COMPLEX AND SOCIAL NETWORKS - LAB 1

November 14, 2018

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INTRODUCTION

This lab report is composed of two parts; plotting the clustering coefficient and the average shortest path as a function of the parameter p in a Watts-Strogatz model and plotting the average shortest path as the function of a network size in a Erdos-Renyi model.

WATTS-STROGATZ MODEL

For the Watts-Strogatz model (WS) we will be plotting both the clustering coefficient, C, and the average shortest path, L, on the same plot. Aside from the P parameter, we held all other parameters constant as follows:

Dimensions (dim): 1
Size (s): 500
Neighbors (nie): 4

For each P value, we created 1,000 random graphs and plotted the average. Initially, we only created a few random graphs, but after trial and error, we found that 1,000 gave us the smooth curve we were looking for. In order to simulate the graph presented in the lab assignment, we needed to choose the appropriate distribution of P values. At first, we simply tested P values at even intervals between 0 and 1, this however gave us a skewed graph as there were too many large P values. Next, we tried taking the $\log_2$ of .0001, which we will call x. We then created a sequence at even intervals between x and 0. Then, to convert each element in this sequence to a P value, we set each as the exponent of 2, that is, we calculated 2^x for each. Again, we ended up with too many large P values. Finally, we tried doing the same procedure, but with $\log_{10}$. This gave us a better distribution of P values with more in the [.0001, .01] range.

In order to plot both C and L on the same graph we needed to normalize the data to a [0,1] range. To do this, we divided all results by a base value obtained by setting P = 0.

For calculating C and L, we used the built-in R functions *transitivity()* and *average.path.length()*.

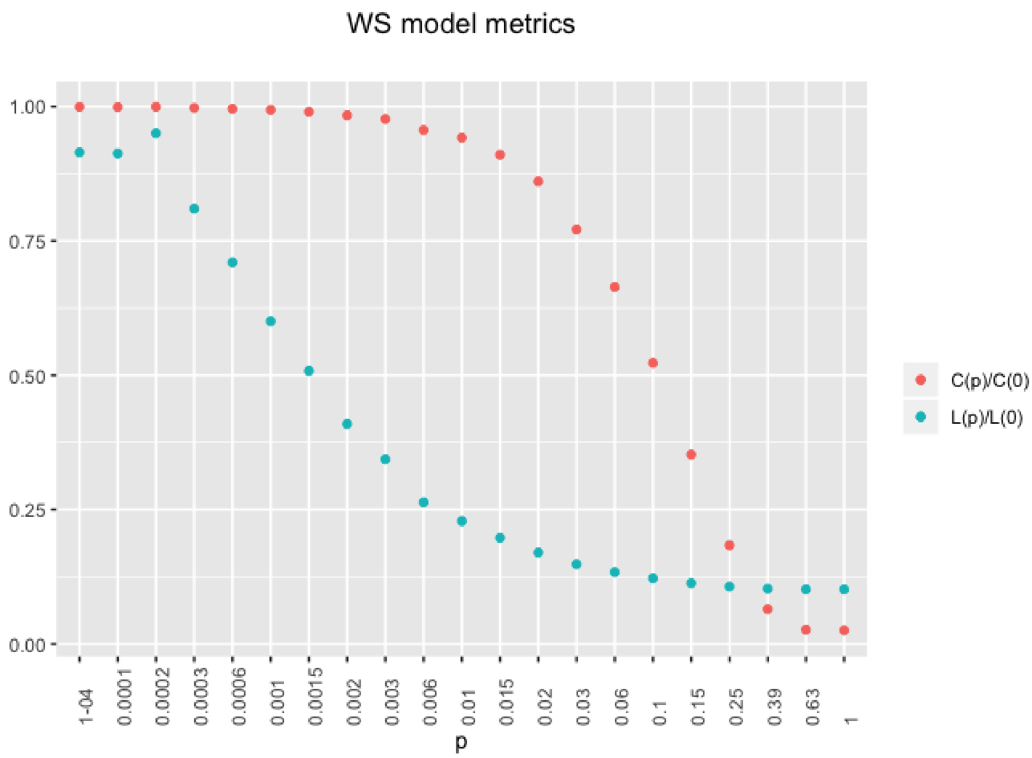

Figure 1

Erdos-Renyi Model

For the Erdos-Renyi model we will be plotting the average shortest path length as a function of the network size, N. In order to measure the path length we needed to select a P value such that each graph would be mostly connected, so that the shortest path does not get stuck on a low value around 1 or 2.

