Principles of Complex Systems, Vol. 1, CSYS/MATH 300
University of Vermont, Fall 2020
Assignment 09 • code name: Competitive Wine Tasting

Due: Friday, November 6, by 4:59 pm, 2020.
Relevant clips, episodes, and slides are listed on the assignment's page:
http://www.uvm.edu/pdodds/teaching/courses/2020-08UVM-300/assignments/09/
Some useful reminders:
Deliverator: Prof. Peter Sheridan Dodds (contact through Teams)
Assistant Deliverator: Michael Arnold (contact through Teams)
Office: The Ether
Office hours: Tuesdays, 12 to 12:50 pm; Wednesdays, 1:15 pm to 2:05 pm; Thursdays, 12 to 12:50 pm; all scheduled on Teams
Course website: http://www.uvm.edu/pdodds/teaching/courses/2020-08UVM-300

All parts are worth 3 points unless marked otherwise. Please show all your workingses clearly and list the names of others with whom you collaborated.

For coding, we recommend you improve your skills with Python, R, and/or Julia. The Deliverator uses Matlab.

Graduate students are requested to use LaTeX (or related TeX variant). If you are new to LaTeX, please endeavor to submit at least n questions per assignment in LaTeX, where n is the assignment number.

Assignment submission: Via Blackboard.

Please submit your project's current draft in pdf format via Blackboard by the same time specified for this assignment. For teams, please list all team member names clearly at the start.

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1. (3 + 3 + 3 + 3) This question is all about pure finite and infinite random networks

   We'll define a finite random network as follows. Take N labelled nodes and add links between each pair of nodes with probability p.

   (a) i. For a random node i, determine the probability distribution for its number of friends k, $P_k(p, N)$.
   ii. What kind of distribution is this?
   iii. What does this distribution tend toward in the limit of large N, if p is fixed?
   (No need to do calculations here; just invoke the right Rule of the Universe.)

(b) Using $P_k(p, N)$, determine the average degree. Does your answer seem right intuitively?

(c) Show that in the limit of $N \to \infty$ but with mean held constant, we obtain a Poisson degree distribution.

Hint: to keep the mean constant, you will need to change p.

(d) i. Compute the clustering coefficients C_1 and C_2 for standard finite random networks (N nodes).

ii. Explain how your answers make sense.

iii. What happens in the limit of an infinite random network with finite mean?