COMP0123 Complex Networks and Webs Coursework 1 Report

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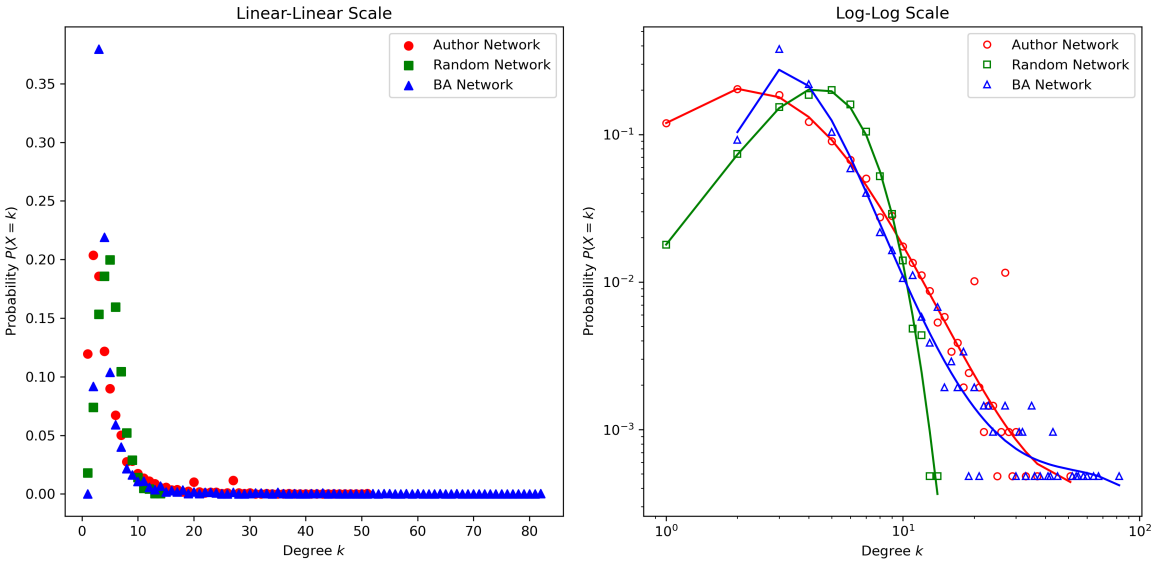
Task 1 - (15 marks)

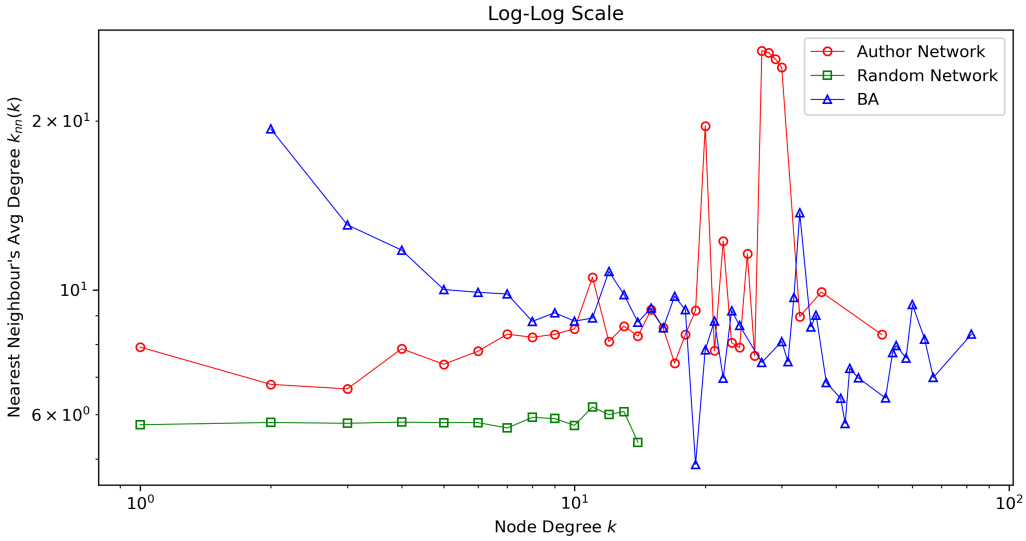
- Calculate the average node degree and the maximum node degree of the 3 networks.
- Plot their degree distribution $P(k)$ on linear-linear scale and log-log scale, respectively.
- Estimate the power-law exponent of the degree distribution $P(k)$ of the author network only.
  - You can fit a curve by 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.

