

Maciej Medyk – COT6930 – Homework 1

Question 1

Social Network

A social structure made of individuals or organizations called nodes, which are connected by one or more specific types of interdependency, such as friendship, kinship, financial exchange, dislike, sexual relationships, or relationships of beliefs, knowledge or prestige.

Undirected graph

The graph whose edges are bi-directional and drawn as they have no direction or orientation. In this graph edge that connects (v, w) is equivalent to edge (w, v)

Adjacency matrix

It's an $N \times N$ matrix that stores the edge connections between the nodes as ones and no immediate connections as zeros. If the graph is undirected the matrix will be symmetrical.

Network Diameter

The maximum shortest path between two nodes within the graph.

Centrality score of a node

Description of importance of the node to the network

Random Walk

The sequence of edges chosen where no rules are followed in choice of edges selected to make the walk and choices are done randomly. This type of walk through the graph can be compared to random walk of the ant on the surface where ant chooses her steps without purpose or defined direction.

Random Graph

Random graph has Poisson degree of distribution where most of the nodes have similar degree forming a bell curve. This happens due to the edges between vertices are assigned at random.

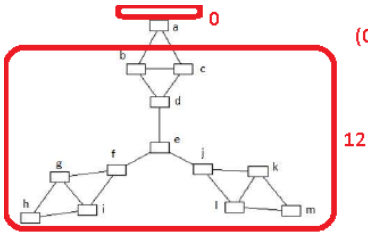
Power-Law Distribution

Power-Law distribution illustrates a relationship between two quantities where a relative change in one quantity results in proportional relative change in other quantity. In social networks as degree increases the degree decreases exponentially and a large number of high degree nodes form a long tail in the graph.

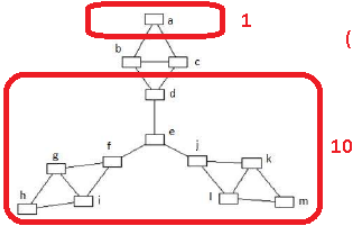
Question 2

Betweenness centrality

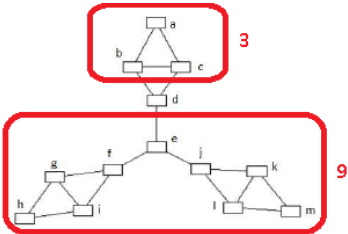
NODE	SCORE	NORMAL
A	0	0.000
B	5	0.076
C	5	0.076
D	27	0.409
E	48	0.727
F	27	0.409
G	5	0.076
H	0	0.000
I	5	0.076
J	27	0.409
K	5	0.076
L	5	0.076
M	0	0.000



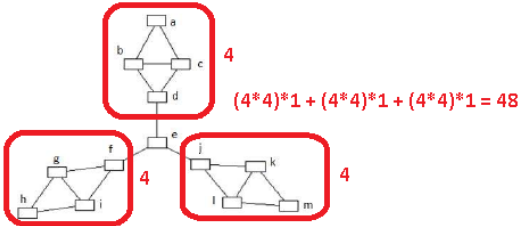
$(0 * 12) * 1 = 0$



$(1 * 10) * 1/2 = 5$



$(3 * 9) * 1 = 27$



$(4 * 4) * 1 + (4 * 4) * 1 + (4 * 4) * 1 = 48$

Normalizing coefficient is $1 / ((n-2) * ((n-1) / 2)) = 1 / (11 * 6) = 1 / 66$

Closeness centrality

	A	B	C	D	E	F	G	H	I	J	K	L	M	
A	0	1	1	2	3	4	5	6	5	4	5	5	6	
B	1	0	1	1	2	3	4	5	4	3	4	4	5	
C	1	1	0	1	2	3	4	5	4	3	4	4	5	
D	2	1	1	0	1	2	3	4	3	2	3	3	4	
E	3	2	2	1	0	1	2	3	2	1	2	2	3	
F	4	3	3	2	1	0	1	2	1	2	3	3	4	
G	5	4	4	3	2	1	0	1	1	3	4	4	5	
H	6	5	5	4	3	2	1	0	1	4	5	5	6	
I	5	4	4	3	2	1	1	1	0	3	4	4	5	
J	4	3	3	2	1	2	3	4	3	0	1	1	2	
K	5	4	4	3	2	3	4	5	4	1	0	1	1	
L	5	4	4	3	2	3	4	5	4	1	1	0	1	
M	6	5	5	4	3	4	5	6	5	2	1	1	0	
SUM	47	37	37	29	24	29	37	47	37	29	37	37	47	SUM(A:M)
SCORE	3.917	3.083	3.083	2.417	2.000	2.417	3.083	3.917	3.083	2.417	3.083	3.083	3.917	SUM(A:M) / N-1
NORMAL	0.255	0.324	0.324	0.414	0.500	0.414	0.324	0.255	0.324	0.414	0.324	0.324	0.255	N-1 / SUM(A:M)

Eigen-Vector centrality

	A	B	C	D	E	F	G	H	I	J	K	L	M
EIGENVECTOR	0.601	0.848	0.848	0.949	1.000	0.949	0.848	0.601	0.848	0.949	0.848	0.848	0.601

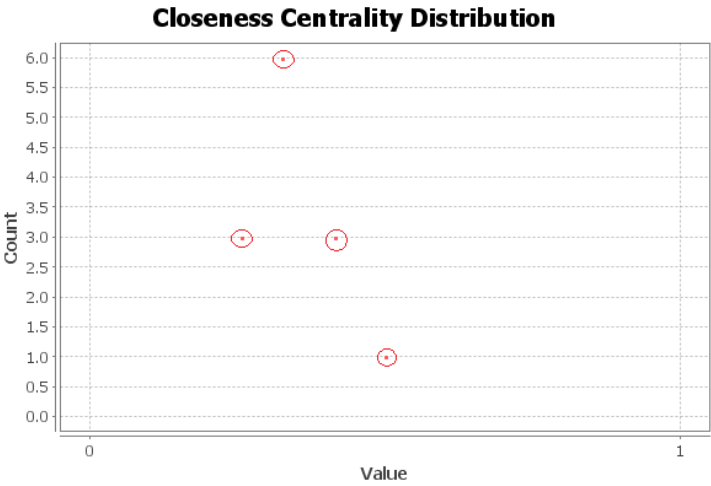
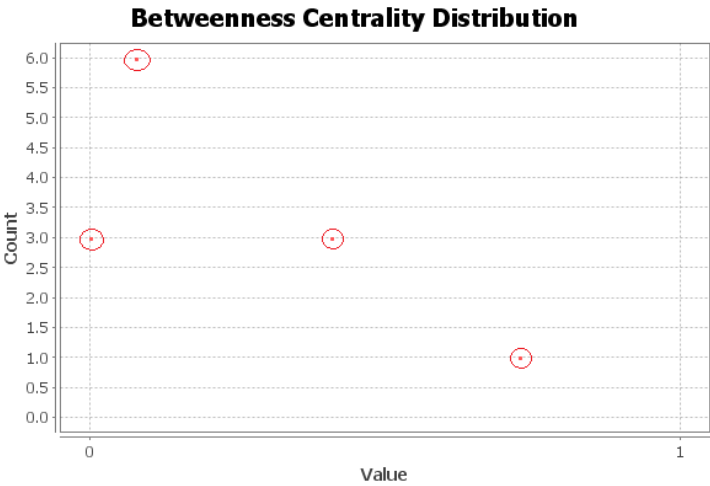
Gephi results - Not normalized

