

### ❖ Final Learn Cluster and Length of each cluster:

In all the cluster I made number wise. The meaning of the number in the cluster is:

0 in the cluster means 0<sup>th</sup> paper in the given CSV file

1 in the cluster means 1<sup>st</sup> paper in the given CSV file

30 in the cluster means 30<sup>th</sup> paper in the given CSV file

141 in the cluster means 141<sup>th</sup> paper in the given CSV file

And so on...

#### ➤ Single Link:

single Link cluster 1 === [30, 3, 99, 43, 2, 4, 9, 10, 14, 19, 21, 22, 24, 27, 28, 32, 33]

single Link cluster 2== [35, 7, 15, 59, 62, 92]

single Link cluster 3== [41, 25, 80, 89, 91, 100, 63, 109, 69, 111, 143, 104, 144, 119, 145, 110, 115, 147, 0, 14, 4, 9, 10, 19, 21, 22, 24, 27, 28, 32, 33, 40, 43, 44, 45, 46, 51, 54, 56, 60, 64, 57, 61, 65, 90, 102, 103, 116, 126, 2, 50, 67, 96, 141]

single Link cluster 4== [49, 17, 135, 2, 8, 29, 31, 55, 67, 68, 95, 20, 86, 96, 123, 76, 136, 146, 4, 19, 0, 18, 70, 116, 39, 24, 50, 79, 37, 106, 133, 87, 10, 27, 28, 33, 43, 51, 21, 22, 14, 32, 40, 44, 45, 46, 54, 9, 56, 60]

single Link cluster 5=== [68, 31]

single Link cluster 6== [81, 74, 131, 112]

single Link cluster 7== [95, 29, 2, 55]

single Link cluster 8== [96, 2, 20]

single Link cluster 9== [110, 22, 84, 46, 60, 104, 45, 115, 147, 119, 145]

single Link cluster 1 length === 17

single Link cluster 2 length== 6

single Link cluster 3 length== 54

single Link cluster 4 length== 50

single Link cluster 5 length=== 2

single Link cluster 6 length== 4

single Link cluster 7 length== 4

single Link cluster 8 length== 3

single Link cluster 9 length== 11

[illegible]

- **Complete Link:**  
complete Link cluster 1 == [87, 26, 21, 12, 14, 52, 86, 99, 124, 23, 33, 40, 85, 97, 121, 126, 132, 140, 75, 8, 24, 34, 50, 55, 67, 79, 112, 123, 125, 128, 136, 139, 38, 48, 53, 77, 29, 95, 98, 114, 149, 9, 13, 32, 43, 63, 65, 73, 44, 51, 102, 111, 115, 118, 119, 122, 127, 129, 22, 45, 47, 66, 71, 103, 110, 113, 105, 107, 1, 42, 72, 94, 141, 0, 18, 20, 57, 61, 76, 88, 28, 120, 59, 62, 108, 36, 109, 142, 145, 4, 3, 30, 19, 70, 64, 90, 93, 116, 117, 15, 58, 82, 10, 27, 54, 80, 89, 91, 131, 134, 144, 148, 2, 46, 60, 6, 74, 39, 81, 37, 96, 104, 56, 7, 35, 25, 41, 133, 146, 147, 31, 68, 69, 83, 84, 92, 11, 5, 106, 137, 138, 143, 17]  
complete Link cluster 2== [16]  
complete Link cluster 3== [49]  
complete Link cluster 4== [78]  
complete Link cluster 5=== [100]  
complete Link cluster 6== [101]  
complete Link cluster 7== [130]  
complete Link cluster 8== [135]  
complete Link cluster 9== []

Complete Link cluster 1 length === 143

Complete Link cluster 2 length== 1  
 Complete Link cluster 3 length== 1  
 Complete Link cluster 4 length== 1  
 Complete Link cluster 5 length=== 1  
 Complete Link cluster 6 length== 1  
 Complete Link cluster 7 length== 1  
 Complete Link cluster 8 length== 1  
 Complete Link cluster 9 length== 0

```
complete Link cluster 1 === [87, 26, 21, 12, 14, 52, 86, 99, 124, 23, 33, 40, 85, 97, 121, 126, 132, 140, 75, 8, 24, 34, 50, 55, 67, 79, 112, 123, 125, 128, 136, 139, 38, 48, 53, 77, 29, 95, 98, 114]
complete Link cluster 2== [16]
complete Link cluster 3== [49]
complete Link cluster 4== [78]
complete Link cluster 5=== [100]
complete Link cluster 6== [101]
complete Link cluster 7== [130]
complete Link cluster 8== [135]
complete Link cluster 9== []
Complete Link cluster 1 length === 143
Complete Link cluster 2 length== 1
Complete Link cluster 3 length== 1
Complete Link cluster 4 length== 1
Complete Link cluster 5 length=== 1
Complete Link cluster 6 length== 1
Complete Link cluster 7 length== 1
Complete Link cluster 8 length== 1
Complete Link cluster 9 length== 0
```

