Homework 1
Networked Life (NETS 112)
Fall 2015
Prof Michael Kearns

Posted September 22, 2015. Due in hard-copy format at the start of lecture on Tuesday, October 6. Please don't forget to write your name and staple the pages together.

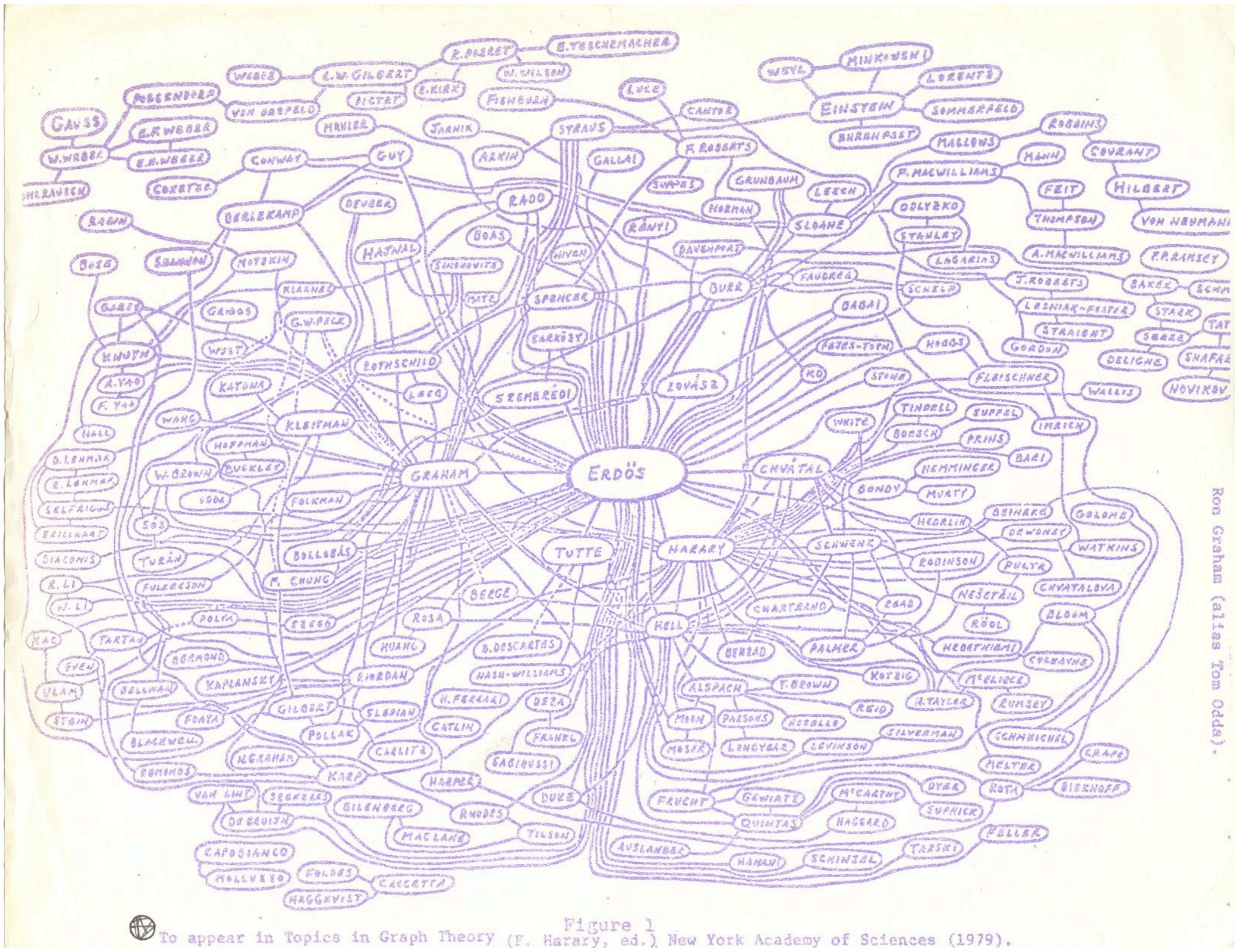
Collaboration of any kind is NOT permitted on the homework.

Your Name:

1. Draw a specific network with the following properties:

* it has exactly 10 vertices
* it is connected
* the worst-case diameter (longest shortest path) is exactly 5, and is between two vertices labeled A and B
* the maximum degree is 3
* the minimum degree is 1

2. Consider the three articles you were asked to read in the “Contagion in Networks” section of the course schedule. Briefly compare, contrast and synthesize these articles (do not simply recite or summarize their content), touching on their motivation, methodology, results, and their limitations and weaknesses.



3. Consider the mathematical collaboration network visualized above from the Erdos Number Project.

a. Is this network connected? Why or why not?

b. What are the names/labels of the vertices of highest and lowest degree? Indicate them on the diagram.

c. Name two mathematicians whose shortest path has length exactly 6. Indicate them on the diagram.

d. Give an estimate of the edge density of the network. Describe your methodology clearly.

e. Give an estimate of the worst-case diameter of the largest connected component of the network. Describe your methodology clearly.

f. Define a mathematician's "Graham number" to be their shortest-path distance to the vertex labeled "GRAHAM" in the diagram. What is Erdos' Graham Number? Name a mathematician with both Graham and Erdos number equal to 1. What general relationships exist between Graham and Erdos numbers?

4. Use the Internet to conduct research about “viral marketing”. Briefly compare and contrast viral marketing with the types of contagion studies and models considered so far in class. Give concrete examples where viral marketing is a more appropriate perspective, and explain why. Try to learn about and summarize what is known about algorithmic and computational issues in viral marketing (where it may be known by different names). Try to go beyond what is found on Wikipedia, and include your sources.

5. Consider a fictitious world in which every individual has at most 3 friends. If every pair of individuals has a path of at most 33 hops between them, give your best estimate of the largest the population could be. Is your estimate larger or smaller than the earth's current population? You are free to do web research or your own calculations to arrive at your estimate, but either way, describe your reasoning and methodology carefully.

6. Consider the navigation problem, in which the goal is to forward a message from an arbitrary start vertex to an arbitrary destination vertex. Suppose the network is connected and has small diameter (so short paths exist between all pairs of vertices). Suppose that a vertex, upon receiving the message, simply blindly forwards the message to a randomly chosen neighbor.

a. Describe the structural properties of networks for which you think this navigation method will be *least* effective. Justify your answer. Feel free to draw illustrative diagrams.

b. Describe the structural properties of networks for which you think this navigation method will be *most* effective. Justify your answer. Feel free to draw illustrative diagrams.

7. Using any reasonable methodology, sample a population of at least 25 of your Facebook friends. For example, you could actually take a random sample, or you could take one friend last name for each letter of the alphabet, etc. For each of your sampled friends, compute the geographic distance between Philadelphia and the current residence of the friend. (For example, a friend in San Francisco is about 2500 miles away.) Then plot a histogram of these distances, and compare/contrast it with the findings in the “Where’s George” study discussed in class.