Label	Weighted Degree	Degree	Eccentricity	Closeness Centrality	Betweenness Centrality	Eigenvector Centrality	PageRank	Clustering Coefficient
A	2.0	2	6.0	3.916667	0.0	0.600584	0.058639	1.0
B	3.0	3	5.0	3.083333	5.0	0.847697	0.083099	0.666667
C	3.0	3	5.0	3.083333	5.0	0.847697	0.083099	0.666667
D	3.0	3	4.0	2.416667	27.0	0.949365	0.081555	0.333333
E	3.0	3	3.0	2.0	48.0	1.0	0.080825	0.0
F	3.0	3	4.0	2.416667	27.0	0.949365	0.081555	0.333333
G	3.0	3	5.0	3.083333	5.0	0.847697	0.083099	0.666667
H	2.0	2	6.0	3.916667	0.0	0.600584	0.058639	1.0
I	3.0	3	5.0	3.083333	5.0	0.847697	0.083099	0.666667
J	3.0	3	4.0	2.416667	27.0	0.949365	0.081555	0.333333
K	3.0	3	5.0	3.083333	5.0	0.847697	0.083099	0.666667
L	3.0	3	5.0	3.083333	5.0	0.847697	0.083099	0.666667
M	2.0	2	6.0	3.916667	0.0	0.600584	0.058639	1.0

Gephi results – Normalized

Label	Weighted Degree	Degree	Eccentricity	Closeness Centrality	Betweenness Centrality	Eigenvector Centrality	PageRank	Clustering Coefficient
A	2.0	2	6.0	0.255319	0.0	0.600584	0.058639	1.0
B	3.0	3	5.0	0.324324	0.075758	0.847697	0.083099	0.666667
C	3.0	3	5.0	0.324324	0.075758	0.847697	0.083099	0.666667
D	3.0	3	4.0	0.413793	0.409091	0.949365	0.081555	0.333333
E	3.0	3	3.0	0.5	0.727273	1.0	0.080825	0.0
F	3.0	3	4.0	0.413793	0.409091	0.949365	0.081555	0.333333
G	3.0	3	5.0	0.324324	0.075758	0.847697	0.083099	0.666667
H	2.0	2	6.0	0.255319	0.0	0.600584	0.058639	1.0
I	3.0	3	5.0	0.324324	0.075758	0.847697	0.083099	0.666667
J	3.0	3	4.0	0.413793	0.409091	0.949365	0.081555	0.333333
K	3.0	3	5.0	0.324324	0.075758	0.847697	0.083099	0.666667
L	3.0	3	5.0	0.324324	0.075758	0.847697	0.083099	0.666667
M	2.0	2	6.0	0.255319	0.0	0.600584	0.058639	1.0

Gephi results – Graphs



Question 3

Degree distribution of the network

	A	B	C	D	E	F	G	H	J
DISTRIBUTION	3	4	2	4	4	2	2	3	2

	ENTIRE NETWORK
DISTRIBUTION	$(3 + 4 + 2 + 4 + 4 + 2 + 2 + 3 + 2) / 9 = 2.8889$

	A	B	C	D	E	F	G	H	J
CLUSTERING COEFFICIENT	0.6667	0.3333	0.0000	0.1667	0.1667	0.0000	0.0000	0.0000	0.0000

	k_i	d_i	$(d_i-1)/2$	COEFFICIENT
A	2	3	1.0	0.6667
B	2	4	1.5	0.3333
C	0	2	0.5	0.0000
D	1	4	1.5	0.1667
E	1	4	1.5	0.1667
F	0	2	0.5	0.0000
G	0	2	0.5	0.0000
H	0	3	1.0	0.0000
J	0	2	0.5	0.0000

$$C_i = \begin{cases} \frac{k_i}{d_i \times (d_i - 1)/2} & d_i > 1 \\ 0 & d_i = 0 \text{ or } 1 \end{cases}$$

	MATH	RESULT
DENSITY	$13 / (9 * ((9 - 1) / 2))$	0.3611111111

	ENTIRE NETWORK
CLUSTERING COEFFICIENT	$(0.667 + 0.333 + 0.167 + 0.167) / 9 = 0.148$

The clustering coefficient is smaller from edge density indicating that it's a many neighboring nodes are not connected to each other. In this graph we see it when neighbors of node C are both B and F and they are not directly connected, then neighbors of node F are both C and J and they are not directly connected, and finally neighbors of node J are F and H which are not directly connected.

[illegible]

Gephi results – Not normalized

Label	Timestamp	Degree	Eccentricity	Closeness Centrality	Clustering Coefficient	Betweenness Centrality	Eigenvector Centrality
A		3	3.0	1.875	0.666667	0.25	0.906392
B		4	3.0	1.625	0.333333	7.416667	1.0
C		2	3.0	2.0	0.0	3.833333	0.385588
D		4	3.0	1.625	0.166667	5.166667	0.982636
E		4	3.0	1.625	0.166667	5.166667	0.982636
F		2	4.0	2.375	0.0	1.666667	0.224914
G		2	4.0	2.25	0.0	0.25	0.600201
H		3	3.0	1.75	0.0	6.416667	0.700433
J		2	3.0	2.125	0.0	2.833333	0.297598

Gephi results – Normalized

Label	Timestamp	Degree	Eccentricity	Closeness Centrality	Clustering Coefficient	Betweenness Centrality	Eigenvector Centrality
A		3	3.0	0.533333	0.666667	0.008929	0.906392
B		4	3.0	0.615385	0.333333	0.264881	1.0
C		2	3.0	0.5	0.0	0.136905	0.385588
D		4	3.0	0.615385	0.166667	0.184524	0.982636
E		4	3.0	0.615385	0.166667	0.184524	0.982636
F		2	4.0	0.421053	0.0	0.059524	0.224914
G		2	4.0	0.444444	0.0	0.008929	0.600201
H		3	3.0	0.571429	0.0	0.229167	0.700433
J		2	3.0	0.470588	0.0	0.10119	0.297598

Gephi results

☒ Network Overview

Average Degree

2.889

Run

?

