Network Science
Autumn 2020
Project 1 (version 1.0)

Due: November 6th, 12:00pm GMT (noon)

There are three files for this assignment: 1) the one that you are reading which is the project description, 2) *project1.ipynb*, a Jupyter notebook which you will complete and submit on Blackboard (see below for details) and 3) *project1.dat*, a data file needed for part 2.

Part 1

Consider the following model for a growing undirected, unweighted graph. Iteration 1: 2 nodes connected by 1 link. Iteration 2: Replace the link between the node pair with new nodes and links so that the two nodes from iteration 1 are only connected by m distinct length-2 paths with $m \geq 1$. Iteration $i + 1$: Apply the process for iteration 2 to each linked node pair in the graph at iteration i. So, for each linked pair of nodes in the graph at iteration i, remove the link and replace it with new nodes and links so that the two 'old' nodes are only connected by m distinct length 2 paths. If $m = 1$, after iteration 2 you will have a chain graph with 3 nodes and 2 links. The graph should not have any self-loops or multi-edges.

1. (4 pts) Complete the function *generate* in *project1.ipynb* so that it takes m and T as input and returns the graph generated by this model after T iterations (see the function documentation for further details).

2. (8 pts) Analyze the graphs generated by this model when $m = 3$. You do not need to compute graphs with more than 5000 nodes, and should provide a clear and concise description of what you consider to be key properties of these graphs where indicated in the notebook. You should include code for generating 1-3 figures illustrating important trends, and your discussion should include explanations of these trends.

Part 2

You have been provided with code that loads *project*1.*dat* and creates a Numpy array containing the edges for a real-world network.

(8 pts) Analyze this network. As in Part 1, you should provide a clear and concise description of your analysis where indicated in the notebook. You should include code

for generating 1-3 figures illustrating key properties of the network, and your discussion should include explanations of these figures and why they are important.

Further guidance

- You should submit both your completed Jupyter notebook and a pdf version of your notebook (generated using File — Download as). To submit your assignment, go to the module Blackboard page and click on"Project 1". There will be an option to attach your completed Jupyter notebook and pdf files to your submission. (these should be named *project*1.*ipynb* and *project*1.*pdf*). After attaching the notebook, submit your assignment, and include the message, "This is my own work unless indicated otherwise."

- Marking will be based on the correctness of your work and the degree to which your submission reflects a good understanding of the material covered up to the release of this assignment. We are particularly interested in your ability to identify and explain important properties and trends, and exhaustive descriptions are not needed. While creative ideas based on class material is welcome, you are not expected to base your work on new ideas/concepts/methods that have not been covered (and it is unlikely that credit will be given for such work). Excluding figures and code, you should aim to keep the pdf version of your notebook to less than 1 page.

- The open-ended questions require sensible time-management on your part. Do not spend so much time on this assignment that it interferes substantially with your other modules. If you are concerned that your approach to the assignment may require an excessive amount of time, please get in touch with the instructor.

- Questions on the assignment should be asked in private settings. This can be a "private" question on Piazza (which is distinct from "anonymous"), using the "Chat" on Teams during a Q&A session, or by arrangement with your Problem class instructor.

- We will not closely examine the efficiency of your code, but it should not be ludicrously slow (e.g. it should not take more than an hour to run the code in the Notebook on a non-ancient computer).

- Please regularly backup your work. For example, you could keep an updated copy of your notebook on OneDrive.

- In order to assign partial credit, we need to understand what your code is doing, so please add comments to the code to help us.