

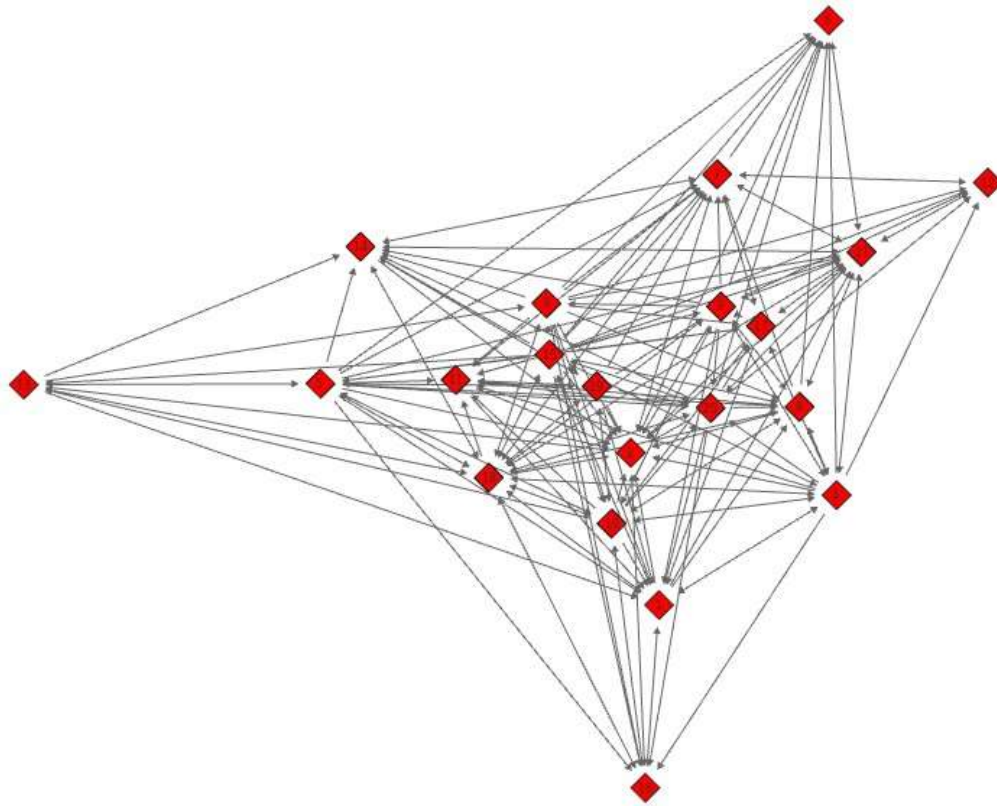
CSE-3024: Web Mining Lab

Lab-14: Social Network Visualizer

Slot : L7+L8

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Dataset: Krackhardt High Tech Managers



1. Matrix: Commands to compute and display the adjacencymatrix and other matrices based on the adjacency, such as Laplacian matrix, Degree Matrix Cocitation Matrix. You can also plot the adjacency matrix.

ADJACENCY MATRIX

Network name: Krackhardt's High-tech managers

Actors: 21

The adjacency matrix of a social network is a NxN matrix where each element (i,j) is the value of the edge from actor i to actor j, or 0 if no edge exists.

Actor/Actor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1
2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3	1	1	0	1	0	1	1	1	1	1	1	1	0	1	0	0	1	1	0	1	1
4	1	1	0	0	0	1	0	1	0	1	1	1	0	0	0	1	1	1	0	1	1
5	1	1	0	0	0	1	1	1	0	1	1	0	1	1	0	1	1	1	1	1	1
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7	0	1	0	0	0	1	0	0	0	0	1	1	0	1	0	0	1	1	0	0	1
8	0	1	0	1	0	1	1	0	0	1	1	0	0	0	0	0	0	1	0	0	1
9	1	1	0	0	0	1	1	1	0	1	1	1	0	1	0	1	1	1	0	0	1
10	1	1	1	1	1	0	0	1	0	0	1	0	1	0	1	1	1	1	1	1	0
11	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13	1	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0
14	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
16	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
17	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
18	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1
19	1	1	1	0	1	0	1	0	0	1	1	0	0	1	1	0	0	1	0	1	0
20	1	1	0	0	0	1	0	1	0	0	1	1	0	1	1	1	1	1	0	0	1
21	0	1	1	1	0	1	1	1	0	0	0	1	0	1	0	0	1	1	0	1	0

Adjacency matrix report.
Created by [Social Network Visualizer](#) v3.0.4: Tue, 19.Apr.2022 08:27:46
Computation time: 11 msec

COCITATION MATRIX REPORT

Network name: Krackhardt's High-tech managers
Actors: 21

The Cocitation matrix, $C = A^T * A$, is a NxN matrix where each element (i,j) is the number of actors that have outbound ties/links to both actors i and j . The diagonal elements, C_{ii} , of the Cocitation matrix are equal to the number of inbound edges of i (inDegree). C is a symmetric matrix.

Actor/Actor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	13	13	4	5	5	6	8	8	4	8	9	5	4	8	4	7	7	10	4	7	8
2	13	18	5	8	5	9	11	10	4	9	11	7	4	10	4	8	9	15	4	8	12
3	4	5	5	4	4	2	4	4	2	3	4	2	3	4	3	3	3	4	3	5	2
4	5	8	4	8	3	4	6	6	3	4	5	3	3	4	2	4	4	6	3	5	6
5	5	5	4	3	5	1	3	3	3	3	4	1	3	4	3	3	2	4	3	4	2
6	6	9	2	4	1	10	7	7	2	6	8	7	2	7	1	5	8	9	2	5	9
7	8	11	4	6	3	7	13	6	3	7	7	4	3	7	2	4	5	8	3	6	10
8	8	10	4	6	3	7	6	10	3	6	8	6	4	7	3	8	8	9	4	7	8
9	4	4	2	3	3	2	3	3	4	3	3	2	2	4	1	2	2	3	2	3	3
10	8	9	3	4	3	6	7	6	3	9	8	4	3	6	2	5	5	8	3	6	7
11	9	11	4	5	4	8	7	8	3	8	11	6	4	8	4	7	8	10	4	7	9
12	5	7	2	3	1	7	4	6	2	4	6	7	1	6	1	4	7	7	1	4	6
13	4	4	3	3	3	2	3	4	2	3	4	1	4	3	2	4	3	3	4	4	3
14	8	10	4	4	4	7	7	4	6	8	6	3	10	3	5	7	9	3	6	7	
15	4	4	3	2	3	1	2	3	1	2	4	1	2	3	4	3	2	3	2	3	2
16	7	8	3	4	3	5	4	8	2	5	7	4	4	5	3	8	6	7	4	5	7
17	7	9	3	4	2	8	5	8	2	5	8	7	3	7	2	6	9	9	3	6	7
18	10	15	4	6	4	9	8	9	3	8	10	7	3	9	3	7	9	15	3	7	10
19	4	4	3	3	3	2	3	4	2	3	4	1	4	3	2	4	3	3	4	4	3
20	7	8	5	5	4	5	6	7	3	6	7	4	4	6	3	5	6	7	4	8	5
21	8	12	2	6	2	9	10	8	3	7	9	6	3	7	2	7	7	10	3	5	15

Values: integers only
- Max value: 18
- Min value: 1

DEGREE MATRIX REPORT

Network name: Krackhardt's High-tech managers
Actors: 21

The degree matrix D of a social network is a NxN matrix where each element (i,i) is the degree of actor i and all other elements are zero.