	Author Network	**Random Network**	**BA Network**
Average Degree $\bar{k}$	4.99	4.99	4.99
Maximum Degree k_{max}	51	14	82
Power-Law Exponent α	2.01		



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

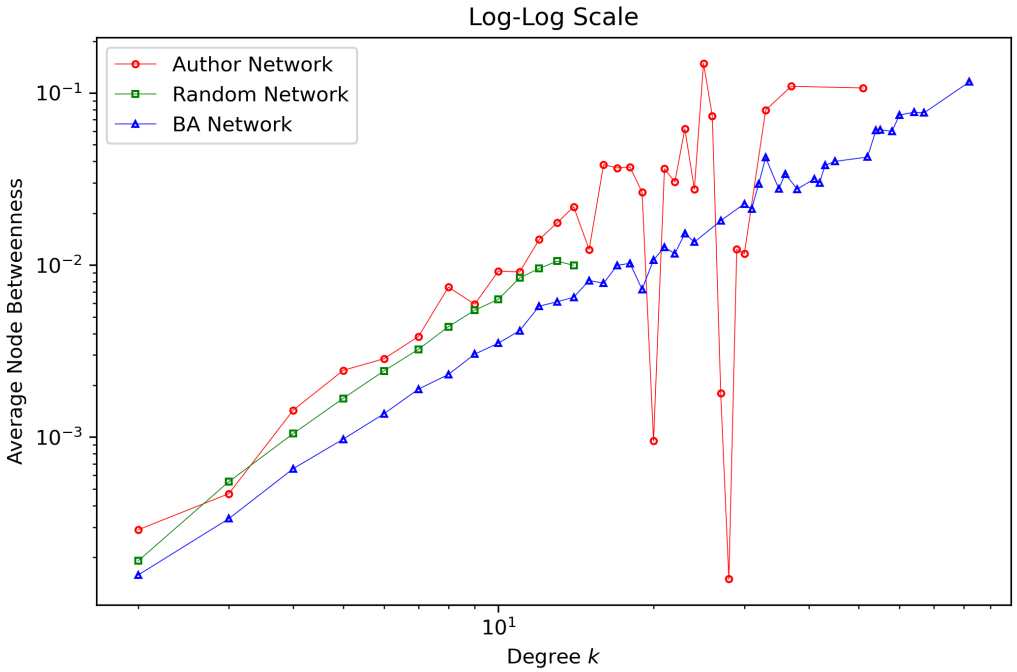


	Author Network	**Random Network**	**BA Network**
Assortative coefficient α	0.47	0.01	-0.09

Task 3 - (15 marks)

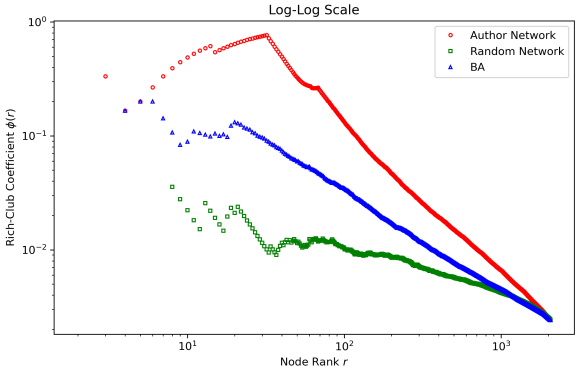
- Calculate the diameter and the average shortest path length of the network
- Calculate and plot the average node between of k-degree nodes as a function of node degree k, where node betweenness is normalised, on log-log scale.
- Briefly discuss your results.

