Social Networks and Online Markets

Homework 1

Due: 3/5/2020, 23:59

Instructions

You must hand in the homeworks electronically and before the due date and time.

The first homework has to be done by each **person individually**.

Handing in: You must hand in the homeworks by the due date and time by an email to `aris@diag.uniroma1.it` that will contain as attachment **(not links to some file-uploading server!)** a .zip or .pdf file with your answers.
After you submit, you will receive an acknowledgement email that your homework has been received and at what date and time. If you have not received an acknowledgement email within 2 days after you submit then contact Aris.

The solutions for the theoretical exercises must contain your answers either typed up or hand written clearly and scanned.

For information about collaboration, and about being late check the web page.

Problem 1. In this homework you need to implement some of the models that we have seen, and measure experimentally some of the graph properties. Of course, each model has its own parameters.

1. The Erdös–Rènyi G_{np} random graph model. Parameters:
   - n: number of nodes
   - p: probability of an edge to exist
2. The Watts–Strogatz small-world model. Parameters:
   - n: number of nodes
   - k: number of initial edges adjacent to each node
   - β: probability of rewiring. In particular, for each node, we consider its $k/2$ neighbors to the right, and each of them is replaced with a random node in the graph.
3. The Barabási–Albert preferential attachment model. Parameters:
   - n: number of nodes
   - ℓ: number of neighbors that a newly arrived node comes with.

   Assume that the inistial graph is a single node. If it makes your life easier, if multiple edges fall on the same node you can ignore the multiple edges.

The goal is to understand these models, for different parameter combinations. Therefore, for each of these models, you should experiment for different values of the parameters. However, the parameter n should always be high (at least $10K$ but it can be up to the order of millions depending on the power of your computer).

For each of the parameter combinations, compute and report in an organized way:

- Degree distribution (you should display it with a plot)

- Diameter
- Clustering coefficient
- Other graph parameters that you may think are interesting

For each set of parameters create different graphs and check if the behavior and the values you obtain are the same for each of these graphs.

You are allowed to use a library (such as NetworkX in case you use Python) to handle the graph or compute the graph functions. However, you should implement yourselves the graphs and not use library or other code for that. If you have any questions about what is allowed, feel free to ask Aris.

You should hand in a zip file containing the code of your program results and a report, in pdf format, which will contain the results of your findings. In the report, for each model, you should display a table with the different combinations and the values that you obtain, and for each parameter combination a plot depicting the degree distribution.

As an advice for when you try your programs, first try with smaller values of n to make sure that your program works (e.g., 500 or 1000), then you should try the higher ones.