Actor/Actor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11

Values: integers only
- Max value: 20
- Min value: 0

LAPLACIAN MATRIX REPORT

Network name: Krackhardt's High-tech managers
Actors: 21

The laplacian matrix L of a social network is a $N \times N$ matrix with $L = D - A$, where D the degree matrix and A the adjacency matrix.
The elements of L are:

- $L_{i,j} = d_i$, if $i = j$,
- $L_{i,j} = -1$, if $i \neq j$ and there is an edge (i,j)
- and all other elements zero.

Actor/Actor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	6	-1	0	-1	0	0	0	-1	0	0	0	0	0	0	0	-1	0	-1	0	0	-1
2	0	3	0	0	0	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	-1
3	-1	-1	15	-1	0	-1	-1	-1	-1	-1	-1	-1	0	-1	0	0	-1	-1	0	-1	-1
4	-1	-1	0	12	0	-1	0	-1	0	-1	-1	-1	0	0	0	-1	-1	0	0	-1	-1
5	-1	-1	0	0	15	-1	-1	-1	0	-1	-1	0	-1	-1	0	-1	-1	-1	-1	-1	-1
6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1
7	0	-1	0	0	0	-1	8	0	0	0	-1	-1	0	-1	0	0	-1	-1	0	0	-1
8	0	-1	0	-1	0	-1	-1	8	0	-1	-1	0	0	0	0	0	0	-1	0	0	-1
9	-1	-1	0	0	0	-1	-1	-1	13	-1	-1	-1	0	-1	0	-1	-1	-1	0	0	-1
10	-1	-1	-1	-1	-1	0	0	-1	0	14	-1	0	-1	0	-1	-1	-1	-1	-1	-1	0
11	-1	-1	0	0	0	0	-1	0	0	0	3	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	-1	0	0	0	0	2	0	0	0	0	0	0	0	0	-1
13	-1	-1	0	0	-1	0	0	0	-1	0	0	0	6	-1	0	0	0	-1	0	0	0
14	0	-1	0	0	0	0	-1	0	0	0	0	0	0	4	0	0	0	-1	0	0	-1
15	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	20	-1	-1	-1	-1	-1	-1
16	-1	-1	0	0	0	0	0	0	0	-1	0	0	0	0	0	4	0	-1	0	0	0
17	-1	-1	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	5	0	0	0	-1
18	-1	-1	-1	-1	-1	0	-1	-1	-1	-1	-1	0	-1	-1	-1	-1	0	17	-1	-1	-1
19	-1	-1	-1	0	-1	0	-1	0	0	-1	-1	0	0	-1	-1	0	0	-1	11	-1	0
20	-1	-1	0	0	0	-1	0	-1	0	0	-1	-1	0	-1	-1	-1	-1	-1	0	12	-1
21	0	-1	-1	-1	0	-1	-1	-1	0	0	0	-1	0	-1	0	0	-1	-1	0	-1	11

Values: integers only
- Max value: 20
- Min value: -1

2. Cohesion: Measures related to the cohesion of the network.
Reciprocity, Symmetry, Geodesic Distances & Average Distance,
Eccentricity, Network Diameter as well as Connectedness,
Clustering Coefficient, Walks and Reachability.

RECIPROCITY (r) REPORT

Network name: Krackhardt's High-tech managers
Actors: 21

Reciprocity, *r*, is a measure of the likelihood of vertices in a directed network to be mutually linked. SocNetV supports two different methods to index the degree of reciprocity in a social network:
- The arc reciprocity, which is the fraction of reciprocated ties over all actual ties in the network.
- The dyad reciprocity which is the fraction of actor pairs that have reciprocated ties over all pairs of actors that have any connection.
In a directed network, the arc reciprocity measures the proportion of directed edges that are bidirectional. If the reciprocity is 1, then the adjacency matrix is structurally symmetric. Likewise, in a directed network, the dyad reciprocity measures the proportion of connected actor dyads that have bidirectional ties between them.
In an undirected graph, all edges are reciprocal. Thus the reciprocity of the graph is always 1.
Reciprocity can be computed on undirected, directed, and weighted graphs.

r range: 0 ≤ r ≤ 1

Arc reciprocity: 90 / 190 = 0.473684
Of all actual ties in the network, 47.3684% are reciprocated.

Dyad reciprocity: 45 / 145 = 0.310345
Of all pairs of actors that have any ties, 31.0345% have a reciprocated connection.

Reciprocity proportions per actor:

Actor:	Label:	Symmetric:	nonSymmetric:	nsym out/nsym:	nsym in/nsym:	nsym out/out:	nsym in/in:
1	v1	0.315789	0.684211	0.230769	0.769231	0.5	0.769231
2	v2	0.190476	0.809524	0.0588235	0.941176	0.333333	0.888889
3	v3	0.3	0.7	0.857143	0.142857	0.8	0.4
4	v4	0.6	0.4	0.75	0.25	0.5	0.25
5	v5	0.4	0.6	0.916667	0.0833333	0.733333	0.2
6	v6	0.181818	0.818182	0	1	0	0.9
7	v7	0.666667	0.333333	0.142857	0.857143	0.125	0.461538
8	v8	0.444444	0.555556	0.4	0.6	0.5	0.6
9	v9	0.117647	0.882353	0.8	0.2	0.923077	0.75
10	v10	0.695652	0.304348	0.857143	0.142857	0.428571	0.111111
11	v11	0.142857	0.857143	0.166667	0.833333	0.666667	0.909091
12	v12	0.444444	0.555556	0	1	0	0.714286
13	v13	0.4	0.6	0.666667	0.333333	0.666667	0.5
14	v14	0.428571	0.571429	0.125	0.875	0.25	0.7
15	v15	0.333333	0.666667	1	0	0.8	0
16	v16	0.5	0.5	0.166667	0.833333	0.25	0.625
17	v17	0.428571	0.571429	0.25	0.75	0.4	0.666667
18	v18	0.9375	0.0625	1	0	0.117647	0
19	v19	0.533333	0.466667	1	0	0.636364	0
20	v20	0.3	0.7	0.642857	0.357143	0.75	0.625
21	v21	0.846154	0.153846	0	1	0	0.266667

Symmetric Proportion of reciprocated ties involving the actor to the total incoming and outgoing ties.
nonSymmetric One minus symmetric
nonSym Out/NonSym Proportion of non-symmetric outgoing ties to the total non-symmetric ties.
nonSym In/NonSym Proportion of non-symmetric incoming ties to the total non-symmetric ties.
nonSym Out/Out Proportion of non-symmetric outgoing ties to the total outgoing ties.
nonSym In/In Proportion of non-symmetric incoming ties to the total incoming ties


SHORTEST PATHS (GEODESICS) MATRIX REPORT

Network name: Krackhardt's High-tech managers
 Actors: 21

The geodesics matrix of a social network is a NxN matrix where each element (i,j) is the number of shortest paths(geodesics) from actor i to actor j, or infinity if no shortest path exists.

