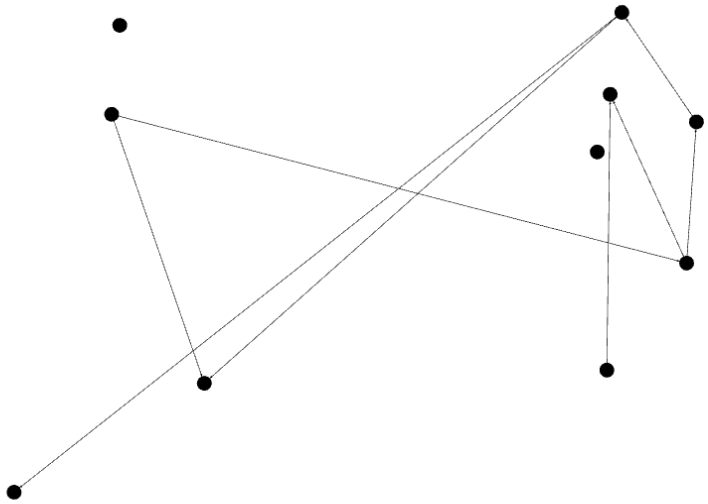
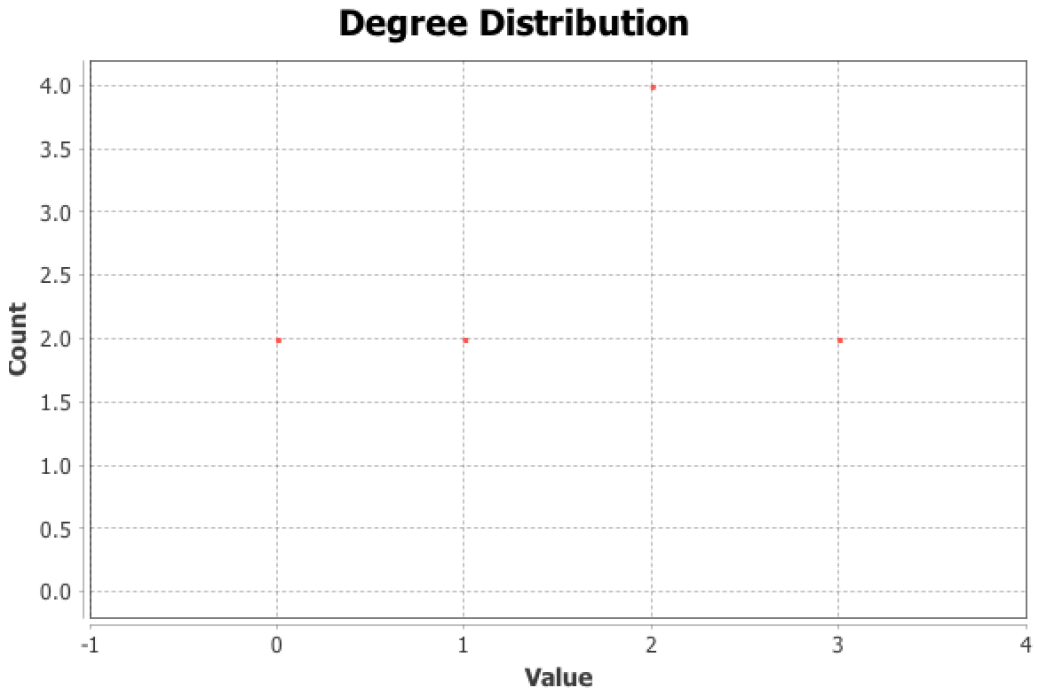
Aishwarya Prem Renu - HW 1

Q1 (a, b)

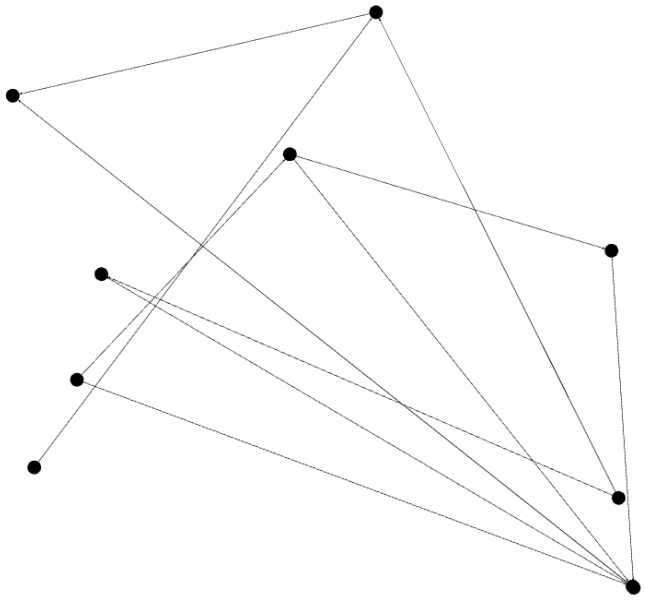
p(Connection) = (1/6)