Avg. Weighted Degree

2.889

Run

?

Network Diameter

4

Run

?

Graph Density

0.361

Run

?

Modularity

0.222

Run

?

PageRank

Run

?

Connected Components

1

Run

?

☒ Node Overview

Avg. Clustering Coefficient

0.148

Run

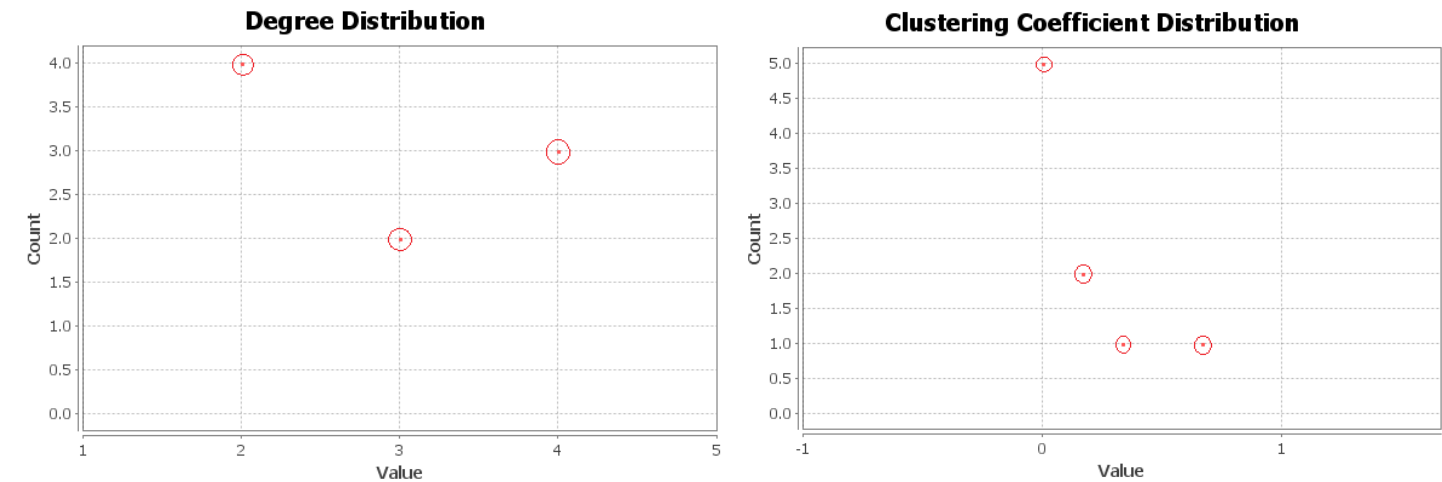
?

Eigenvector Centrality

Run

?

Gephi results – Graphs



Question 4

Edge density and clustering coefficient of whole network

Clustering coefficient for entire network is $19.40171 / 33 = 0.587931$

Edge density for entire network is $78 / (34 * ((34 - 1) / 2)) = 0.13903743$

The clustering coefficient is larger from edge density indicating that it's a collaboration graph meaning that many nodes which are neighboring of nodes 1, 3, 33, and 34 are connected to each other. You see the node 33 and 34 are having same neighboring nodes like 9, 15, 16, 19, 21, 23, 24, 30, and 32. Those relationship cause the clustering coefficient to be high.

	d_i	k_i	$(d_i-1)/2$	RESULT
1	16	18	7.5	0.15000
2	9	12	4.0	0.33333
3	10	11	4.5	0.24444
4	6	10	2.5	0.66667
5	3	2	1.0	0.66667
6	4	3	1.5	0.50000
7	4	3	1.5	0.50000
8	4	6	1.5	1.00000
9	5	5	2.0	0.50000
10	2	0	0.5	0.00000
11	3	2	1.0	0.66667
12	1	0	0.0	0.00000
13	2	1	0.5	1.00000
14	5	6	2.0	0.60000
15	2	1	0.5	1.00000
16	2	1	0.5	1.00000
17	2	1	0.5	1.00000
18	2	1	0.5	1.00000
19	2	1	0.5	1.00000
20	3	1	1.0	0.33333
21	2	1	0.5	1.00000
22	2	1	0.5	1.00000
23	2	1	0.5	1.00000
24	5	4	2.0	0.40000
25	3	1	1.0	0.33333
26	3	1	1.0	0.33333
27	2	1	0.5	1.00000
28	4	1	1.5	0.16667
29	3	1	1.0	0.33333
30	4	4	1.5	0.66667
31	4	3	1.5	0.50000
32	6	3	2.5	0.20000
33	12	13	5.5	0.19697
34	17	15	8.0	0.11029
sum	156		sum	19.40171
Clustering coefficient				0.587931

$$C_i = \begin{cases} \frac{k_i}{d_i \times (d_i - 1) / 2} & d_i > 1 \\ 0 & d_i = 0 \text{ or } 1 \end{cases}$$

Calculate average distance between two pairs of nodes and calculate diameter of network

Diameter of the network is 5
Average distance between two pairs of nodes is 2.337