Actor/Actor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1	1	2	1	1	4	4	1	1	4	3	2	1	2	1	1	2	1	1	3	1
2	8	1	1	1	2	1	1	1	3	5	1	2	2	2	3	4	2	2	2	1	1
3	1	1	1	1	2	1	1	1	1	1	1	1	2	1	3	6	1	1	2	1	1
4	1	1	3	1	2	1	7	1	1	1	1	1	2	3	3	1	1	1	2	1	1
5	1	1	4	6	1	1	1	1	2	1	1	3	1	1	4	1	1	1	1	1	1
6	5	1	1	1	1	1	1	1	2	4	6	1	1	1	2	3	1	1	1	1	1
7	3	1	2	3	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1
8	4	1	3	1	2	1	1	1	1	1	1	3	2	3	2	3	4	1	2	4	1
9	1	1	3	6	2	1	1	1	1	1	1	1	2	1	2	1	1	1	2	3	1
10	1	1	1	1	1	7	9	1	4	1	1	4	1	7	1	1	1	1	1	1	10
11	1	1	5	1	2	2	1	1	2	5	1	1	2	1	2	1	1	2	2	6	3
12	8	2	1	1	2	2	1	1	3	5	1	1	2	2	3	4	2	2	2	1	1
13	1	1	1	2	1	3	5	4	1	3	3	1	1	1	1	4	2	1	2	2	6
14	1	1	2	2	1	3	1	2	1	1	2	2	1	1	1	1	2	1	1	2	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	2	3	2	1	2	3	1	1	2	15	2	1	2	1	1	1	2	2	3
17	1	1	1	1	5	4	1	3	5	1	2	3	5	2	7	2	1	4	5	2	1
18	1	1	1	1	1	10	1	1	1	1	1	7	1	1	1	1	9	1	1	1	1
19	1	1	1	5	1	6	1	7	3	1	1	4	4	1	1	6	6	1	1	1	9
20	1	1	3	6	2	1	9	1	2	4	1	1	2	1	1	1	1	1	2	1	1
21	5	1	1	1	1	1	1	2	4	6	1	1	1	2	3	1	1	1	1	1	1

Values: integers only
 - Max value: 15
 - Min value: 1



Average Graph Distance — Social Network Visualizer v3.0.4

The average shortest path length in this connected network is the sum of pair-wise distances divided by N * (N - 1).

Average distance: 1.64048

OK

ECCENTRICITY (e) REPORT

Network name: Krackhardt's High-tech managers

Actors: 21

The eccentricity e measures how far, at most, is each node from every other node.

In a connected graph, the eccentricity e of a vertex is the maximum geodesic distance between that vertex and all other vertices. In a disconnected graph, the eccentricity e of all vertices is considered to be infinite.

e range: $1 \leq e \leq \infty$

Actor	Label	e
1	v1	2
2	v2	3
3	v3	2
4	v4	2
5	v5	2
6	v6	3
7	v7	2
8	v8	2
9	v9	2
10	v10	2
11	v11	3
12	v12	3
13	v13	2
14	v14	2
15	v15	1
16	v16	3
17	v17	3
18	v18	2
19	v19	2
20	v20	2
21	v21	2

Max e (Graph Diameter) = 3 (node 2)

Min e (Graph Radius) = 1 (node 15)

e classes = 3

$e = 1$ when the node is connected to all others (star node).

$e > 1$ when the node is not directly connected to all others. Larger eccentricity means the actor is farther from others.

$e = \infty$ there is no path from that node to one or more other nodes.



CLUSTERING COEFFICIENT (CLC) REPORT

Network name: Krackhardt's High-tech managers
Actors: 21

The local Clustering Coefficient, introduced by Watts and Strogatz (1998), quantifies how close each node and its neighbors are to being a complete subgraph (clique). For each node *u*, the local CLC score is the proportion of actual links between its neighbors divided by the number of links that could possibly exist between them. The CLC index is used to characterize the transitivity of a network. A value close to one indicates that the node is involved in many transitive relations. CLC* is the normalized CLC, divided by maximum CLC found in this network.

CLC range: 0 ≤ CLC ≤ 1
CLC range: 0 ≤ CLC* ≤ 1

Node	Label	CLC	CLC*	CLC	CLC*	√CLC*
1	v1	0.833333	0.833333	83.333333		
2	v2	1.000000	1.000000	100.000000		
3	v3	0.666667	0.666667	66.666667		
4	v4	0.633333	0.633333	63.333333		
5	v5	0.750000	0.750000	75.000000		
6	v6	0.000000	0.000000	0.000000		
7	v7	0.484762	0.484762	48.476190		
8	v8	0.833333	0.833333	83.333333		
9	v9	0.800000	0.800000	80.000000		
10	v10	0.553571	0.553571	55.357143		
11	v11	0.900000	0.900000	90.000000		
12	v12	1.000000	1.000000	100.000000		
13	v13	1.000000	1.000000	100.000000		
14	v14	1.000000	1.000000	100.000000		
15	v15	0.833333	0.833333	83.333333		
16	v16	0.833333	0.833333	83.333333		
17	v17	0.666667	0.666667	66.666667		
18	v18	0.447619	0.447619	44.761905		
19	v19	0.916667	0.916667	91.666667		
20	v20	0.833333	0.833333	83.333333		
21	v21	0.463636	0.463636	46.363636		

Max CLC = 1.000000 (node 2)
Min CLC = 0.000000 (node 6)
CLC Mean = 0.650933
CLC Variance = 2.152611

GROUP / NETWORK AVERAGE CLUSTERING COEFFICIENT (GCLC)

GCLC = 0.650933
Range: 0 < GCLC < 1
GCLC = 0, when there are no cliques (i.e. acyclic tree).
GCLC = 1, when every node and its neighborhood are complete cliques.

TOTAL WALKS MATRIX

Network name: Krackhardt's High-tech managers
Actors: 21
The Total Walks matrix of a social network is a NxN matrix where each element (i,j) is the total number of walks of any length (less than or equal to 20) between actor i and actor j, or 0 if no walk exists.
A walk is a sequence of edges and vertices, where each edge's endpoints are the two vertices adjacent to it. In a walk, vertices and edges may repeat.
Warning: Walks count unordered pairs of nodes.

