

Faculty Development Programme on
Network Science: Foundation Of Social Network Analysis

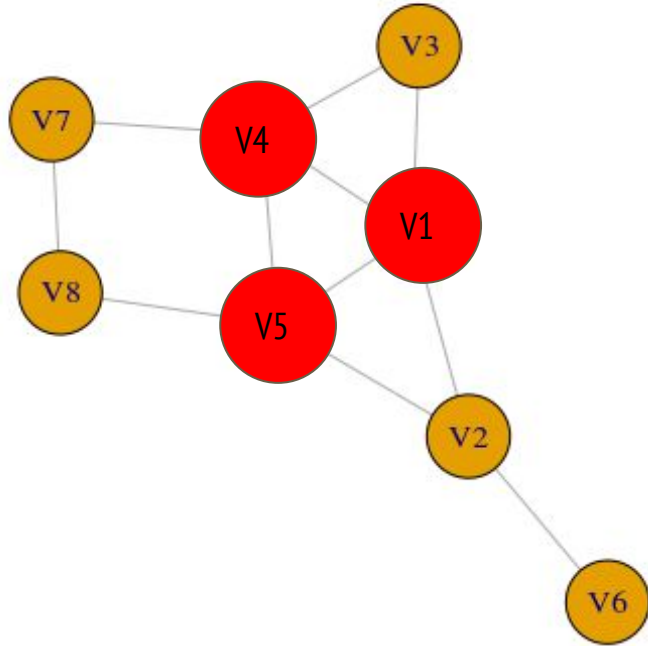
Network Centrality Measures

Hands-on Session (Day 2)

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PART 1: Degree-based Centrality Measures

Degree Centrality (number of ties)



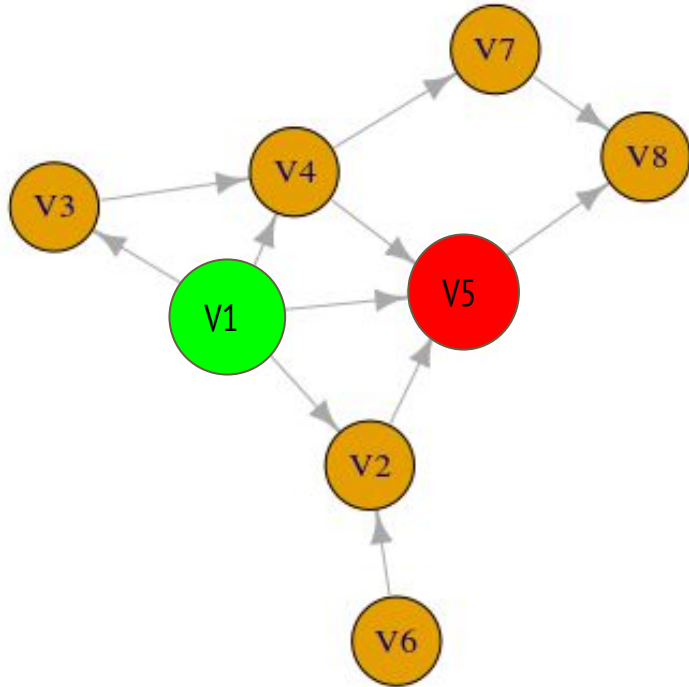
```
> degree ( network , mode="all") #undirected graph
```

OUTPUT :

	V1	V4	V5	V2	V3	V7	V8	V6
DC:	4	4	4	3	2	2	2	1

- V1, V4 and V5 are most central.

Degree Centrality for Directed graph



```
> degree ( network , mode="in") #indegree
```

OUTPUT :

	V1	V2	V3	V4	V5	V6	V7	V8
DC:	0	2	1	2	3	0	1	2

- V5 is most central.

