S_1 \Rightarrow \mu = \frac{40}{8} = 5$$

$$S_1 \Rightarrow \frac{54}{10} = 5.4$$

Individual	Distance to Mean of C ₁	Distance to mean of C ₂	Member G ₁	Member G ₂	Mean Vector C ₁	Mean Vector C ₂	
	A	B				A	B
1	1.5	7.5	1, 2	6	1.5	2	4.5 5
2			1, 2	6	1.5	2	4.5 5
3	3.5	2.5	1, 2	3, 6	1.5	2	4.5 5
4	8.5	2.5	1, 2	3, 4, 6	1.5	2	4.5 5
5	5	1	1, 2	3, 4, 5, 6	1.5	2	4.5 5
6					1.5	2	4.5 5
7	3.5	1.5	1, 2	3, 4, 5, 6, 7	1.5	2	4.5 5

$$\bar{G}_1 = \frac{1+1.5}{2}, \frac{1+2}{2} = 1.25, 1.5$$

$$\bar{G}_2 = \frac{3+5+3.5+4.5+3.5}{5}, \frac{4+7+5+5+4.5}{5} = 3.9, 5.1$$

⑪ چیز Thresholding
~~thresholding~~ 4 تا 7
Thresholdiv T = [4,7]
اینطور

ນິຕິທະຍົກ
ເມືອງລວມ
59010734

② Splitting and Merging

0	0	0	0	2	3	2
0	4	3	1	1	2	2
0	5	4	1	2	2	1
0	6	5	1	2	7	1
1	7	6	2	7	7	2
1	7	7	2	1	7	0
1	9	2	1	0	0	0
0	2	1	1	0	0	0

individual	Distance 1	Distance 2	Mem d1	Mem d2	Mean Vector 1	Mean Vector 2
1			2	6	1.5, 2	4.5, 5
2	$ 1.5 - 1 + 2 - 1 $ 1.5	$ (4.5 - 1) + (5 - 1) $ 7.5	2, 1	6		
3	3.5	2.5	2, 1, 3	6, 3		
4	8.5	2.5	2, 1, 5	6, 3, 4		
5	5	2.5	2, 1	6, 3, 4, 5		
6	6	1	2, 1	6, 3, 4, 5		
7	-4.5	1.5	2, 1	6, 3, 4, 5, 7		

$$\mu_1 = (1.25, 1.5)$$

$$\mu_2 = (3.9, 5.1)$$

T = 3 - 7

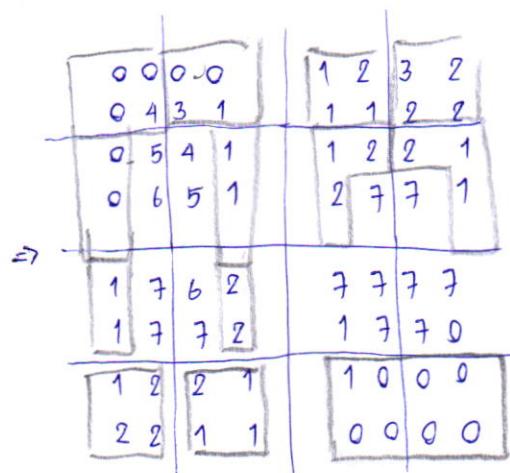
threshold

21M 8785 59010781

0	0	0	0	0	0	3	0
0	4	3	0	0	0	0	0
0	5	4	0	0	0	0	0
0	6	5	0	0	7	7	0
0	7	6	0	7	7	7	7
0	7	7	0	0	7	7	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Splitting and Merging

