CP 290 Urban Systems and Network Science

Discussion 2

February 9, 2018

The files for this discussion can be downloaded on BCourses under `Files/Discussion2`.

1 Small World Networks and Random Graphs

Clustering coefficient: $C_i = \frac{2e_i}{k_i(k_i-1)} = \frac{e_i}{\frac{k_i(k_i-1)}{2}}$, where e_i is the number of edges among node i's neighbors, and $\frac{k_i(k_i-1)}{2}$ is the maximum number of edges possible among its neighbors.

Properties	Small World	Random Graph
Parameters	N, k, p	N, p
Also called	Watts-Strogatz	Erdos-Renyi
Python command	`nx.watts_strogatz_graph(N,k,p)`	`nx.fast_gnp_random_graph(N,p)`
Average degree	$< k >= k$	Np
Average path length	very fast decay with p	$\approx \frac{\ln N}{\ln <k>}$
Clustering coefficient	$C_p = C_0 \times (1-p)^3$	$C = p = \frac{<k>}{N-1}$
Average number of links	$\frac{kN}{2}$	$\frac{pN(N-1)}{2}$

1. You are given a network with 2,000 nodes and 6,000 edges. What is its average degree?

   Answer: $< k >= \frac{2E}{N} = 6$

2. If this network is a RG, what would be the value of p that gives the same value of average degree?

   Answer: $< k >= Np, \therefore p = \frac{<k>}{N} = 6/2000 = 0.003$

3. If this network is a SW network, what would be the value of k that gives the same average degree? What would be the value of p that gives a clustering coefficient of 0.06? Hint: the average clustering coefficient of a SW network with $p = 0$ is given by $\frac{3(<k>-2)}{4(<k>-1)}$.

   Answer: $k =< k >= 6$

   $C_0 = \frac{3\times(6-2)}{4\times(6-1)} = 0.6, C_p = C_0 \times (1-p)^3 = 0.06 \Longrightarrow (1-p)^3 = 0.1$

   $p \approx 0.54$

2 Matplotlib Bootcamp

In this exercise, we will make use of `numpy` and `matplotlib` to visualize a dataset. Our dataset contains the Gender Development Index and the Human Development Index (HDI) in 2015 for each country.

See `hdi_plots.ipynb` and download `HDI_data.csv` for this exercise.

3 Network Exercise

See the iPython notebooks from Lecture 8.