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1	118075476745808	1986797134093408	8114420668251264	180128893863787696	4366785874731384	12385999348663424	35337206431798672	1188125139988112	3618408055271832	810544827244848	13996544826262656	88943878323939568	3948888698888104	18214241325758208	6482281361779648	81872881788937136	7861538
2	1623712576351616	3582333336626528	1815486154791042	2664308561512688	296213524455798	3676485819753832	4548841633712096	3288635961798344	1888112872514238	2429738124562044	1268924484661312	24827638268487984	1268797343269728	3831499883717776	11861741761431424	2489139158714688	285432
3	24386142516463296	48171388109174688	256888895703808	71961788187770388	8884287257038468	2535786322265812	33268897887984872	2288877399168432	7476584126286384	2688188871833808	22877485143345056	18588462573703536	8878464285128776	38821314363617728	8878464285128776	18588462877703536	388681
4	18747123858045120	3358654484812888	944887684288808	5238935302614208	4889118879947884	155421097495897488	24177812236588284	2348763248249248	5768473881251768	1292632821894808	175888816455056	12771364316823976	6217958611852916	16151295976784956	8494832683968384	12886139163897888	151790
5	2486206868155836	4388847887984492	12831887558291296	21861522124287072	8453822582975872	2089428176248448	3235636142556874	2325636182284208	7634874681251768	173788888656896	2328475142412536	188848762848820384	6288777388818084	23431325414683744	9237381888878284	1781278878815688	2837618
6	187897812873888	3546817883713478	1886152878134638	183179584318296	775814442873142	2288888888888282	2721897814584832	19688538888881112	6467788114882327	1453843888288788	18718582387223352	1437772887848888	7888842788881816	18181338818987582	7818849318888836	1441748371256452	178791
7	2488878888888888	1888788888888888	878248881888818	8278488888888888	2788888888888888	2788888888888888	4888888888888888	8888888888888888	2888888888888888	8888888888888888	8888888888888888	8888888888888888	8888888888888888	8888888888888888	8888888888888888	8888888888888888	8888888888888888
8	1815554888288888	2488881887818272	777812231887208	1283874888887888	3267874888888888	1484888888888888	1848888888888888	2488888888888888	4388888888888888	8878888888888888	9748888888888888	9748888888888888	4787888888888888	1231288888888888	5188788888888888	8788888888888888	11888888
9	1882881528478386	313488881833888	95783872474338	1828888158887888	485388428848888	1843881835373884	2488148878848288	17788187788478818	5718888888888888	1284888888888888	1741888888888888	1741888888888888	6185443248248888	18311858187418248	8888113688778888	1277888888888888	15888888
10	2941511888827384	484913218888129984	3115483857888728	25388182757888128	1822888892483832	3889485778456328	37881854888854884	21471884143584748	8818288888352738	28288812888888378	27848577487844848	28887887848118888	28887887848118888	28887887848118888	28887887848118888	28887887848118888	28887887848118888
11	4888888888888888	1888888888888888	1588188888888888	1127788888888888	1127788888888888	2588822188881888	3288822188881888	2884188888888888	8711888888888888	2488174458162484	2827888888888888	2827888888888888	2827888888888888	2827888888888888	2827888888888888	2827888888888888	2827888888888888
12	287812875788272	54874878885884	148381788757888	2842528517188884	288255128788884	3488888888888888	4218888888888888	3851383888888888	3851383888888888	2257888774733884	3851383888888888	3851383888888888	3851383888888888	3851383888888888	3851383888888888	3851383888888888	3851383888888888
13	1228113888888888	2882218287888884	82168488813778	1886388888888888	481887818222888	127821884118388	1828888888888888	134878288464432	378818888877228	8488888888888888	114818887888428	838878848888178	88788781228888	1855388888888888	6547888888888888	838888128212888	983888
14	788128828728878	1122888884112272	485878188788888	683881118888888	2882551883847484	821428251812888	1818888888888888	7341888884884388	2481888888888888	1422888888888888	7384888888888888	5381728888888888	28184524748451884	8788878118888888	7818888888888888	5378128888888888	8269333
15	7778288888888888	4882842878733488	1845281188888888	3112813888888888	1334538888888888	3734538888888888	4818888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888
16	8888888888888888	1818888888888888	6841781888888888	8342888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888
17	1888888888888888	1282188238288872	3813488888888888	6888888888888888	2772348888888888	7727348888888888	8888888888888888	8813288888888888	2888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888
18	1488288488128878	578878881278128	1778888872743872	2988788888888888	1288888888888888	3888888888888888	4888888888888888	3888888888888888	1888888888888888	2772888888888888	2772888888888888	2772888888888888	2772888888888888	2772888888888888	2772888888888888	2772888888888888	2772888888888888
19	1488888888888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888	1233588128888888
20	1837718888888888	3888812888888888	1971888888888888	1888812888888888	4781888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888
21	7788888888888888	2877888128888888	1984878888888888	3518888888888888	1818888888888888	1818888888888888	1818888888888888	1818888888888888	1818888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888	1888888888888888

Values: integers only
- Max value: 6.0386e+17
- Min value: 0 (usually denotes unconnected nodes, in distance matrix)

3. Prominence: Methods to measure how prominent (important) each actor (node) is inside the network. Contains all Centrality and Prestige measures: Degree Centrality, Closeness Centrality, Betweenness Centrality, Stress Centrality, Eccentricity Centrality, Power Centrality, Information Centrality, Eigenvector Centrality, Degree Prestige, Pagerank Prestige, and Proximity Prestige.

DEGREE CENTRALITY (DC) REPORT

Network name: Krackhardt's High-tech managers
Actors: 21

In undirected networks, the DC index is the sum of edges attached to a node u.
In directed networks, the index is the sum of outbound arcs from node u to all adjacent nodes (also called "outDegree Centrality").
If the network is weighted, the DC score is the sum of weights of outbound edges from node u to all adjacent nodes.
Note: To compute inDegree Centrality, use the Degree Prestige measure.
DC' is the standardized index (DC divided by N-1 (non-valued nets) or by sumDC (valued nets)).

DC range: $0 \leq DC \leq 20$

DC' range: $0 \leq DC' \leq 1$

Node#	Label#	DC#	DC' #	%DC' #
1	v1	6.000000	0.300000	30.000000
2	v2	3.000000	0.150000	15.000000
3	v3	15.000000	0.750000	75.000000
4	v4	12.000000	0.600000	60.000000
5	v5	15.000000	0.750000	75.000000
6	v6	1.000000	0.050000	5.000000
7	v7	8.000000	0.400000	40.000000
8	v8	8.000000	0.400000	40.000000
9	v9	13.000000	0.650000	65.000000
10	v10	14.000000	0.700000	70.000000
11	v11	3.000000	0.150000	15.000000
12	v12	2.000000	0.100000	10.000000
13	v13	6.000000	0.300000	30.000000
14	v14	4.000000	0.200000	20.000000
15	v15	20.000000	1.000000	100.000000
16	v16	4.000000	0.200000	20.000000
17	v17	5.000000	0.250000	25.000000
18	v18	17.000000	0.850000	85.000000
19	v19	11.000000	0.550000	55.000000
20	v20	12.000000	0.600000	60.000000
21	v21	11.000000	0.550000	55.000000

DC Sum = 190.000000

Max DC' = 1.000000 (node 15)

