COMP0123 Complex Networks and Webs Coursework 1 Report

Roman Ryan Karim

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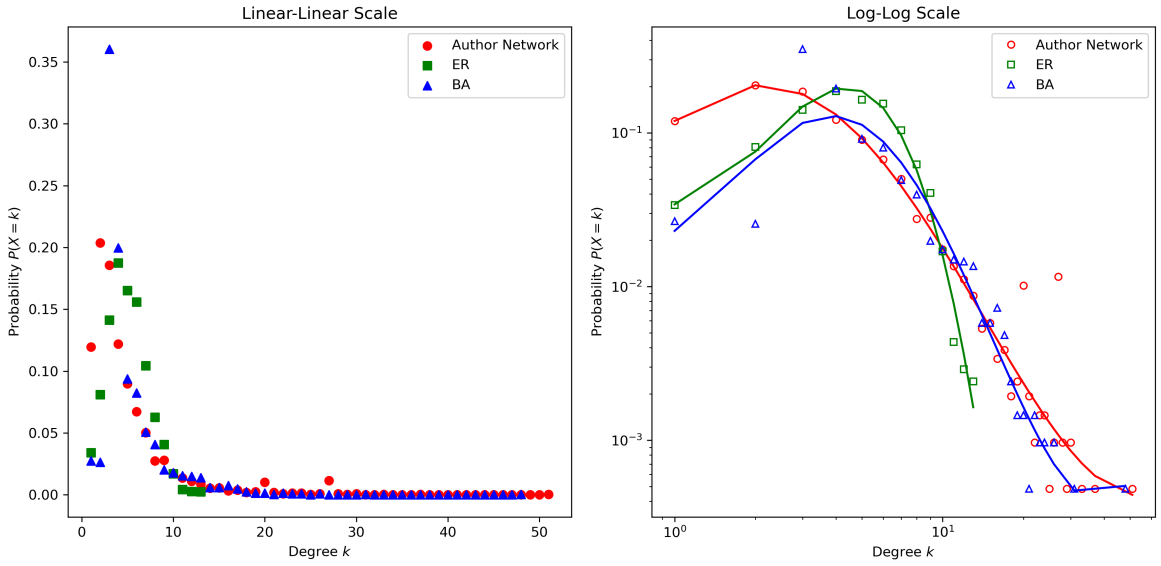
Task 1 - (15 marks)

- Calculate the average node degree and the maximum node degree of the 3 networks.
- Plot their degree distribution $P(k)$ on linear-linear scale and log-log scale, respectively.
- Estimate the power-law exponent of the degree distribution $P(k)$ of the author network only.
  - You can fit a curve by using the function polyfit from the numpy library.
  - Ideally, you can do the fitting on CCDF (the complementary cumulative distribution function) on log-log scale.
- Briefly discuss your results, e.g. difference of the networks.

The average node degree is given by $\bar{k} = \frac{1}{N}\sum_{i=1}^{N} = \frac{2E}{N}$. Given that all 3 of our networks (author network, random network & BA network) have 2,068 unique nodes and 5,163 unique links; $\bar{k} = \frac{2(5163)}{2068} = 4.99$ (2 d.p.).

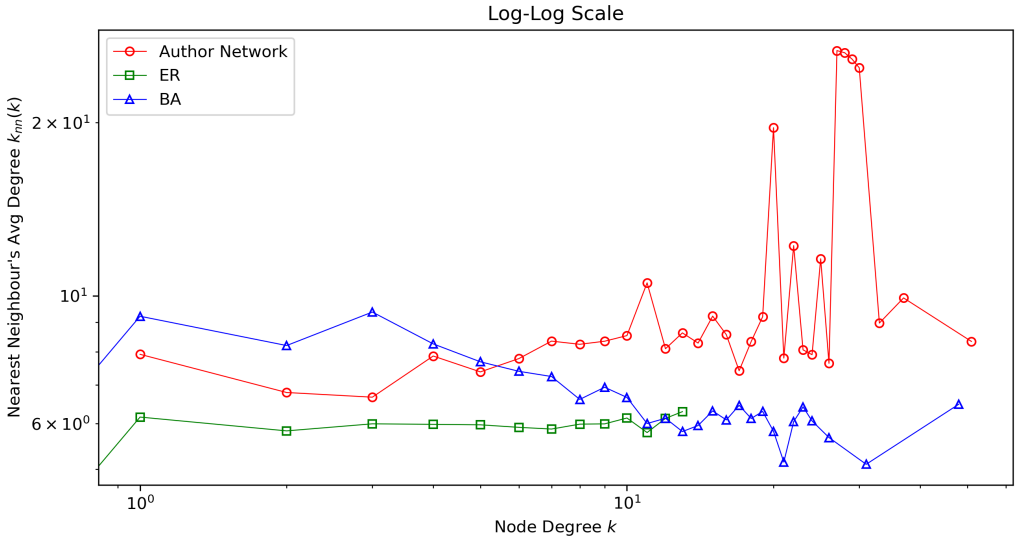
Networks	Average Node Degree	Maximum Node Degree
Author Network	4.99	51
Random Network	4.99	13
BA Network	4.99	48