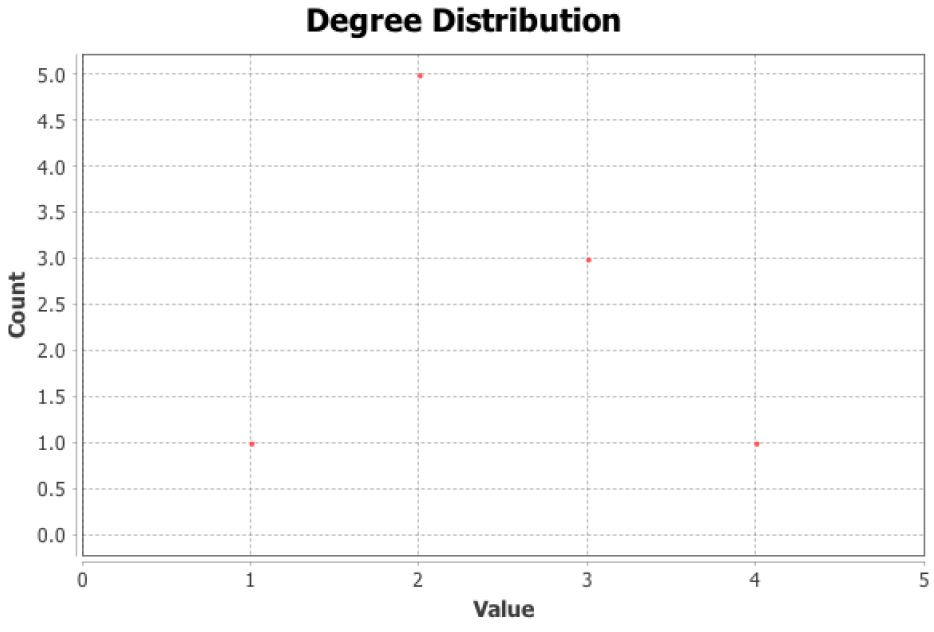
- The graph is not fully-connected. There are two unreachable nodes
- There are 8 edges
- The average degree = 0.8, network diameter = inf
- There is 1 cycle
- Average clustering coefficient = 0 (no triangles in graph)



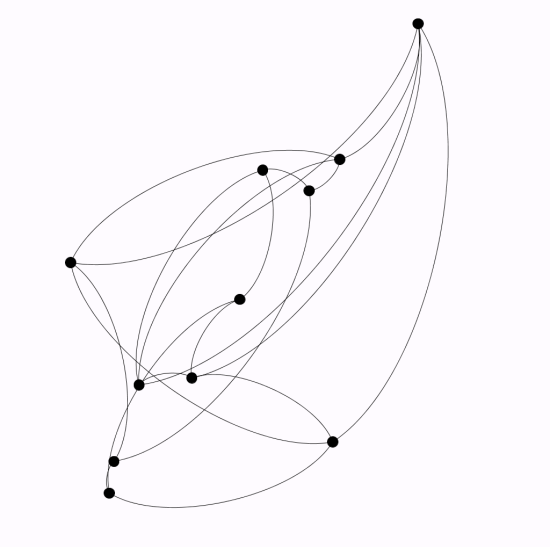
p(Connection) = (1/3)



- The graph is fully-connected.
- There are 12 edges
- The average degree = 1.2, network diameter = 4, Avg path length = 2.178
- There are cycles in the graph
- Average clustering coefficient = 0.167 (1 triangle in graph)

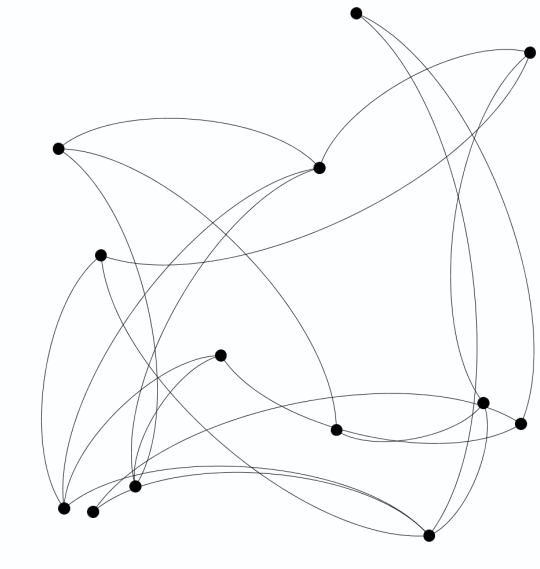


Q1 c)



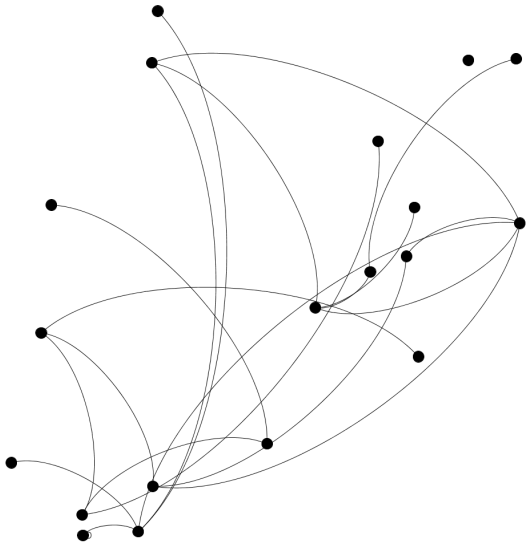
Wood: I had 2 concentric circles, 1 mode at their centre, 5 nodes on each circle. Each node on the circles connected to its immediate neighbors. Corresponding nodes on each of the circles connected to each other, and the all the nodes on the first circle connected to the centre. (11 nodes, 20 edges)