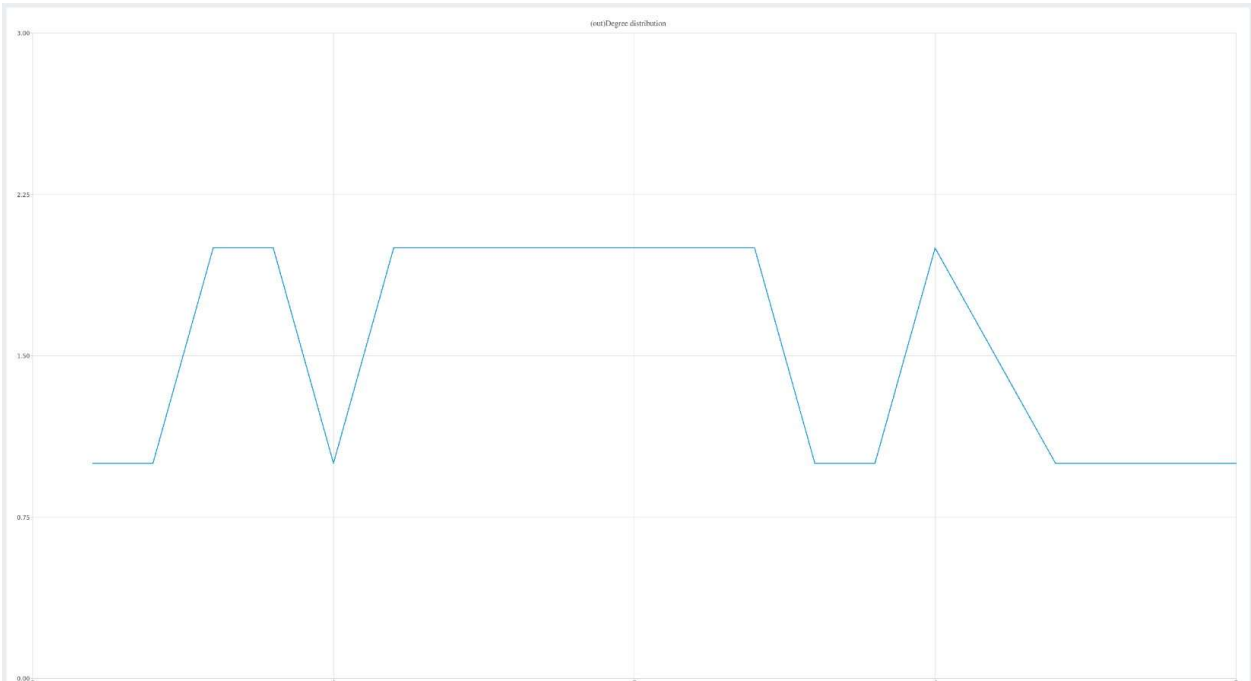
Min DC' = 0.050000 (node 6)

DC' classes = 14

DC' Sum = 9.500000

DC' Mean = 0.452381

DC' Variance = 0.070828



CLOSENESS CENTRALITY (CC) REPORT

Network name: Krackhardt's High-tech managers
Actors: 21

*The CC index is the inverted sum of geodesic distances from each node u to all other nodes.
Note: The CC index considers outbound arcs only and isolate nodes are dropped by default.
Read the Manual for more.*

CC' is the standardized index (CC multiplied by (N-1 minus isolates)).

CC range: $0 \leq CC \leq 0.05$ ($1 / \text{Number of node pairs excluding } u$)

CC' range: $0 \leq CC' \leq 1$ (CC'=1 when a node is the center of a star graph)

Node ‡	Label ‡	CC ‡	CC' ‡	%CC' ‡
1	v1	0.029412	0.588235	58.823529
2	v2	0.022222	0.444444	44.444444
3	v3	0.040000	0.800000	80.000000
4	v4	0.035714	0.714286	71.428571
5	v5	0.040000	0.800000	80.000000
6	v6	0.020833	0.416667	41.666667
7	v7	0.031250	0.625000	62.500000
8	v8	0.031250	0.625000	62.500000
9	v9	0.037037	0.740741	74.074074
10	v10	0.038462	0.769231	76.923077
11	v11	0.022222	0.444444	44.444444
12	v12	0.021739	0.434783	43.478261
13	v13	0.029412	0.588235	58.823529
14	v14	0.027778	0.555556	55.555556
15	v15	0.050000	1.000000	100.000000
16	v16	0.027027	0.540541	54.054054
17	v17	0.025000	0.500000	50.000000
18	v18	0.043478	0.869565	86.956522
19	v19	0.034483	0.689655	68.965517
20	v20	0.035714	0.714286	71.428571
21	v21	0.034483	0.689655	68.965517

CC Sum = 0.677516

Max CC' = 1.000000 (node 15)

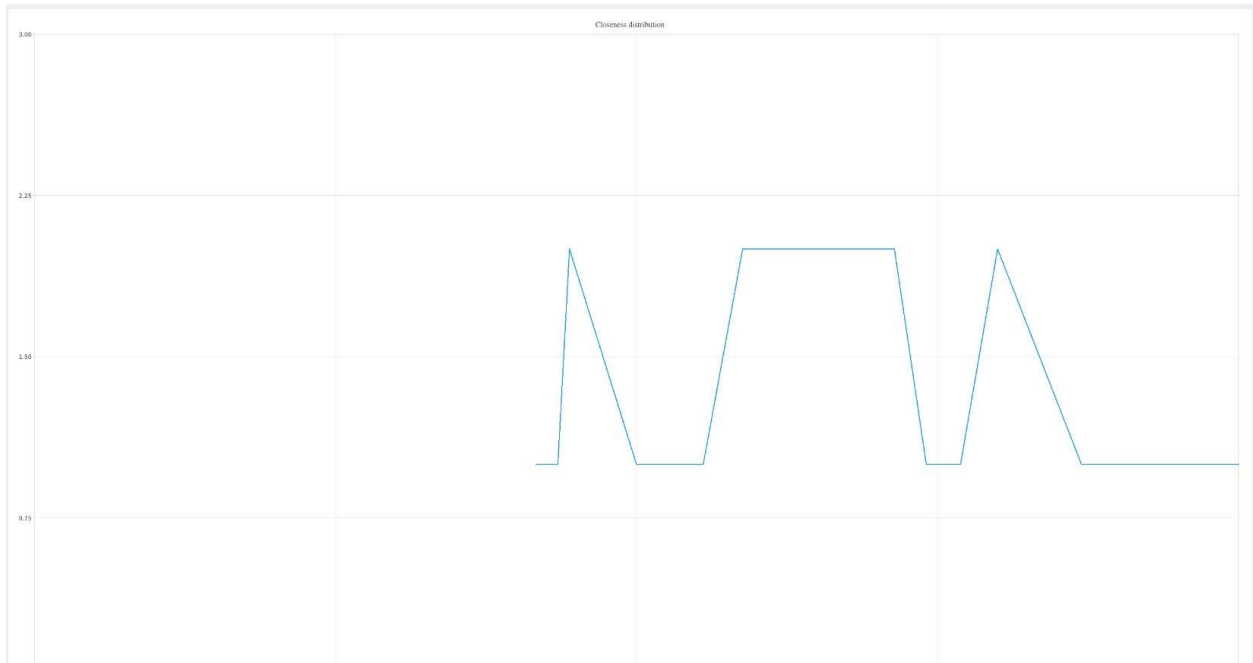
Min CC' = 0.416667 (node 6)

CC' classes = 15

CC' Sum = 13.550323

CC' Mean = 0.645253

CC' Variance = 0.023174



BETWEENNESS CENTRALITY (BC)

Network name: Krackhardt's High-tech managers
Actors: 21

The BC index of a node u is the sum of $\delta_{(s,t,u)}$ for all $s,t \in V$ where $\delta_{(s,t,u)}$ is the ratio of all geodesics between s and t which run through u .
Read the Manual for more.
BC' is the standardized index (BC divided by $(N-1)(N-2)/2$ in symmetric nets or $(N-1)(N-2)$ otherwise.