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	MAX	SUM	AVG
1	0	1	1	1	1	1	1	1	1	2	1	1	1	1	3	3	2	1	3	1	3	1	3	3	2	2	3	2	2	3	2	1	2	2	3	58	1.706
2	1	0	1	1	2	2	2	1	2	2	2	2	2	1	3	3	3	1	3	1	3	1	3	3	3	3	3	2	2	3	1	2	2	2	3	68	2.000
3	1	1	0	1	2	2	2	1	1	1	2	2	2	1	2	2	3	2	2	2	2	2	2	2	2	3	3	1	1	2	2	2	1	2	3	59	1.735
4	1	1	1	0	2	2	2	1	2	2	2	2	1	1	3	3	3	2	3	2	3	2	3	3	3	3	3	2	2	3	2	2	2	2	3	71	2.088
5	1	2	2	2	0	2	1	2	2	3	1	2	2	2	4	4	2	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	87	2.559
6	1	2	2	2	2	0	1	2	2	3	1	2	2	2	4	4	1	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	86	2.529
7	1	2	2	2	1	1	0	2	2	3	2	2	2	2	4	4	1	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	86	2.529
8	1	1	1	1	2	2	2	0	2	2	2	2	2	2	3	3	3	2	3	2	3	2	3	3	3	3	4	2	2	3	2	2	2	3	4	75	2.206
9	1	2	1	2	2	2	2	2	0	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	3	3	2	2	2	2	1	2	1	1	3	64	1.882
10	2	2	1	2	3	3	3	2	2	0	3	3	3	2	2	2	4	3	2	2	2	3	2	2	3	3	2	2	2	2	2	2	2	1	4	76	2.235
11	1	2	2	2	1	1	2	2	2	3	0	2	2	2	4	4	2	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	87	2.559
12	1	2	2	2	2	2	2	2	2	3	2	0	2	2	4	4	3	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	90	2.647
13	1	2	2	1	2	2	2	2	2	3	2	2	0	2	4	4	3	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	89	2.618
14	1	1	1	1	2	2	2	2	2	2	2	2	2	0	2	2	3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2	1	3	64	1.882
15	3	3	2	3	4	4	4	3	2	2	4	4	4	2	0	2	5	4	2	2	2	4	2	2	3	3	2	2	2	2	2	2	1	1	5	89	2.618
16	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	0	5	4	2	2	2	4	2	2	3	3	2	2	2	2	2	2	1	1	5	89	2.618
17	2	3	3	3	2	1	1	3	3	4	2	3	3	3	5	5	0	3	5	3	5	3	5	5	4	4	5	4	4	5	4	3	4	4	5	116	3.412
18	1	1	2	2	2	2	2	2	2	3	2	2	2	2	4	4	3	0	4	2	4	2	4	4	3	3	4	3	3	4	2	2	3	3	4	88	2.588
19	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	2	5	4	0	2	2	4	2	2	3	3	2	2	2	2	2	2	1	1	5	89	2.618
20	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	0	2	2	2	2	3	3	2	2	2	2	2	2	2	1	3	66	1.941
21	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	2	5	4	2	2	0	4	2	2	3	3	2	2	2	2	2	2	1	1	5	89	2.618
22	1	1	2	2	2	2	2	2	2	3	2	2	2	2	4	4	3	2	4	2	4	0	4	4	3	3	4	3	3	4	2	2	3	3	4	88	2.588
23	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	2	5	4	2	2	2	4	0	2	3	3	2	2	2	2	2	2	1	1	5	89	2.618
24	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	2	5	4	2	2	2	4	2	0	2	1	2	1	2	1	2	2	1	1	5	84	2.471
25	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	2	0	1	3	1	2	3	3	1	2	2	4	88	2.588
26	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	1	1	0	3	2	2	2	3	1	2	2	4	88	2.588
27	3	3	3	3	4	4	4	4	2	2	4	4	4	2	2	2	5	4	2	2	2	4	2	2	3	3	0	2	2	1	2	2	2	1	5	91	2.676
28	2	2	1	2	3	3	3	2	2	2	3	3	3	2	2	2	4	3	2	2	2	3	2	1	1	2	2	0	2	2	2	2	2	1	4	72	2.118
29	2	2	1	2	3	3	3	2	2	2	3	3	3	2	2	2	4	3	2	2	2	3	2	2	2	2	2	2	0	2	2	1	2	1	4	73	2.147
30	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	2	5	4	2	2	2	4	2	1	3	2	1	2	2	0	2	2	1	1	5	86	2.529
31	2	1	2	2	3	3	3	2	1	2	3	3	3	2	2	2	4	2	2	2	2	2	2	2	3	3	2	2	2	2	0	2	1	1	4	72	2.118
32	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	1	1	2	2	1	2	2	0	1	1	3	61	1.794
33	2	2	1	2	3	3	3	2	1	2	3	3	3	2	1	1	4	3	1	2	1	3	1	1	2	2	2	2	2	1	1	1	0	1	4	64	1.882
34	2	2	2	2	3	3	3	3	1	1	3	3	3	1	1	1	4	3	1	1	1	3	1	1	2	2	1	1	1	1	1	1	1	0	4	60	1.765
DIAMETER OF NETWORK																																			5	AVG	2.337

Find node with highest closeness centrality score

Highest node closeness centrality is 3.515 and normalized closeness centrality is 0.569

