# Exercise 4

Introduction to Complex Network Analysis

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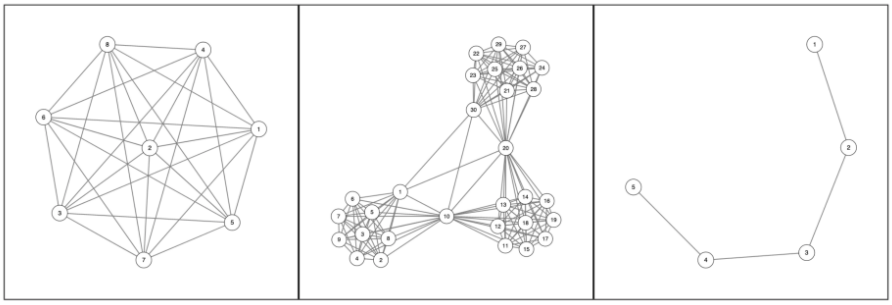
## 1

We are given 3 graphs, which we can annotate by A, B and C in the same order as they are given.



(a) Diameter

It is obvious that graph A is a complete graph, meaning all of its nodes are connected, which means that the diameter is 1. Graph B consists of 3 complete subgraphs which are connected with with a complete subgraph of 4 nodes in the middle. From the picture it seems that the maximum diameter is 3. Graph C has a diameter of 4.

Diameter (smallest to biggest): A, B, C.

(b) Density

A complete graph has density 1, making graph A the graph with the biggest density, while graph C will have the lowest.

Density (smallest to biggest): C, B, A.

(c) Average clustering coefficient

The average clustering coefficient of A is 1, since all neighbours are connected. On the other hand, graph C has a clustering coefficient of 0. Graph B is in between.

Average clustering coefficient (smallest to biggest): C, B, A.

# 2

In order to find out which network from the given si random, at the beginning we can assume that all networks are random. Since the expected value of the clustering coefficient is closer to the probability p, we assume that C = p.

In order to check if a grah is indeed random, I use the formula for the expected number of edges in a random graph which is given by the formula:

$$\langle L \rangle = p\frac{N(N-1)}{2} \tag{1}$$

We compute the expected number of links for all networks:

$\langle L_{X1} \rangle = 0.08\frac{4941(4941-1)}{2} = 976.34$
The true number of edges in network X1 is 6594.

$\langle L_{X2} \rangle = 0.07\frac{125(125-1)}{2} = 542.5$
The true number of edges in network X2 is 560.

$\langle L_{X3} \rangle = 0.009\frac{256985(256985-1)}{2} = 297.18$
The true number of edges in network X3 is 7778954.

Considering the results, we see that the formula for the expected number of links best approximates the number of edges of network X2. The other results are far from the true number. So we can conclude that network X2 has the highest probability to be a random network.