BC range: $0 \leq BC \leq 380$ (Number of pairs of nodes excluding u)
BC' range: $0 \leq BC' \leq 1$ (BC'=1 when the node falls on all geodesics)

Node#	Label#	BC#	BC' #	%BC' #
1	v1	13.746825	0.036176	3.617586
2	v2	5.935714	0.015620	1.562030
3	v3	6.604762	0.017381	1.738095
4	v4	13.708730	0.036076	3.607561
5	v5	5.078571	0.013365	1.336466
6	v6	0.000000	0.000000	0.000000
7	v7	27.624603	0.072696	7.269632
8	v8	3.974603	0.010459	1.045948
9	v9	3.953968	0.010405	1.040518
10	v10	18.296825	0.048150	4.814954
11	v11	1.198413	0.003154	0.315372
12	v12	0.253968	0.000668	0.066834
13	v13	0.892857	0.002350	0.234962
14	v14	0.588889	0.001550	0.154971
15	v15	6.132540	0.016138	1.613826
16	v16	0.700000	0.001842	0.184211
17	v17	2.531746	0.006662	0.666249
18	v18	88.916667	0.233991	23.399123
19	v19	0.753968	0.001984	0.198413
20	v20	7.979365	0.020998	2.099833
21	v21	60.126984	0.158229	15.822891

BC Sum = 269.000000
Max BC' = 0.233991 (node 18)
Min BC' = 0.000000 (node 6)
BC' classes = 21
BC' Sum = 0.707895
BC' Mean = 0.033709
BC' Variance = 0.003231

BC' DISTRIBUTION

STRESS CENTRALITY (SC)

Network name: Krackhardt's High-tech managers

Actors: 21

The SC index of each node u is the sum of $\sigma(s,t,u)$:

the number of geodesics from s to t through u .

SC' is the standardized index (SC divided by sumSC).

SC range: $0 \leq SC \leq 380$

SC' range: $0 \leq SC' \leq 1$ (SC'=1 when the node falls on all geodesics)

Node	Label	SC	SC'	%SC'
1	v1	24.000000	0.040201	4.020101
2	v2	20.000000	0.033501	3.350084
3	v3	32.000000	0.053601	5.360134
4	v4	43.000000	0.072027	7.202680
5	v5	22.000000	0.036851	3.685092
6	v6	0.000000	0.000000	0.000000
7	v7	40.000000	0.067002	6.700168
8	v8	21.000000	0.035176	3.517588
9	v9	14.000000	0.023451	2.345059
10	v10	49.000000	0.082077	8.207705
11	v11	7.000000	0.011725	1.172529
12	v12	2.000000	0.003350	0.335008
13	v13	3.000000	0.005025	0.502513
14	v14	4.000000	0.006700	0.670017
15	v15	27.000000	0.045226	4.522613
16	v16	3.000000	0.005025	0.502513
17	v17	13.000000	0.021776	2.177554
18	v18	159.000000	0.266332	26.633166
19	v19	4.000000	0.006700	0.670017
20	v20	35.000000	0.058626	5.862647
21	v21	75.000000	0.125628	12.562814

SC Sum = 597.000000

Max SC' = 0.266332 (node 18)

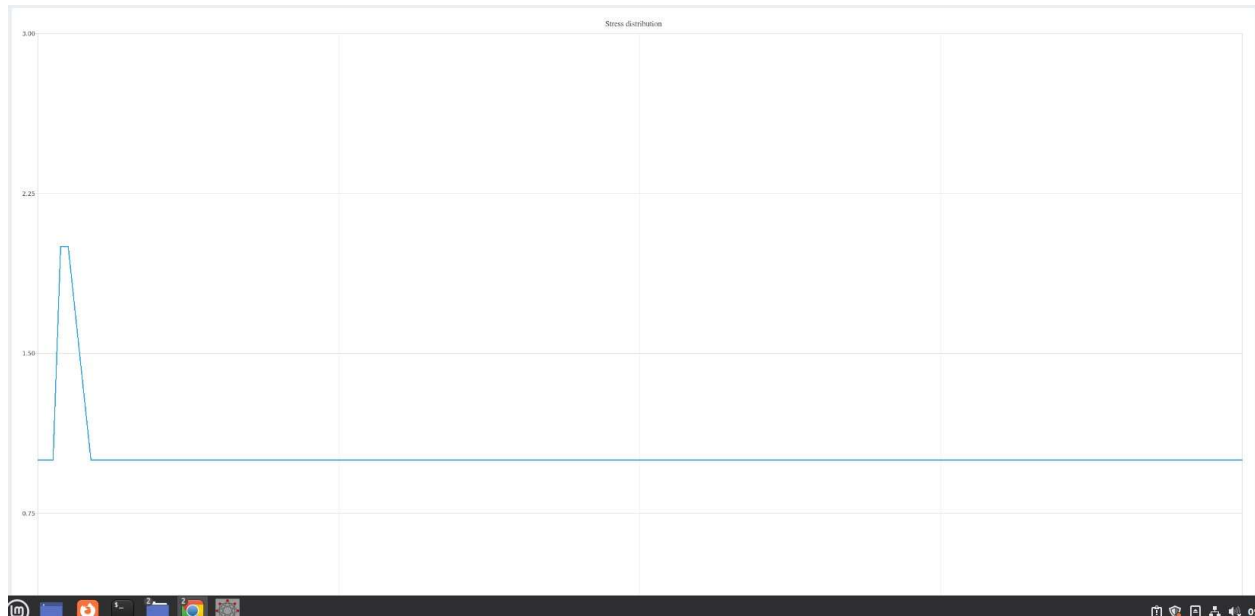
Min SC' = 0.000000 (node 6)

BC classes = 19

SC' Sum = 1.000000

SC' Mean = 0.047619

SC' Variance = 0.003358



ECCENTRICITY CENTRALITY (EC)

Network name: Krackhardt's High-tech managers
Actors: 21

The EC score of a node u is the inverse maximum geodesic distance from u to all other nodes in the network. This index is also known as Harary Graph Centrality. EC is standardized.

