Assignment1

Dynamical processes in complex networks

January 2023

1 Create a 1-d chain of nodes with the following rule:

$$A_{ij} = \frac{1}{r^c}, \tag{1}$$

where r is the network distance between nodes i and j. c is a constant integer value in between 0 to 100.

$$A_{ii} = 0 \quad \text{always.} \tag{2}$$

(a) Plot average degree vs. c for nodes N=500 and 1000.
(b) Plot average degree vs. N (node number) for c=1 and 2.
(c) Plot a histogram of degree for N=1000 and c=2.
(d) What will happen to the degrees if we make it as a ring?

2 Create a network with following rules:

$$A_{ij} = A_{ji} = 1 \quad \text{if} \quad p > 0.5 \tag{3}$$

$$A_{ij} = A_{ji} = 0 \quad \text{if} \quad p < 0.5 \tag{4}$$

$$A_{ii} = A_{jj} = 0 \quad \text{always.} \tag{5}$$

Where p is a random number obtained from a random uniform distribution (0,1).
(a) Plot average degree($< k >$) with respect to nodes number (N=10 to 1000).
(b) Plot second moment of degree($< k^2 >$) vs. node(N).
(c) Plot the second smallest eigen values of Laplacian matrix with respect to N.

3 Consider the Zachary's Karate club graph (provided in networkx):

(a) Plot all the centrality measures with respect to node index.
(b) Plot the histogram of the degree list.

(c) Plot eigenvector centrality with respect to degree.

4 Create a random regular graph:

(a) Plot average path length and average clustering coefficient vs. node number (N=10 to 10000) for average degree 4 and 8.
(b) Plot average path length and average clustering coefficient vs. average degree($< k >$=1 to 30) for network size N=1000 and 5000.