Complex Networks

Project 3: Network models

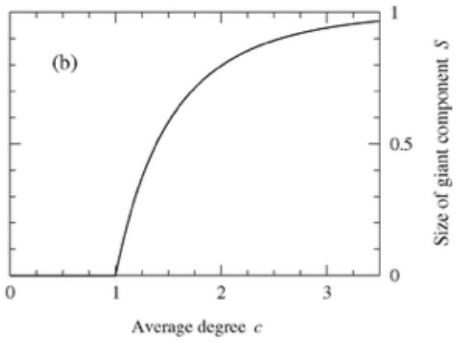
Send the solutions to: projetosicmc@gmail.com

1 – Comparison of network models

- Generate 30 networks according to the models: Erdös-Rényi, Watts-Strogatz (p=0.01 and p=0.1) e Barabási-Albert. Consider N = 1000 and <k> = 10.
- In table, include the mean and standard deviation of the following measures: (i) number o nodes, (ii) average degree, (iii) second moment of degree distribution, (iv) average shortest path length, (v) average clustering coefficient, (vi) transitivity, (vii) assortativity coefficient.
- Show the degree distributions of the ER, WS and BA networks
- Discuss the main differences and similarities between the models.

2 – Erdös-Rényi network model

- For the model ER (N,p), obtain the phase transition curve:



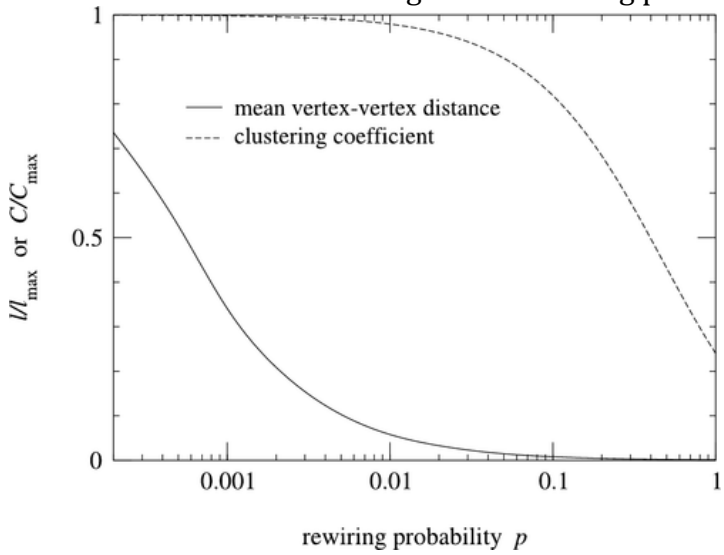
- Verify the small-world property by plotting the average shortest path length and diameter in terms of the number of nodes:

$$d_{\max} = \frac{\log N}{\log\langle k \rangle}$$

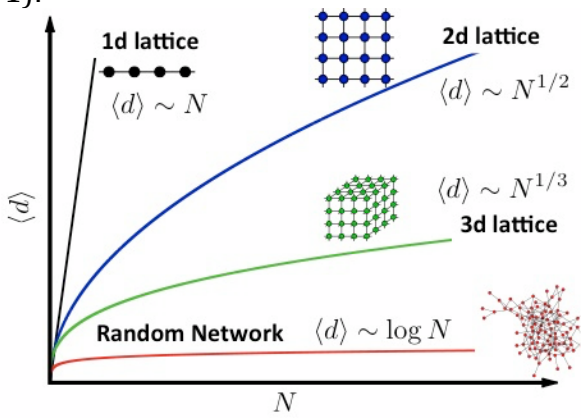
Consider <k> = 4, 10, 20 and 30 and N from 100 to 1000 in steps of 100.

3 – Watts-Strogatz model

- Generate small-world networks and get the following plot:



- Verify the variance of the degree distribution in terms of the parameter p, i.e., construct a plot of the second moment of degree distribution in terms of p.
- Plot the degree distribution of the small-world model for p=0.001, 0.01 and 0.1.
- Obtain the following plot in terms of p (consider curves for p=0, 0.001, 0.01, 0.1 and 1):

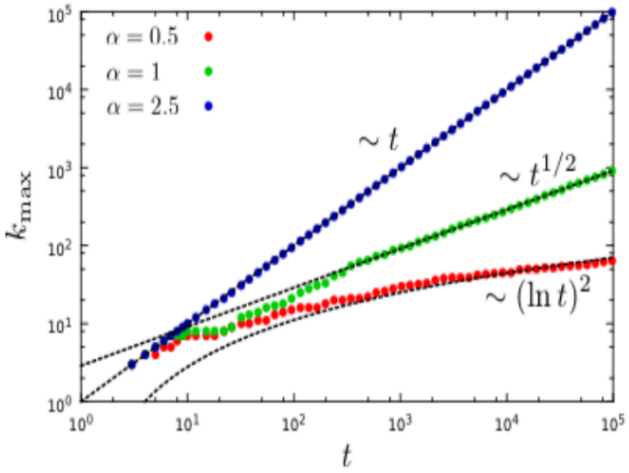


4 – Scale-free network model

- Compare the Barabási-Albert with the configuration model (gamma= -3) in terms of the following measures (construct a table): (i) number o nodes, (ii) average degree, (iii) second moment of degree distribution, (iv) average shortest path length, (v) average clustering coefficient, (vi) transitivity, (vii) assortativity coefficient.
- Using the igraph package, generate networks according the non-linear Barabási model:

https://igraph.org/c/doc/igraph-Generators.html#igraph_barabasi_game

Obtain this curve and discuss the results (t is the number of steps in the model, network size):



For alpha = 0.5, 1 and 1.5 and 2,5, obtain the table:

- (i) number o nodes, (ii) average degree, (iii) second moment of degree distribution, (iv) average shortest path length, (v) average clustering coefficient, (vi) transitivity, (vii) assortativity coefficient.

5 – Classification of networks

- Choose three networks and perform the classification. Show the results by using the PCA. For example (real network represented by X):