Node mixing in networks by (not) degree

You are given different networks in Pajek format (edge list and LNA formats are also available).

- Simple toy network for testing (tiny)
- Zachary karate club network (small)
- Java class dependency network (smallish)
- iMDB actors collaboration network (medium)
- Part of Facebook social network (medium)
- Part of Internet overlay map (medium)
- Part of Google web graph (large)

I. Degree assortative and disassortative networks

1. **(code)** Implement Newman's node degree mixing coefficient r as sample Pearson correlation coefficient between the linked nodes' degrees k and k'.

   $$r(k,k') = \frac{\sum_i (k_i - \langle k \rangle)(k'_i - \langle k' \rangle)}{\sigma_k \sigma_{k'}}$$

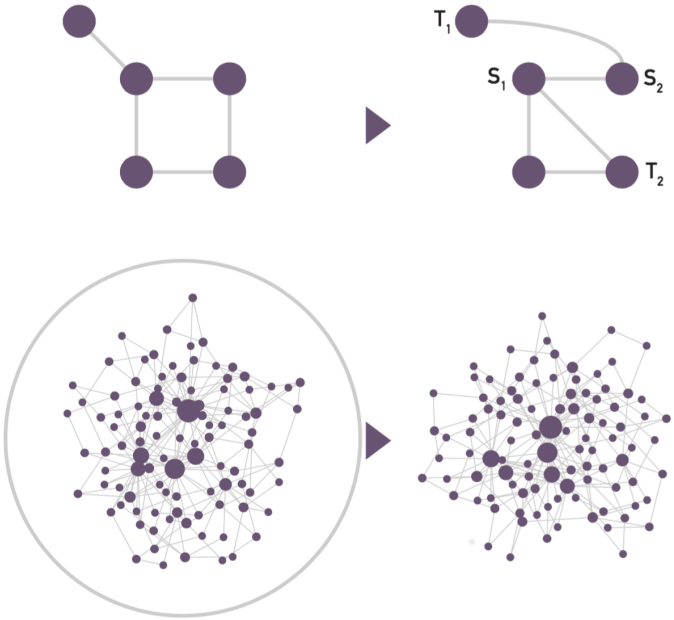
   Treat all networks as undirected graphs and compute their undirected degree mixing coefficient r. Are the networks assortative $r > 0$, disassortative $r < 0$ or neutral $r \approx 0$?

2. **(code)** For undirected networks, generate corresponding Erdös-Rényi random graphs and compute their undirected degree mixing coefficient r. Are random graphs assortative $r > 0$, disassortative $r < 0$ or neutral $r \approx 0$?

3. **(code)** For directed networks, compute all four directed degree mixing coefficients $r_{(in,in)}$, $r_{(in,out)}$, $r_{(out,in)}$ and $r_{(out,out)}$. Are the networks assortative $r_{\cdot} > 0$, disassortative $r_{\cdot} < 0$ or neutral $r_{\cdot} \approx 0$?

II. Structurally disassortative networks by degree

1. **(answer)** Consider network randomization by degree-preserving link rewiring. What is the expected undirected degree mixing coefficient r' after rewiring if you allow for multiple links between the nodes? What about if you restrict the process to generate only simple graphs?



2. **(code)** Apply link rewiring with simple links to degree disassortative networks and compute their degree mixing coefficient r' after rewiring. Are the networks indeed degree disassortative $r' \approx 0$ or (partly) structurally disassortative $r' < 0$?

III. Node mixing by *not* degree

Study node mixing in networks by some property *other* than node degree. This can be either some structural property of nodes (e.g. node clustering coefficient C or corrected clustering coefficient C^{μ}) or external information associated with each node (e.g. traffic loads in Slovenian highways network).