Average degree: 3.33
Path Length: 1.818
Connected Components: 1
Clustering Coefficient: 0.197
Total triangles: 5



Asphalt: I had a bunch of quadrilaterals and triangles connected together with common edges. (13 nodes, 20 edges)

Average degree: 3.077
Path Length: 2.128
Connected Components: 1
Clustering Coefficient: 0.11
Total Triangles: 2

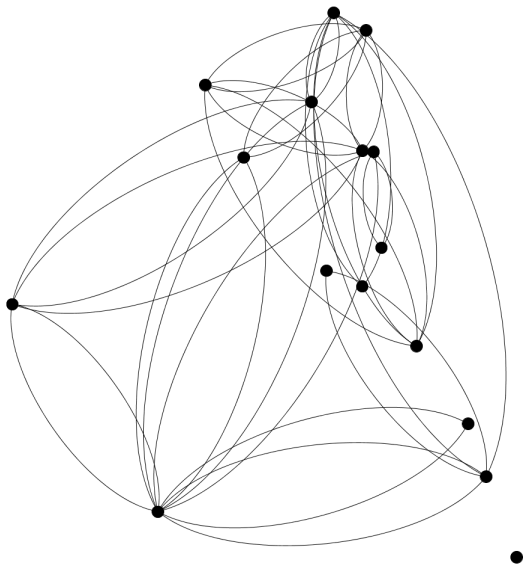


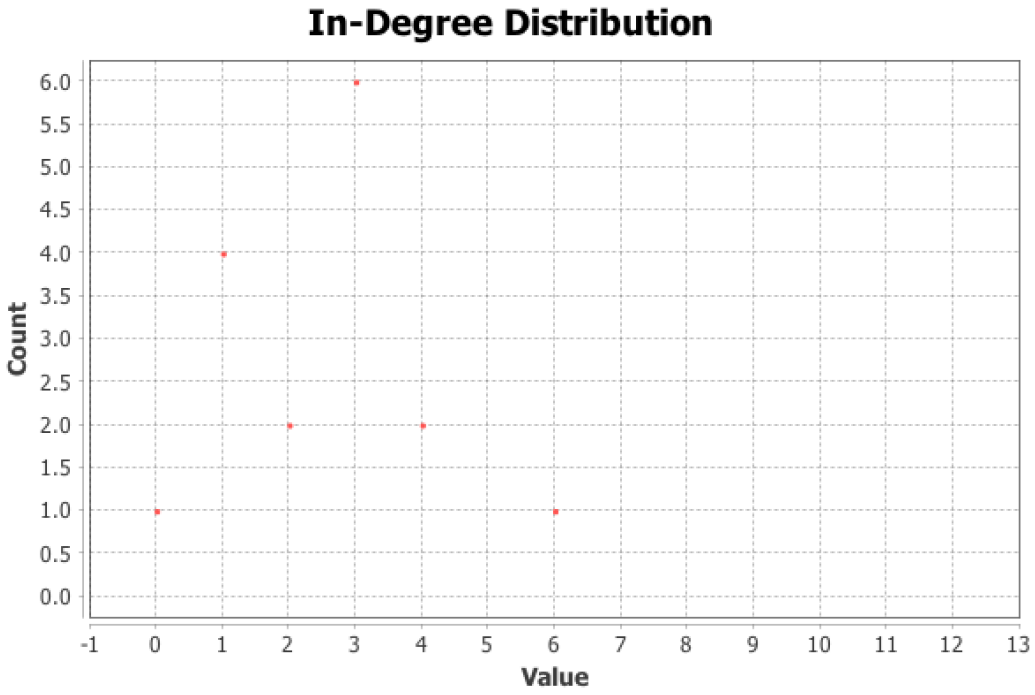
Glass: This is similar to the wood but there are some single nodes which are not all connected to each other. (19 nodes, 21 edges)

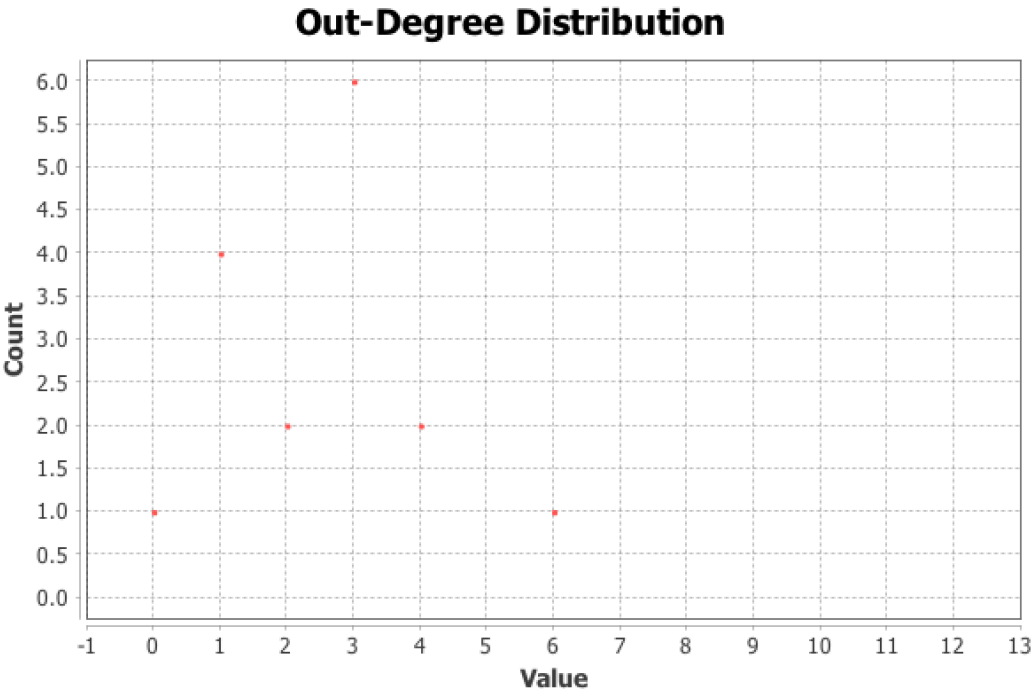
Average degree: 2.211
Path Length: 3.503
Connected Components: 2
Clustering Coefficient: 0.233
Total Triangles: 3