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	MAX	SCORE	NORM	
1	0	1	1	1	1	1	1	1	1	2	1	1	1	1	3	3	2	1	3	1	3	1	3	3	2	2	3	2	2	3	2	1	2	2	3	1.758	0.569	
2	1	0	1	1	2	2	2	1	2	2	2	2	2	1	3	3	3	1	3	1	3	1	3	3	3	3	3	2	2	3	1	2	2	2	3	2.061	0.485	
3	1	1	0	1	2	2	2	1	1	1	2	2	2	1	2	2	3	2	2	2	2	2	2	2	2	3	3	1	1	2	2	2	1	2	3	1.788	0.559	
4	1	1	1	0	2	2	2	1	2	2	2	2	1	1	3	3	3	2	3	2	3	2	3	3	3	3	3	2	2	3	2	2	2	2	3	2.152	0.465	
5	1	2	2	2	0	2	1	2	2	3	1	2	2	2	4	4	2	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	2.636	0.379	
6	1	2	2	2	2	0	1	2	2	3	1	2	2	2	4	4	1	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	2.606	0.384	
7	1	2	2	2	1	1	0	2	2	3	2	2	2	2	4	4	1	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	2.606	0.384	
8	1	1	1	1	2	2	2	0	2	2	2	2	2	2	3	3	3	2	3	2	3	2	3	3	3	3	4	2	2	3	2	2	2	3	4	2.273	0.440	
9	1	2	1	2	2	2	2	2	0	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	3	3	2	2	2	2	1	2	1	1	3	1.939	0.516	
10	2	2	1	2	3	3	3	2	2	0	3	3	3	2	2	2	4	3	2	2	2	3	2	2	3	3	2	2	2	2	2	2	2	1	4	2.303	0.434	
11	1	2	2	2	1	1	2	2	2	3	0	2	2	2	4	4	2	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	2.636	0.379	
12	1	2	2	2	2	2	2	2	2	3	2	0	2	2	4	4	3	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	2.727	0.367	
13	1	2	2	1	2	2	2	2	2	3	2	2	0	2	4	4	3	2	4	2	4	2	4	4	3	3	4	3	3	4	3	2	3	3	4	2.697	0.371	
14	1	1	1	1	2	2	2	2	2	2	2	2	2	0	2	2	3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2	1	3	1.939	0.516	
15	3	3	2	3	4	4	4	3	2	2	4	4	4	2	0	2	5	4	2	2	2	4	2	2	3	3	2	2	2	2	2	2	1	1	5	2.697	0.371	
16	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	0	5	4	2	2	2	4	2	2	3	3	2	2	2	2	2	2	1	1	5	2.697	0.371	
17	2	3	3	3	2	1	1	3	3	4	2	3	3	3	5	5	0	3	5	3	5	3	5	5	4	4	5	4	4	5	4	3	4	4	5	3.515	0.284	
18	1	1	2	2	2	2	2	2	2	3	2	2	2	2	4	4	3	0	4	2	4	2	4	4	3	3	4	3	3	4	2	2	3	3	4	2.667	0.375	
19	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	2	5	4	0	2	2	4	2	2	3	3	2	2	2	2	2	2	1	1	5	2.697	0.371	
20	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	0	2	2	2	2	3	3	2	2	2	2	2	2	2	1	3	2.000	0.500	
21	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	2	5	4	2	2	0	4	2	2	3	3	2	2	2	2	2	2	1	1	5	2.697	0.371	
22	1	1	2	2	2	2	2	2	2	3	2	2	2	2	4	4	3	2	4	2	4	0	4	4	3	3	4	3	3	4	2	2	3	3	4	2.667	0.375	
23	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	2	5	4	2	2	2	4	0	2	3	3	2	2	2	2	2	2	1	1	5	2.697	0.371	
24	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	2	5	4	2	2	2	4	2	0	2	1	2	1	2	1	2	2	1	1	5	2.545	0.393	
25	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	2	0	1	3	1	2	3	3	1	2	2	4	2.667	0.375	
26	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	1	1	0	3	2	2	2	3	1	2	2	4	2.667	0.375	
27	3	3	3	3	4	4	4	4	2	2	4	4	4	2	2	2	5	4	2	2	2	4	2	2	3	3	0	2	2	1	2	2	2	1	5	2.758	0.363	
28	2	2	1	2	3	3	3	2	2	2	3	3	3	2	2	2	4	3	2	2	2	3	2	1	1	2	2	0	2	2	2	2	2	1	4	2.182	0.458	
29	2	2	1	2	3	3	3	2	2	2	3	3	3	2	2	2	4	3	2	2	2	3	2	2	2	2	2	2	0	2	2	1	2	1	4	2.212	0.452	
30	3	3	2	3	4	4	4	3	2	2	4	4	4	2	2	2	5	4	2	2	2	4	2	1	3	2	1	2	2	0	2	2	1	1	5	2.606	0.384	
31	2	1	2	2	3	3	3	2	1	2	3	3	3	2	2	2	4	2	2	2	2	2	2	2	3	3	2	2	2	2	0	2	1	1	4	2.182	0.458	
32	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	1	1	2	2	1	2	2	0	1	1	3	1.848	0.541	
33	2	2	1	2	3	3	3	2	1	2	3	3	3	2	1	1	4	3	1	2	1	3	1	1	2	2	2	2	2	1	1	1	0	1	4	1.939	0.516	
34	2	2	2	2	3	3	3	3	1	1	3	3	3	1	1	1	4	3	1	1	1	3	1	1	2	2	1	1	1	1	1	1	1	0	4	1.818	0.550	
DIAMETER OF NETWORK																																				5	3.515	0.569

Gephi results - Not normalized

Label ▲	Degree	Number of triangles	Eccentricity	Clustering Coefficient	Closeness Centrality	Betweenness Centrality	Eigenvector Centrality
01	16	18	3.0	0.15	1.757576	231.071429	0.922465
02	9	12	3.0	0.333333	2.060606	28.478571	0.600023
03	10	11	3.0	0.244444	1.787879	75.850794	0.809326
04	6	10	3.0	0.666667	2.151515	6.288095	0.52246
05	3	2	4.0	0.666667	2.636364	0.333333	0.211959
06	4	3	4.0	0.5	2.606061	15.833333	0.22586
07	4	3	4.0	0.5	2.606061	15.833333	0.22586
08	4	6	4.0	1.0	2.272727	0.0	0.429562
09	5	5	3.0	0.5	1.939394	29.529365	0.604308
10	2	0	4.0	0.0	2.30303	0.447619	0.270907
11	3	2	4.0	0.666667	2.636364	0.333333	0.211959
12	1	0	4.0	0.0	2.727273	0.0	0.140743
13	2	1	4.0	1.0	2.69697	0.0	0.219014
14	5	6	3.0	0.6	1.939394	24.215873	0.489921
15	2	1	5.0	1.0	2.69697	0.0	0.27549
16	2	1	5.0	1.0	2.69697	0.0	0.27549
17	2	1	5.0	1.0	3.515152	0.0	0.074117
18	2	1	4.0	1.0	2.666667	0.0	0.230881
19	2	1	5.0	1.0	2.69697	0.0	0.27549
20	3	1	3.0	0.333333	2.0	17.146825	0.381378
21	2	1	5.0	1.0	2.69697	0.0	0.27549
22	2	1	4.0	1.0	2.666667	0.0	0.230881
23	2	1	5.0	1.0	2.69697	0.0	0.27549
24	5	4	5.0	0.4	2.545455	9.3	0.414003
25	3	1	4.0	0.333333	2.666667	1.166667	0.161771
26	3	1	4.0	0.333333	2.666667	2.027778	0.168968
27	2	1	5.0	1.0	2.757576	0.0	0.206758
28	4	1	4.0	0.166667	2.181818	11.792063	0.360355
29	3	1	4.0	0.333333	2.212121	0.947619	0.350427
30	4	4	5.0	0.666667	2.606061	1.542857	0.370582
31	4	3	4.0	0.5	2.181818	7.609524	0.455212
32	6	3	3.0	0.2	1.848485	73.009524	0.52255
33	12	13	4.0	0.19697	1.939394	76.690476	0.835129
34	17	15	4.0	0.110294	1.818182	160.551587	1.0