We estimate the power-law exponent to be $\alpha = 2.01$ for the author network.

Task 2 - (15 marks)

- Calculate and plot the nearest neighbour's average degree k_{nn} as a function of degree k, on log-log scale.
- Calculate the assortative coefficient of the networks.
- Briefly discuss your results

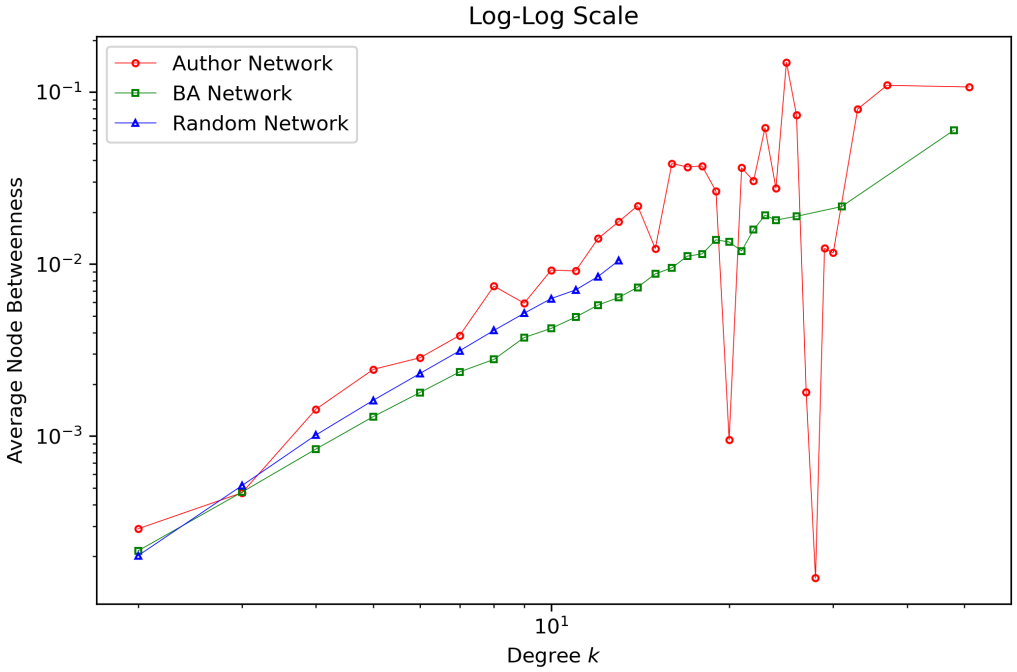


Networks	**Assortative Coefficient**
Author Network	0.47
Random Network	0.01
BA Network	- 0.16

Task 3 - (15 marks)

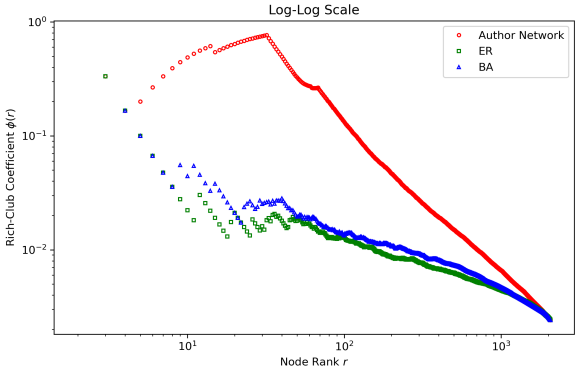
- Calculate the diameter and the average shortest path length of the network
- Calculate and plot the average node between of k-degree nodes as a function of node degree k, where node betweenness is normalised, on log-log scale.
- Briefly discuss your results.