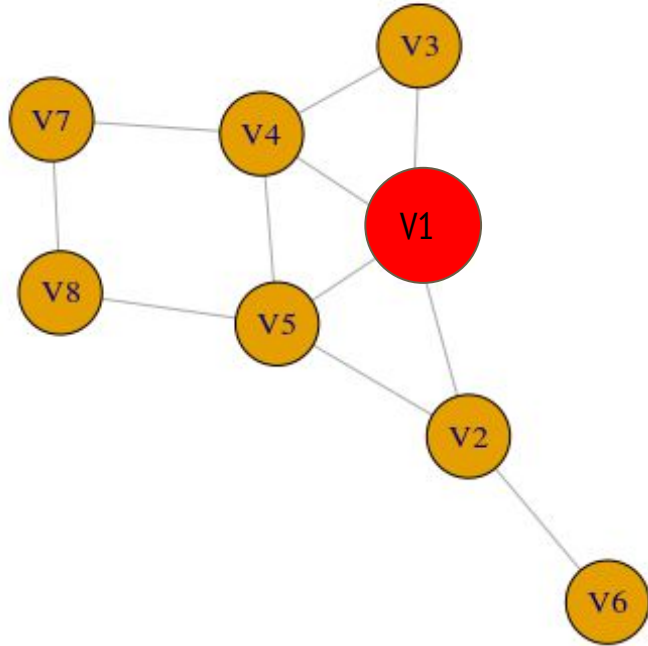
```
> degree ( network , mode="out") #outdegree
```

OUTPUT :

	V1	V2	V3	V4	V5	V6	V7	V8
DC:	4	1	1	2	1	1	1	0

- V1 is most central.

Eigenvector Centrality (centrality proportional to the sum of centralities of neighbors)



```
> eigen_centrality ( network, directed=F, weights=NA)
```

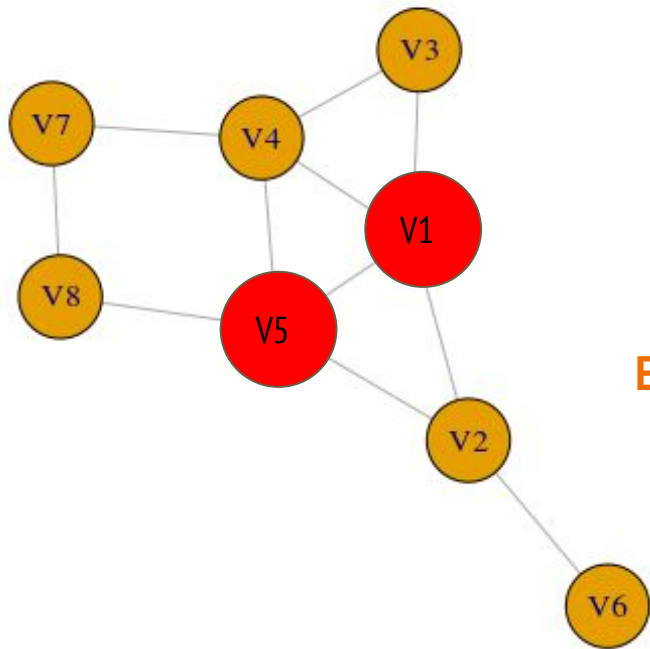
OUTPUT :

	V1	V2	V3	V4	V5	V6	V7	V8
EVC:	1	0.681	0.608	0.940	0.958	0.213	0.431	0.436

- V1 is most central.

PART 2: Flow-based Centrality Measures

Eccentricity Centrality (The less eccentric a node is, the more central it is.)