Here we can see a clear difference in the average degree between nodes in glass vs wood. Glass is the most brittle of the 3, whereas wood is the least brittle, and we can see that the degree is higher in wood than glass showing that there are more connections per node. We can also see that the clustering coefficient in wood is lower, meaning that the connections are more spread out, and there is kind of a mesh when compared to glass making glass more brittle and asphalt has the least clustering coefficient.
Path length is lowest in wood, and I think that this could relate to connections between nodes which are further apart being still a few nodes away, leading to ore elasticity when compared with glass – a connection indicating that the nodes can be moved away while still maintaining the integrity of the material.

Q2. a)





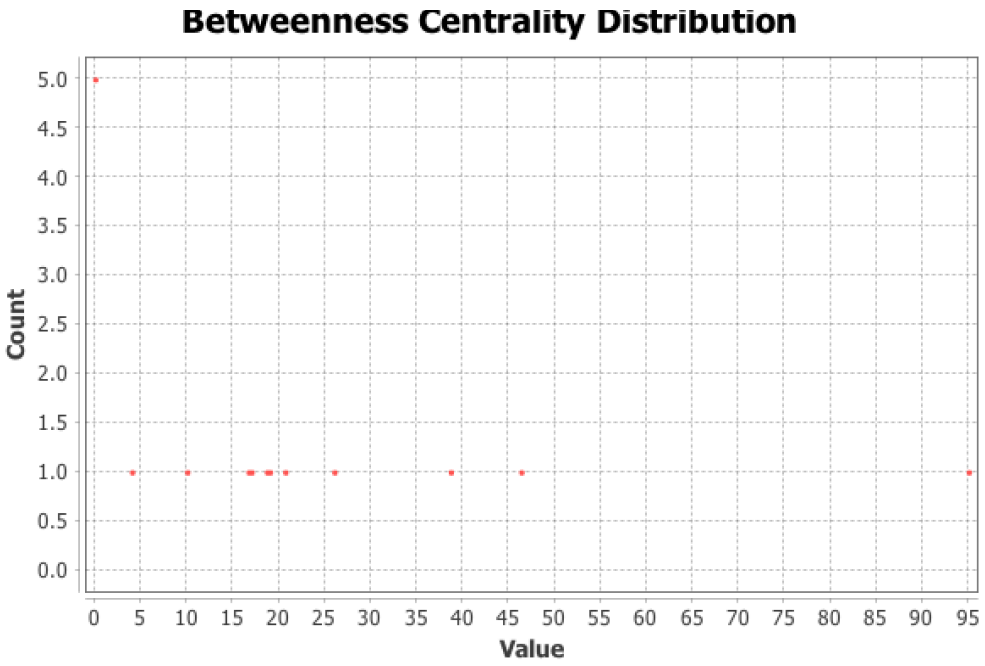


Q2 b)

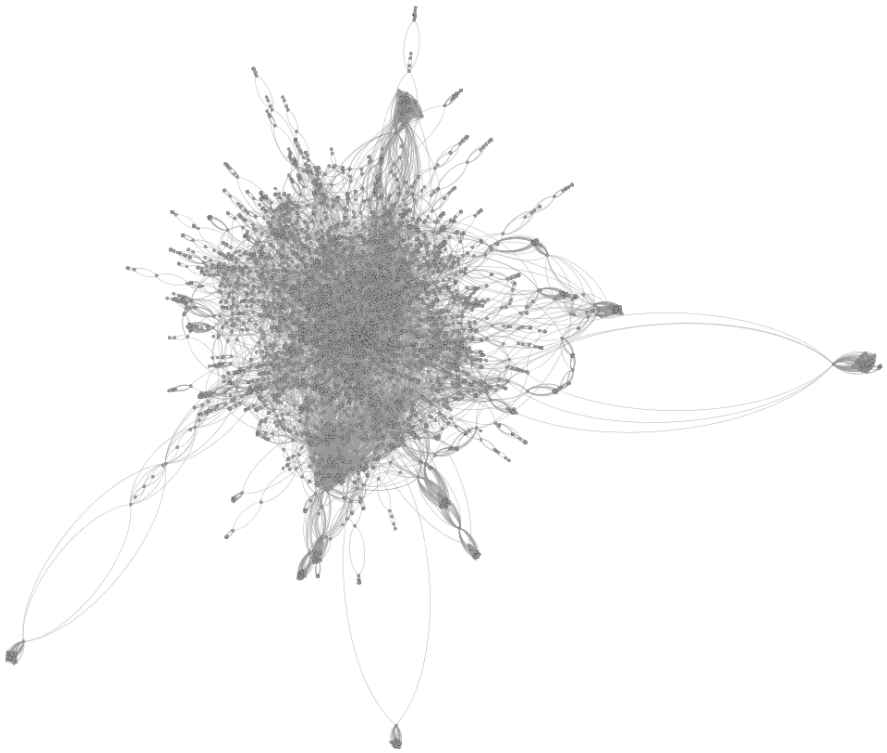
Average distance of strongly connected component = 2.4857
Network diameter = 5