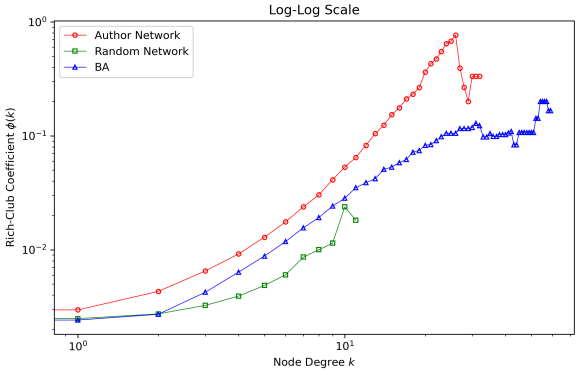
	Author Network	**Random Network**	**BA Network**
Diameter d	19	10	7
Average shortest path length ℓ	7.30	4.97	4.18



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



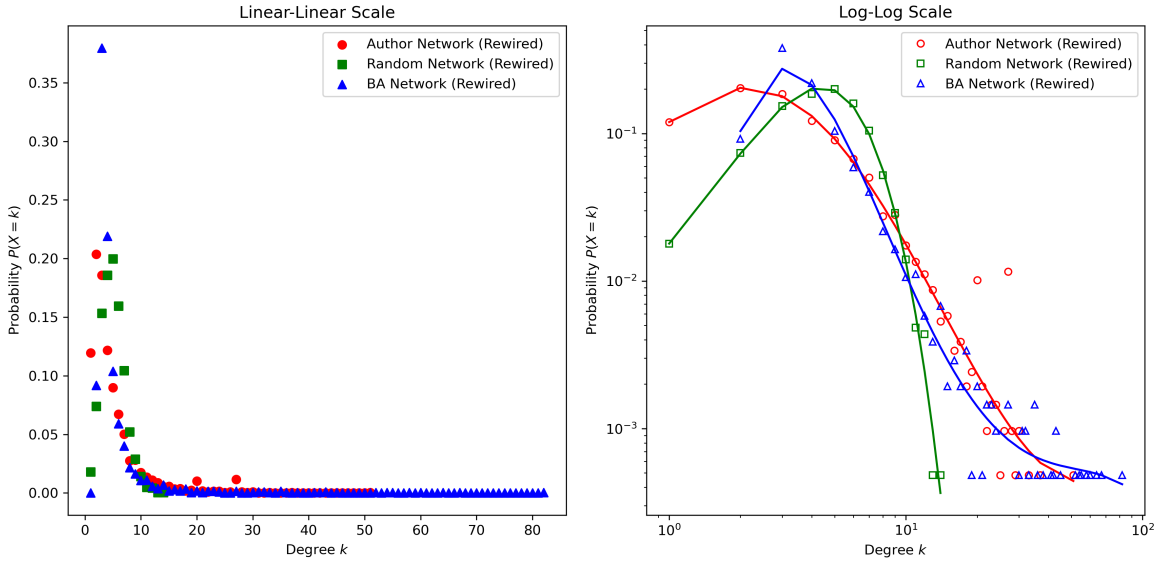


Task 5 - (15 marks)

- 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 3 networks. In each network, show every 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
- For each of the randomised networks, calculate the average clustering coefficient, the assortative coefficient, the size of the giant component, and the average shortest path length in the giant component. Show these results and compare with those of the 3 original networks in a table,
- Briefly discuss your result.



Original	**Author Network**	**Random Network**	**BA Network**
Giant Component Size N	2068	2068	2068
Average Clustering Coefficient C	0.62	0.00	0.01
Assortative coefficient α	0.47	0.01	-0.09
Average shortest path length ℓ	7.30	4.97	4.18
Rewired			
Giant Component Size N			
Average Clustering Coefficient C	0.01	0.00	0.01
Assortative coefficient α	0.05	0.01	-0.02
Average shortest path length ℓ	4.44	4.98	4.24

References