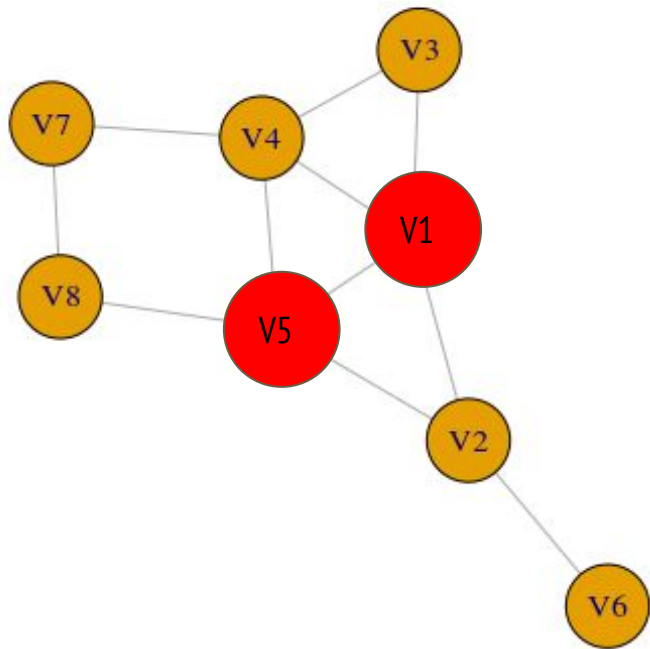
```
> eccentricity ( network)
```

OUTPUT :

	V1	V2	V3	V4	V5	V6	V7	V8
$E(V_i)$	2	3	3	3	2	4	4	3
$EC=1/E(V_i)$	0.5	0.33	0.33	0.33	0.5	0.25	0.25	0.33

- V1, V5 are most central.

Closeness Centrality (centrality based on distance from other nodes in the graph)



```
> closeness ( network, mode="all", weights=NA)
```

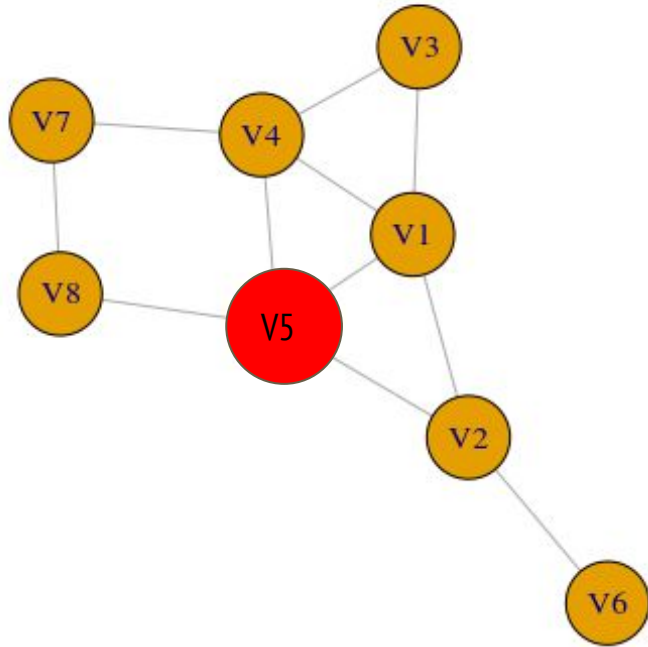
OUTPUT :

	V1	V2	V3	V4	V5	V6	V7	V8
$D = \sum_j d(v_i, v_j)$	10	12	14	11	10	18	15	14
$CC = 1/D$	0.1	0.083	0.071	0.091	0.1	0.056	0.067	0.071

- V1, V5 are most central.

$$\begin{aligned}\sum_j d(\mathbf{v}_1, \mathbf{v}_j) &= d(\mathbf{v}_1, \mathbf{v}_2) + d(\mathbf{v}_1, \mathbf{v}_3) + d(\mathbf{v}_1, \mathbf{v}_4) + d(\mathbf{v}_1, \mathbf{v}_5) + d(\mathbf{v}_1, \mathbf{v}_6) + d(\mathbf{v}_1, \mathbf{v}_7) + d(\mathbf{v}_1, \mathbf{v}_8) \\ &= 1 + 1 + 1 + 1 + 2 + 2 + 2 \\ &= 10\end{aligned}$$