We can see that this distance is lesser than the network diameter which makes sense. This is because there are some nodes which are not strongly connected to the largest strongly connected component, which is what causes the increase in network diameter when compared with the average distance.

Q2 c)

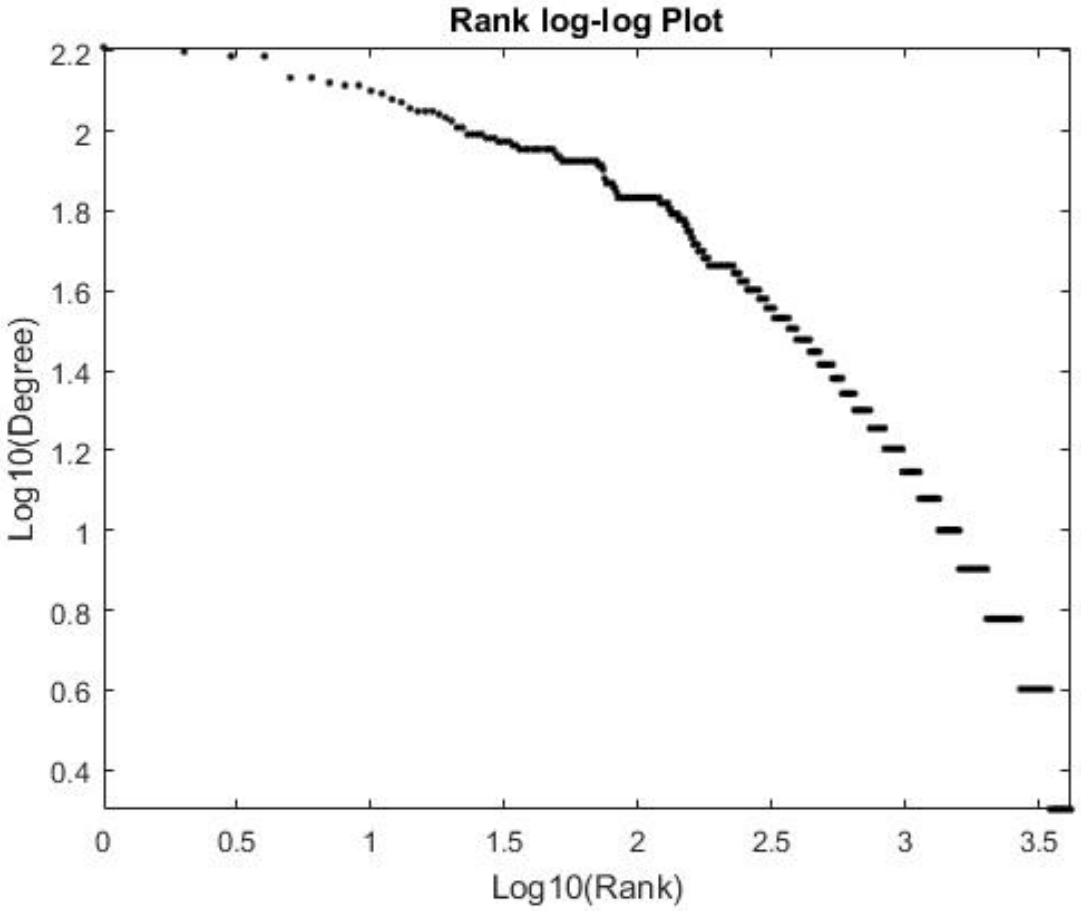


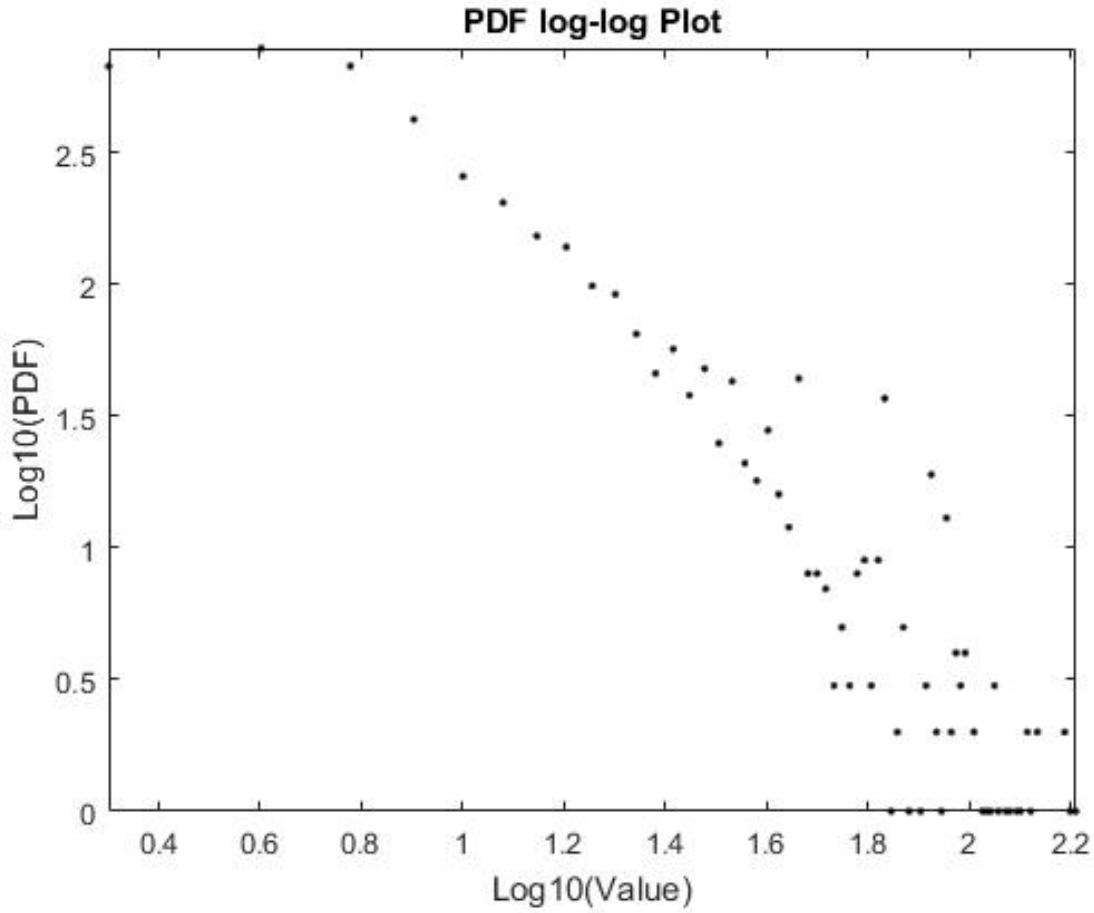
Q3. a)



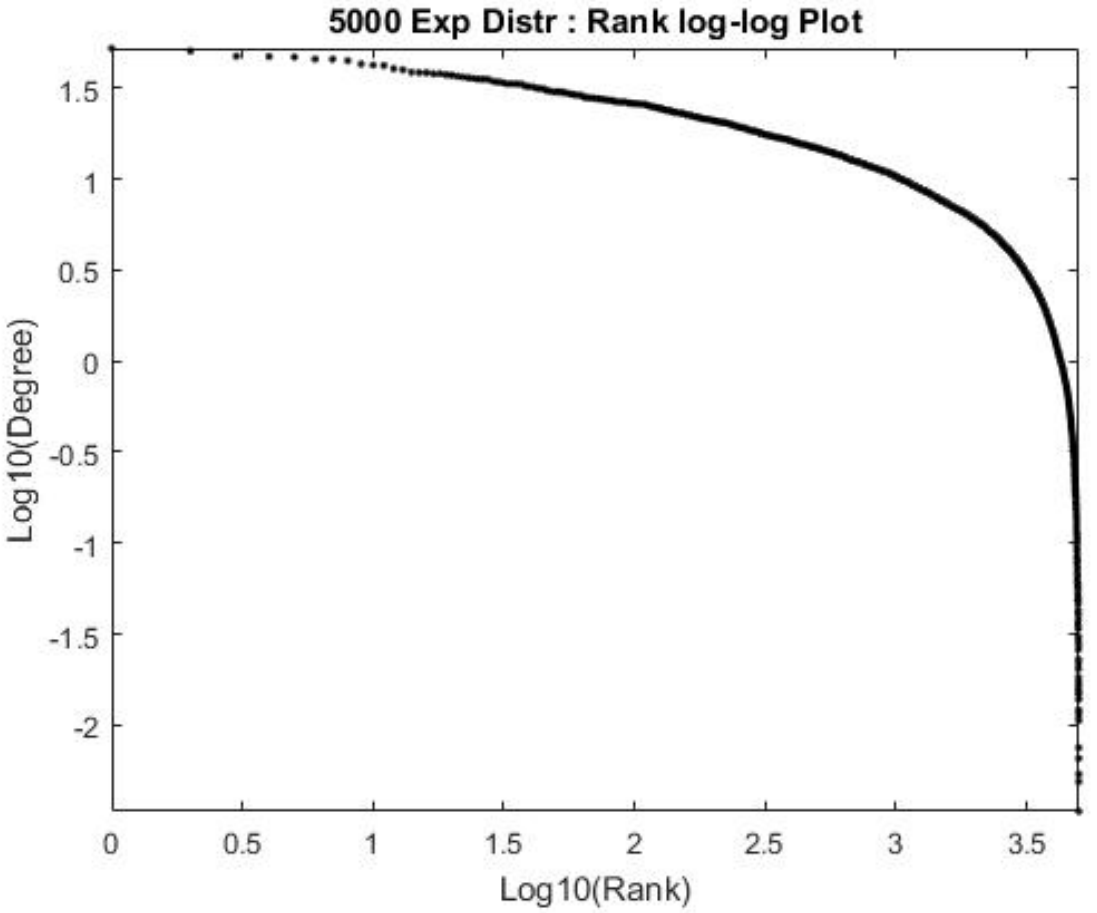
Average degree = 6.457
Average path length = 6.05
Diameter = 17
Average clustering coefficient of this network = 0.557

