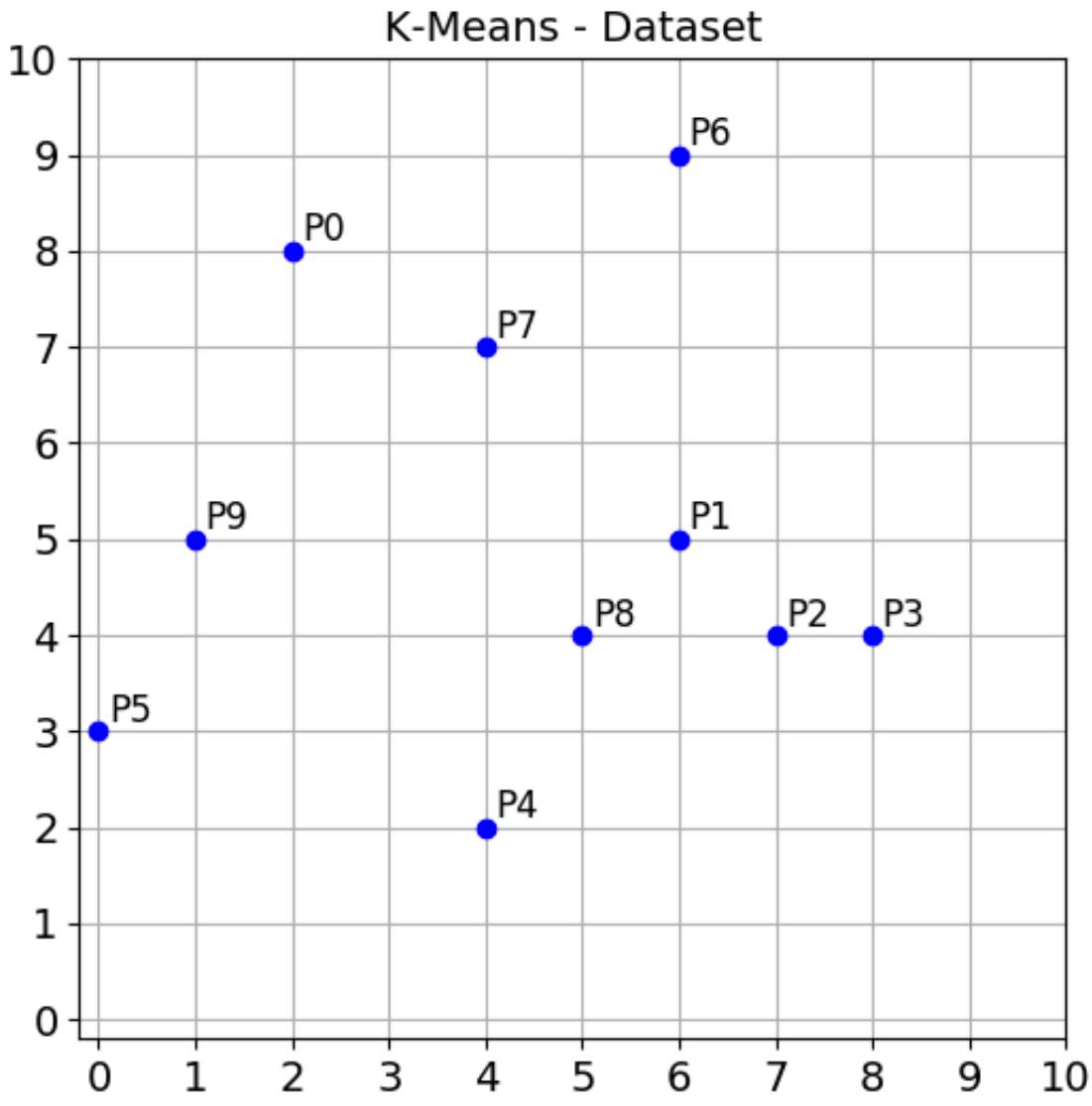
Ex. - Clustering

K-means simulation

Initial centroids:
C1 = P2 =(7,4)
C2 = P8 =(5,4)



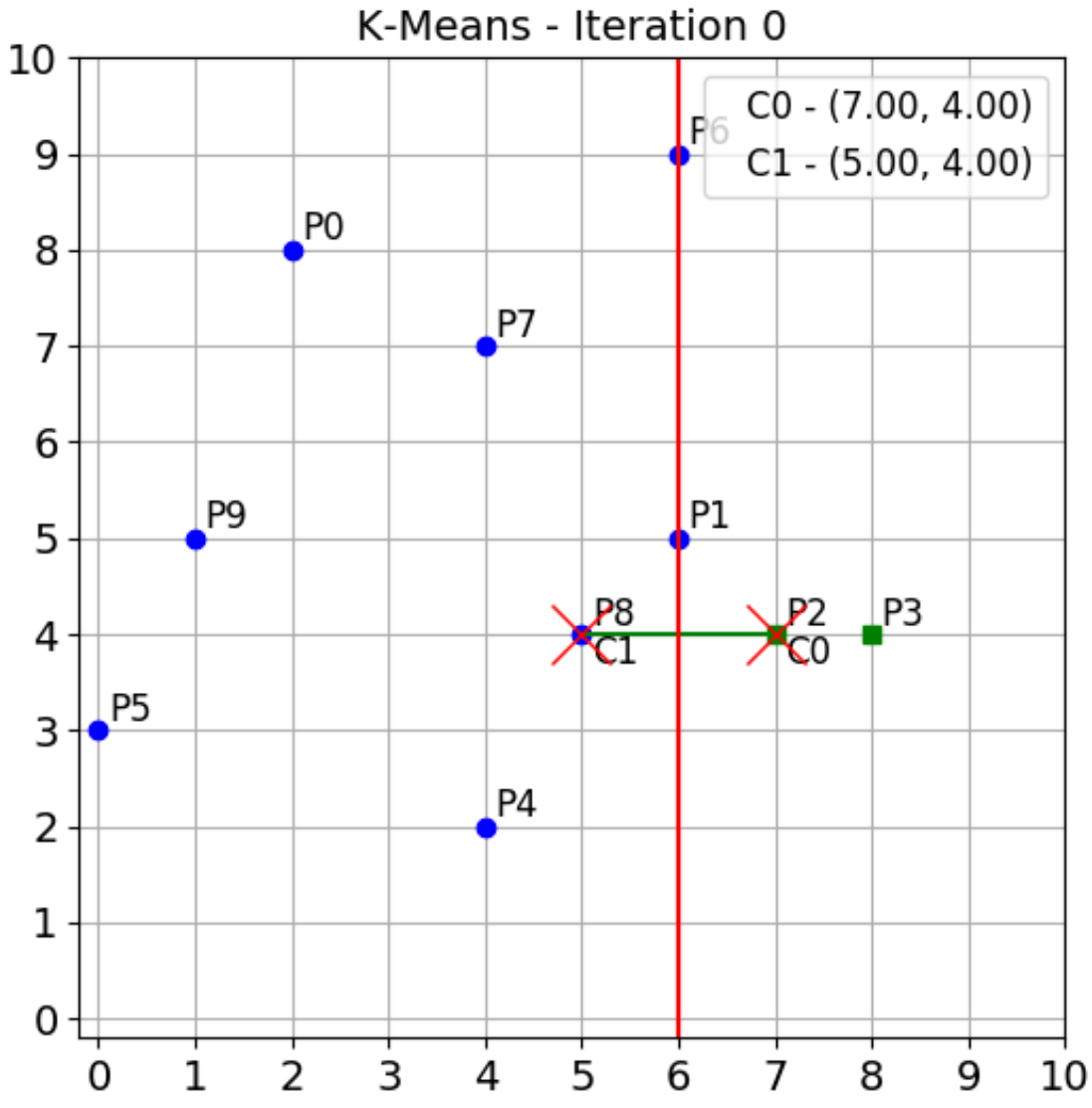
Solution: Identify the **Bisecting lines** dividing the plane between pairs of centroids

Cluster1
P0,P7,P9,P8,P5,P4,P1,P6

Cluster2
P2,P3

Centrod1:
X1 = (0+1+2+4+4+5+6+6)/8 = 3.5
Y1 = (2+3+4+5+5+7+8+9)/8 = 5.38

Centrod2:
X2 = (7+8)/2 = 7.5
Y2 = (4+4)/2 = 4



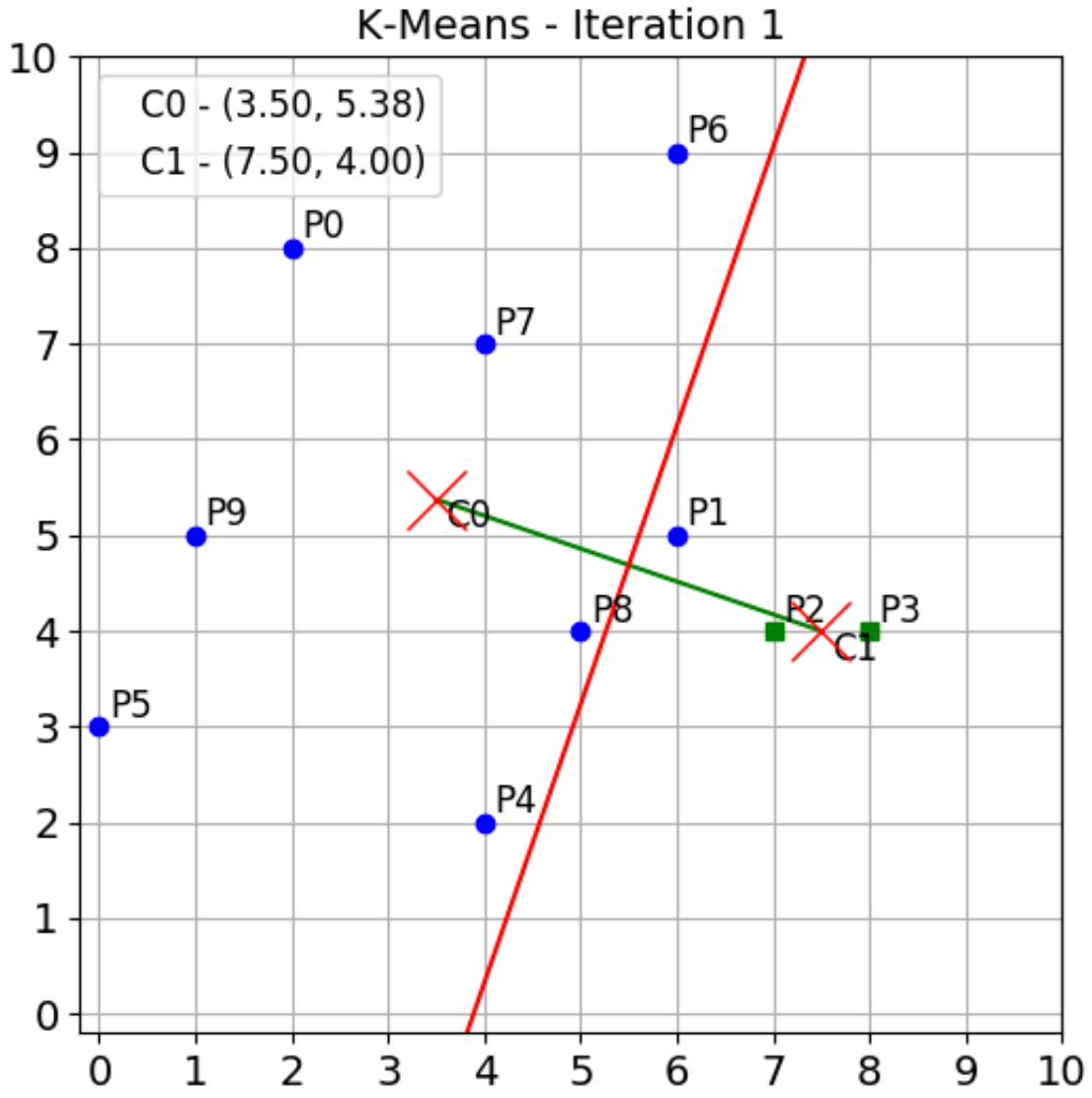
Solution: Identify the **Bisecting lines** dividing the plane between pairs of centroids

Cluster1
P0,P7,P9,P8,P5,P4,P6

Cluster2
P1,P2,P3

Centrod1:
X1 = (0+1+2+4+4+5+6)/7 = 3.14
Y1 = (2+3+4+5+7+8+9)/7 = 5.43

Centrod2:
X2 = (6+7+8)/3 = 7
Y2 = (5+4+4)/3 = 4.33



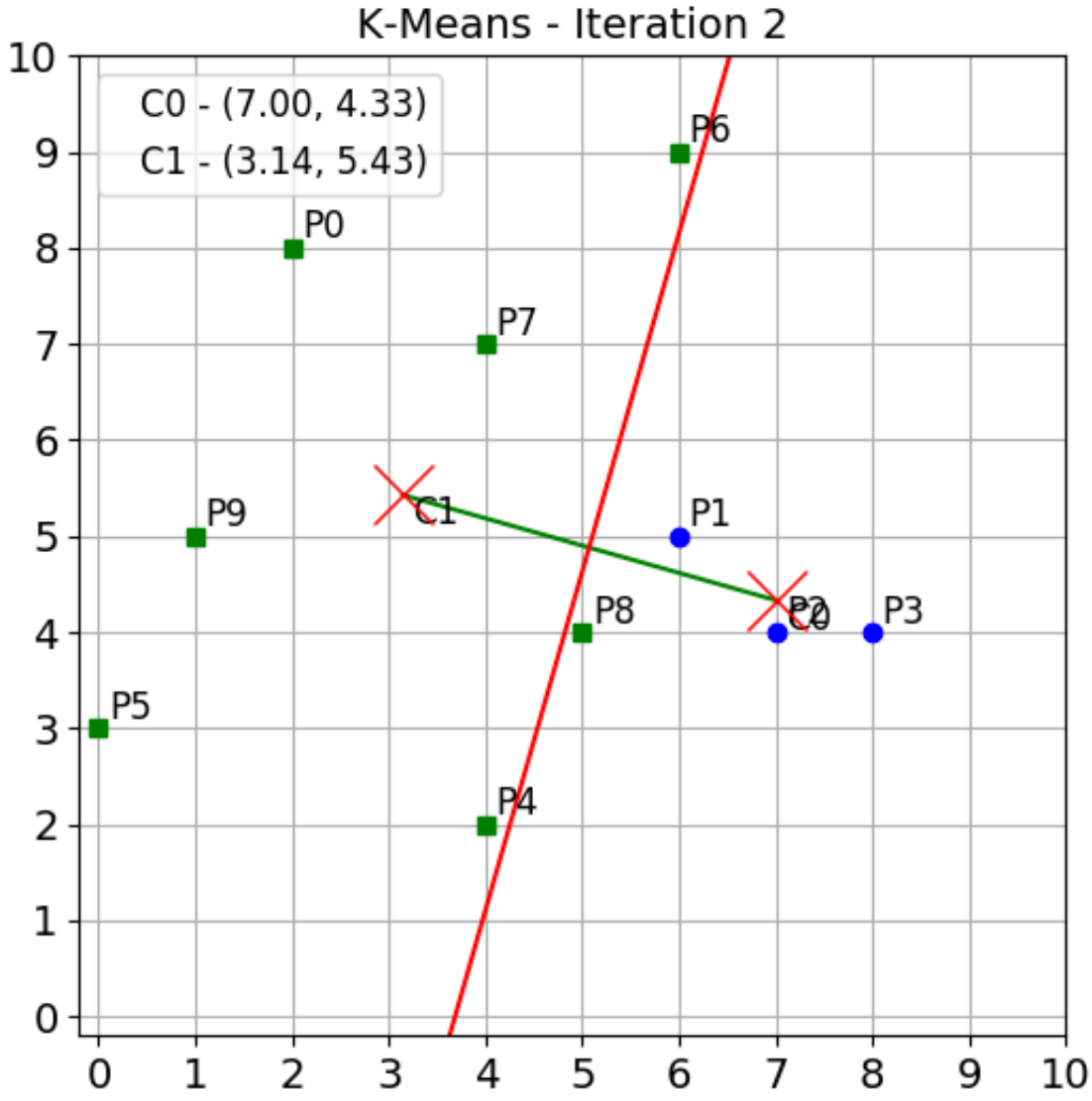
Solution: Identify the **Bisecting lines** dividing the plane between pairs of centroids

Cluster1
P0,P7,P9,P5,P4,P6

Cluster2
P1,P2,P3,P8

Centrod1:
X1 = (0+1+2+4+4+6)/6 = 2.83
Y1 = (2+3+5+7+8+9)/6 = 5.67

Centrod2:
X2 = (6+7+8+5)/4 = 6.5
Y2 = (5+4+4+4)/4= 4.25



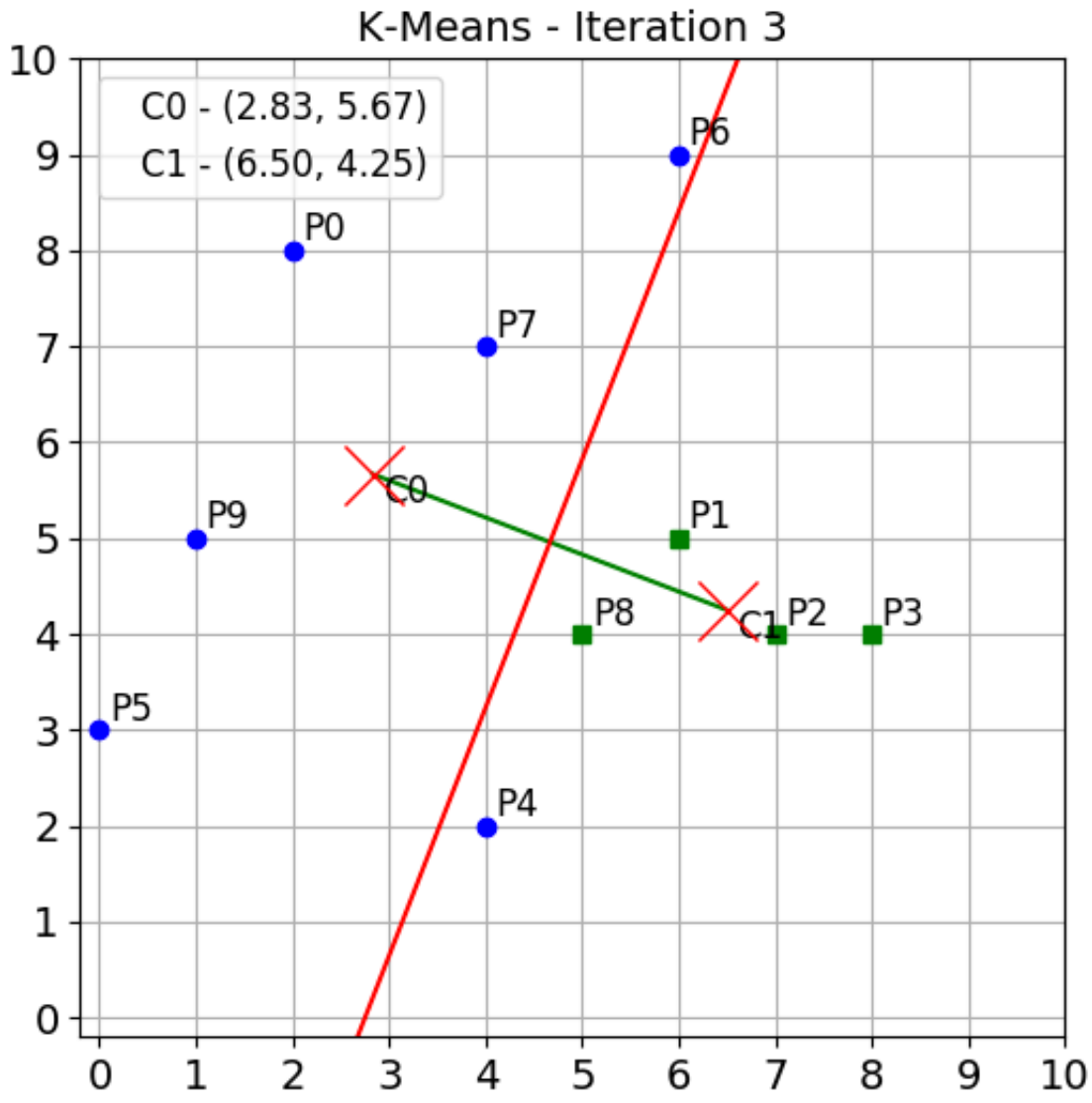
Solution: Identify the **Bisecting lines** dividing the plane between pairs of centroids

Cluster1
P0,P7,P9,P5,P6

Cluster2
P1,P2,P3,P8,P4

Centrod1:
X1 = (0+1+2+4+6)/5 = 2.6
Y1 = (3+5+7+8+9)/5 = 6.4

Centrod2:
X2 = (6+7+8+5+4)/5 = 6
Y2 = (5+4+4+4+2)/5 = 3,8

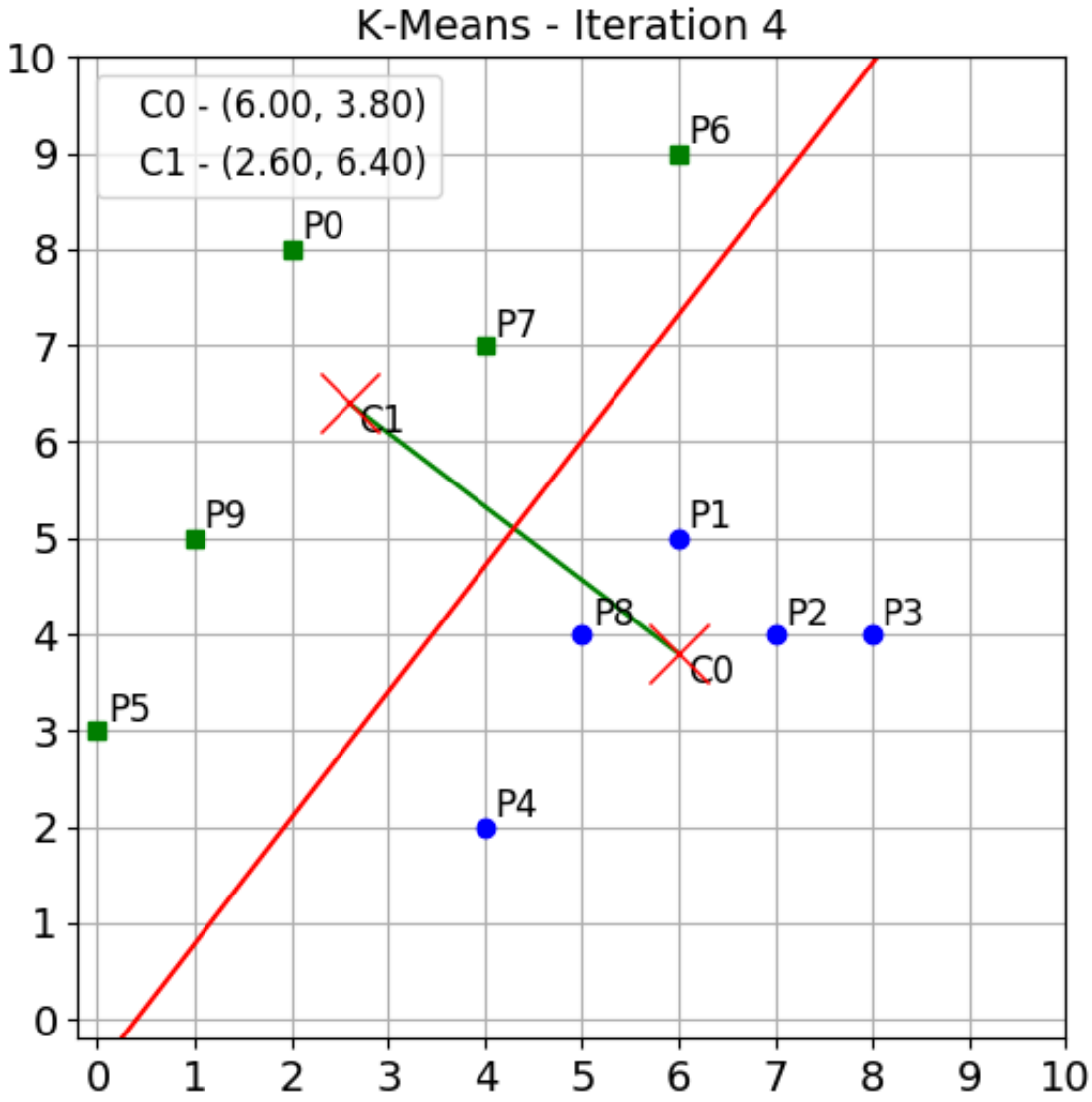


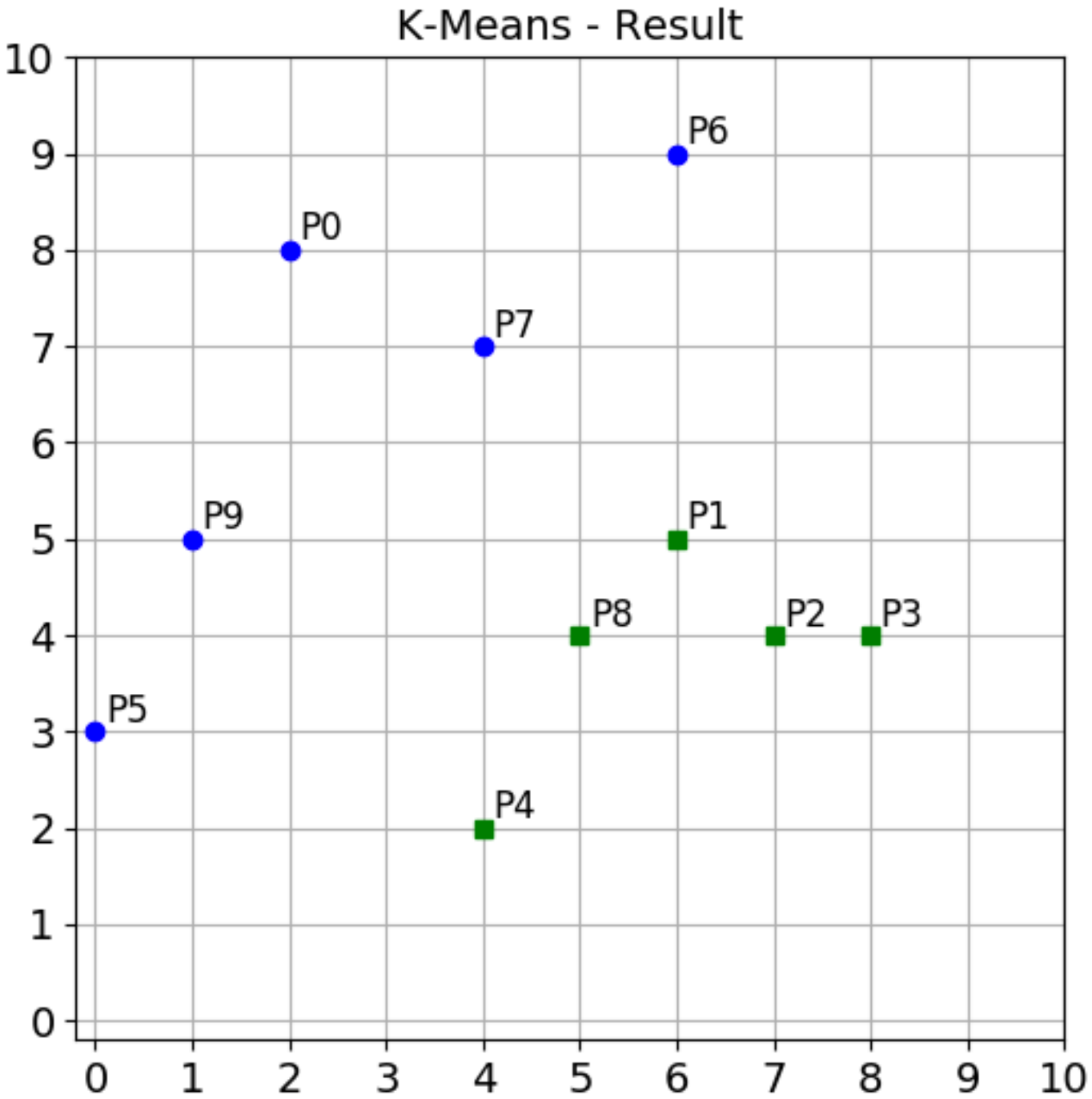
Solution: Identify the **Bisecting lines** dividing the plane between pairs of centroids

Cluster1
P0,P7,P9,P5,P6

Cluster2
P1,P2,P3,P8,P4

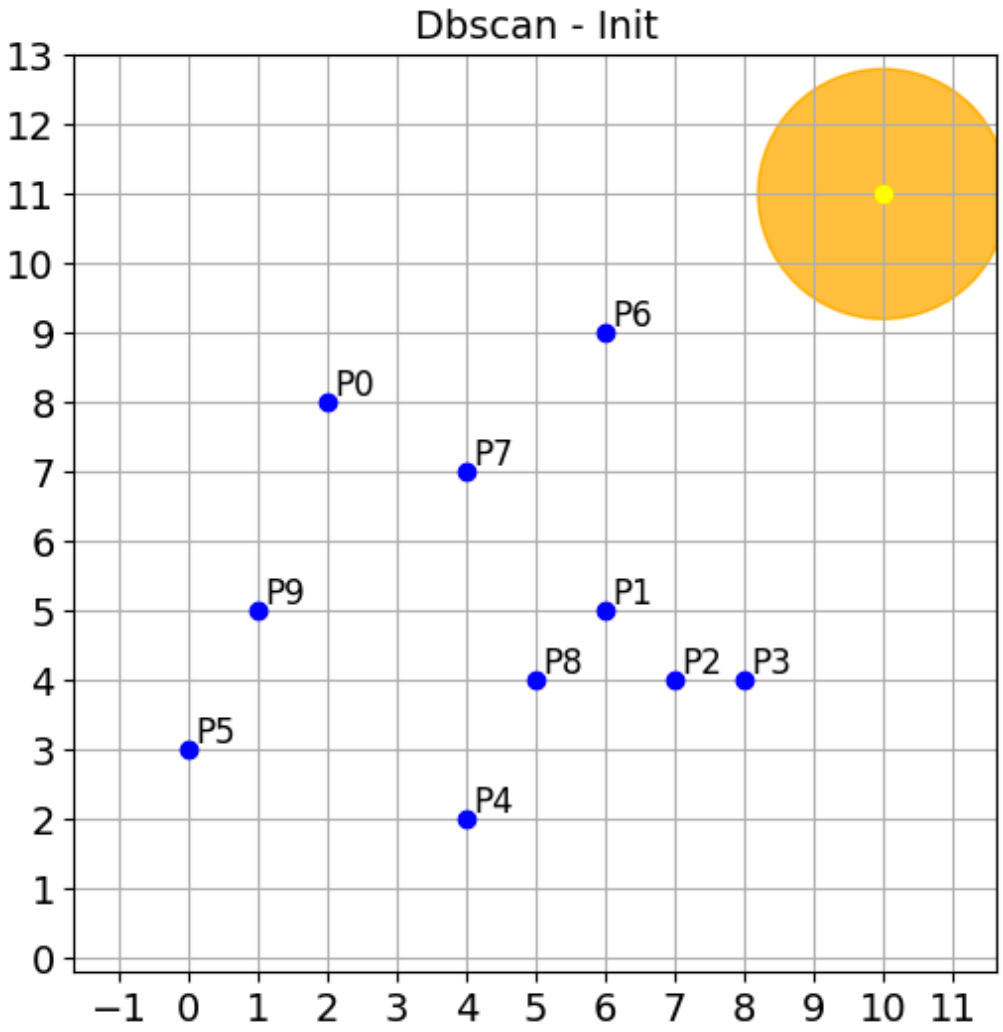
The cluster composition does not change, so K-means stops




K-Means - Result
P6
P0
P7
P9
P1
P8
P2
P3
P5
P4
0
1
2
3
4
5
6
7
8
9
10

DBSCAN - Simulation

- Eps = 1.8
- MinPoints=3
  - (included the point)



DBSCAN

- Eps = 1.8
- MinPoints=3
  - (included the point)

CORE POINTS:

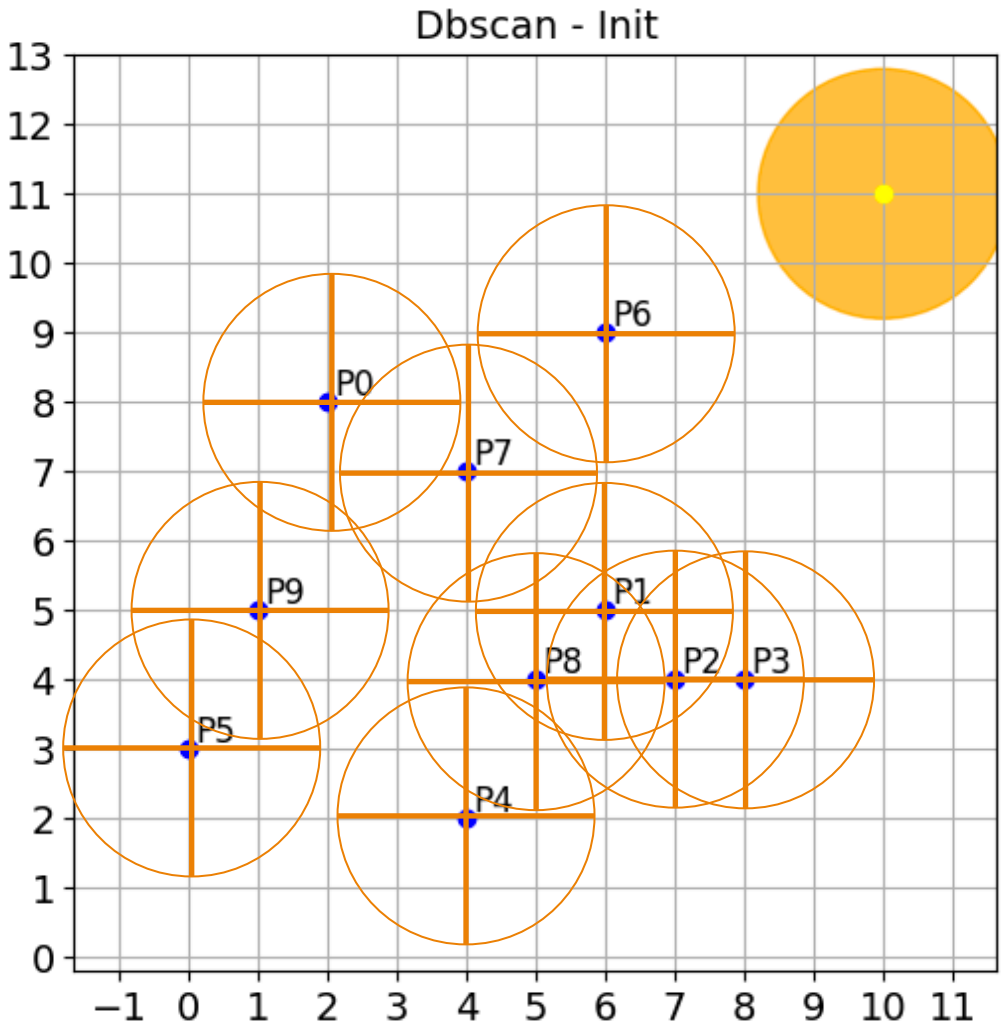
- P1
- P2

BORDER POINTS

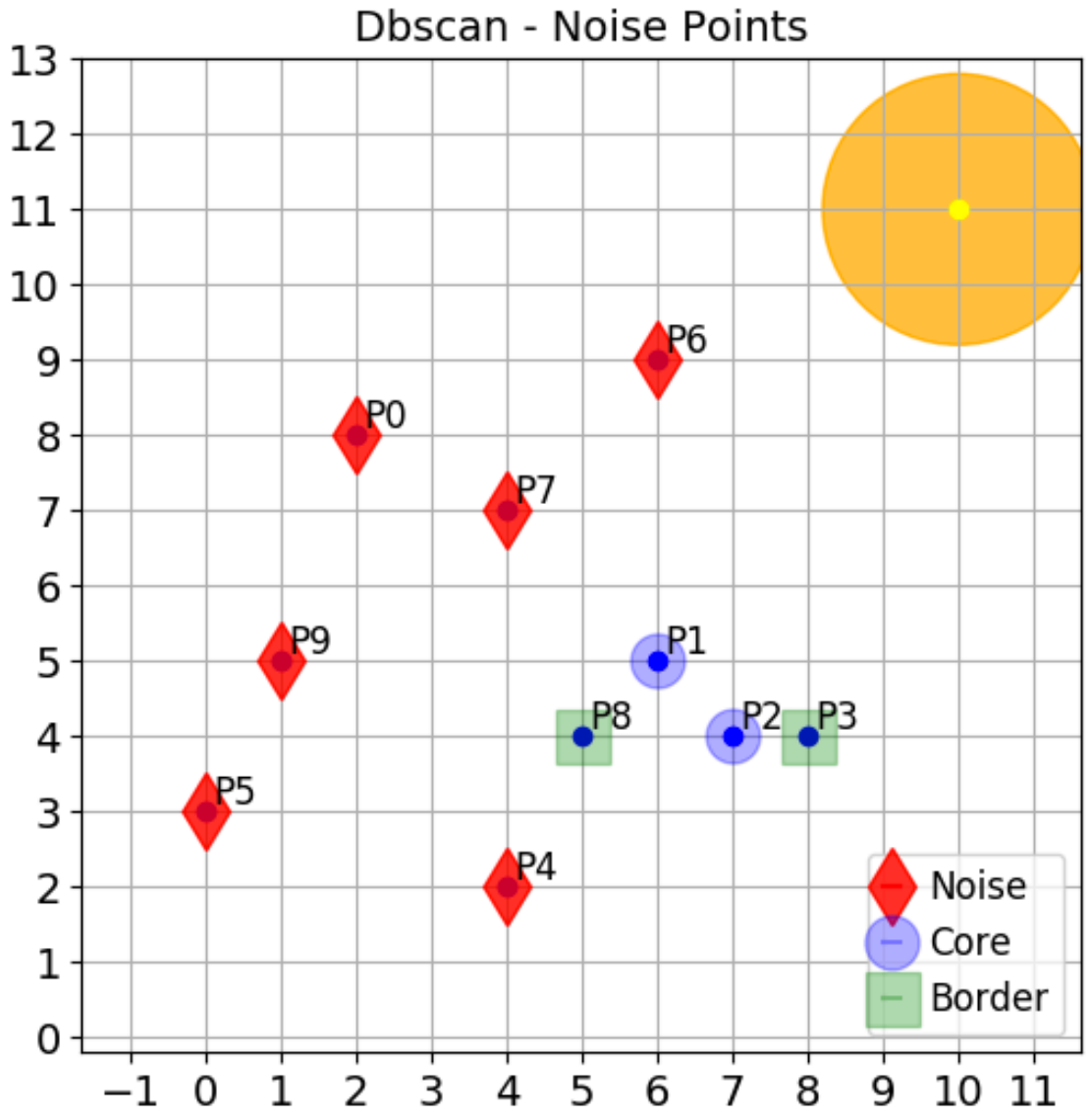
- P3
- P8

NOISE POINTS

- P4,P5, P9, P0, P6, P7

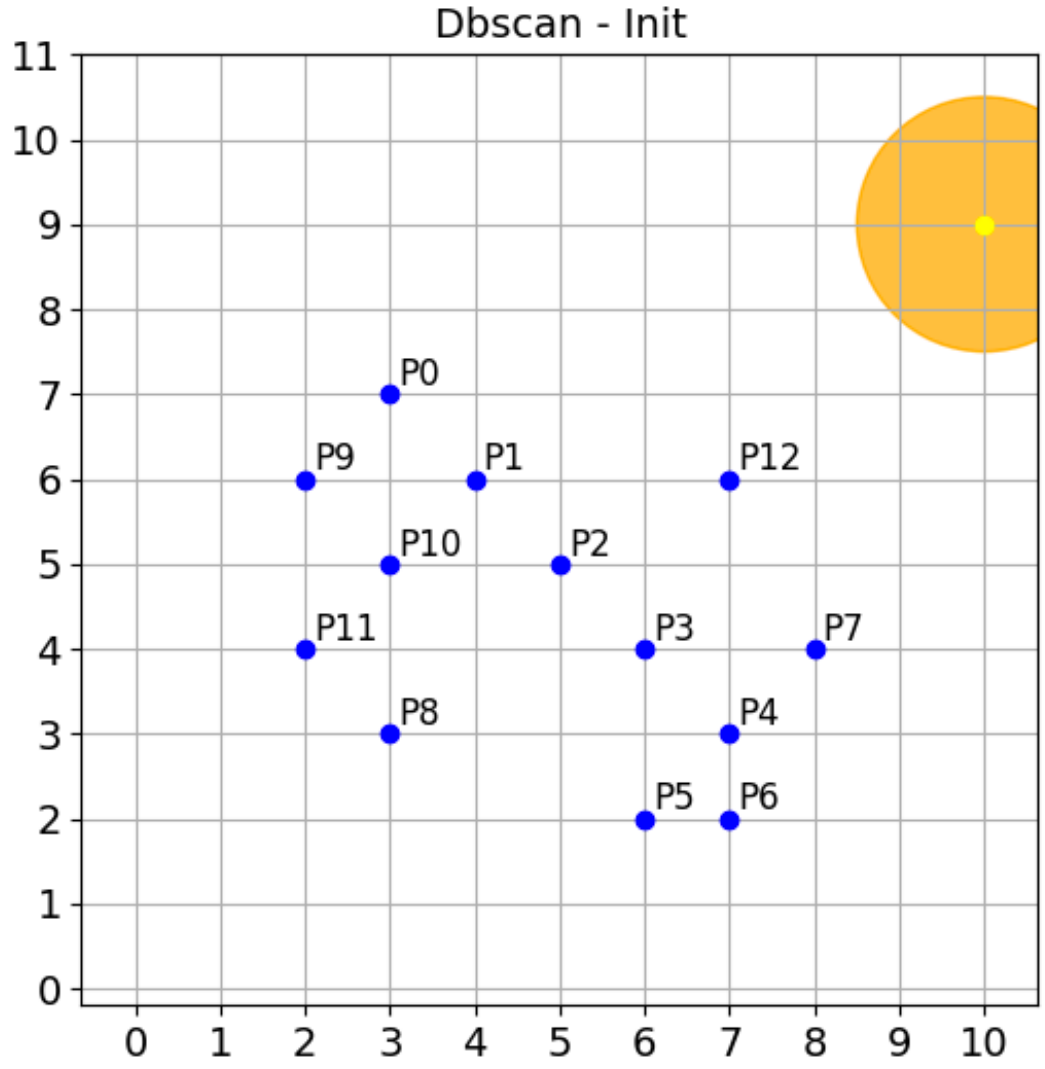


DBSCAN


Dbscan - Noise Points
P0
P1
P2
P3
P4
P5
P6
P7
P8
P9
Noise
Core
Border

DBSCAN EX. 2

- Eps = 1.5
- MinPoints=3
  - (included the point)