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	9
2	2	1	1	0	0	0	0



Individual			Member G1	Member G2	Mean Vector		Mean Vector cluster 2
	Distance 1	Distance 2			Cluster A	Cluster B	
1			2	6	1.5	2	
2	$(1.5-1) + (2-1)/5$	7.5	2, 1	6			
3	3.5	2.5	2, 1, 3	6, 3			
4	8.5	2.5	2, 1, 3	6, 4, 3			
5	5	2.5	2, 1, 3	6, 4, 5, 3			
6	6	1	2, 1	6, 4, 5, 3			
7	4.5	1.5	2, 1	6, 4, 5, 3, 7			
				1.25	5.1		

$$\mu_1 = \left(1.25, \frac{1.5}{5} \right)$$

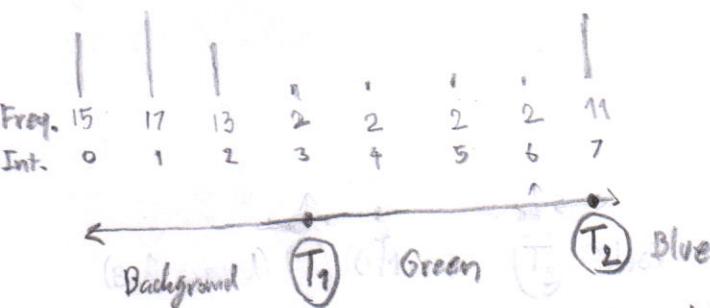
$$\mu_2 = (3.9, 5.1)$$

① Thresholding

59010728 NARIN K. BANNASAN

GROUP:

Approach: (Histogram) of $f(x,y)$



Background T_1 Green T_2 Blue

let $T_1 = 3$ and $T_2 = 6$ be the Global threshold

$$\text{output image } g(x,y) = \begin{cases} 0 & ; 0 < f(x,y) \leq T_1 \\ 1 & ; T_1 < f(x,y) < T_2 \\ 2 & ; T_2 \leq f(x,y) \end{cases}$$

$$g(x,y) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 1 & 0 & 2 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Auz ✓

② Region Growing

let $S_1 = 5$ $E_1 = 2$

let $S_2 = 7$ $E_2 = 2$

and the same criteria in the example
(copying from P6 of 5th edn)

Grow S_1 (1st Iteration)

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0



0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	9	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

$$\mu = (4+4+5+5+6+6) / 6 = 5$$

$$S_1(\text{new}) = 5$$

(2nd Iteration)

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0



0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

$$\mu = \frac{4+3+5+4+6+5+7+6+7+7}{10} = 5.4$$

$$\mu = 5.4 \rightarrow S_1(\text{new}) = 5.4$$

No pixels differs from 5.4 by 2

Finished Growing S_1 !

Grow S_2

0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0



0	0	0	0	1	2	3	2
0	4	3	1	1	1	2	2
0	5	4	1	1	2	2	1
0	6	5	1	2	7	7	1
1	7	6	2	7	7	7	7
1	7	7	2	1	7	7	0
1	2	2	1	1	0	0	0
2	2	1	1	0	0	0	0

No more pixels that differs from 7 by 2

Finished Growing S_2 !

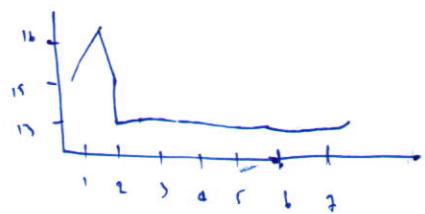
$$g(x, y) =$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 2 & 2 & 0 \\ 0 & 1 & 1 & 0 & 2 & 2 & 2 & 0 \\ 0 & 1 & 1 & 0 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Amz

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Thresholding



Threshold.

0	0	0	0	1	1	2	3	2
0	0	3	1	1	1	1	2	2
0	0	4	1	1	1	2	2	1
1	0	0	1	1	2	0	0	1
-	-	-	-	1	-	-	-	,
1	0	0	2	1	1	0	0	0
1	0	0	2	1	1	0	0	0
1	2	2	1	1	0	0	0	0
2	2	1	1	1	0	0	0	0