Q3. b)




PDF log-log Plot
Log10(PDF)
Log10(Value)
2.5
2
1.5
1
0.5
0
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2

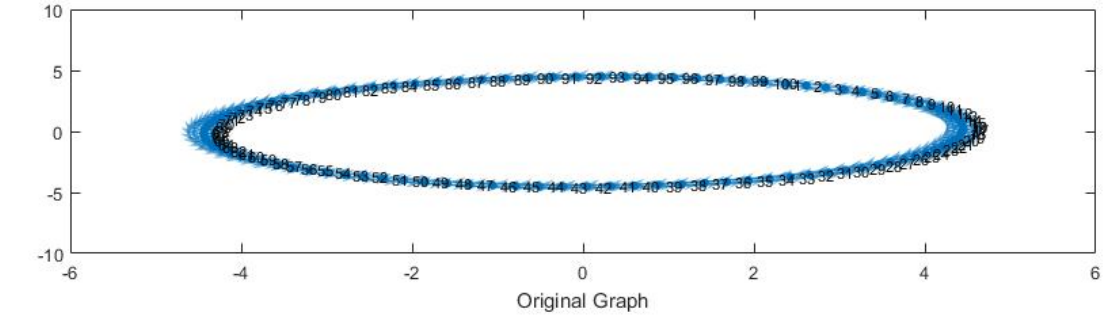
Q3. c)

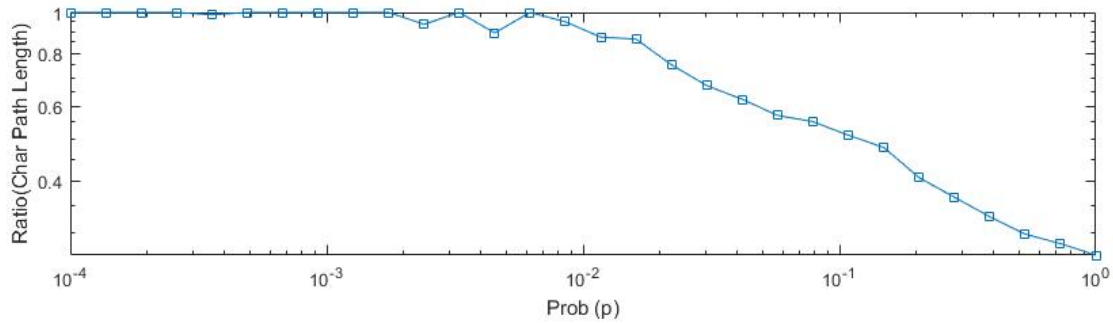

5000 Exp Distr : Rank log-log Plot
Log10(Degree)
Log10(Rank)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
0.5
1
1.5
2
2.5
3
3.5

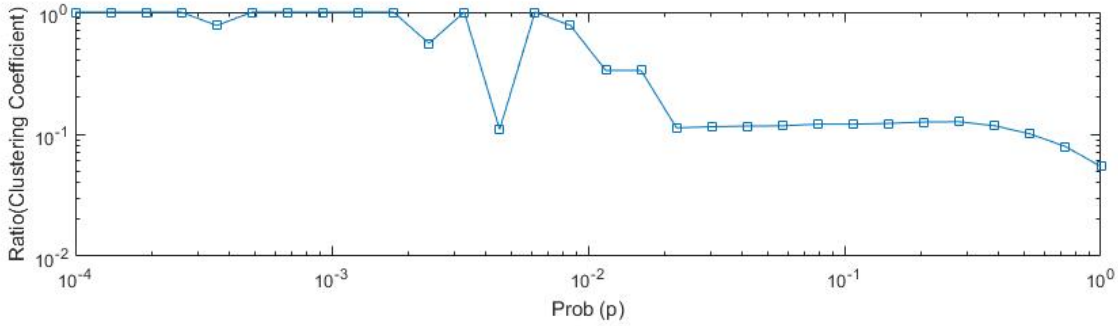
The collaboration network is an exponentially distributed network in terms of the degrees of nodes - as we can see the rank plots have a similar shape. Hence, the graphs look like the collaboration network is a scale-free network with power law degree distribution.

Q4.

As we can see below, as we increased the randomness of the graph, the characteristic path length decreased and so did the clustering coefficient. With the original method of connecting each node to its nearest 4 neighbors, most of the neighbors were