- **Girvan-Newman:**

Girvan-Newman cluster1: [0, 1, 2, 4, 132, 133, 135, 8, 136, 137, 138, 17, 18, 19, 20, 146, 27, 29, 31, 36, 39, 49, 50, 55, 67, 68, 70, 76, 79, 86, 87, 95, 96, 106, 116, 117, 123, 126]

Girvan-Newman cluster2: [129, 3, 99, 71, 30]

Girvan-Newman cluster3: [130, 5, 9, 141, 14, 143, 145, 147, 148, 21, 22, 32, 33, 40, 42, 44, 45, 46, 51, 54, 56, 57, 60, 61, 64, 78, 84, 90, 93, 103, 104, 110, 114, 115, 119]

Girvan-Newman cluster4: [6, 11, 16, 144, 149, 25, 41, 63, 65, 69, 72, 80, 89, 91, 94, 97, 100, 101, 109, 111]

Girvan-Newman cluster5: [134, 7, 12, 13, 15, 23, 26, 35, 47, 48, 53, 59, 62, 66, 73, 83, 85, 88, 92, 113, 118, 127]

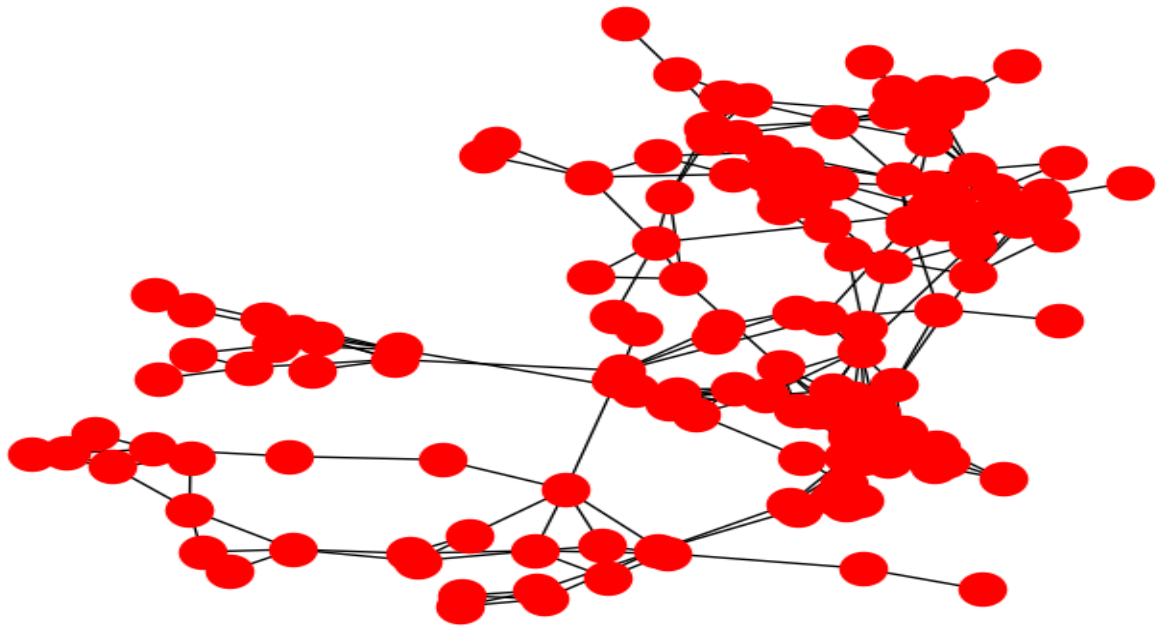
Girvan-Newman cluster6: [37, 10, 140, 24, 121]

Girvan-Newman cluster7: [131, 74, 112, 81, 28]

