Node degree mixing in networks

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

- A simple toy network for testing (tiny)
- The famous Zachary karate club network (small)
- Java class dependency network (smallish)
- iMDB actors collaboration network (medium)
- A part of the Facebook social network (medium)
- A part of the Internet overlay map (medium)
- A part of the Google web graph (large)

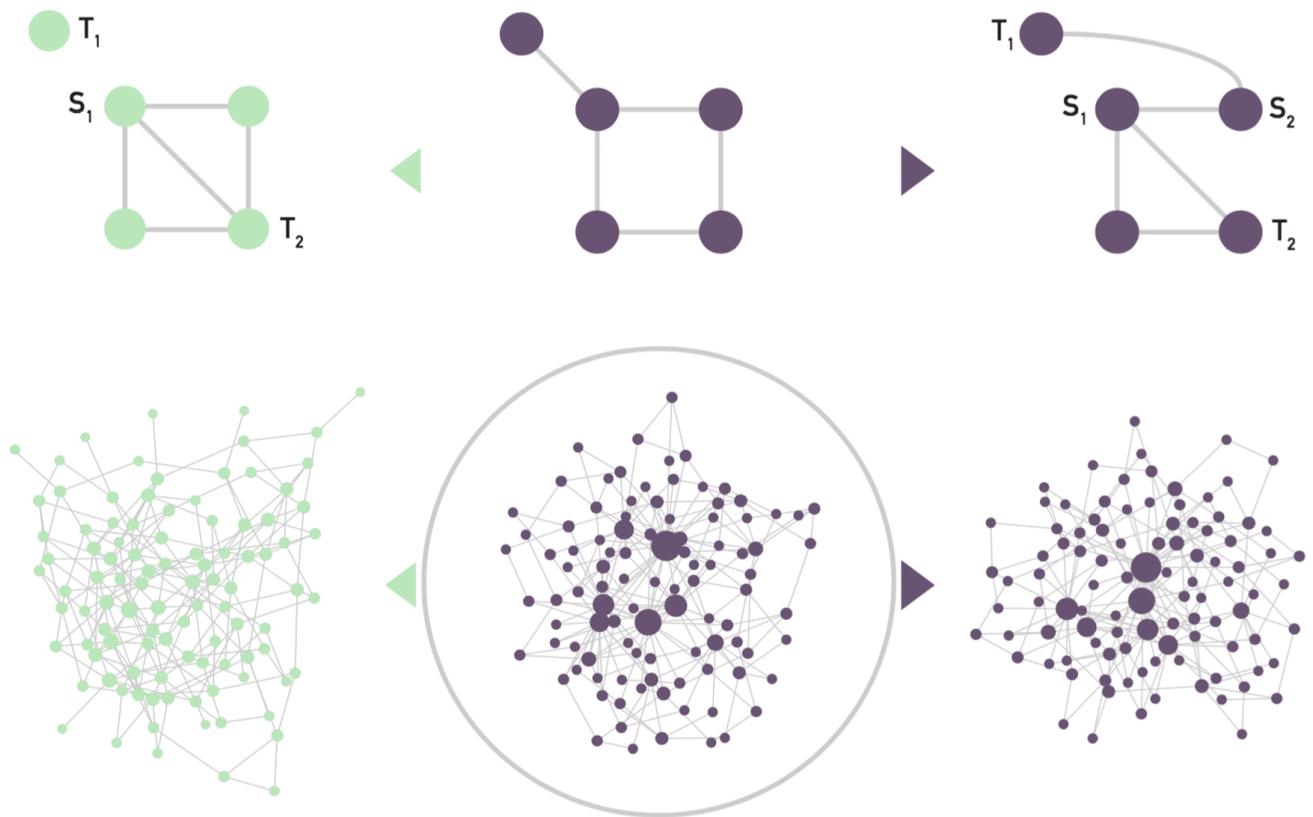## I. Assortative and disassortative networks

1. Try to implement Newman's degree mixing coefficient r as the sample Pearson correlation coefficient of linked nodes' degrees. You should use the same routine as in Homework #1.

$$r(x, y) = \frac{\sum_i (x_i - \langle x \rangle)(y_i - \langle y \rangle)}{\sqrt{\sum_i (x_i - \langle x \rangle)^2} \sqrt{\sum_i (y_i - \langle y \rangle)^2}}$$

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

3. For undirected networks, generate also the corresponding Erdös-Rényi random graphs and compute their degree mixing coefficient r. Are random graphs assortative $r > 0$, disassortative $r < 0$ or neutral $r \approx 0$?

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

II. Structurally disassortative networks

1. Consider degree-preserving link rewiring or randomization applied to undirected networks. What is the expected 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. Apply link rewiring with simple links to degree disassortative networks and compute their degree mixing coefficient r' after rewiring. Are the networks indeed disassortative $r' \approx 0$ or only structurally disassortative $r' < 0$?