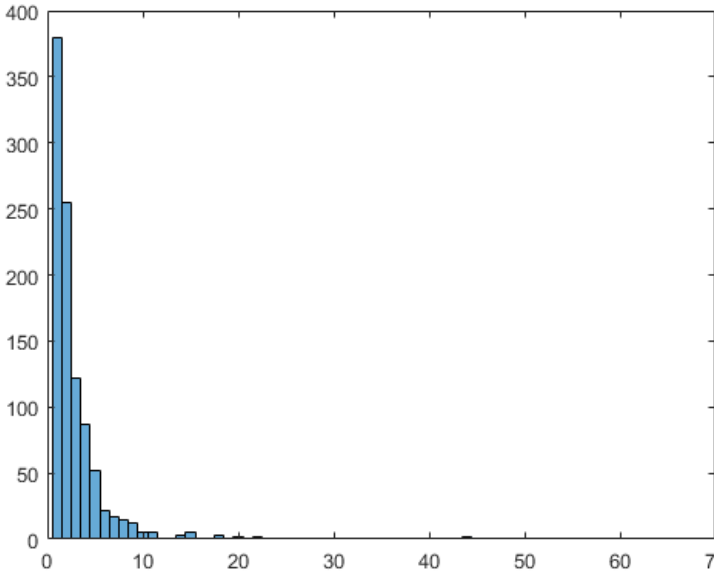


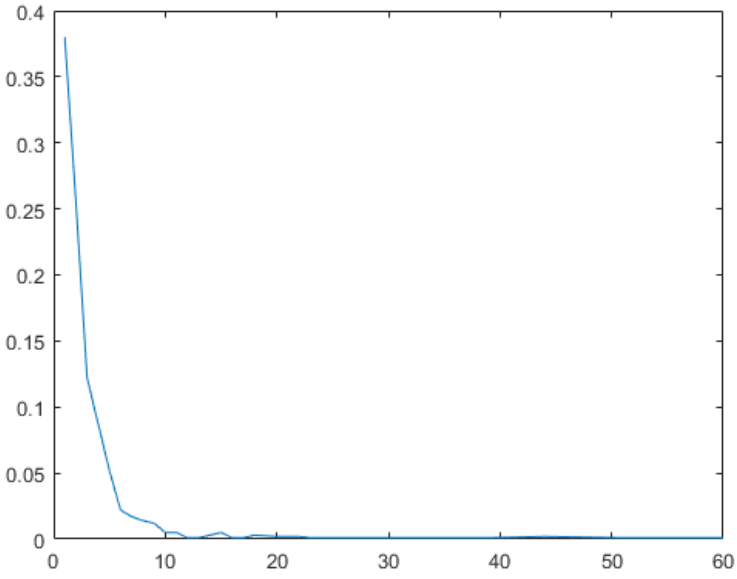
connected to each other because of their geographical distribution on the circle. Hence, when two of these edges were moved to an edge somewhere further away in the graph, this reduced the clustering coefficient, since it is less likely that those two random edges were also connected when compared to the likeliness if they were actual neighbors. Also, since we are now connecting to random nodes which are likely to be further away than the closest 4 neighbors for 100 nodes, the average path reduces since we are now able to easily connect to possibly far regions of the graph.

Q5.

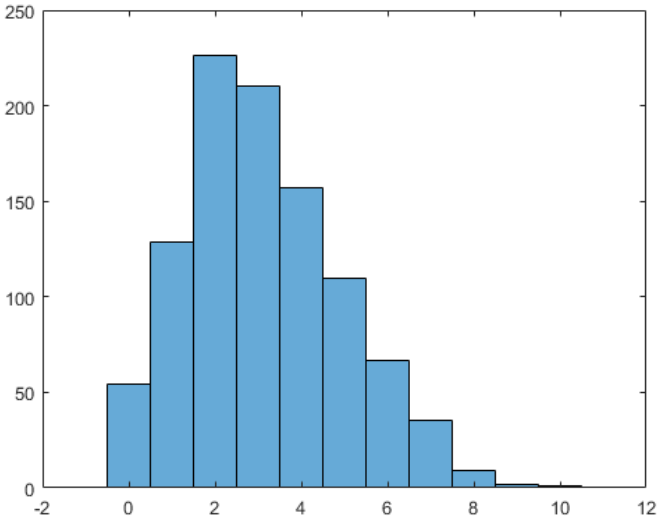
Degree distributions of the two graphs:

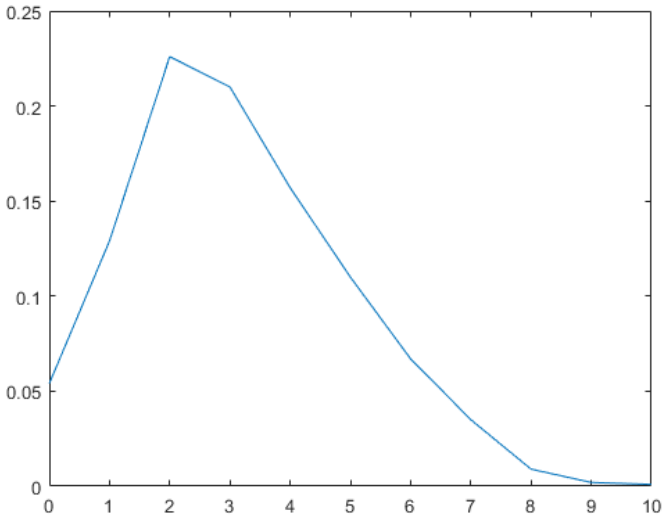
Graph 1:





Graph 2:





^Number of nodes
|
|
|
————————————> Degree

As we can see above, there is a huge difference in the distributions of the above two graphs. The first graph has a power law distribution whereas the second has a normal distribution. As we can see, the stats are the following:

Graph1:
Max degree: 76
Min degree: 1
Hubs: There are a few hubs with a large number of edges.
Clustering Coefficient: 0.0169

Graph1:
Max degree: 9
Min degree: 0
Hubs: There are a large number of hubs with moderate number of edges.
Clustering Coefficient: 0.0036