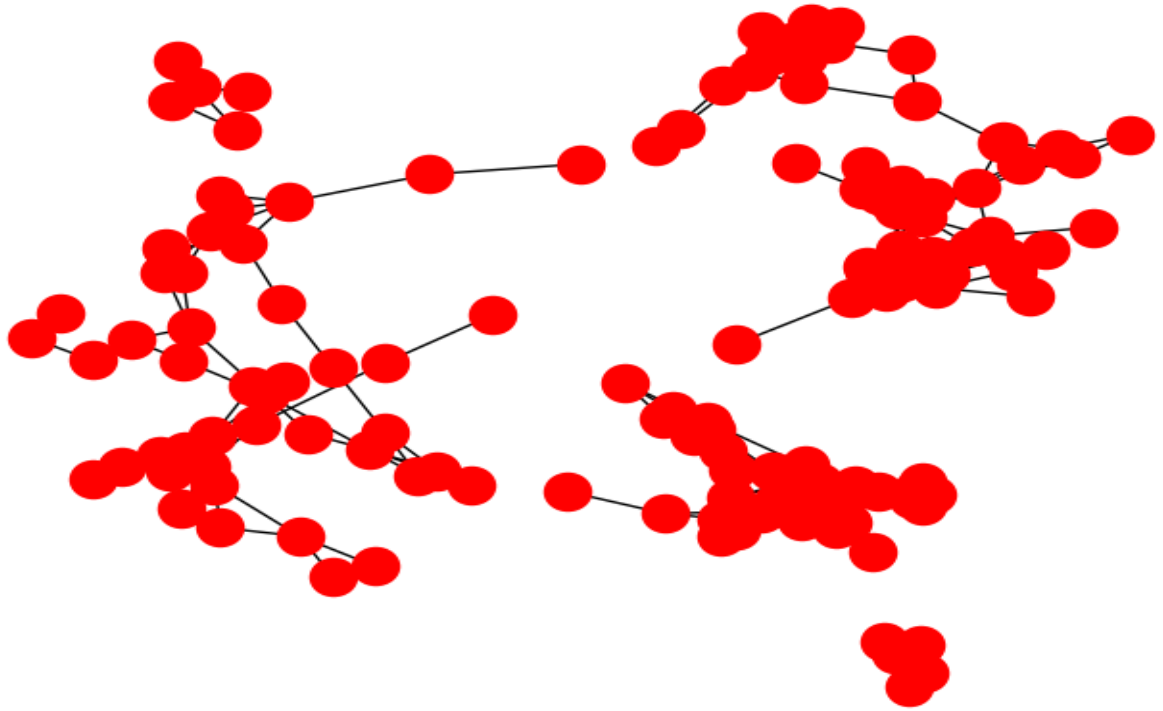
Girvan-Newman cluster8: [34, 58, 38, 105, 139, 108, 142, 82, 120, 122, 124, 125]

Girvan-Newman cluster9: [98, 43, 102]

Girvan-Newman cluster1 length: 38  
Girvan-Newman cluster2 length: 5  
Girvan-Newman cluster3 length: 35  
Girvan-Newman cluster4 length: 20  
Girvan-Newman cluster5 length: 22  
Girvan-Newman cluster6 length: 5  
Girvan-Newman cluster7 length: 5  
Girvan-Newman cluster8 length: 12  
Girvan-Newman cluster9 length: 3



**Fig:** *Girvan-Newman Graph Before Clustering*



**Fig:** *Girvan-Newman Graph After Clustering*

```

edge to remove (136, 43)
edge to remove (71, 142)
Girvan-Newman cluster1: [0, 1, 2, 4, 132, 133, 135, 8, 136, 137, 138, 17, 18, 19, 20, 146, 27, 29, 31, 36, 39, 49, 50, 55, 67, 68, 70, 76, 79, 86, 87, 95, 96, 106, 116, 117, 123, 126]
Girvan-Newman cluster2: [129, 3, 99, 71, 30]
Girvan-Newman cluster3: [130, 5, 9, 141, 14, 143, 145, 147, 148, 21, 22, 32, 33, 40, 42, 44, 45, 46, 51, 54, 56, 57, 60, 61, 64, 78, 84, 90, 93, 103, 104, 110, 114, 115, 119]
Girvan-Newman cluster4: [6, 11, 16, 144, 149, 25, 41, 63, 65, 69, 72, 80, 89, 91, 94, 97, 100, 101, 109, 111]
Girvan-Newman cluster5: [134, 7, 12, 13, 15, 23, 26, 35, 47, 48, 53, 59, 62, 66, 73, 83, 85, 88, 92, 113, 118, 127]
Girvan-Newman cluster6: [37, 10, 140, 24, 121]
Girvan-Newman cluster7: [131, 74, 112, 81, 28]
Girvan-Newman cluster8: [34, 58, 38, 105, 139, 108, 142, 82, 120, 122, 124, 125]
Girvan-Newman cluster9: [98, 43, 102]
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Girvan-Newman cluster7 length: 5
Girvan-Newman cluster8 length: 12
Girvan-Newman cluster9 length: 3

Process finished with exit code 0

```

❖ **NMI values of the three clustering's :**

Single Link: NMI===== -0.4462607884076171

Complete Link: NMI===== 0.8690053446310221

Girvan-Newman: NMI===== -0.6219960280837483

```
Single Link: NMI===== -0.4462607884076171
Complete Link: NMI===== 0.8690053446310221
Girvan-Newman: NMI===== -0.6219960280837483
Process finished with exit code 0
```

❖ **Thresholds:**

I have taken:

thresholds>0 for **complete link**

thresholds>0.2 for **single link**