EC range: $0 \leq EC \leq 1$ (EC=1 when the actor has ties to all other nodes)

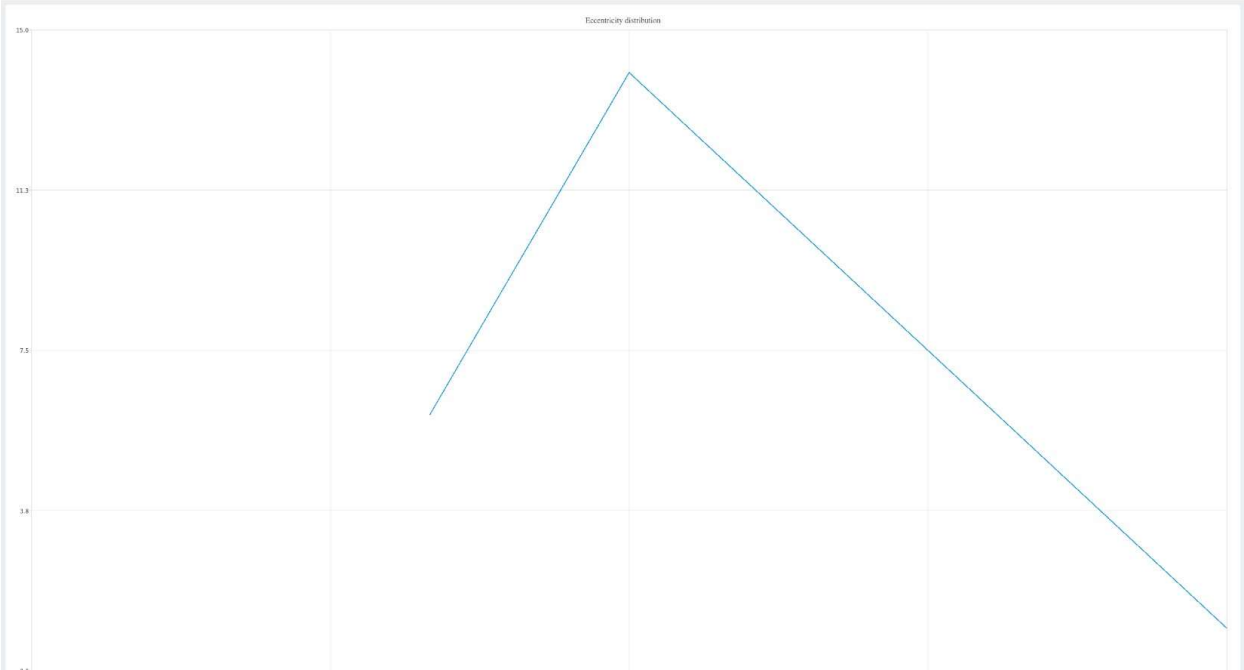
Node #	Label	EC=EC'	%EC'
1	v1	0.500000	50.000000
2	v2	0.333333	33.333333
3	v3	0.500000	50.000000
4	v4	0.500000	50.000000
5	v5	0.500000	50.000000
6	v6	0.333333	33.333333
7	v7	0.500000	50.000000
8	v8	0.500000	50.000000
9	v9	0.500000	50.000000
10	v10	0.500000	50.000000
11	v11	0.333333	33.333333
12	v12	0.333333	33.333333
13	v13	0.500000	50.000000
14	v14	0.500000	50.000000
15	v15	1.000000	100.000000
16	v16	0.333333	33.333333
17	v17	0.333333	33.333333
18	v18	0.500000	50.000000
19	v19	0.500000	50.000000
20	v20	0.500000	50.000000
21	v21	0.500000	50.000000

Max EC = 1.000000 (node 15)
Min EC = 0.333333 (node 2)
EC classes = 3

EC Sum = 10.000000
EC Mean = 0.476190
EC Variance = 0.019274

EC DISTRIBUTION

EC DISTRIBUTION



EIGENVECTOR CENTRALITY (EVC)

Network name: Krackhardt's High-tech managers
Actors: 21

The Eigenvector Centrality of each node is the i_{th} element of the leading eigenvector of the adjacency matrix, that is the eigenvector corresponding to the largest positive eigenvalue. Proposed by Bonacich (1972), the Eigenvector Centrality is an extension of the simpler Degree Centrality because it gives each actor a score proportional to the scores of its neighbors. has lots of ties or it has ties to other nodes with high EVC. The eigenvector centralities are also known as Gould indices. EVC' is the scaled EVC (EVC divided by max EVC). EVC'' is the standardized index (EVC divided by the sum of all EVCs).

EVC range: $0 \leq EVC < 1$ (The eigenvector has unit euclidean length)

EVC' range: $0 \leq EVC' \leq 1$

Node	Label	EVC	EVC'	EVC''	%EVC
1	v1	0.138872	0.331747	0.035851	33.174663
2	v2	0.041222	0.098475	0.010642	9.847452
3	v3	0.283177	0.676473	0.073104	67.647285
4	v4	0.219113	0.523433	0.056566	52.343278
5	v5	0.291403	0.696123	0.075228	69.612312
6	v6	0.024667	0.058927	0.006368	5.892695
7	v7	0.111970	0.267481	0.028996	26.748050
8	v8	0.167518	0.400178	0.043246	40.017848
9	v9	0.217968	0.520696	0.056270	52.069579
10	v10	0.344213	0.822279	0.088861	82.227944
11	v11	0.035386	0.084534	0.009135	8.453364
12	v12	0.038234	0.091335	0.009870	9.133492
13	v13	0.143442	0.342665	0.037011	34.266455
14	v14	0.091909	0.219750	0.023748	21.975008
15	v15	0.418608	1.000000	0.108067	100.000000
16	v16	0.112206	0.268237	0.028998	26.823712
17	v17	0.086602	0.206880	0.022357	20.687978
18	v18	0.402452	0.961405	0.103096	96.140485
19	v19	0.287478	0.686746	0.074214	68.674619
20	v20	0.213415	0.509020	0.055095	50.902047
21	v21	0.203593	0.486356	0.052559	48.635579

Max EVC = 0.418608 (node 15)
Min EVC = 0.024667 (node 6)
EVC classes = 21

EVC Sum = 3.873607
EVC Mean = 0.184457
EVC Variance = 0.013594

DEGREE PRESTIGE (DP)

Network name: Krackhardt's High-tech managers
Actors: 21

The DP index, also known as InDegree Centrality, of a node u is the sum of inbound edges to that node from all adjacent nodes. If the network is weighted, DP is the sum of inbound arc weights (Indegree) to node u from all adjacent nodes. DP' is the standardized index (DP divided by $N-1$).

DP range: $0 \leq DP \leq 20$

DP' range: $0 \leq DP' \leq 1$

Node ‡	Label ‡	DP ‡	DP' ‡	%DP' ‡
1	v1	13.000000	0.650000	65.000000
2	v2	18.000000	0.900000	90.000000
3	v3	5.000000	0.250000	25.000000
4	v4	8.000000	0.400000	40.000000
5	v5	5.000000	0.250000	25.000000
6	v6	10.000000	0.500000	50.000000
7	v7	13.000000	0.650000	65.000000
8	v8	10.000000	0.500000	50.000000
9	v9	4.000000	0.200000	20.000000
10	v10	9.000000	0.450000	45.000000
11	v11	11.000000	0.550000	55.000000
12	v12	7.000000	0.350000	35.000000
13	v13	4.000000	0.200000	20.000000
14	v14	10.000000	0.500000	50.000000
15	v15	4.000000	0.200000	20.000000
16	v16	8.000000	0.400000	40.000000
17	v17	9.000000	0.450000	45.000000
18	v18	15.000000	0.750000	75.000000
19	v19	4.000000	0.200000	20.000000
20	v20	8.000000	0.400000	40.000000
21	v21	15.000000	0.750000	75.000000

DP Sum = 190.000000

Max DP' = 0.900000 (node 2)

Min DP' = 0.200000 (node 9)

DP' classes = 10

DP' Sum = 9.500000

DP' Mean = 0.452381

DP' Variance = 0.039399

POWER CENTRALITY (PC)

Network name: Krackhardt's High-tech managers
Actors: 21

The PC index, introduced by Gil and Schmidt, of a node u is the sum of the sizes of all Nth-order neighbourhoods with weight 1/n. PC' is the standardized index: The PC score divided by the total number of nodes in the same component minus 1

PC range: 0 ≤ PC ≤ 20
PC' range: 0 ≤ PC' ≤ 1 (PC'=1 when the node is connected to all (star).)