Gephi results - Normalized

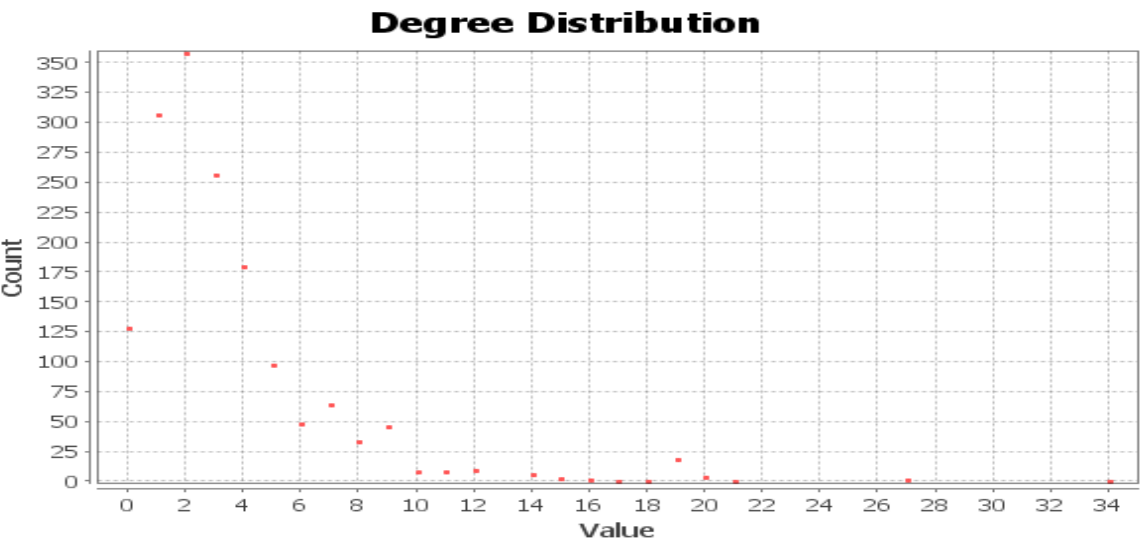
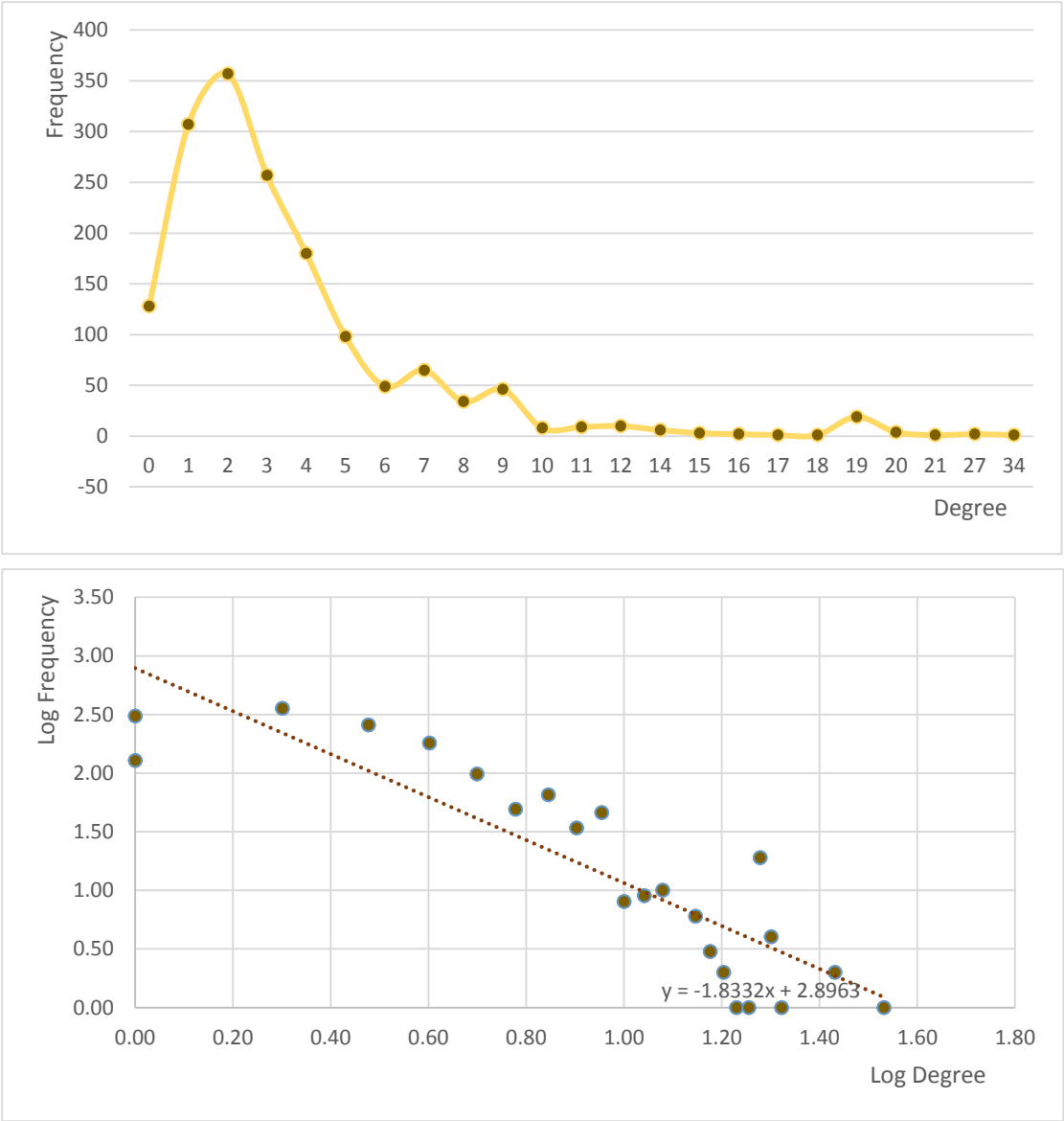
Label ▲	Degree	Number of triangles	Eccentricity	Clustering Coefficient	Closeness Centrality	Betweenness Centrality	Eigenvector Centrality
01	16	18	3.0	0.15	0.568966	0.437635	0.95754
02	9	12	3.0	0.333333	0.485294	0.053937	0.70159
03	10	11	3.0	0.244444	0.559322	0.143657	0.838534
04	6	10	3.0	0.666667	0.464789	0.011909	0.556486
05	3	2	4.0	0.666667	0.37931	0.000631	0.213923
06	4	3	4.0	0.5	0.383721	0.029987	0.227546
07	4	3	4.0	0.5	0.383721	0.029987	0.227546
08	4	6	4.0	1.0	0.44	0.0	0.45043
09	5	5	3.0	0.5	0.515625	0.055927	0.605076
10	2	0	4.0	0.0	0.434211	0.000848	0.271522
11	3	2	4.0	0.666667	0.37931	0.000631	0.213923
12	1	0	4.0	0.0	0.366667	0.0	0.143296
13	2	1	4.0	1.0	0.370787	0.0	0.224862
14	5	6	3.0	0.6	0.515625	0.045863	0.599325
15	2	1	5.0	1.0	0.370787	0.0	0.271269
16	2	1	5.0	1.0	0.370787	0.0	0.271269
17	2	1	5.0	1.0	0.284483	0.0	0.073452
18	2	1	4.0	1.0	0.375	0.0	0.246237
19	2	1	5.0	1.0	0.370787	0.0	0.271269
20	3	1	3.0	0.333333	0.5	0.032475	0.395132
21	2	1	5.0	1.0	0.370787	0.0	0.271269
22	2	1	4.0	1.0	0.375	0.0	0.246237
23	2	1	5.0	1.0	0.370787	0.0	0.271269
24	5	4	5.0	0.4	0.392857	0.017614	0.406733
25	3	1	4.0	0.333333	0.375	0.00221	0.158697
26	3	1	4.0	0.333333	0.375	0.00384	0.165242
27	2	1	5.0	1.0	0.362637	0.0	0.203735
28	4	1	4.0	0.166667	0.458333	0.022333	0.358689
29	3	1	4.0	0.333333	0.452055	0.001795	0.349596
30	4	4	5.0	0.666667	0.383721	0.002922	0.364045
31	4	3	4.0	0.5	0.458333	0.014412	0.46276
32	6	3	3.0	0.2	0.540984	0.138276	0.518685
33	12	13	4.0	0.19697	0.515625	0.145247	0.825572
34	17	15	4.0	0.110294	0.55	0.304075	1.0

