Lab work, Session 4
Information Retrieval

Fall 2016
Ricard Gavaldà, Marta Arias

In this session:

- We are going to compute several metrics on two network models

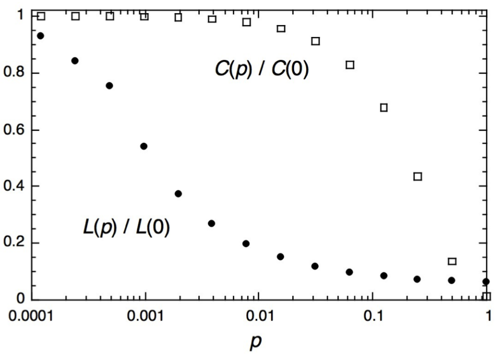
1 Network models

Erdős-Rényi model (ER model). The ER model takes two parameters: n, the number of vertices in the resulting network, and p, the probability of having an edge between any two pairs of nodes. A graph following this model is generated by connecting pairs of vertices with probability p, independently for each pair of vertices. Erdős-Rényi graphs have $\binom{n}{2}p$ edges in expectation.

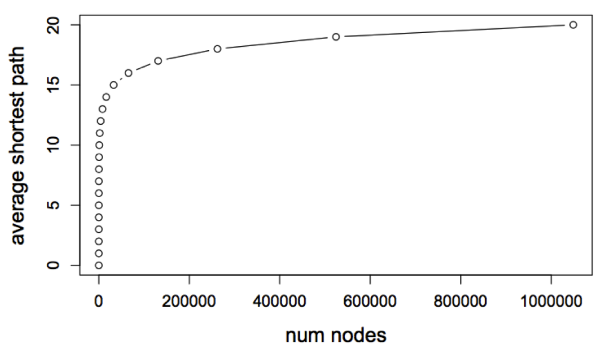
Watts-Strogatz model (WS model). The WS model takes two parameters as well: n, the number of vertices in the resulting network, and p, the probability of random rewiring edges in the initial network. A graph following this model is generated by initially laying all nodes out in a circle, and connecting each node to its four closest nodes. After that, we randomly reconnect each edge with probability p.

2 Your task

Your task is to reproduce these graphs introduced in our first lecture. Feel free to use network analysis software tools such as `networkx` or `igraph`.



(a)



(b)

That is, your task is to: (a) plot the clustering coefficient and the average shortest-path as a function of the parameter p of the WS model, and (b) plot the average shortest-path length as a function of the network size of the ER model.

Notice that in order to include both values — average shortest path and clustering coefficient — in the same figure in plot (a), the clustering coefficient and the average shortest-path values are normalized to be within the range $[0, 1]$. This is achieved by dividing the values by the value obtained at the left-most point, that is, when $p = 0$.

In case of plot (b), you will have to experiment with appropriate values of p which may depend on the parameter n. You will notice that for large values of n your code may take too long, compute values for n that are reasonable for you. Also, make sure that you chose values for p that result (with high probability) in connected graphs. To achieve this, you can use a result from [**?**] stating:

- If $p < \frac{(1-\epsilon)\ln n}{n}$ then a graph in $G(n, p)$ will almost surely contain isolated vertices, and thus be disconnected
- If $p > \frac{(1+\epsilon)\ln n}{n}$ then a graph in $G(n, p)$ will almost surely be connected

3 Deliverables

To deliver: **You must deliver a brief report (1 or 2 pages) describing your results and the main difficulties/choices you had while implementing this lab session's work. You also have to hand in the source code of your implementations.**

Procedure: Submit your work through the Rac at `https://raco.fib.upc.edu/`. Since these sessions can be done in pairs, it is enough if 1 person of the pair submits, however, state clearly both names so that I can account for it. The restrictions on what couples are allowed will be stated in class.

Deadline: Work must be delivered within 2 weeks from the lab. Late deliveries risk being penalized or not accepted at all. If you anticipate problems with the deadline, tell me as soon as possible.