Splitting and Merging

0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0
0 1 1 0 0 0 0 0 0
0 1 1 0 0 0 0 0 0
0 2 2 0 0 0 0 0 0
0 1 1 0 2 2 2 2 2
0 1 1 0 0 2 2 2 2
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0



$$L_2 = \sqrt{\sum_{i=1}^M (f_i - c_i)^2}$$

$$L_1 = \sum_{i=1}^M |f_i - c_i|$$

in dividend	c_1	c_2	Distance to mean cluster 1	Distance to mean cluster 2	Member 61	Member 62	Cluster 1	Cluster 2.
1	3	7	5	6	1		A 1 B 3 4	A 1 B 3.5 4.5
2			3.5	4.5	1,2		3 4	3.5 4.5
3			0	-	1,2,3		3 4	3.5 4.5
4			7	6.9	1,2,3	4	3 4	3.5 4.5
5			1.5	0.5		4,5	3 4	3.5 4.5
6			2.5	1.5		4,5,6	3 4	3.5 4.5
7			-	0		4,5,6,7	3 4	3.5 4.5

$$61 \{1,2,3\} = 1.8, 2.3$$

$$62 \{4,5,6,7\} = 10.6, 5.37$$

Three holding

6	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	2	1	0	0	0	0	0
0	2	1	0	1	2	2	0
0	2	1	0	1	2	2	0
0	2	1	0	1	2	2	0

$$S_1 = 5$$

$$E_1 = 1$$

$$S_2 = 7$$

$$E_2 = 0$$

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	0

$$S_1 = 5$$

$$E_1 = 1$$

$$S_2 = 7$$

$$E_2 = 0$$

$$S_{\text{iter}} = 5$$

Individual	Distance to mean of cluster 1	Distance to mean of cluster 2	Number β_1	Number β_2	Mean vector Cluster 1	Mean vector Cluster 2	Update mean
1	1.25	2.25	2,1	5	1.5 1 2	3.5 9 5	$S_1: 1.25, 1, 5$
3	5.25	1.25	2,1	5,1,3	15.9 2	3.5 9 5	$S_2: 9.75, 12.75$
4	31.95	5.25	2,1	S,3,4,1,4	15.9 2	3.5 9 5	
6	18	1	2,1	S,3,4,1,6	15.9 2	3.5 9 5	
7	0.25	2.1	S,3,4,1,7	15.9 2	3.5 9 5		

80 100 1500
500 11500

Thresholding

0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	2	2	0	0
0	0	1	0	2	2	2	2	0
0	2	0	0	0	2	2	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

$S_1 = 5$

$E_1 = 1$

$S_2 = 7$

$E_2 = 0$

Region growing

0	0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0
0	1	1	0	0	2	2	0	0
0	0	1	0	2	2	2	2	0
0	2	0	0	0	2	2	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

$S_1 = 5$

$R_1 = 2$

$S_2 = 7$

$E_2 = 0$

Samples	A	B
1	1	1
2	1.5	2
3	3	4
4	5	7
5	3.5	5
6	4.5	5
7	3.5	4.5

New Initial centroid

	Individual	centroid
Group 1	4	(5,7)
Group 2	7	(3.5, 4.5)

Update #1 centroid

	Individual	centroid
Cluster 1	1,2,3,4	(2.6, 2.5)
Cluster 2	5,6,7	(3.8, 4.8)

Update #2 centroid

	Individual	centroid
Cluster 1	1,2,3	(1.8, 2.3)
Cluster 2	4,5,6,7	(4.1, 5.4)

Iteration #1

Step	Clusters 1		Clusters 2	
	individual	centroid	individual	centroid
1	4	(5,7)	7	(3.5, 4.5)
2	4,1	(9,4)	"	"
3	4,1,2	(2.5,3.3)	"	"
4	4,1,2,3	(2.6,3.5)	"	"
5	"	"	7,5	(3.5, 4.75)
6	"	"	7,5,6	(3.8, 4.8)

Iteration #2

Individual	Distance to Mean of cluster 1	Distance to Mean of cluster 2	cluster results
1	2.97	1.72	1
2	1.86	3.62	1
3	0.64	1.13	1
4	4.24	2.5	2
5	1.75	0.36	2
6	2.42	0.72	2
7	1.35	0.42	2