Betweenness Centrality (Number of geodesics that pass through the node or the edge.)



```
> betweenness ( network, directed=F, weights=NA)
```

OUTPUT :

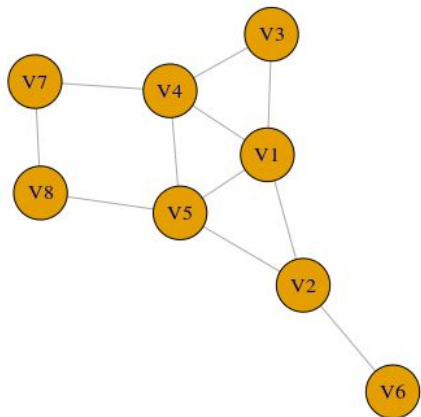
	V1	V2	V3	V4	V5	V6	V7	V8
BC:	4.5	6	0	5	6.5	0	0.83	1.16

- V5 is most central.

$$\begin{aligned}
 BC(V5) &= Y_{18}(v5) + Y_{24}(v5) + Y_{27}(v5) + Y_{28}(v5) + Y_{38}(v5) + Y_{46}(v5) + Y_{48}(v5) + Y_{67}(v5) + Y_{68}(v5) \\
 &= 1 + \frac{1}{2} + \frac{2}{3} + 1 + \frac{2}{3} + \frac{1}{2} + \frac{1}{2} + \frac{2}{3} + 1 \\
 &= 6.5
 \end{aligned}$$

PART 3: Web Centrality Measures

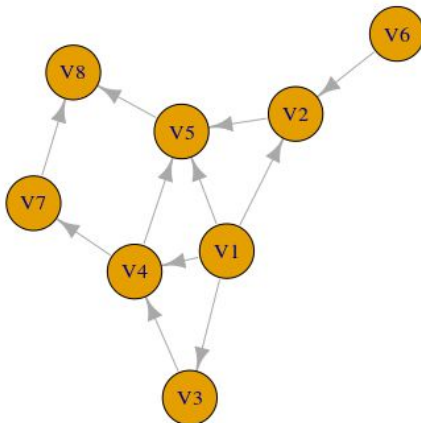
PageRank (Eigenvector centrality with random jump)



```
> page_rank(g) #undirected graph
```

OUTPUT :

V1	V2	V3	V4	V5	V7	V8	V6
0.170	0.141	0.091	0.171	0.172	0.096	0.096	0.058

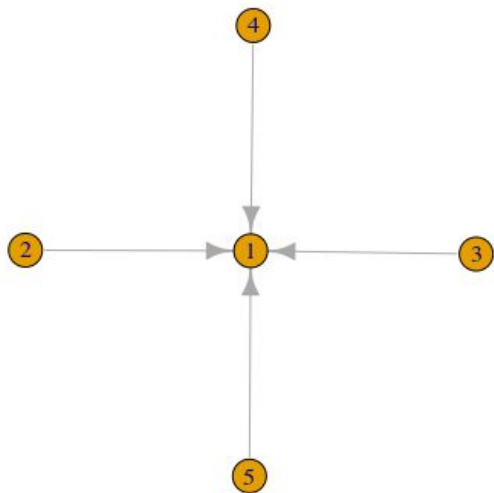


```
> page_rank(g, directed = TRUE) #directed graph
```

OUTPUT :

V1	V2	V3	V4	V5	V7	V8	V6
0.051	0.106	0.062	0.115	0.202	0.100	0.309	0.051

Hub and Authority



```
> hub_score ( star_graph, weights=NA)$vector  
# indicates to how many pages of importance does the page point to.
```

OUTPUT :

	1	2	3	4	5
hub_score:	2.220446e-16	1	1	1	1

```
> authority_score ( star_graph, weights=NA)$vector  
#indicates how many good pages (high rank) point to it.
```

OUTPUT :

	1	2	3	4	5
authority_score:	1	0	0	0	0

Thankyou !