Question 5

Draw degree distribution of whole network

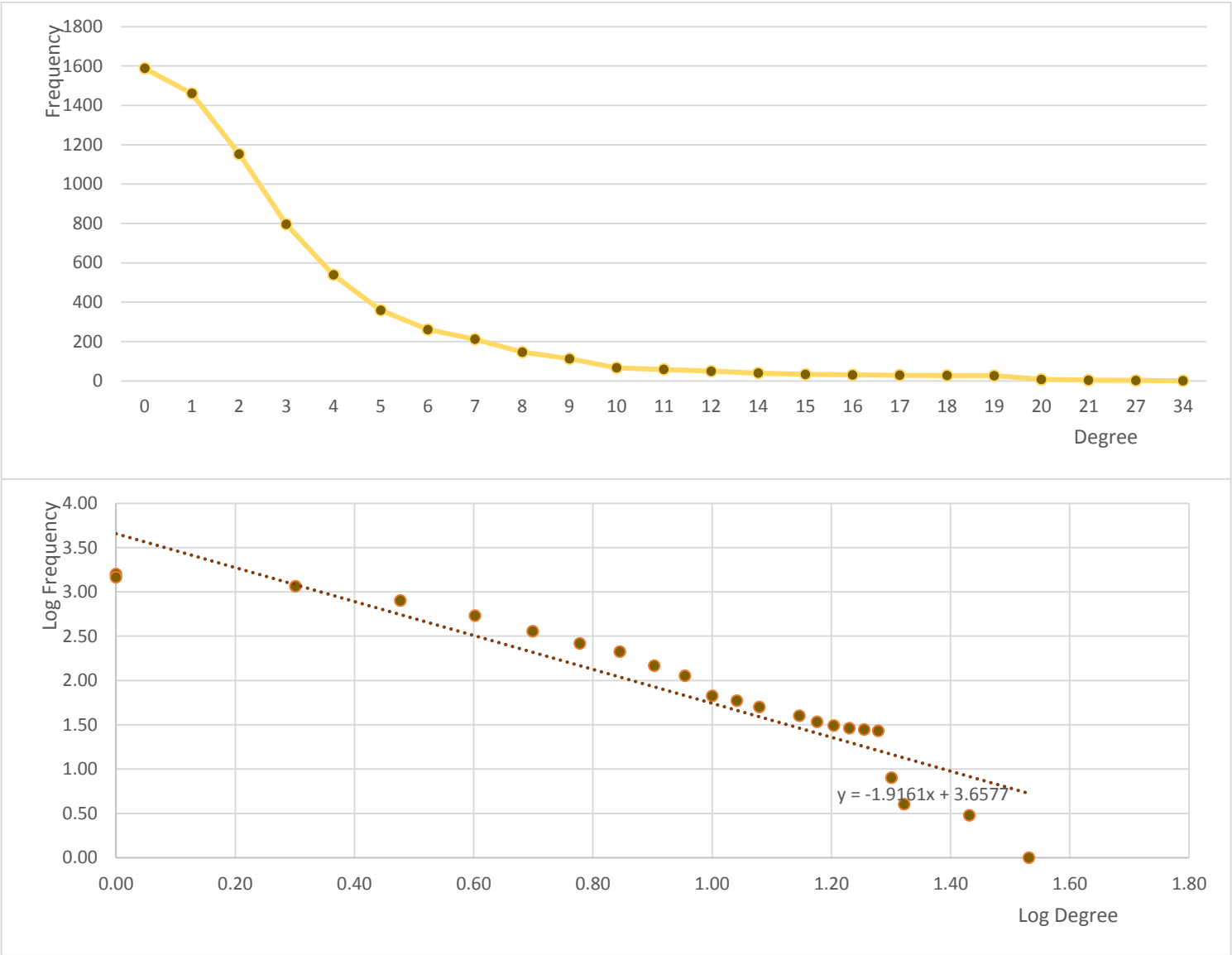
The first graph shows degree of distribution while second graph shows log-log scale and validates power law distribution.

