1) Find the clusters using Single linkage technique

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	x	y
P_1	0.40	0.53
P_2	0.22	0.38
P_3	0.35	0.32
P_4	0.26	0.19
P_5	0.08	0.41
P_6	0.45	0.30

Solution

Step 1: Euclidean distance

$$\text{Distance}\left[(x,y)(a,b)\right] = \sqrt{(x-a)^2 + (y-b)^2}$$

Step 2:

Get the distance Matrix

Table:

	P_1	P_2	P_3	P_4	P_5	P_6
P_1	0					
P_2	0.234	0				
P_3	0.22	0.16	0			
P_4	0.37	0.20	0.16	0		
P_5	0.34	0.14	0.28	0.28	0	
P_6	0.24	0.25	0.11	0.22	0.39	0

$d(P_2, P_1)$

$= \sqrt{(0.22 - 0.40)^2 + (0.38 - 0.53)^2}$

$= \sqrt{0.03 + 0.02}$

$= 0.234$

$d(P_3, P_1)$

$= \sqrt{(0.35 - 0.40)^2 + (0.32 - 0.53)^2}$

$= \sqrt{0.002 + 0.04}$

$= 0.22$

$d(P_3, P_2)$

$= \sqrt{(0.35 - 0.22)^2 + (0.32 - 0.38)^2}$

$= \sqrt{0.0169 + 0.0036}$

$= \sqrt{0.0205} \quad = 0.15$

$d(P_4, P_1)$

$= \sqrt{(0.26 - 0.40)^2 + (0.19 - 0.53)^2}$

$= \sqrt{0.0196 + 0.1156}$

$= \sqrt{0.1352} \quad = 0.37$

$d(P_4, P_2)$

$= \sqrt{(0.26 - 0.22)^2 + (0.19 - 0.38)^2}$

$= \sqrt{0.0016 + 0.0361}$

$= \sqrt{0.0397} \quad = 0.20$

$d(P_4, P_3)$

$= \sqrt{(0.26 - 0.35)^2 + (0.19 - 0.32)^2}$

$= \sqrt{0.0081 + 0.0169}$

$= 0.15$

$d(P_5, P_1)$

$= \sqrt{(0.08 - 0.40)^2 + (0.41 - 0.53)^2}$

$= \sqrt{0.1024 + 0.0144}$

$= 0.34$

$d(P_5, P_2)$

$= \sqrt{(0.08 - 0.22)^2 + (0.41 - 0.38)^2}$

$= \sqrt{0.0196 + 0.0009}$

$= \sqrt{0.0205} = 0.14$

$d(P_6, P_3)$

$= \sqrt{(0.08 - 0.26)^2 + (0.41 - 0.19)^2}$

$= \sqrt{0.0324 + 0.0484}$

$= 0.28$

$d(P_6, P_1)$

$= \sqrt{(0.45 - 0.40)^2 + (0.30 - 0.53)^2}$

$= \sqrt{0.0026 + 0.0529}$

$= 0.24$

$d(P_6, P_2)$

$= \sqrt{(0.45 - 0.22)^2 + (0.30 - 0.38)^2}$

$= \sqrt{0.0529 + 0.0064}$

$= 0.25$

$d(P_6, P_3)$

$= \sqrt{(0.45 - 0.35)^2 + (0.30 - 0.32)^2}$

$= \sqrt{0.01 + 0.0004}$

$= 0.11$

$d(P_6, P_4)$

$= \sqrt{(0.45 - 0.26)^2 + (0.30 - 0.19)^2}$

$= \sqrt{0.0361 + 0.0121}$

$= 0.22$

$d(P_6, P_5)$

$= \sqrt{(0.45 - 0.08)^2 + (0.30 - 0.41)^2}$

$= \sqrt{0.1369 + 0.0121}$

$= \sqrt{0.149}$

$= 0.39$

Step 3:

Find the minimum element from the distance matrix

$\therefore$ 0.11 is the Smallest value (P_3, P_6)

(i) Recalculate the distance matrix,

$\min(\text{dist}(x, y))$

Table 2:

	P_1	P_2	P_3 P_6	P_4	P_5
P_1	0				
P_2	0.234	0			
P_3 P_6	0.22	0.15	0		
P_4	0.37	0.20	0.15	0	
P_5	0.34	0.14	0.28	0.29	0

$\min(\text{dist}((P_3, P_6), P_1))$
$\min(\text{dist}(P_3, P_1), (P_6, P_1))$
$\min(\text{dist}(0.22, 0.23)$
$= 0.22$

$\min(\text{dist}((P_3, P_6), P_2))$
$\min(\text{dist}((P_3, P_2), (P_6, P_2))$
$\min(\text{dist}(0.15, 0.25))$
$= 0.15$

$\min(\text{dist}((P_3, P_6), P_4))$
$\min(\text{dist}((P_3, P_4), (P_6, P_4))$
$\min(\text{dist}(0.15, 0.22)$
$= 0.15$

$\min(\text{dist}((P_3, P_6), P_5))$
$\min(\text{dist}((P_3, P_5), (P_6, P_5))$
$\min(\text{dist}(0.28, 0.39)$
$= 0.28$

∴ Smallest element is 0.14 (P_2, P_5)

Table 3:

	P_1	P_2 P_5	P_3 P_6	P_4
P_1	0			
P_2 P_5	0.23	0		
P_3 P_6	0.22	0.15	0	
P_4	0.37	0.20	0.15	0

min (dist ((P2, P5), P1))
min (dist (P2, P1), (P5, P1))
min (dist (0.23, 0.34)
= 0.23

min (dist (P3, P6), (P2, P5))
min (dist [(P3, P2), (P3, P4), (P6, P2), (P6, P5)])
min (0.15, 0.28, 0.26, 0.39)

= 0.15

min (dist ((P2, P5), P4))
min (dist ((P2, P4), (P5, P4))
min (dist (0.20, 0.28)
= 0.20
∴ Smallest element = 0.15

[(P3, P6), (P2, P5)]

Table : 4

	P_1	$P_2 P_5 P_3 P_6$	P_4
P_1	0		
$P_2 P_5 P_3 P_6$	0.23	0	
P_4	0.37	0.15	0

$\min (dist ((P_2 P_5 P_3 P_6), P_1))$

$\min (dist ((P_2, P_1), (P_5, P_1), (P_3, P_1), (P_6, P_1))$

$= \min (dist (0.23, 0.34, 0.22, 0.23)$

$= 0.23$

$\min (dist ((P_2 P_5 P_3 P_6), P_4))$

$\min (dist ((P_2, P_4), (P_5, P_4), (P_3, P_4), (P_6, P_4))$

$= \min (dist (0.20, 0.28, 0.15, 0.22))$

$= 0.15.$

$\therefore$ Smallest element $= 0.15$ $[P_4, P_2 P_5 P_3 P_6]$

Table 5:

	P_1	$P_2 P_5 P_3 P_6 P_4$
P_1	0	
$P_2 P_5 P_3 P_6 P_4$	0.22	0

$\min(\text{dist}(P_2P_5P_3P_6, P_4, P_1))$

$\min(\text{dist}((P_2, P_1), (P_5, P_1), (P_3, P_1), (P_6, P_1), (P_4, P_1))$

$\min(\text{dist}[0.23, 0.34, 0.22, 0.24, 0.37])$

$= 0.22$

Dendogram: