DATA MINING
Exercises Clustering

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K-Means

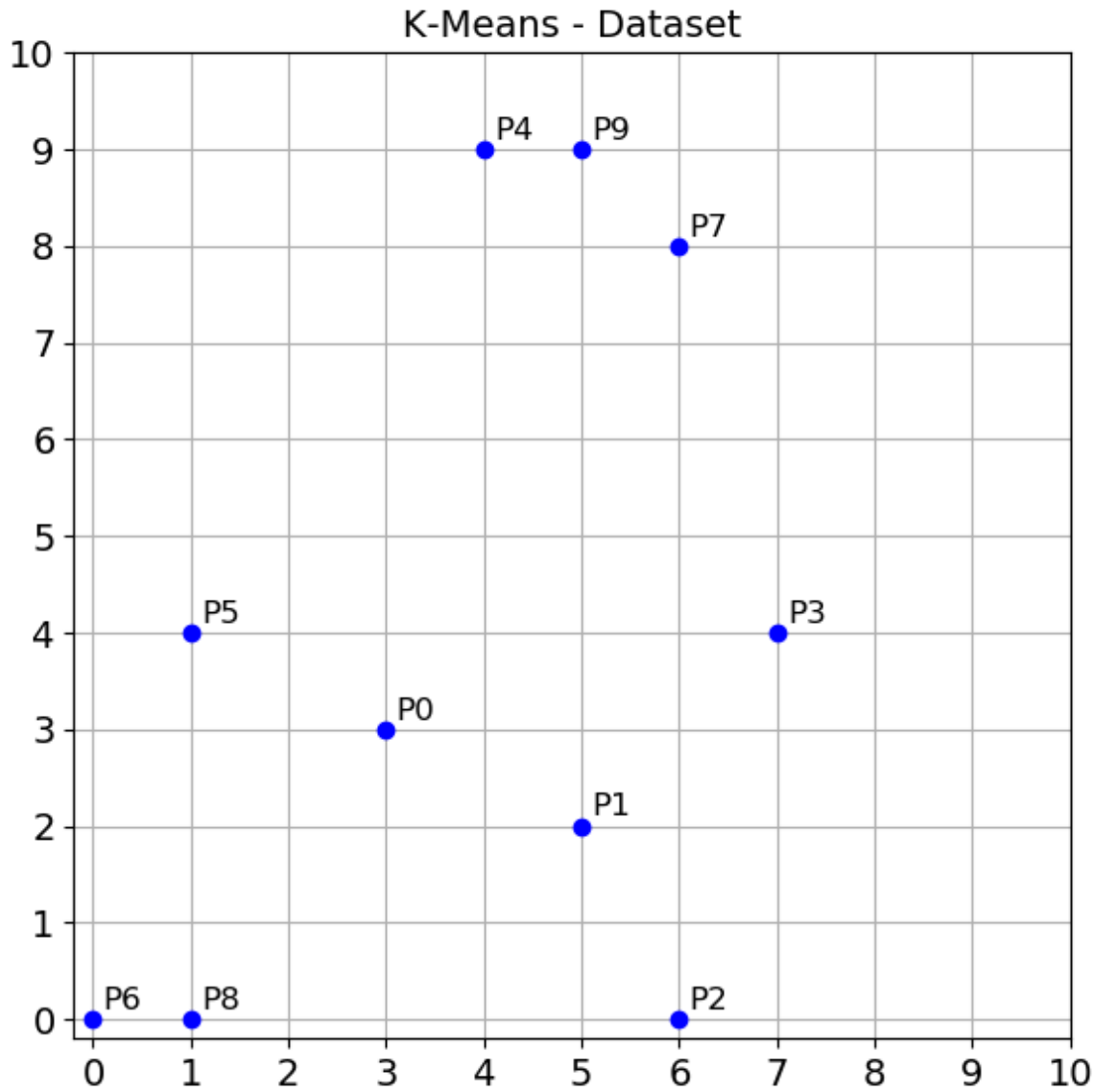
Ex 1

K-means simulation

Initial centroids:

C1 = P1=(5,2)

C2 = P5=(1,4)



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

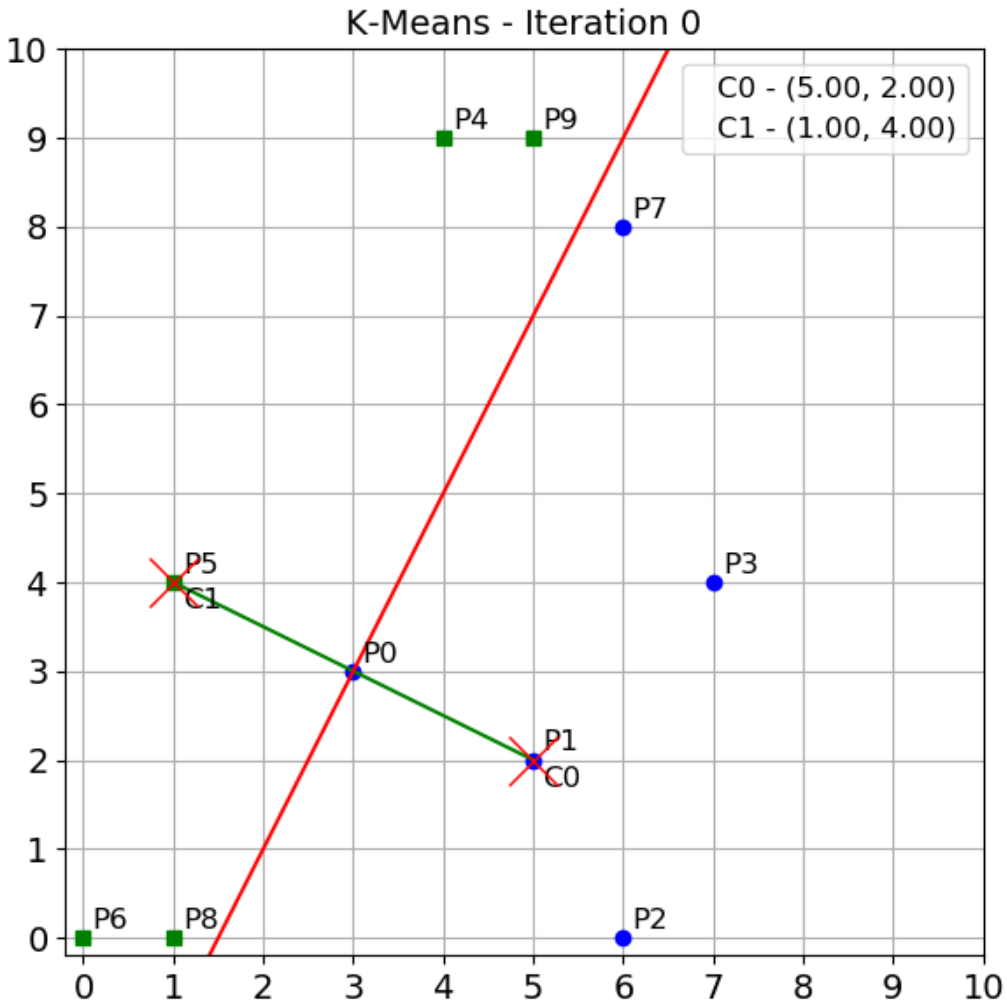
Cluster 1: P0,P1,P2,P3,P7

Cluster 2: P5,P4,P6,P8,P9

Centrod1:

C1= (5.40, 3.40)

C2= (2.20, 4.40)



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

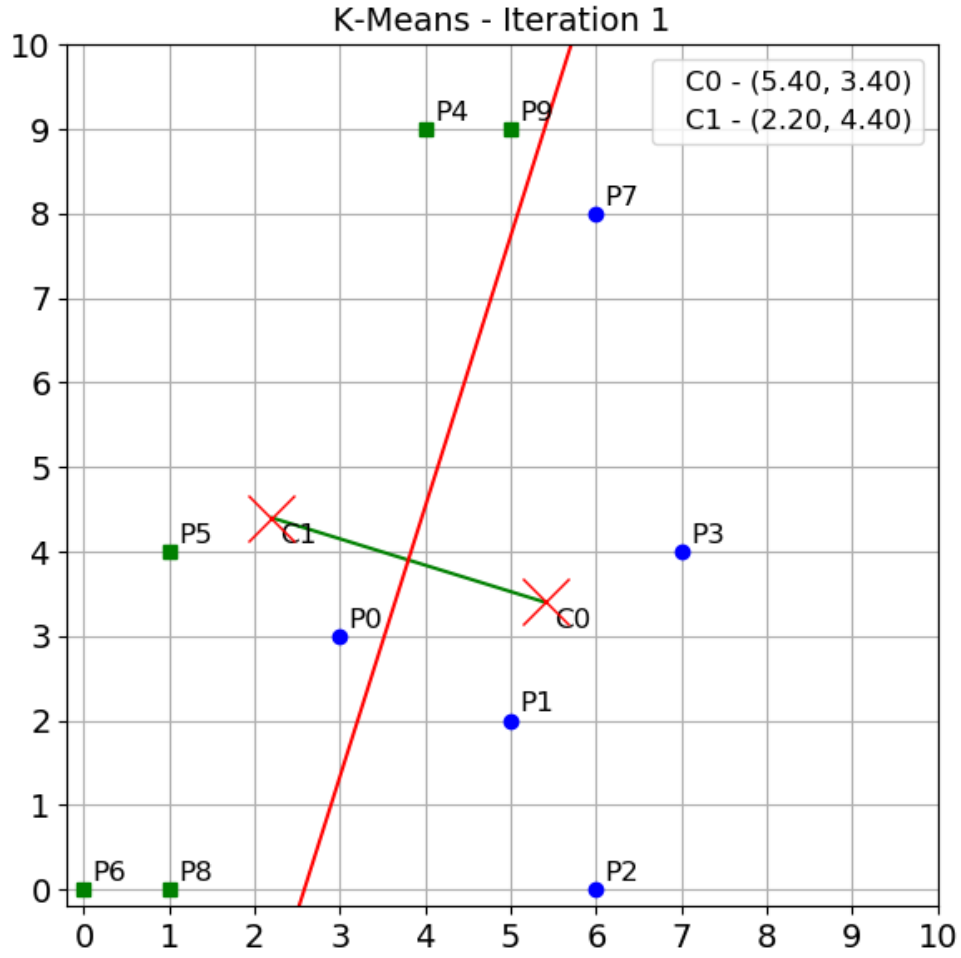
Cluster 1: P1,P2,P3,P7

Cluster 2: P5,P4,P6,P8,P9,P0

Centrod1:

C1= (6.00, 3.50)

C2= (2.33, 4.17)



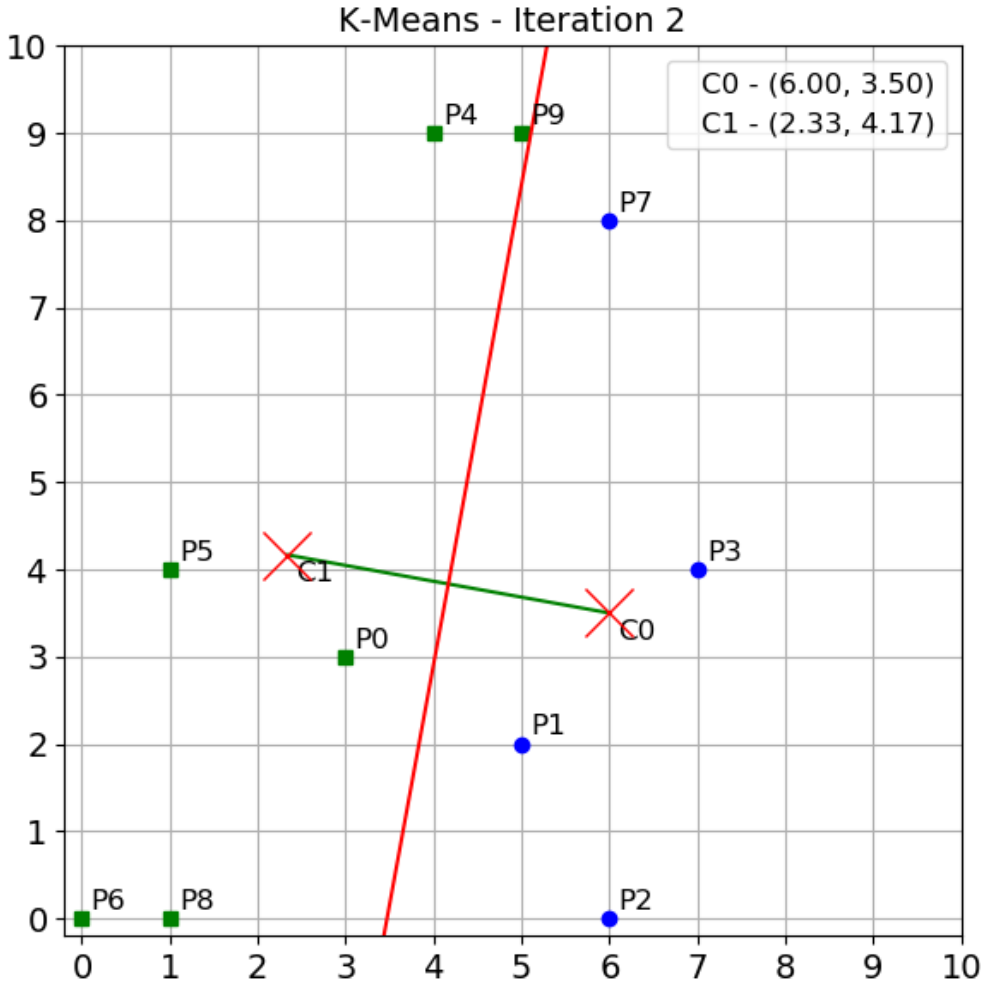
Solution: Identify the Bisecting lines dividing the plane between pairs of centroids

Cluster 1: P1,P2,P3,P7

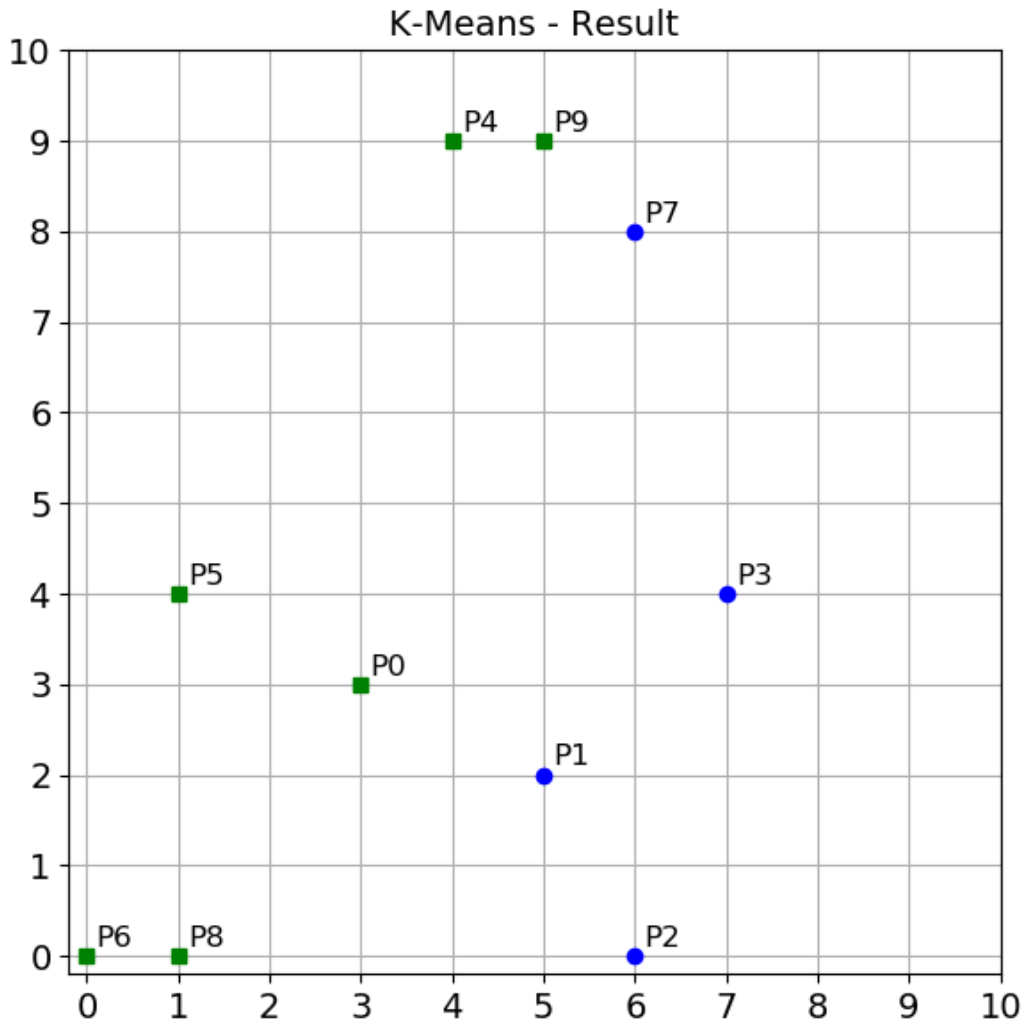
Cluster 2: P5,P4,P6,P8,P9,P0

The cluster composition does not change,

so K-means stops



K-means result



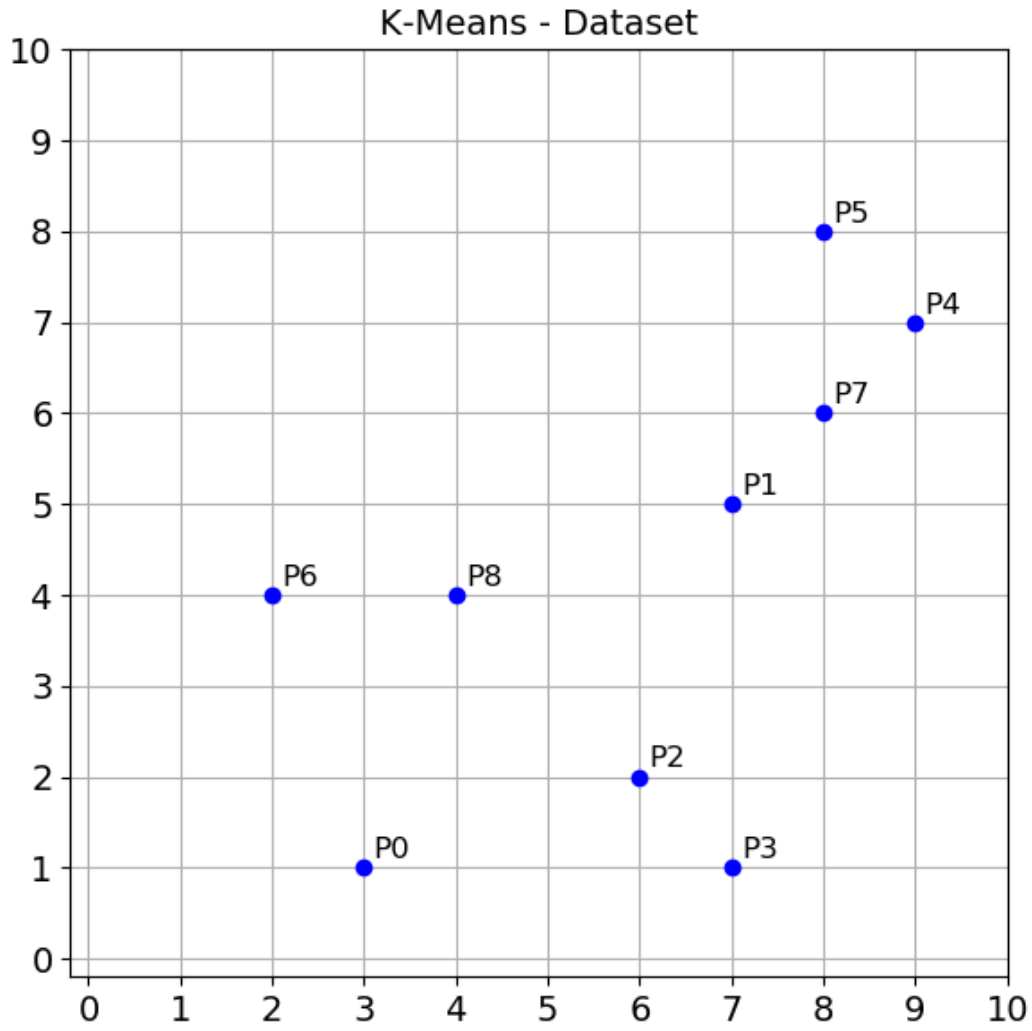
Ex 2

K-means simulation

Initial centroids:

C1 = P2=(6,2)

C2 = P1=(7,5)



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

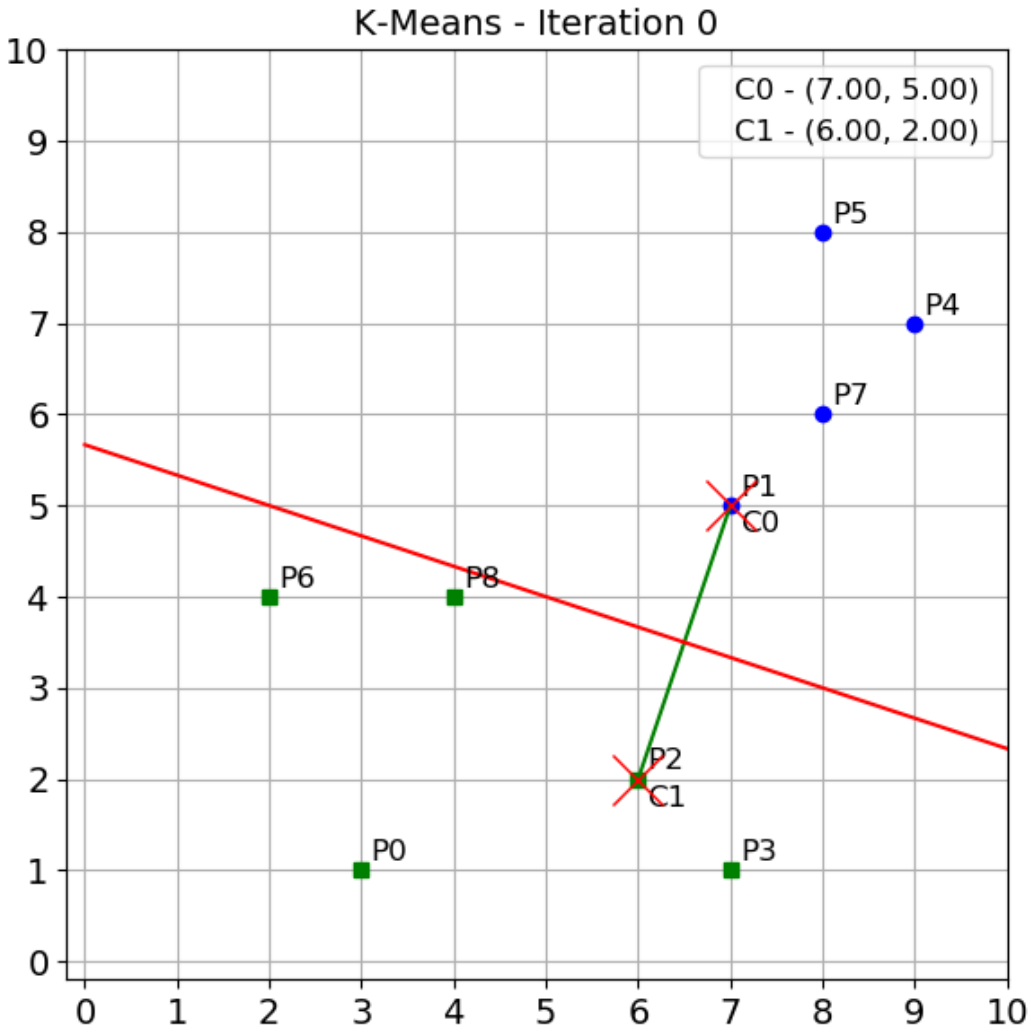
Cluster 1: P0,P2,P3,P6,P8

Cluster 2: P1,P4,P5,P7

Centrod1:

X1=(2+3+4+6+7)/5=4.4 **Y1**=(4+1+4+2+1)/5=2.4

X2=(6+8+8+9)/4=8 **Y2**=(5+6+8+7)/4=6.5



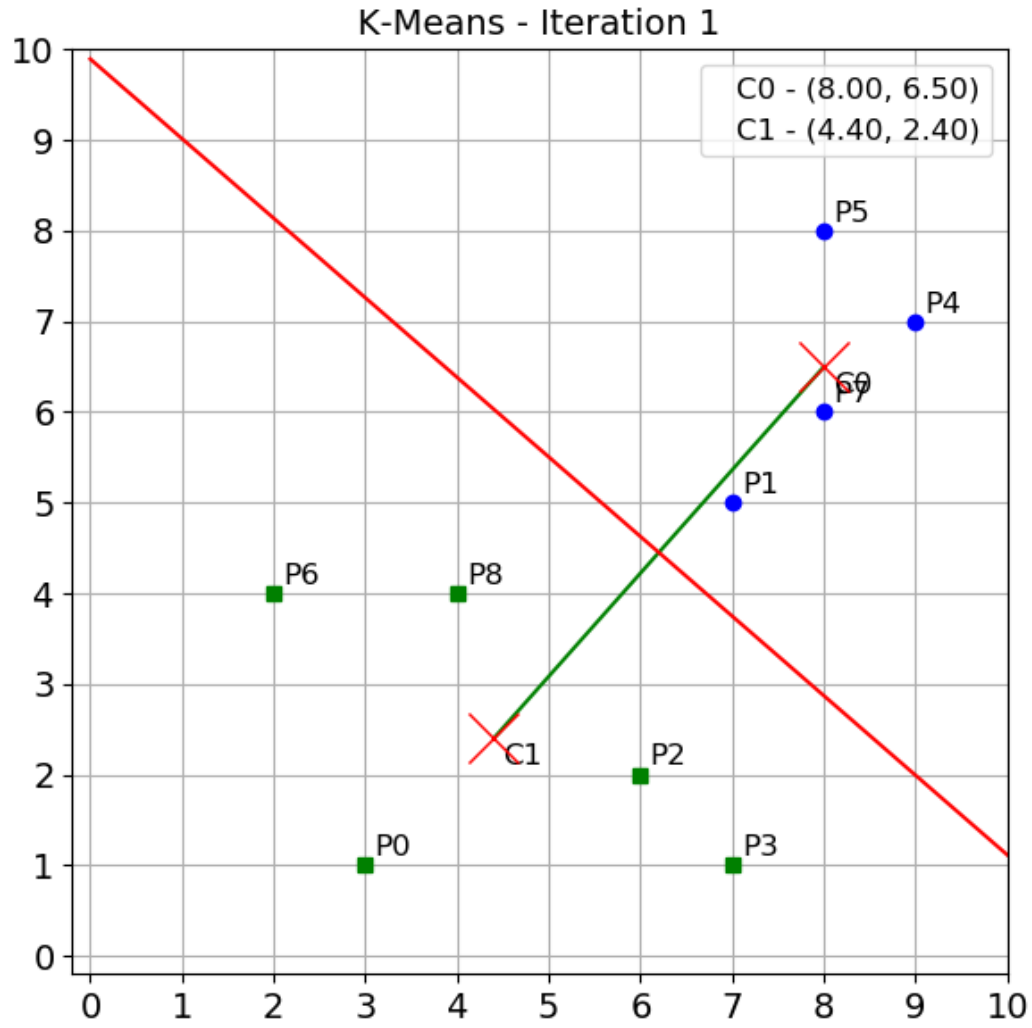
Solution: Identify the Bisecting lines dividing the plane between pairs of centroids

Cluster 1: P0,P2,P3,P6,P8

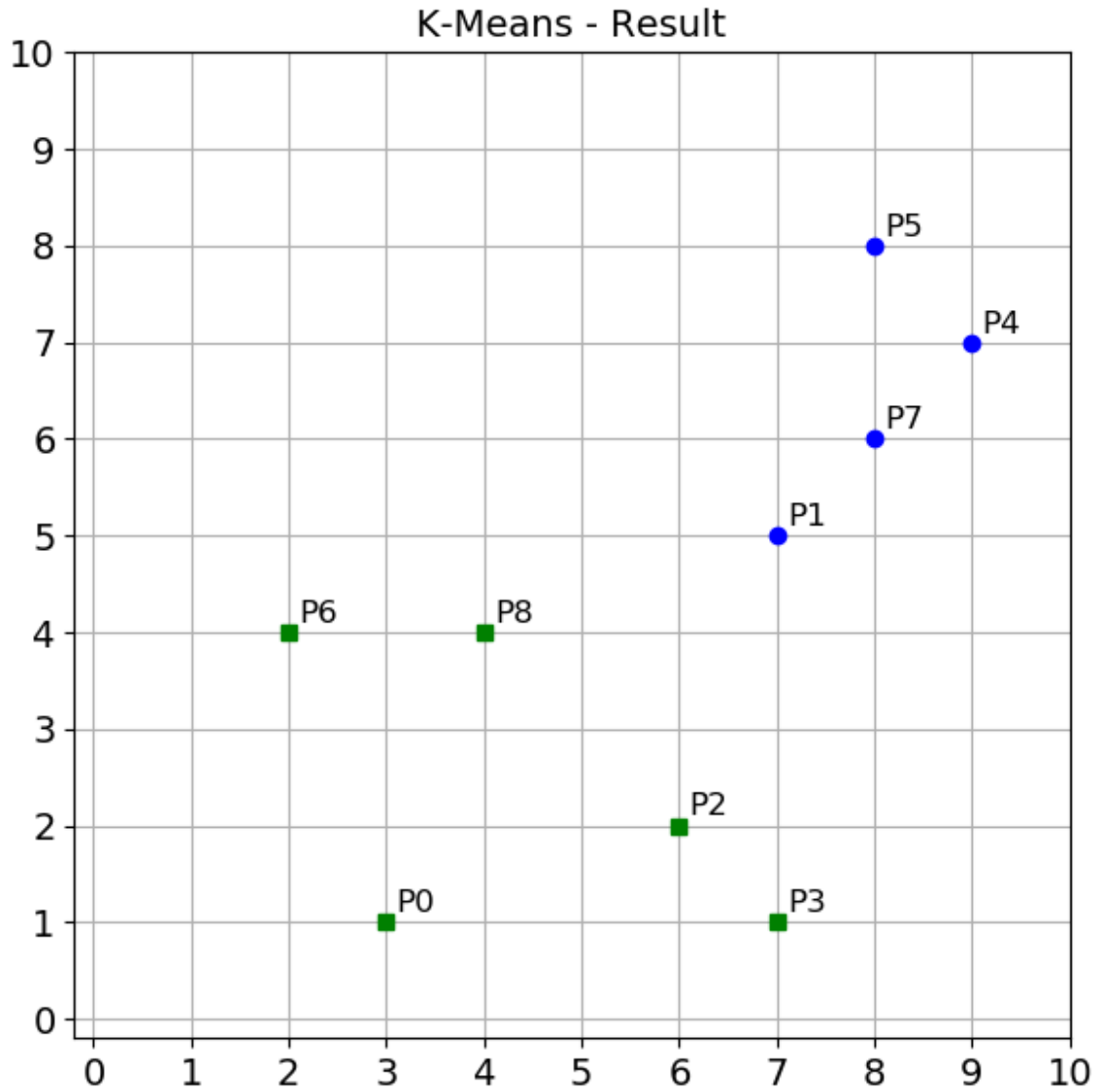
Cluster 2: P1,P4,P5,P7

The cluster composition does not change,

so K-means stops



K-means result



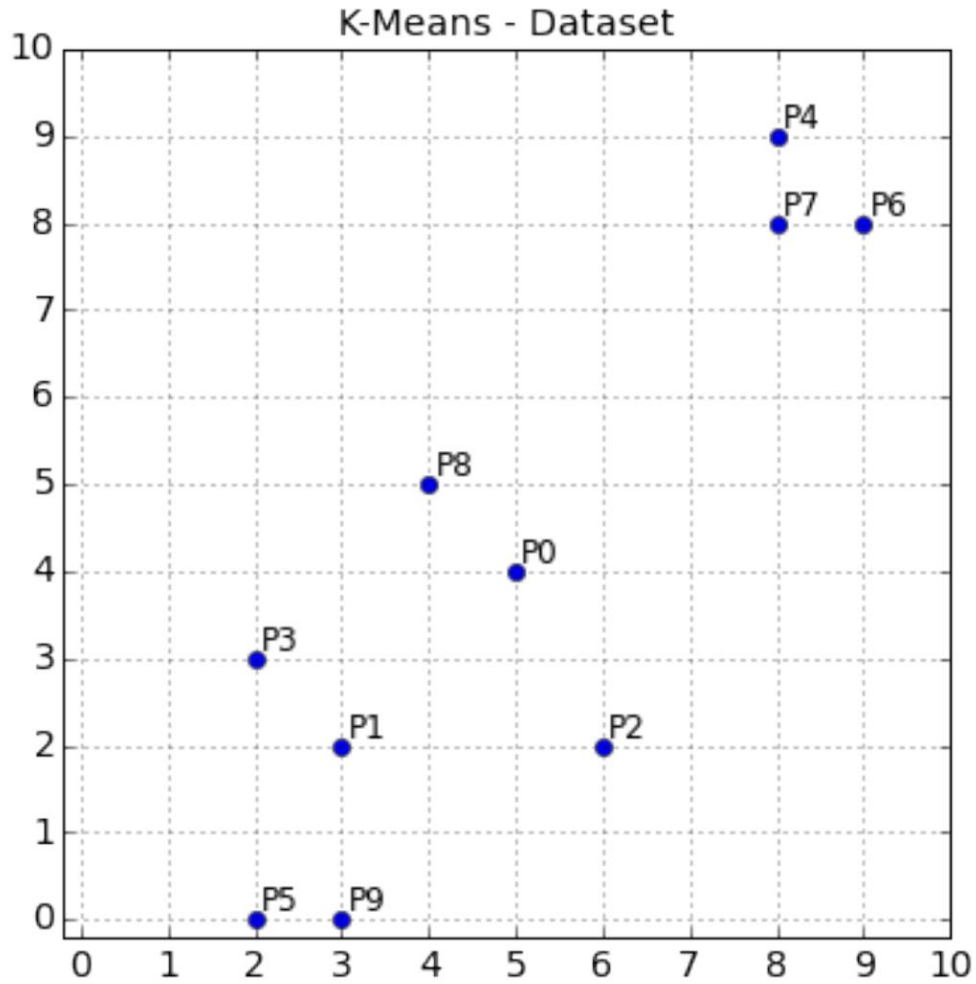
Ex 3

a) Apply **K-means** to the dataset in the below table and figure using K=2, and the centroids c1=P2 and c2=P9. Explain what happens in any iteration **(10 points).**

b) Discuss the reason of the k-means termination **(4 points)**.

c) Identify another couple of initial centroids leading to the same clustering obtained in a) **(2 points)**.

Points	X	Y
P0	5	4
P1	3	2
P2	6	2
P3	2	3
P4	8	9
P5	2	0
P6	9	8
P7	8	8
P8	4	5
P9	3	0

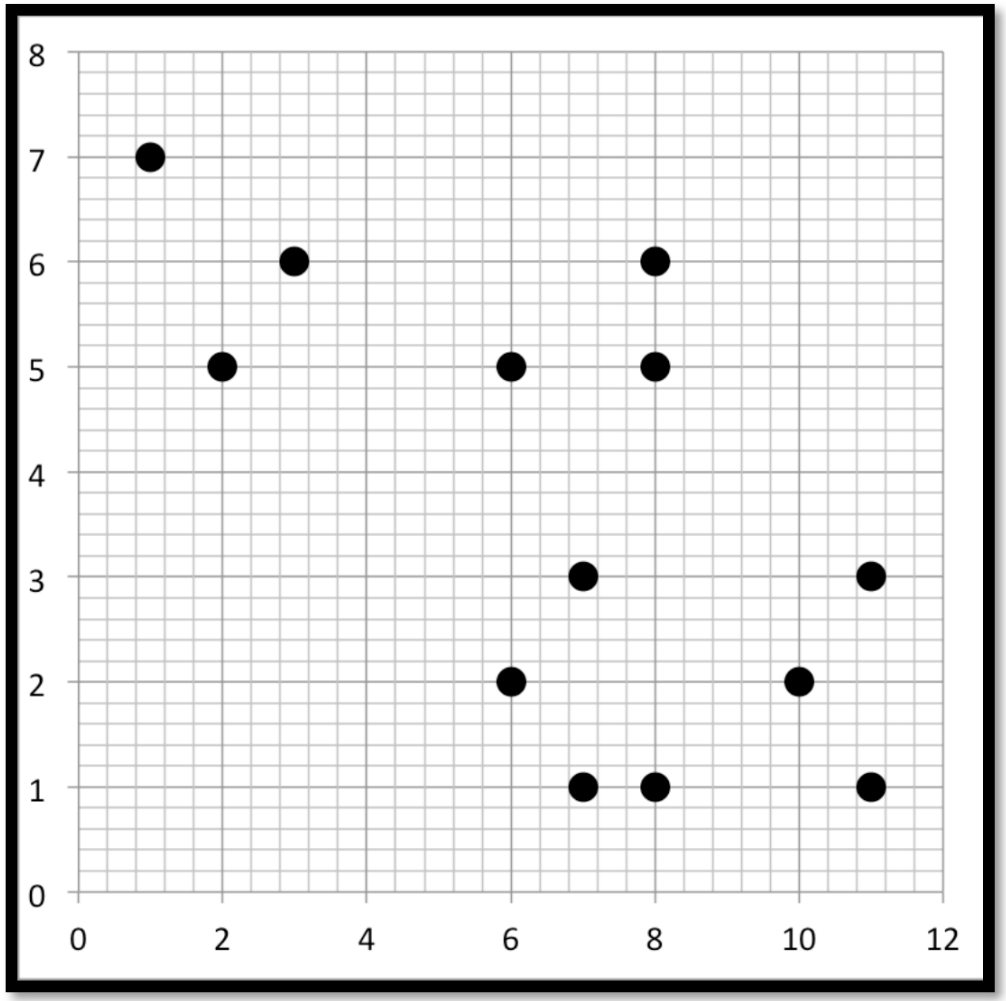


Ex 4

a) Apply **K-means** to the dataset in the below table and figure using K=2, and the centroids c1=P5 and c2=P8. Explain what happens in any iteration.

b) Discuss the reason of the k-means termination

Points	X	Y
P1	1	7
P2	2	5
P3	3	6
P4	10	2
P5	11	1
P6	11	3
P7	6	2
P8	7	1
P9	7	3
P10	8	1
P11	6	5
P12	8	6
P13	8	5

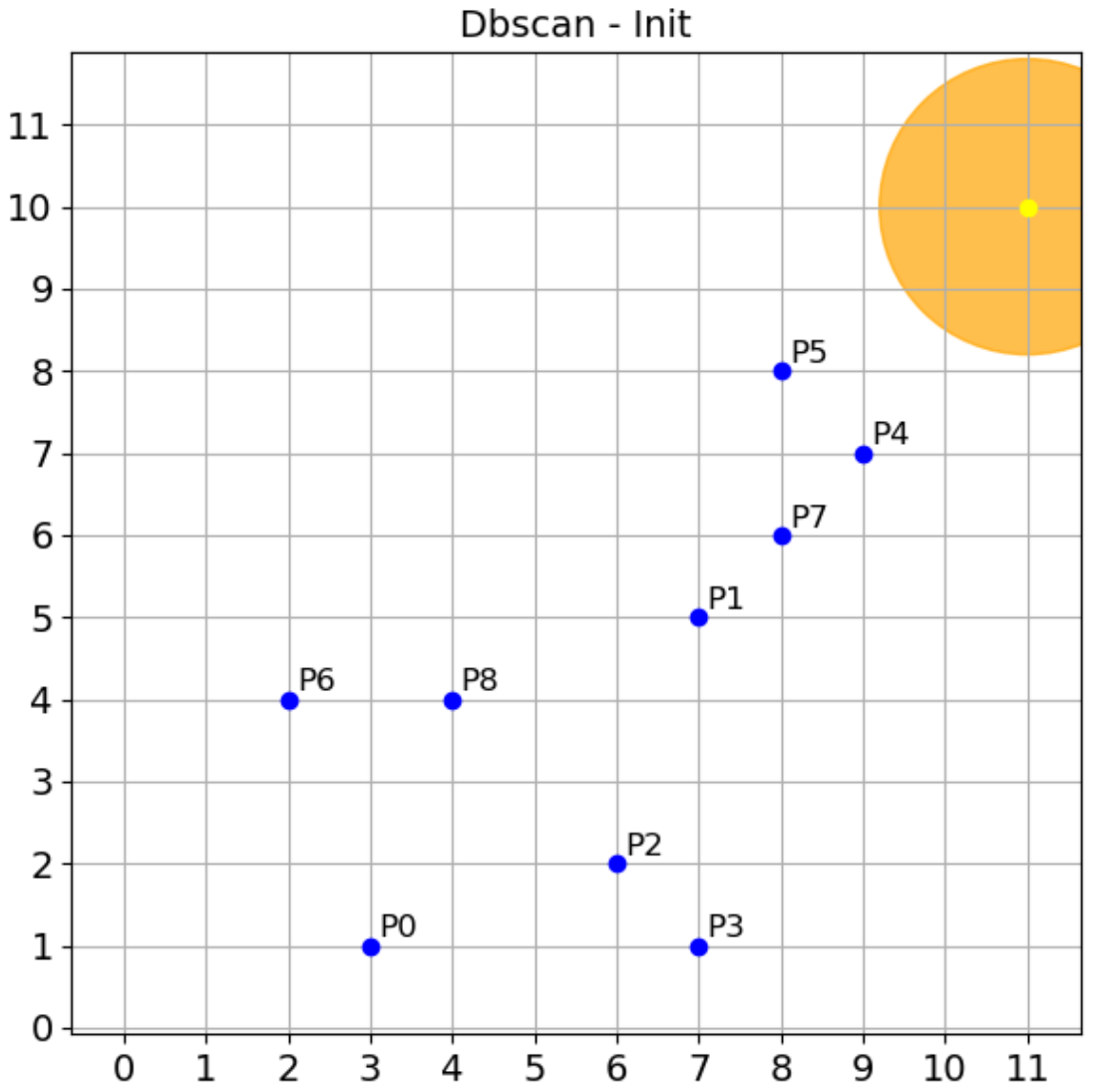


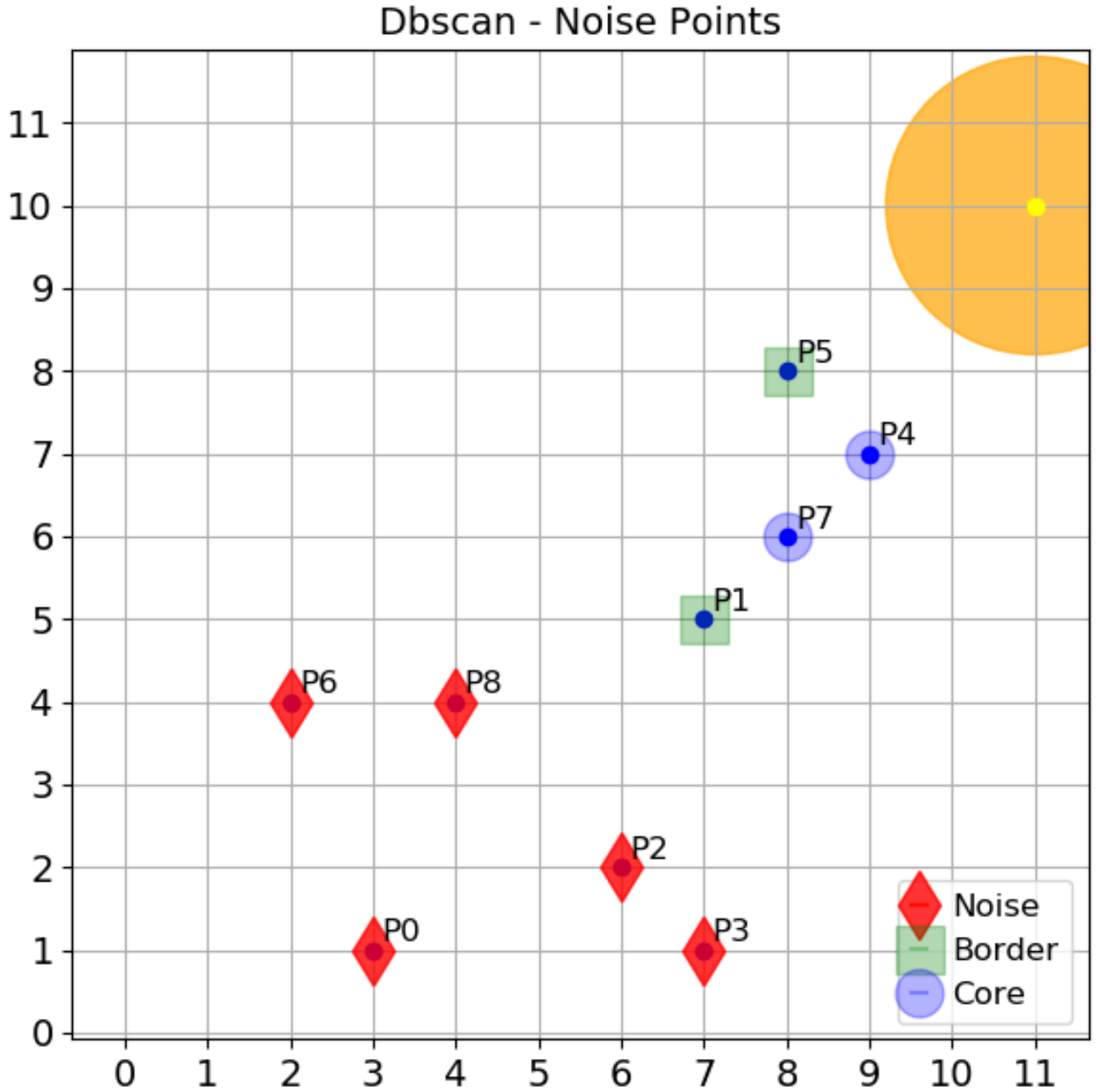
DBSCAN

Ex 5

DBSCAN simulation

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

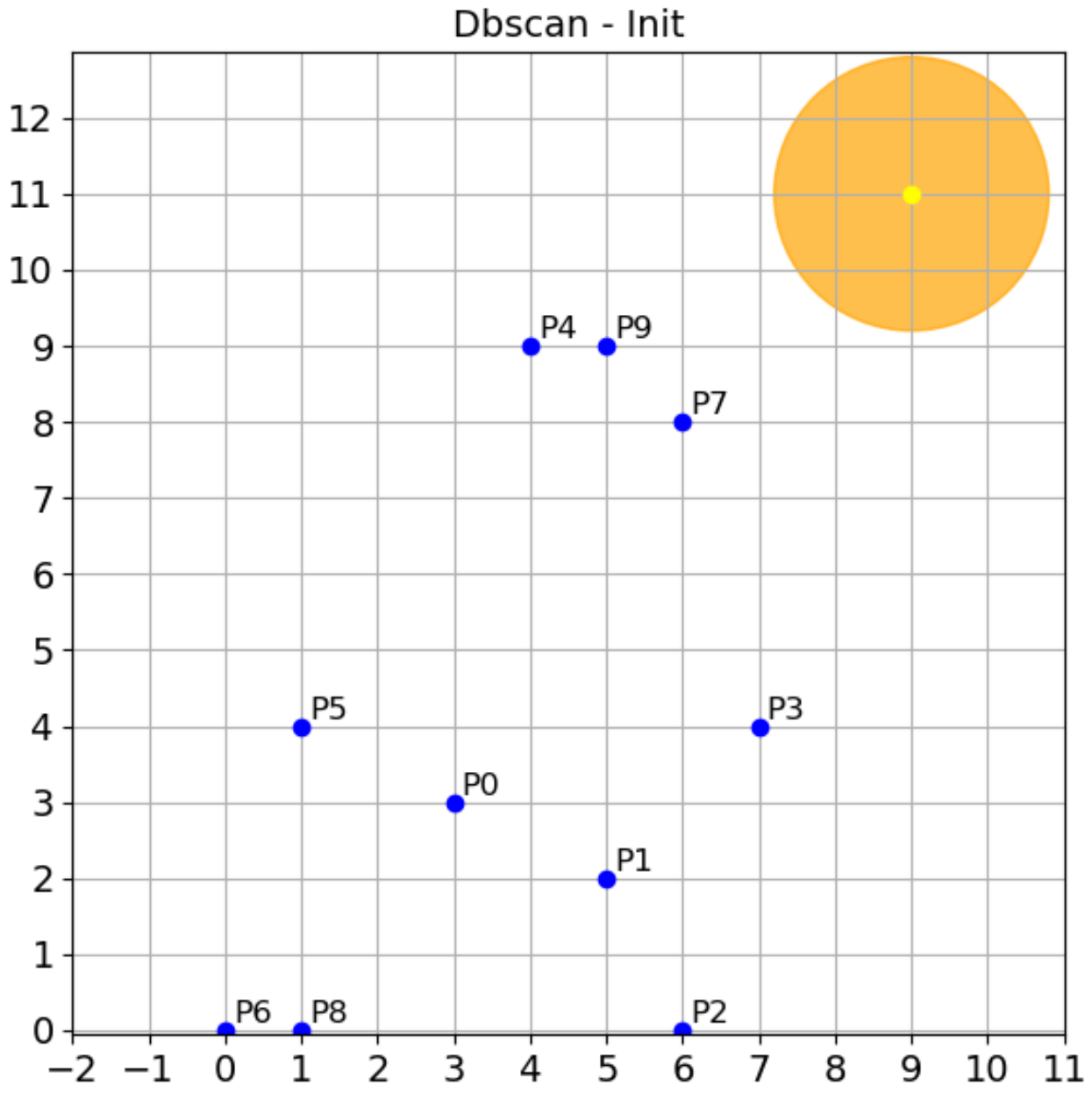


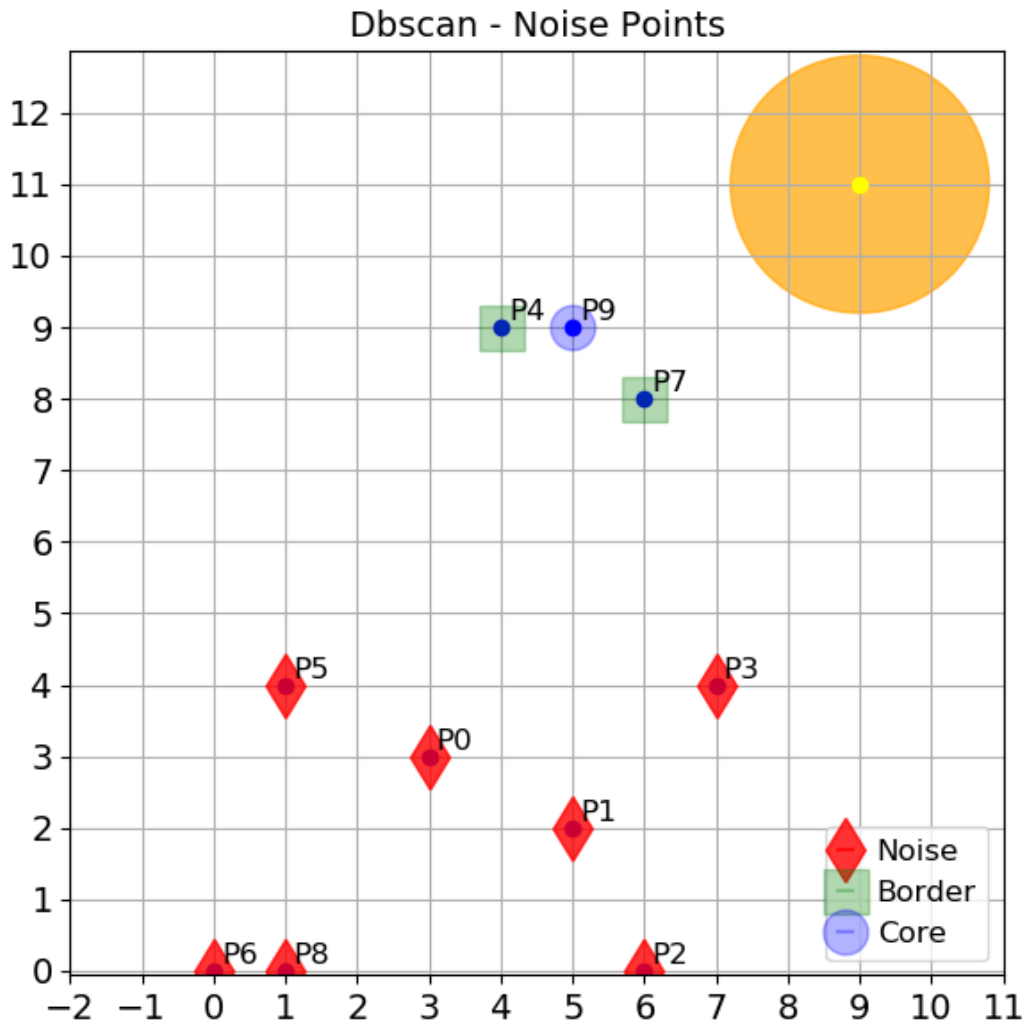

Dbscan - Noise Points
P5
P4
P7
P1
P6
P8
P2
P0
P3
Noise
Border
Core
0
1
2
3
4
5
6
7
8
9
10
11

Ex 6

DBSCAN simulation

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

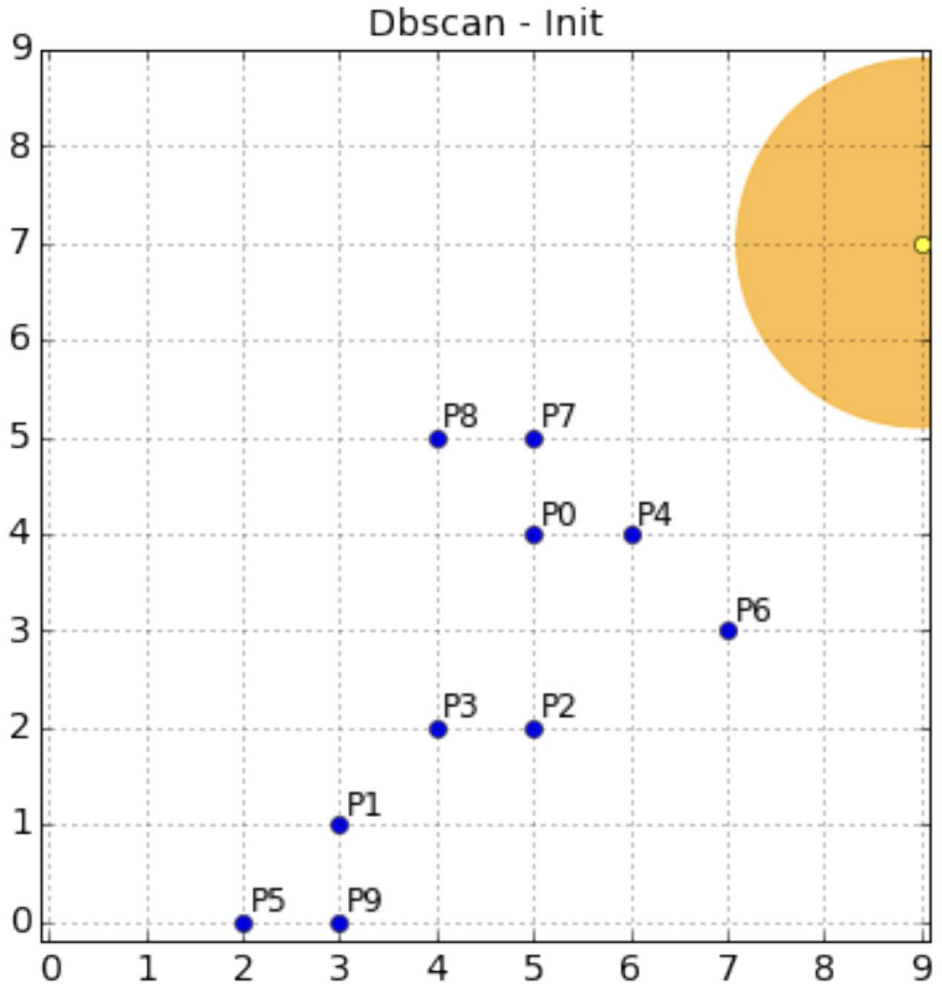



Dbscan - Noise Points
P4
P9
P7
P5
P3
P0
P1
P6
P8
P2
Noise
Border
Core

Ex 7

a) Apply **Dbscan** on the data of previous exercise with radius eps=1.9 and minPts=3 (2 neighbor plus the point itself) and for each point specify if it is a core point, border point or noise **(10 points).**
b) Indicate the composition of the clusters obtained **(2 points).**
c) Which is the minimum eps to obtain a unique cluster? How many core and border points are presents in this new clustering? **(3 points).**

Points	X	Y
P0	5	4
P1	3	1
P2	5	2
P3	4	2
P4	6	4
P5	2	0
P6	7	3
P7	5	5
P8	4	5
P9	3	0



Hierarchical Clustering

Ex 8

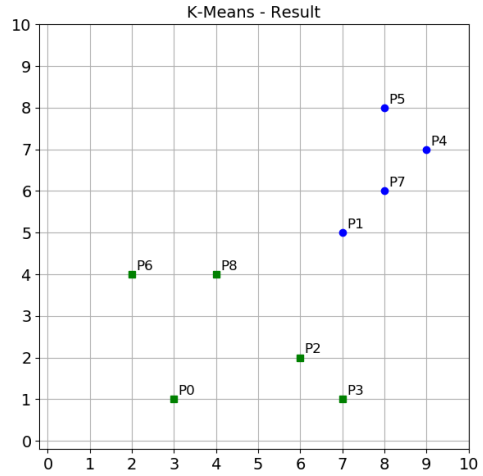
Hierarchical: Single-LINK

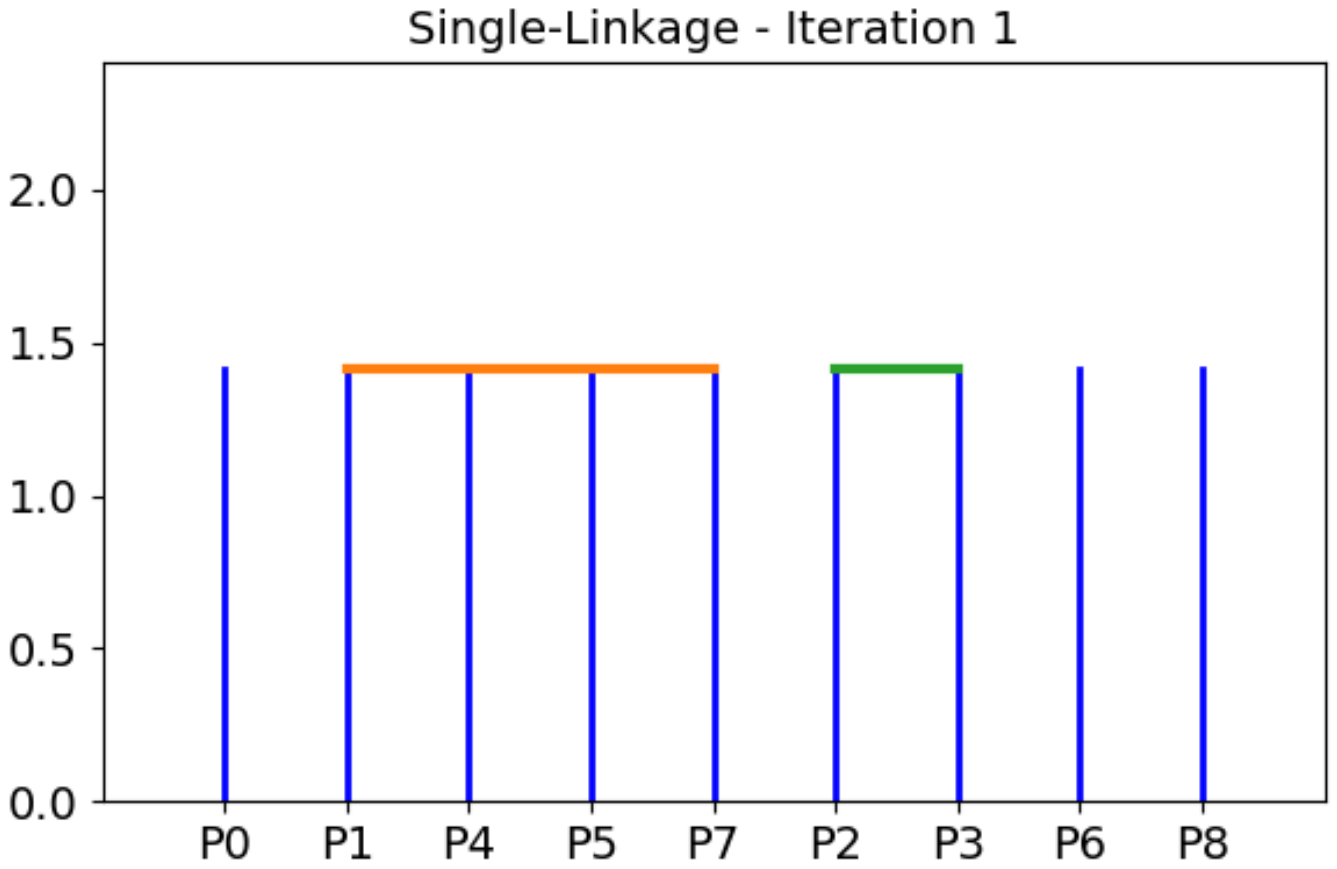
Euclidean Distance

0	5.66	3.16	4	8.49	8.6	3.16	7.07	3.16
5.66	0	3.16	4	2.83	3.16	5.1	**1.41**	3.16
3.16	3.16	0	**1.41**	5.83	6.32	4.47	4.47	2.83
4	4	**1.41**	0	6.32	7.07	5.83	5.1	4.24
8.49	2.83	5.83	6.32	0	**1.41**	7.62	1.41	5.83
8.6	3.16	6.32	7.07	**1.41**	0	7.21	2	5.66
3.16	5.1	4.47	5.83	7.62	7.21	0	6.32	2
7.07	**1.41**	4.47	5.1	1.41	2	6.32	0	4.47
3.16	3.16	2.83	4.24	5.83	5.66	2	4.47	0

Min Distance

distance merge 1.41

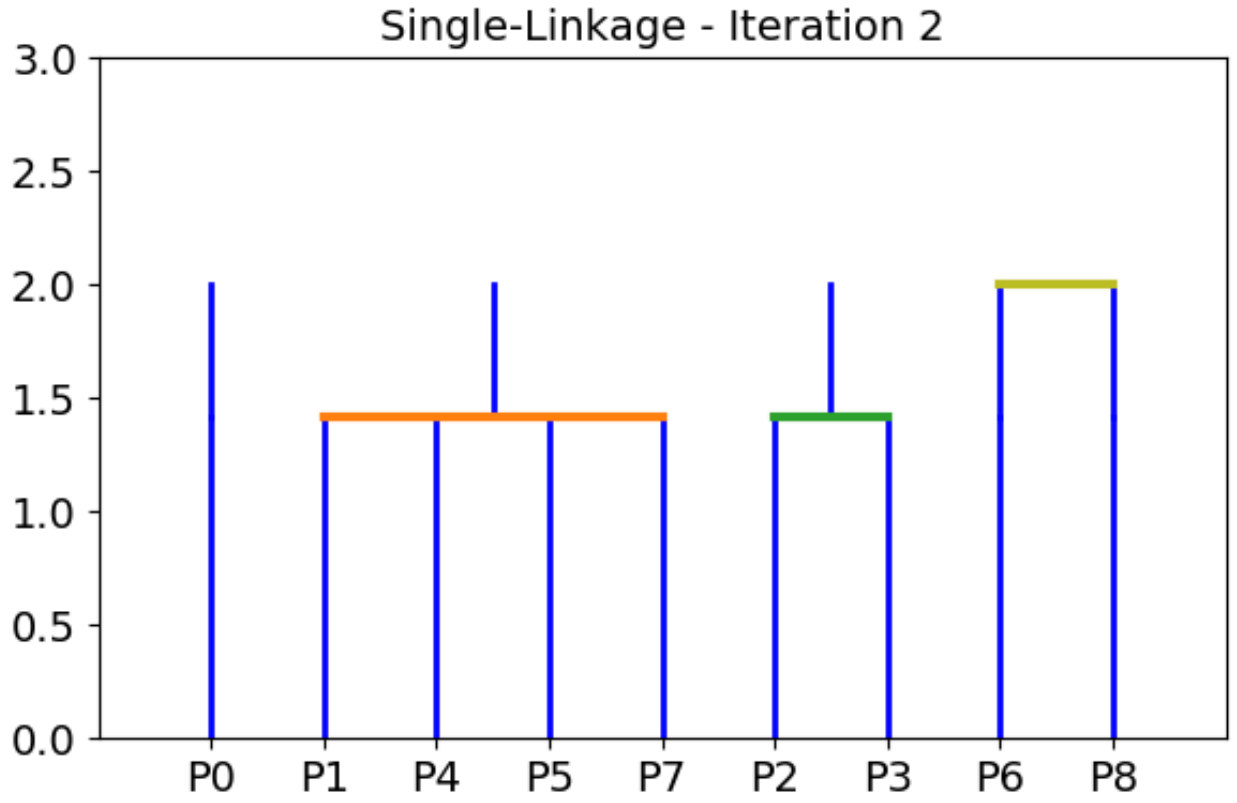




Hierarchical: **Single-LINK**- Euclidean Distance

[(0,),	(1,4,5,7)	(2, 3),	(6,),	(8,)]
[0.	5.66	3.16	3.16	3.16]
[5.66	0.	3.16	5.1	3.16]
[3.16	3.16	0.	4.47	2.83]
[3.16	5.1	4.47	0.	2.]
[3.16	3.16	2.83	2.	0.]

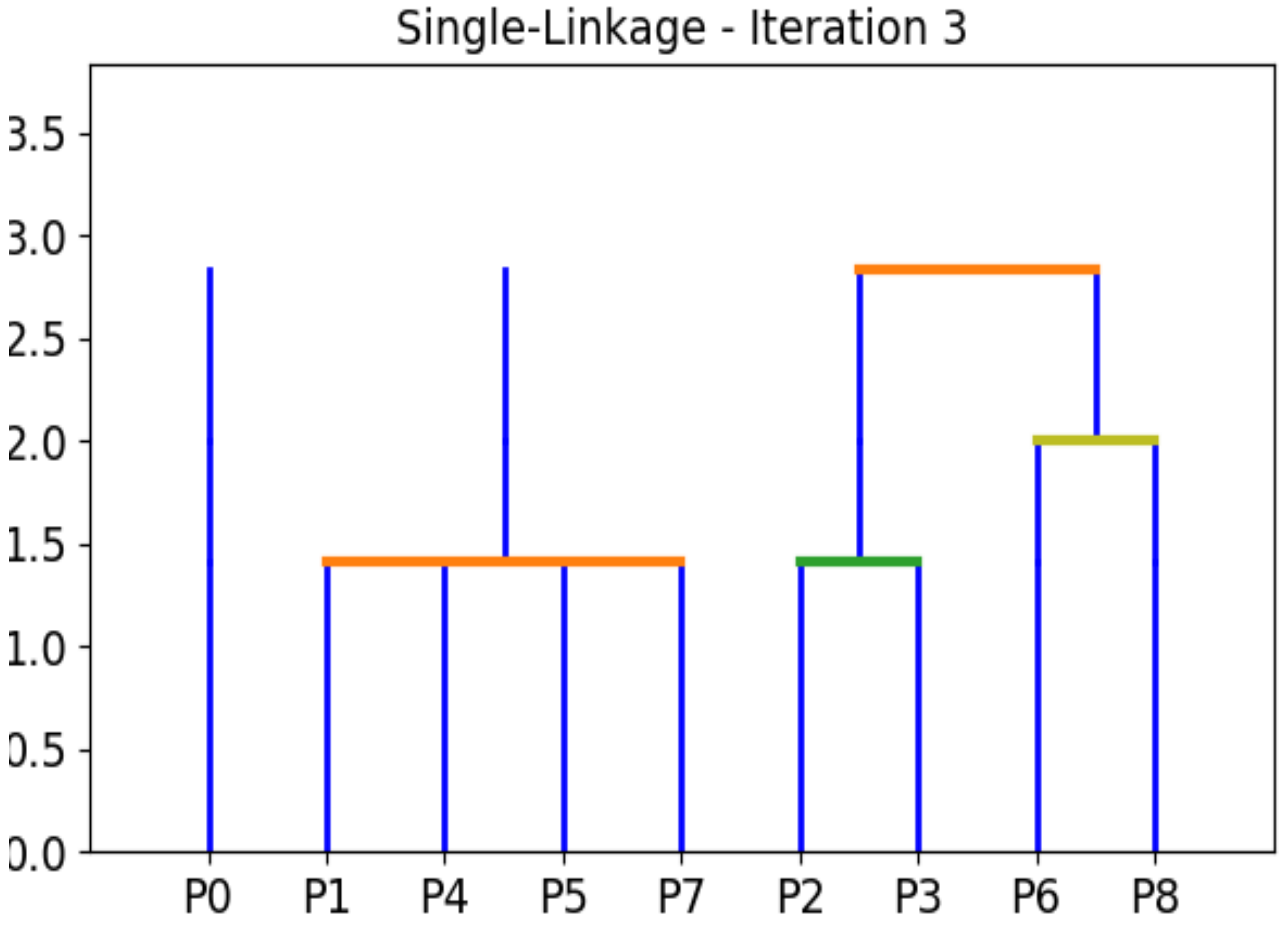
distance merge 2.00



Hierarchical: Single-LINK- Euclidean Distance

[(0,),	(1,4,5,7)	(2, 3),	(6, 8)]
[0.	5.66	3.16	3.16]
[5.66	0.	3.16	3.16]
[3.16	3.16	0.	2.83]
[3.16	3.16	2.83	0.]

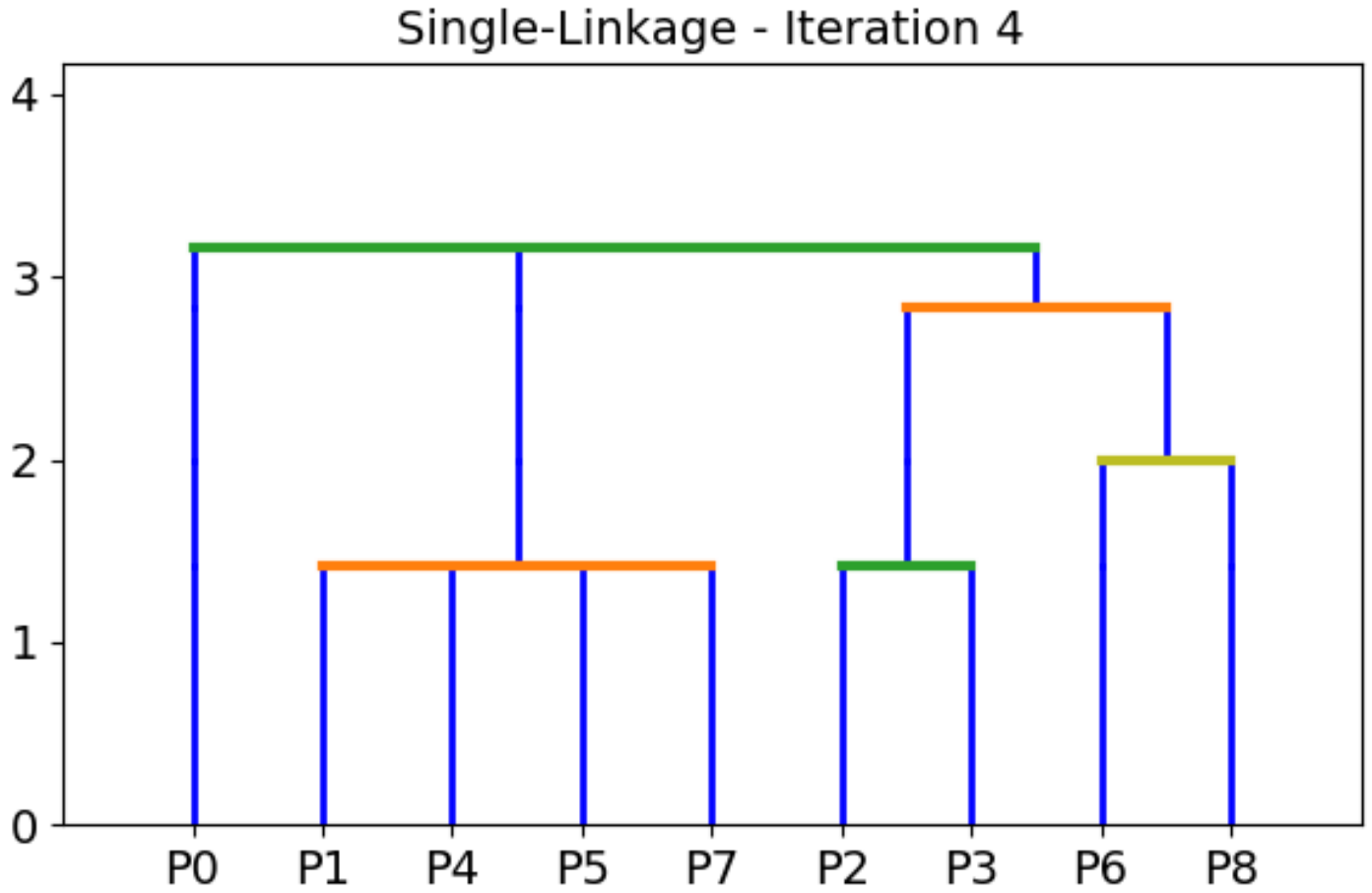
distance merge 2.83



Hierarchical: Single-LINK- Euclidean Distance

[(0,),	(1,4,5,7)	(2,3,6,8)]
[0.	5.66	3.16]
[5.66	0.	3.16]
[3.16	3.16	0.]

distance merge 3.16

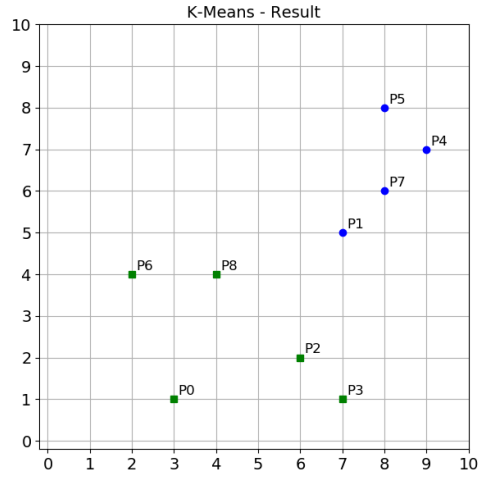


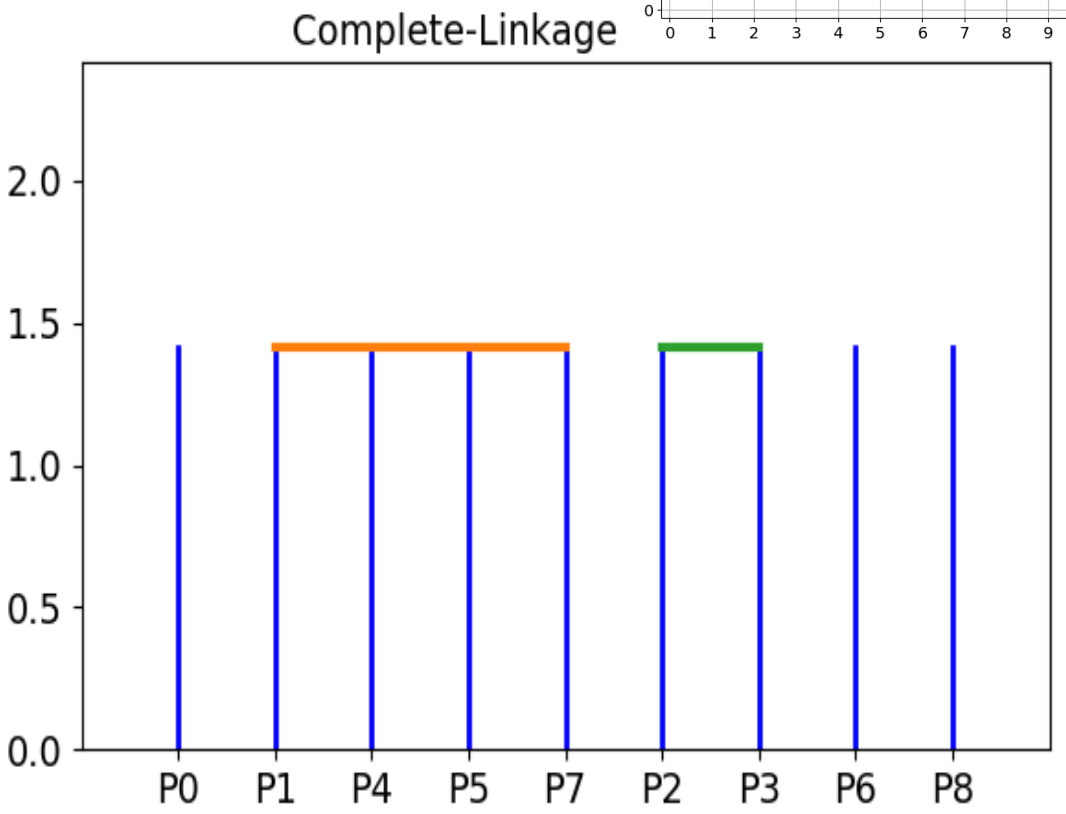
Ex 9

Hierarchical: **Complete-LINK**

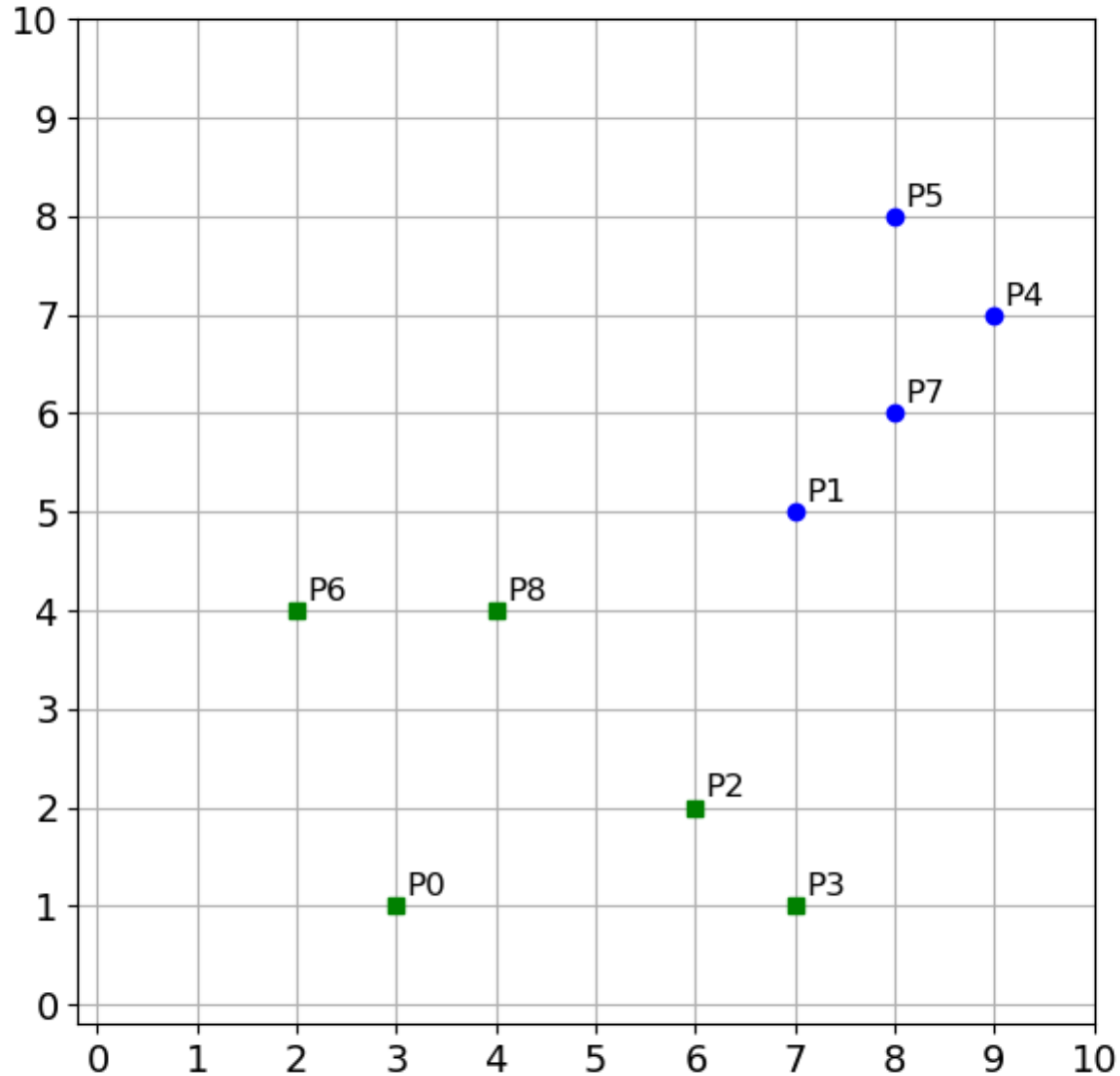
Euclidean Distance

0	5.66	3.16	4	8.49	8.6	3.16	7.07	3.16
5.66	0	3.16	4	2.83	3.16	5.1	**1.41**	3.16
3.16	3.16	0	**1.41**	5.83	6.32	4.47	4.47	2.83
4	4	**1.41**	0	6.32	7.07	5.83	5.1	4.24
8.49	2.83	5.83	6.32	0	**1.41**	7.62	1.41	5.83
8.6	3.16	6.32	7.07	**1.41**	0	7.21	2	5.66
3.16	5.1	4.47	5.83	7.62	7.21	0	6.32	2
7.07	**1.41**	4.47	5.1	1.41	2	6.32	0	4.47
3.16	3.16	2.83	4.24	5.83	5.66	2	4.47	0





Where is the “mistake” ????

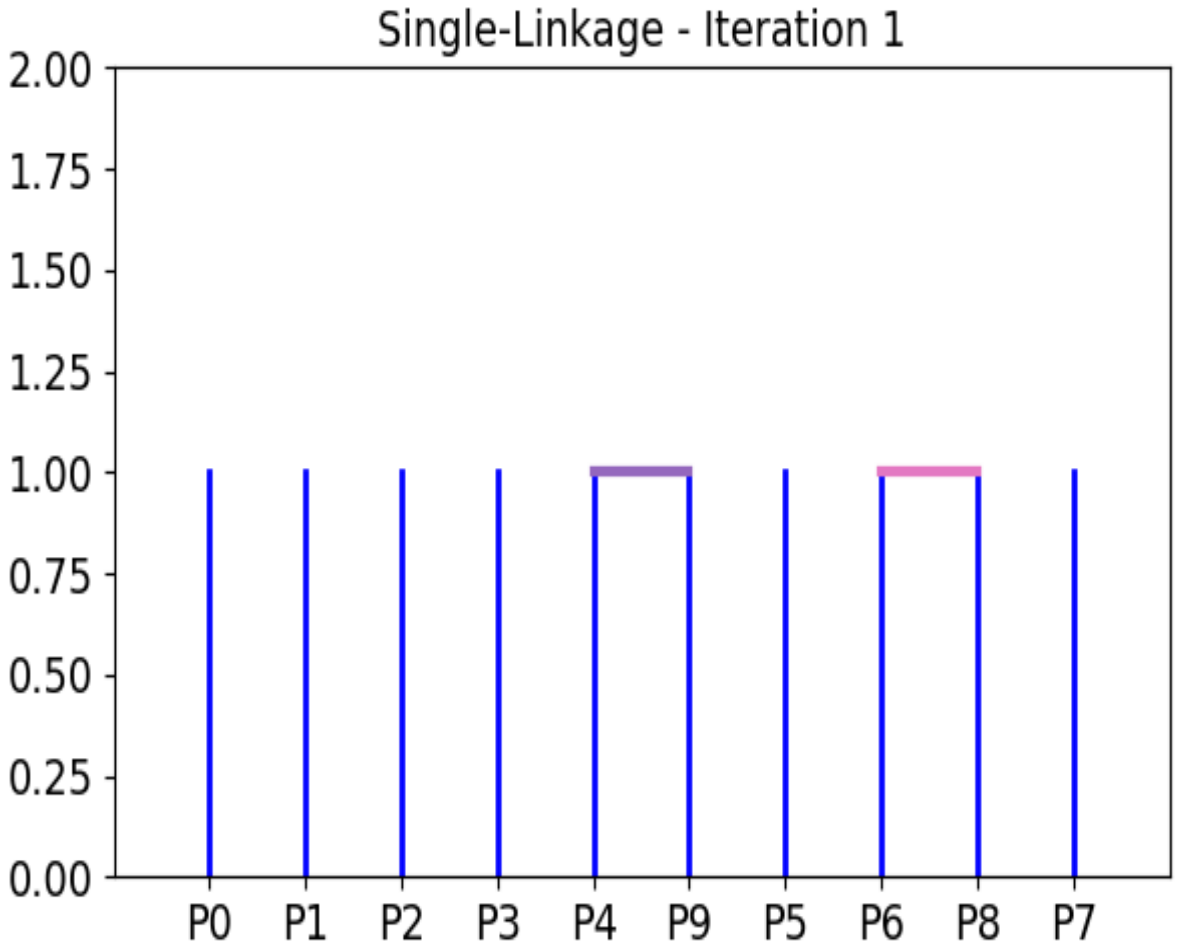

10
9
8
7
6
5
4
3
2
1
0
0
1
2
3
4
5
6
7
8
9
10
P5
P4
P7
P1
P6
P8
P2
P0
P3

Ex 10

Hierarchical: Single-LINK- Euclidean Distance

(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0.	2.24	4.24	4.12	6.08	2.24	4.24	5.83	3.61	6.32
2.24	0.	2.24	2.83	7.07	4.47	5.39	6.08	4.47	7.
4.24	2.24	0.	4.12	9.22	6.4	6.	8.	5.	9.06
4.12	2.83	4.12	0.	5.83	6.	8.06	4.12	7.21	5.39
6.08	7.07	9.22	5.83	0.	5.83	9.85	2.24	9.49	1.
2.24	4.47	6.4	6.	5.83	0.	4.12	6.4	4.	6.4
4.24	5.39	6.	8.06	9.85	4.12	0.	10.	1.	10.3
5.83	6.08	8.	4.12	2.24	6.4	10.	0.	9.43	1.41
3.61	4.47	5.	7.21	9.49	4.	1.	9.43	0.	9.85
6.32	7.	9.06	5.39	1.	6.4	10.3	1.41	9.85	0.

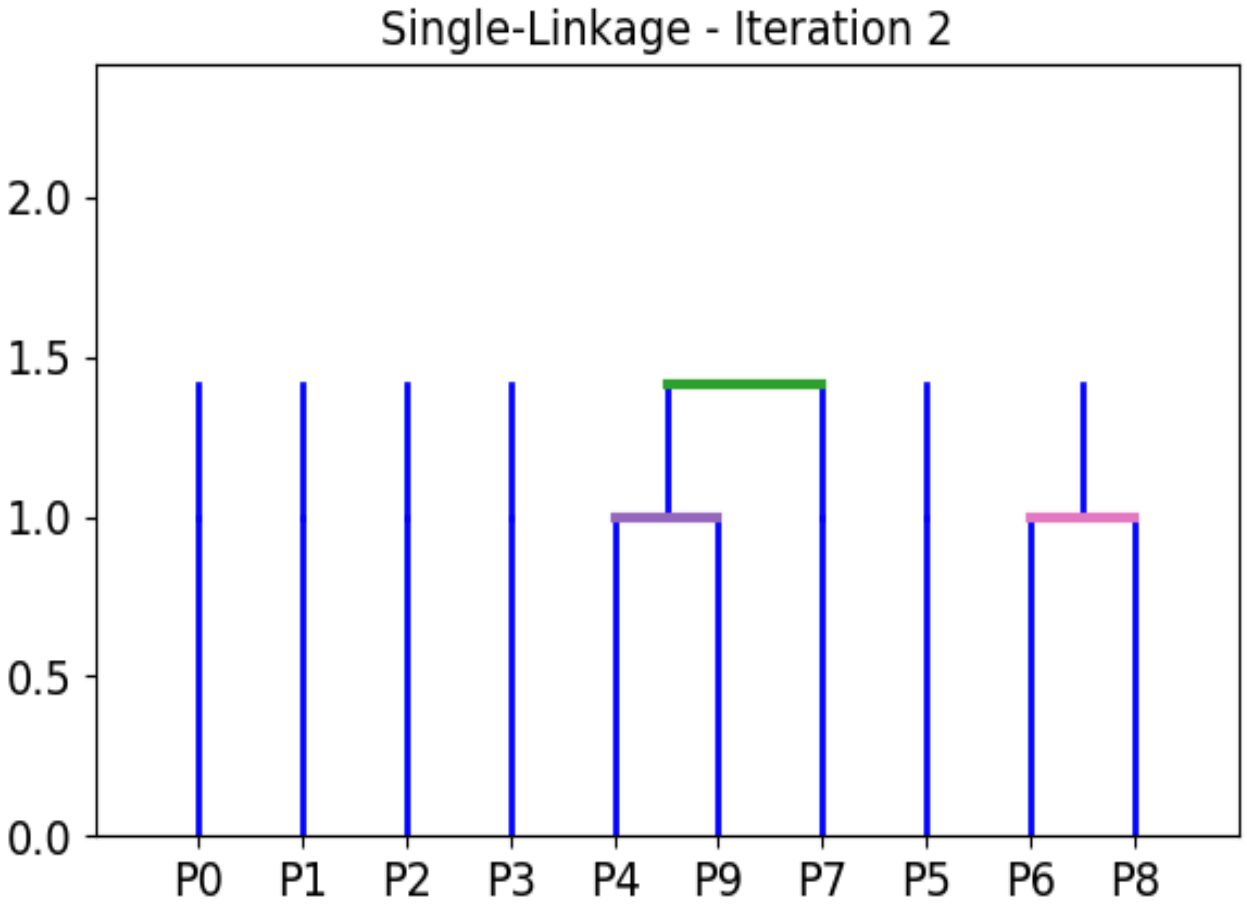
distance merge 1.00



Hierarchical: Single-LINK- Euclidean Distance

(0)	(1)	(2)	(3)	(4,9)	(5)	(6,8)	(7)
[0.	2.24	4.24	4.12	6.08	2.24	3.61	5.83]
[2.24	0.	2.24	2.83	7.	4.47	4.47	6.08]
[4.24	2.24	0.	4.12	9.06	6.4	5.	8.]
[4.12	2.83	4.12	0.	5.39	6.	7.21	4.12]
[6.08	7.	9.06	5.39	0.	5.83	9.49	1.41]
[2.24	4.47	6.4	6.	5.83	0.	4.	6.4]
[3.61	4.47	5.	7.21	9.49	4.	0.	9.43]
[5.83	6.08	8.	4.12	1.41	6.4	9.43	0.]

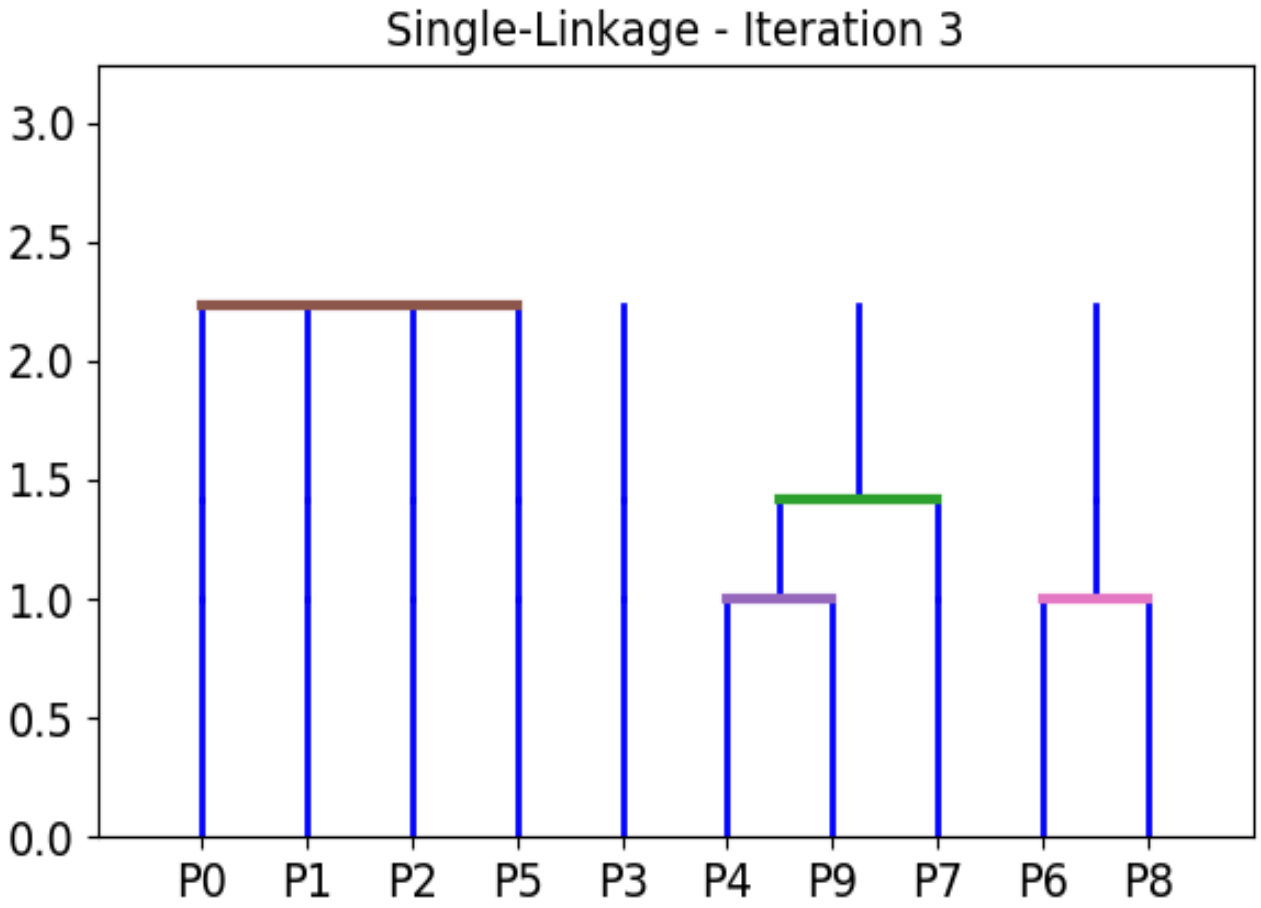
distance merge 1.41



Hierarchical: Single-LINK- Euclidean Distance

(0)	(1)	(2)	(3)	(4,7,9)	(5)	(6,8)
[0.	2.24	4.24	4.12	5.83	2.24	3.61]
[2.24	0.	2.24	2.83	6.08	4.47	4.47]
[4.24	2.24	0.	4.12	8.	6.4	5.]
[4.12	2.83	4.12	0.	4.12	6.	7.21]
[5.83	6.08	8.	4.12	0.	5.83	9.43]
[2.24	4.47	6.4	6.	5.83	0.	4.]
[3.61	4.47	5.	7.21	9.43	4.	0.]

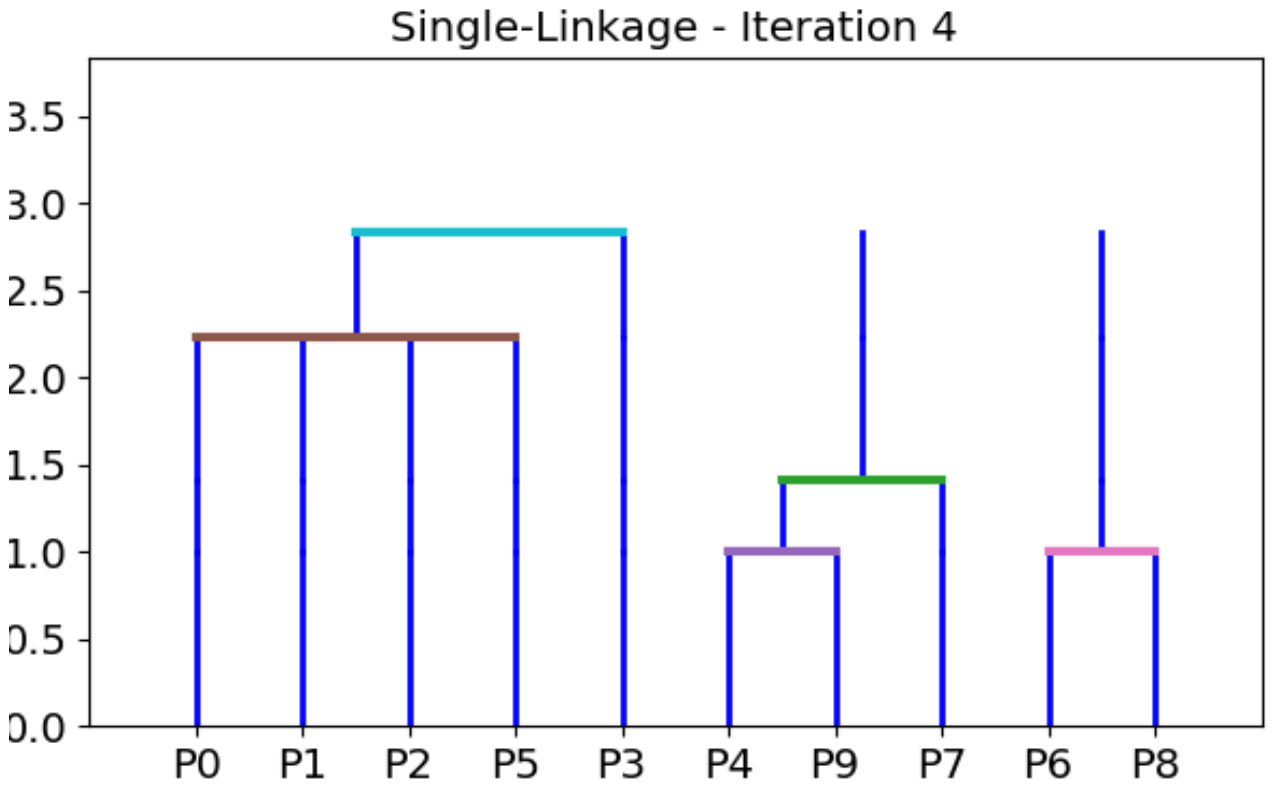
distance merge 2.24



Hierarchical: Single-LINK- Euclidean Distance

(0,1,2,5)	(3)	(4,7,9)	(6,8)
[[0.	2.83	5.83	3.61]
[2.83	0.	4.12	7.21]
[5.83	4.12	0.	9.43]
[3.61	7.21	9.43	0.]

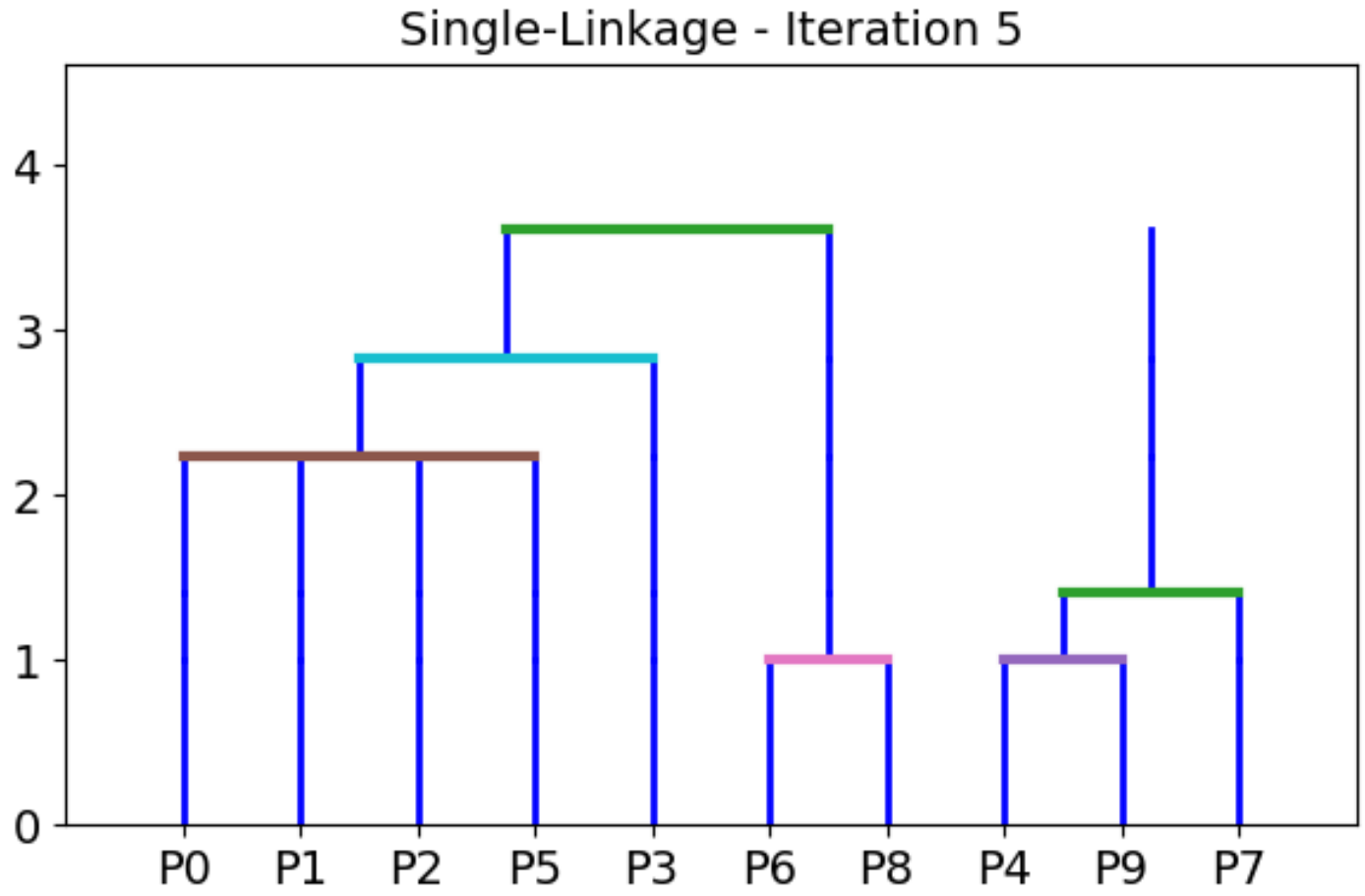
distance merge 2.83



Hierarchical: Single-LINK- Euclidean Distance

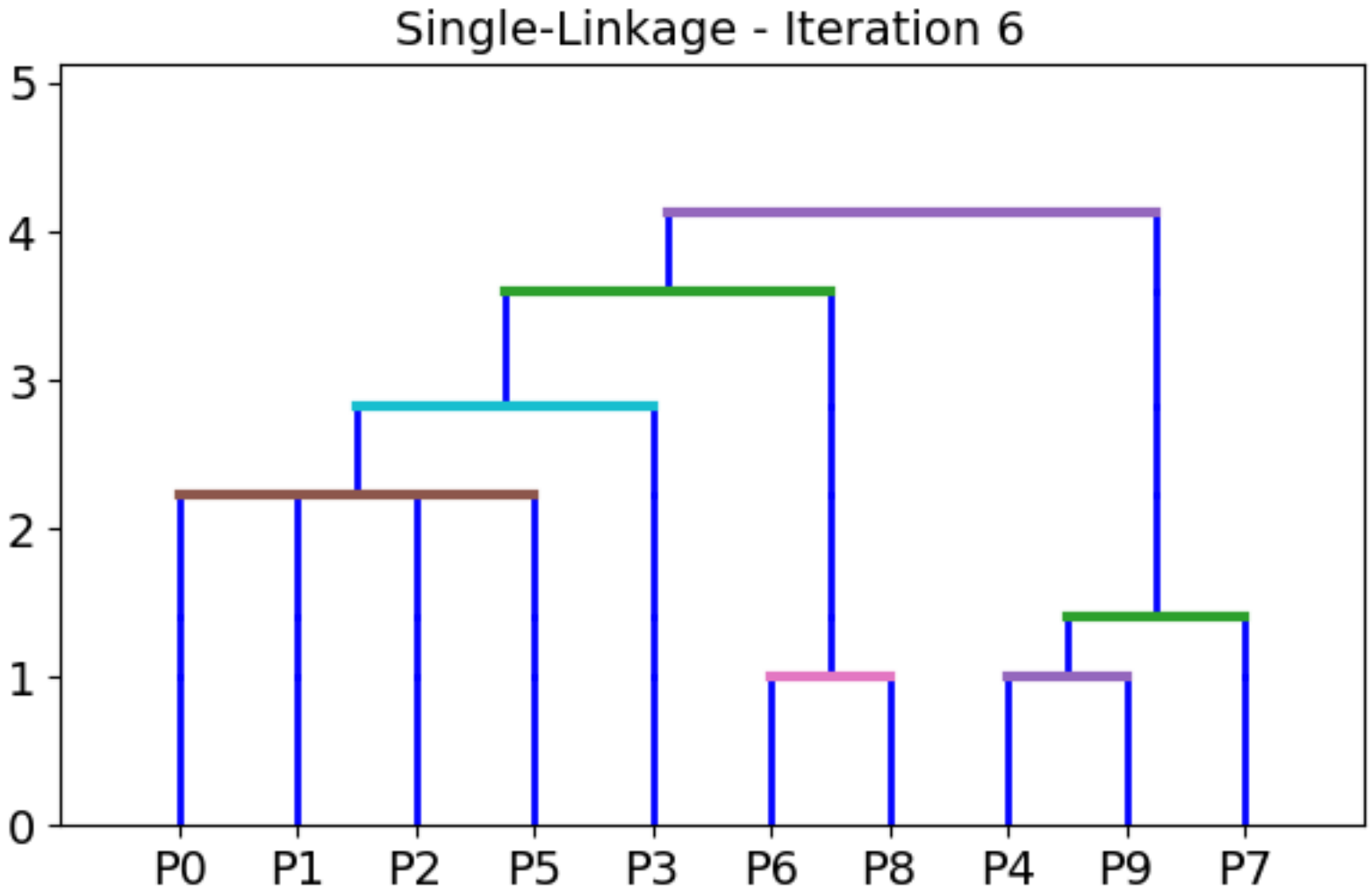
(0,1,2,3,5)	(4,7,9)	(6,8)
[0.	4.12	3.61]
[4.12	0.	9.43]
[3.61	9.43	0.]

distance merge 3.61



Hierarchical: Single-LINK- Euclidean Distance

(0,1,2,3,5,6,8]	(4,7,9)
[0.	4.12]
[4.12	0.]



Ex 11/12

Consider the following points and use the Manhattan distance to solve the following exercises:

1. Apply the single-linkage HAC on the dataset and draw the corresponding dendogram.
2. Apply the complete-linkage HAC on the dataset and draw the corresponding dendogram.

P1	1	7
P2	6	2
P3	7	1
P4	7	3
P5	8	1
P6	6	5
P7	8	6
P8	8	5