Row Labels	Degree Count
0	128
1	307
2	357
3	257
4	180
5	98
6	49
7	65
8	34
9	46
10	8
11	9
12	10
14	6
15	3
16	2
17	1
18	1
19	19
20	4
21	1
27	2
34	1
Grand Total	1588



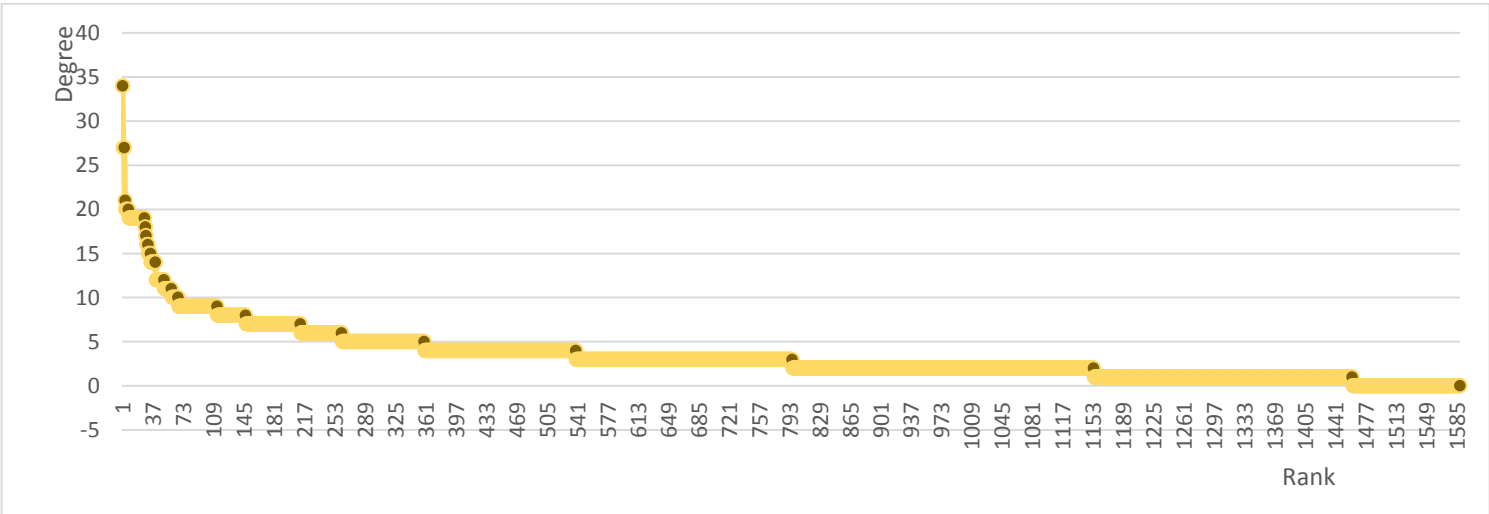
Cumulative degree distribution of the network with log-log space

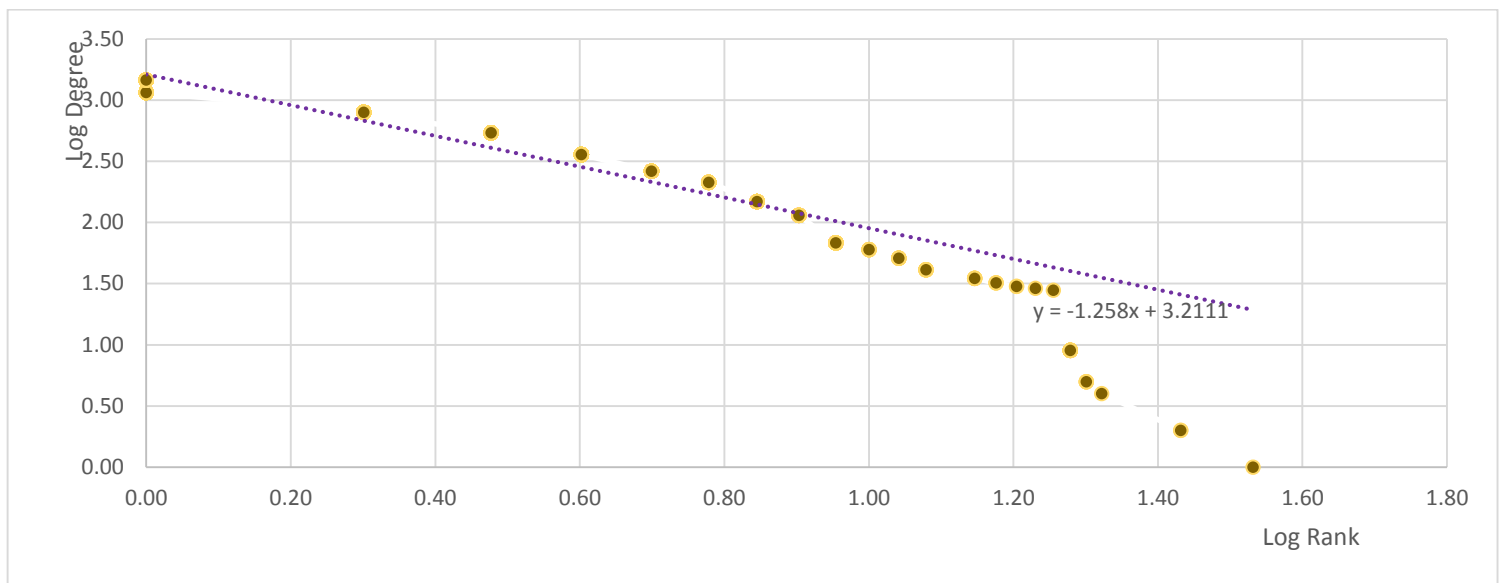
The first graph shows cumulative degree of distribution while second graph shows log-log scale and shows power law distribution.



Rank degree distribution with log-log space

The first graph shows rank degree of distribution while second graph shows log-log scale and validates power law distribution.





Clustering coefficient and diameter of the network

Clustering coefficient of the network is 0.878 and diameter of the network is 17.

Network Overview		
Average Degree	3.451	Run ⓘ
Avg. Weighted Degree	1.498	Run ⓘ
Network Diameter	17	Run ⓘ
Graph Density	0.002	Run ⓘ
Modularity	0.955	Run ⓘ
PageRank		Run ⓘ
Connected Components	396	Run ⓘ
Node Overview		
Avg. Clustering Coefficient	0.878	Run ⓘ
Eigenvector Centrality		Run ⓘ