Node	Label	PC	PC'	%PC'
1	v1	13.000000	0.650000	65.000000
2	v2	10.166667	0.508333	50.833333
3	v3	17.500000	0.875000	87.500000
4	v4	16.000000	0.800000	80.000000
5	v5	17.500000	0.875000	87.500000
6	v6	9.000000	0.450000	45.000000
7	v7	14.000000	0.700000	70.000000
8	v8	14.000000	0.700000	70.000000
9	v9	16.500000	0.825000	82.500000
10	v10	17.000000	0.850000	85.000000
11	v11	10.166667	0.508333	50.833333
12	v12	9.666667	0.483333	48.333333
13	v13	13.000000	0.650000	65.000000
14	v14	12.000000	0.600000	60.000000
15	v15	20.000000	1.000000	100.000000
16	v16	11.833333	0.591667	59.166667
17	v17	11.666667	0.583333	58.333333
18	v18	18.500000	0.925000	92.500000
19	v19	15.500000	0.775000	77.500000
20	v20	16.000000	0.800000	80.000000
21	v21	15.500000	0.775000	77.500000

PC Sum = 298.500000
Max PC' = 1.000000 (node 15)
Min PC' = 0.450000 (node 6)
PC classes = 15
PC' Sum = 14.925000
PC' Mean = 0.710714
PC' Variance = 0.023433

PAGERANK PRESTIGE (PRP)

Network name: Krackhardt's High-tech managers
Actors: 21

The PRP is an importance ranking index for each node based on the structure of its incoming Links/edges and the rank of the nodes linking to it. For each node u the algorithm counts all inbound links (edges) to it, but it normalizes each inbound link from a node v by the outDegree of v. The PR values correspond to the principal eigenvector of the normalized link matrix.
Note: In weighted relations, each backlink to a node u from another node v is considered to have weight=1 but it is normalized by the sum of outbound edge weights of v. Therefore, nodes with high outLink weights give smaller percentage of their PR to node u.
PRP' is the scaled PRP (PRP divided by max PRP).

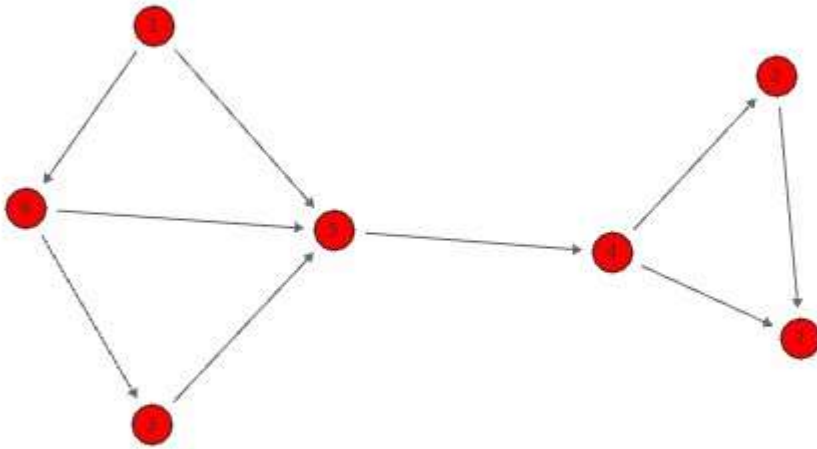
PRP range: (1-d)/N = 0.00714286 ≤ PRP
PRP' range: 0 ≤ PRP' ≤ 1

Node	Label	PRP	PRP'	%PRP'
1	v1	0.045403	0.301668	30.166828
2	v2	0.093901	0.573390	57.339041
3	v3	0.026906	0.184664	18.466434
4	v4	0.046045	0.301165	30.116491
5	v5	0.016316	0.099631	9.963121
6	v6	0.071509	0.437143	43.714266
7	v7	0.104898	0.635239	63.523915
8	v8	0.041879	0.255726	25.572585
9	v9	0.014957	0.091335	9.133494
10	v10	0.025546	0.189416	18.041610
11	v11	0.038822	0.237061	23.706073
12	v12	0.039610	0.241871	24.187140
13	v13	0.014144	0.086368	8.636838
14	v14	0.043975	0.268524	26.852400
15	v15	0.015949	0.097392	9.739217
16	v16	0.027697	0.169127	16.912732
17	v17	0.042329	0.258471	25.847114
18	v18	0.072184	0.446289	44.628865
19	v19	0.014144	0.086370	8.636965
20	v20	0.032681	0.199559	19.955880
21	v21	0.163765	1.000000	100.000000

Max PRP = 0.163765 (node 21)
Min PRP = 0.014144 (node 13)
PRP classes = 21
PRP Sum = 0.999854
PRP Mean = 0.047512
PRP Variance = 0.001288

Challenging Task

We expect that the user who receives the gift voucher will send it to their friends in the network. You want the voucher to reach as many nodes as possible. However, we now want to ensure that the voucher reaches the nodes in the lowest average number of hops.



- i. Which centrality measure should be computed to identify the suitable person to forward the voucher?

Betweenness Centrality

- ii. Now a competitor has developed a strategy to remove a person from the network in order to disrupt the distribution of your company's voucher. Identify the single riskiest person to be removed under your competitor's strategy?

BETWEENNESS CENTRALITY (BC)

Network name: unnamed

Actors: 7

The BC index of a node u is the sum of $\delta_{(s,t,u)}$ for all $s,t \in V$ where $\delta_{(s,t,u)}$ is the ratio of all geodesics between s and t which run through u .
Read the Manual for more.

BC' is the standardized index (BC divided by $(N-1)(N-2)/2$ in symmetric nets or $(N-1)(N-2)$ otherwise.

BC range: $0 \leq BC \leq 30$ (Number of pairs of nodes excluding u)

BC' range: $0 \leq BC' \leq 1$ (BC'=1 when the node falls on all geodesics)

Node	Label	BC	BC'	%BC'
1	-	0.000000	0.000000	0.000000
2	-	0.000000	0.000000	0.000000
3	-	0.000000	0.000000	0.000000
4	-	0.000000	0.266667	26.666667
5	-	9.000000	0.300000	30.000000
6	-	1.000000	0.033333	3.333333
7	-	0.000000	0.000000	0.000000

BC Sum = 10.000000

Max BC' = 0.300000 (node 5)

Min BC' = 0.000000 (node 1)

BC' classes = 4

BC' Sum = 0.600000

BC' Mean = 0.085714

BC' Variance = 0.015828

BC' DISTRIBUTION

As Node 5 has the highest Betweenness Centrality, removing that node will hamper the organisation distribution of vouchers.