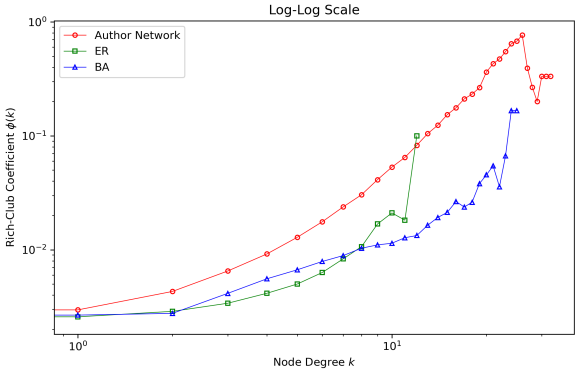
Networks	**Diameter**	**Avg Shortest Path Length**
Author Network	19	7.30
Random Network	10	4.93
BA Network	10	4.56



Task 4 - (15 marks)

- Calculate and plot the rich-club coefficient as a function of node rank on log-log scale
- Calculate and plot the rich-club coefficient as a function of node degree on log-log scale
- Briefly discuss your result



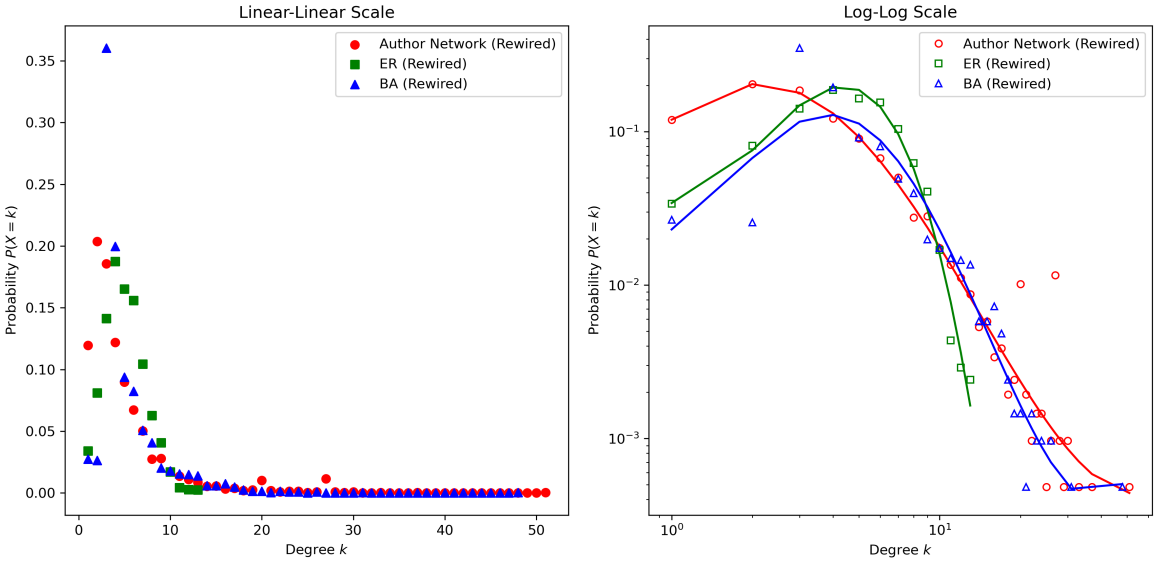


Task 5 - (15 marks)

- Obtain the community structure (with the largest modularity value) of the 3 networks
- Give the number of communities and the size (i.e. number of nodes) of the top 3 largest communities in each netwoork.
- Visualise the network and show each community with a different colour.
- Briefly discuss your result

Task 6 - (25 marks)

- Randomly rewire the 3 networks while preserving the degree distribution; and obtain the maximal random case of each network
- For the 3 randomised networks, plot their degree distribution
- Calculate the average clustering coefficient, the assortative coefficient, and the average shortest path length of the 3 networks and the 3 randomised networks; show and compare the results in a table
- Briefly discuss you result.



	Avg Clustering Coefficient	**Assortative Coefficient**	**Avg Shortest Path Length**
Author Network	0.62	0.47	7.30
Author Network (rewired)	0.01	0.05	4.43
Random Network	0.00	0.01	4.93
Random Network (rewired)	0.00	-0.03	4.94
BA Network	0.01	-0.16	4.56
BA Network (rewired)	0.00	-0.13	4.55

References