

# PHYS 597A: Graphs and networks in systems biology

## Homework assignment 4, due Thursday Feb. 15

1. Read chapter III, sections A-F (pages 54-58) and chapter V, sections A-C (pages 63-66) of "Statistical mechanics of complex networks". Write down three questions or ideas that you had while reading about random graphs. Follow up on your questions and let me know what you find.

2. Answer the following questions:

a) At what connection probability you expect the existence of 1. a tree with six nodes, 2. a cycle with six nodes, and 3. a completely connected subgraph with six nodes in a random graph?

b) A random graph has a connected component that unites a large fraction of its nodes. What is our expectation for the graph's average degree?

c) A random graph has the following degree distribution:

$$P(k) = C_{11}^k \left(\frac{1}{3}\right)^k \left(\frac{2}{3}\right)^{11-k} \quad (1)$$

What is the number of nodes and the connection probability? What is the expectation value of the average degree of this graph?

d) A random graph has average degree  $\langle k \rangle = 10$ . 1. How much is the expected average distance between nodes for  $N = 10^n$ , where  $n=2, 3, \dots$ ? 2. How much is the clustering coefficient for the same network sizes?

e) Answer the same two questions as in d) for a ring lattice where every node has degree  $k = 10$ .