To do this, we followed the recommendation of [1], namely,

$P > \frac{(1+\epsilon)\ln n}{n}$

We have also changed the number of nodes N for each graph, with the possible values being one of the following: $5, 10, 15, 30, 50, 100, 500, 1000, 10000, 20000$.

We have not computed graphs with N larger than 20.000 as our computers weren't powerful enough. However, we can still observe the logarithmic tendency that the average shortest path takes while increasing the network size of each graph in the graphic below.

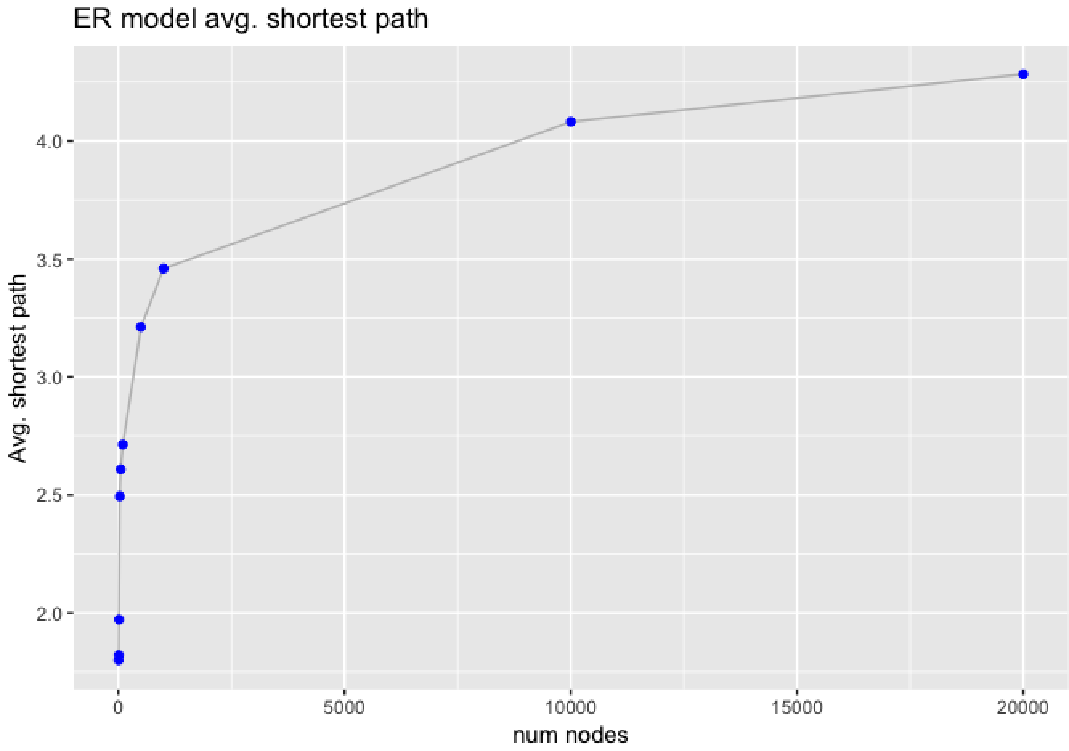

Figure 2

This graphic shows one of the executions, but since Erdos-Renyi models are somewhat random, the graphic will vary slightly from run to run.

CODE

All of the code used to create theses graphs is included in the report. The Watts-Strogatz graph is contained in the function *ws_generator* and the Erdos-Renyi in *er_generator*. Details are explained in-line in the .r file.

Bibliography

[1] Paul Erdos and A Renyi. On the evolution of random graphs. Publ. Math. Inst. Hungar. Acad. Sci, 5:17âĂŞ61, 1960.