DBSCAN 2

- Eps = 1.8
- MinPoints=3
  - (included the point)

CORE POINTS:

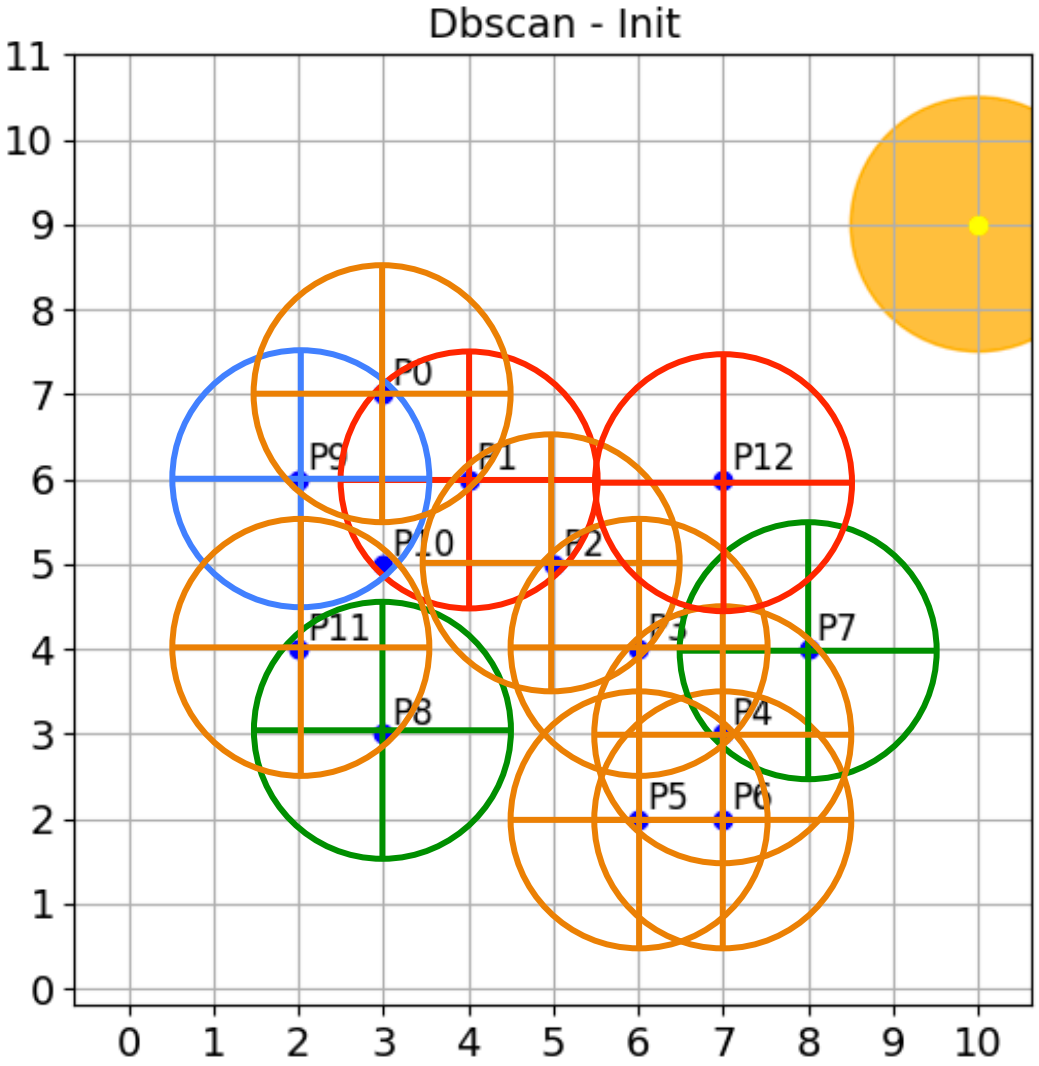
- P5
- P6
- P4
- P3
- P2
- P1
- P0
- P9
- P11

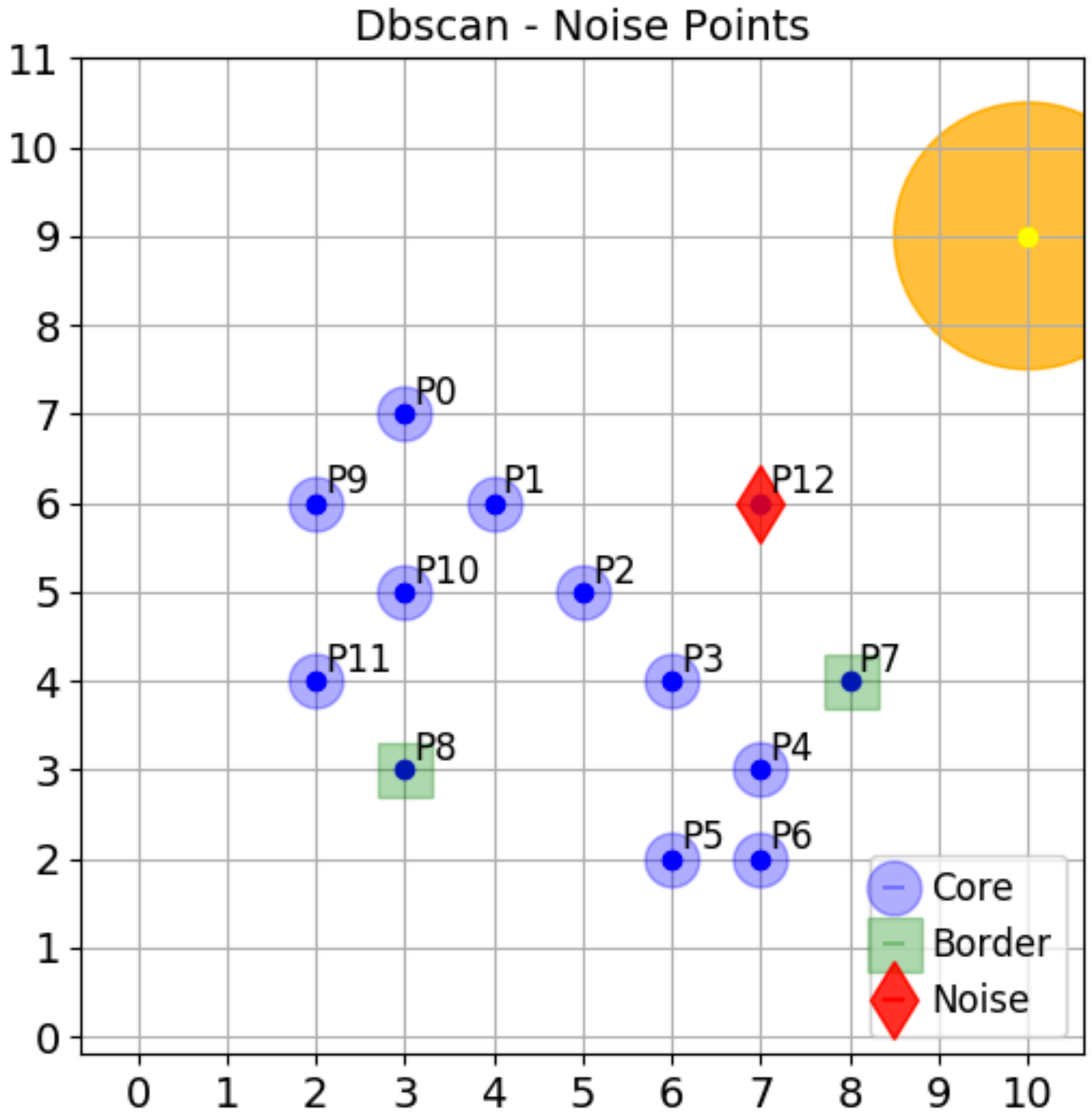
BORDER POINTS

- P8
- P7

NOISE POINTS

- P12




Dbscan - Noise Points
P0
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
Core
Border
Noise

Hierarchical

P0	X	1	Y	3
P1	X	5	Y	5
P2	X	4	Y	3
P3	X	4	Y	1
P4	X	3	Y	1
P5	X	3	Y	2

Euclidean Distance

$$\left((x_0-x_1)^2 + (y_0-y_1)^2\right)^{1/2}$$

Distance Matrix

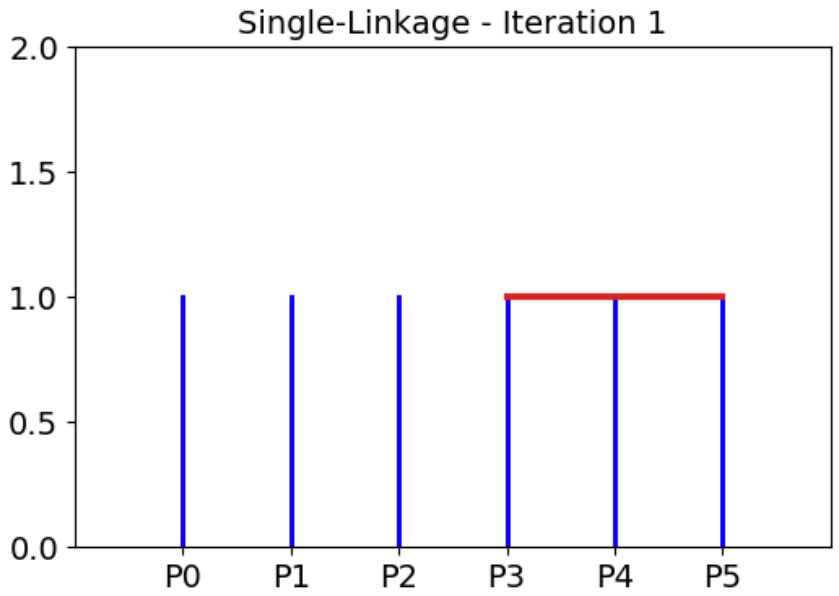
	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
P0	0.0	4.47	3.0	3.61	2.83	2.24
P1	4.47	0.0	2.24	4.12	4.47	3.61
P2	3.0	2.24	0.0	2.0	2.24	1.41
P3	3.61	4.12	2.0	0.0	1.0	1.41
P4	2.83	4.47	2.24	1.0	0.0	1.0
P5	2.24	3.61	1.41	1.41	1.0	0.0

Hierarchical: Single-LINK

Distance Matrix

	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Minimum Distance



Hierarchical: Single-LINK

Distance Matrix

	(0,)	(1,)	(2,)	(3, 4, 5)
0	0.0	4.47	3.0	
1	4.47	0.0	2.24	
2	3.0	2.24	0.0	
(3,4,5)				0.0

D([3,4,5], 0) =

- D(3,0) = 3.61
- D(4,0) = 2.83
- D(5,0) = 2.24

Min Distance

	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Hierarchical: Single-LINK

Distance Matrix

	(0,)	(1,)	(2,)	(3, 4, 5)
0	0.0	4.47	3.0	2.24
1	4.47	0.0	2.24	
2	3.0	2.24	0.0	
(3,4,5)	2.24			0.0

D([3,4,5], 1) =

- D(3,1) = 4.12
- D(4,1) = 4.47
- D(5,1) = 3.61

Min Distance

	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Hierarchical: Single-LINK

Distance Matrix

	(0,)	(1,)	(2,)	(3, 4, 5)
0	0.0	4.47	3.0	2.24
1	4.47	0.0	2.24	3.61
2	3.0	2.24	0.0	
(3,4,5)	2.24	3.61		0.0

D([3,4,5], 2) =

D(3,2) = 2

D(4,2) = 2.24

D(5,2) = 1.41

Min Distance

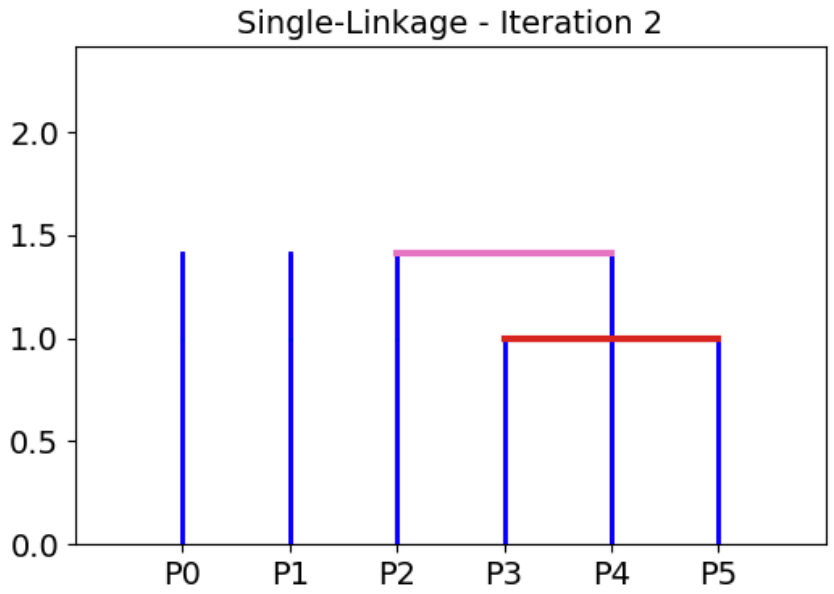
	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Hierarchical: Single-LINK

Distance Matrix

	(0,)	(1,)	(2,)	(3, 4, 5)
0	0.0	4.47	3.0	2.24
1	4.47	0.0	2.24	3.61
2	3.0	2.24	0.0	1.41
(3,4,5)	2.24	3.61	1.41	0.0

Minimum Distance



Hierarchical: Single-LINK

Distance Matrix

	((0),),)	((1),),)	((2,), (3, 4, 5))
0	0.0	4.47	
1	4.47	0.0	
(2,3,4,5)			0.0

D([2,3,4,5], 0) =

- D(2,0) = 3
- D(3,0) = 3.61
- D(4,0) = 2.83
- D(5,0) = 2.24

Min Distance

	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Hierarchical: Single-LINK

Distance Matrix

	((0),),)	((1),),)	((2,), (3, 4, 5))
0	0.0	4.47	2.24
1	4.47	0.0	
(2,3,4,5)	2.24		0.0

D([2,3,4,5], 1) =

- D(2,1) = 2.24
- D(3,1) = 4.12
- D(4,1) = 4.47
- D(5,1) = 3.61

Min Distance

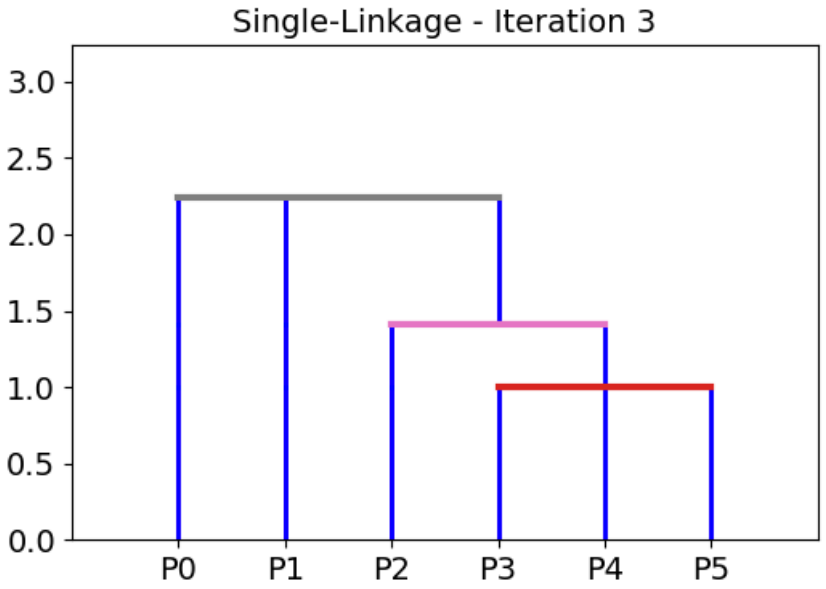
	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Hierarchical: Single-LINK

Distance Matrix

	((0),),)	((1),),)	((2,), (3, 4, 5))
0	0.0	4.47	2.24
1	4.47	0.0	2.24
(2,3,4,5)	2.24	2.24	0.0

Minimum Distance



Hierarchical – Complete Link

P0	X	1	Y	3
P1	X	5	Y	5
P2	X	4	Y	3
P3	X	4	Y	1
P4	X	3	Y	1
P5	X	3	Y	2

Euclidean Distance

$$((x_0-x_1)^2 + (y_0-y_1)^2)^{1/2}$$

Distance Matrix

	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
P0	0.0	4.47	3.0	3.61	2.83	2.24
P1	4.47	0.0	2.24	4.12	4.47	3.61
P2	3.0	2.24	0.0	2.0	2.24	1.41
P3	3.61	4.12	2.0	0.0	1.0	1.41
P4	2.83	4.47	2.24	1.0	0.0	1.0
P5	2.24	3.61	1.41	1.41	1.0	0.0

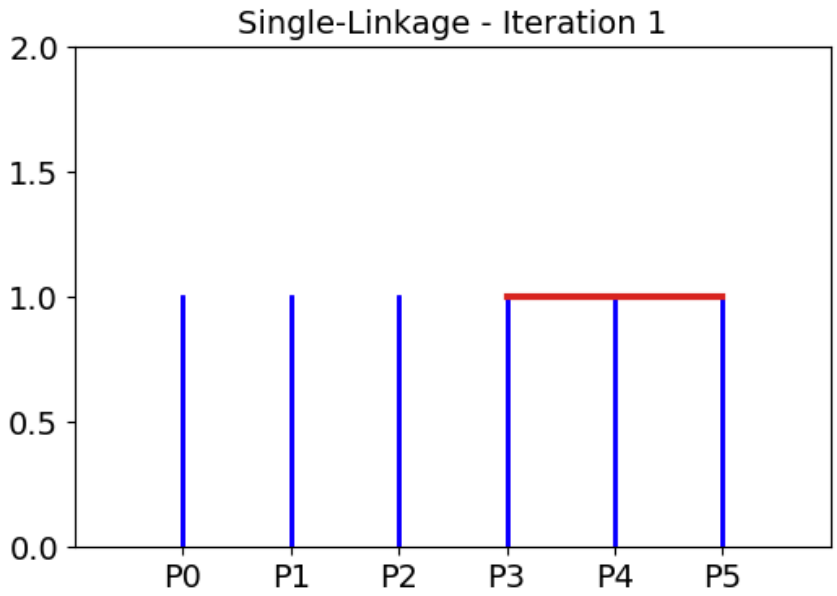
Hierarchical: Complete-LINK

Distance Matrix

	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Minimum Distance

First Step **equal** to SINGLE LINK



Hierarchical: Complete-LINK

Distance Matrix

	(0,)	(1,)	(2,)	(3, 4, 5)
0	0.0	4.47	3.0	
1	4.47	0.0	2.24	
2	3.0	2.24	0.0	
(3,4,5)				0.0

D([3,4,5], 0) =

- D(3,0) = 3.61
- D(4,0) = 2.83
- D(5,0) = 2.24

Max Distance

	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Hierarchical: Complete-LINK

Distance Matrix

	(0,)	(1,)	(2,)	(3, 4, 5)
0	0.0	4.47	3.0	3.61
1	4.47	0.0	2.24	
2	3.0	2.24	0.0	
(3,4,5)	3.61			0.0

$D([3,4,5], 1) =$

- D(3,1) = 4.12
- D(4,1) = 4.47
- D(5,1) = 3.61

Max Distance

	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Hierarchical: Complete-LINK

Distance Matrix

	(0,)	(1,)	(2,)	(3, 4, 5)
0	0.0	4.47	3.0	3.61
1	4.47	0.0	2.24	
2	3.0	2.24	0.0	
(3,4,5)	3.61	4.47		0.0

D([3,4,5], 2) =

- D(3,2) = 2
- D(4,2) = 2.24
- D(5,2) = 1.41

Max Distance

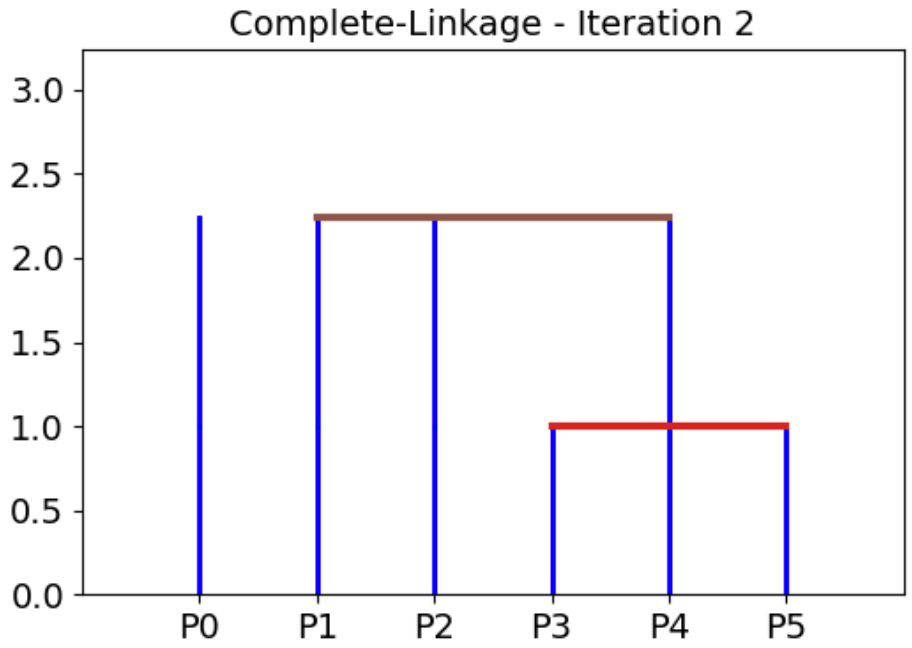
	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Hierarchical: Complete-LINK

Distance Matrix

	(0,)	(1,)	(2,)	(3, 4, 5)
0	0.0	4.47	3.0	3.61
1	4.47	0.0	2.24	4.47
2	3.0	2.24	0.0	2.24
(3,4,5)	3.61	4.47	2.24	0.0

Minimum Distance



Hierarchical: Complete-LINK

Distance Matrix

	((0,),)	((1,), (2,), (3, 4, 5))
0	0.0	
(1,2,3,4,5)		0.0

D([1,2,3,4,5], 0) =

- D(1,0) = 4.47
- D(2,0) = 3
- D(3,0) = 3.61
- D(4,0) = 2.83
- D(5,0) = 2.24

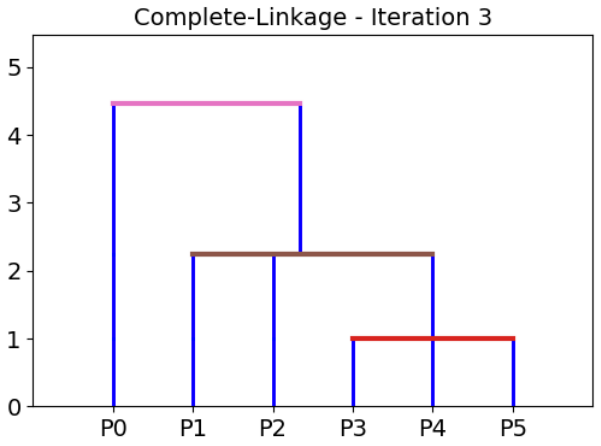
Max Distance

	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0

Hierarchical: Complete-LINK

Distance Matrix

	((0,),)	((1,), (2,), (3, 4, 5))
0	0.0	4.47
(1,2,3,4,5)	4.47	0.0



D([1,2,3,4,5], 0) =

- D(1,0) = 4.47
- D(2,0) = 3
- D(3,0) = 3.61
- D(4,0) = 2.83
- D(5,0) = 2.24

Max Distance

	(0,)	(1,)	(2,)	(3,)	(4,)	(5,)
0	0.0	4.47	3.0	3.61	2.83	2.24
1	4.47	0.0	2.24	4.12	4.47	3.61
2	3.0	2.24	0.0	2.0	2.24	1.41
3	3.61	4.12	2.0	0.0	1.0	1.41
4	2.83	4.47	2.24	1.0	0.0	1.0
5	2.24	3.61	1.41	1.41	1.0	0.0