1.022 Introduction to Network Models **Fall 2018**

Homework 3

3.1 Erdős Rényi graphs

In this homework we will explore numerically some of the properties of Erdős Rényi (ER) graphs. For this we will create ER graphs with $n = 5000$ nodes, and increasing probability p.

(a) ***[20 points]*** Create a number of ER graphs with increasing probability p. Your probabilites should cover the range $p = [10^{-5}, 10^{-2}]$ with 'logspace' (`np.logspace`). Plot the size of the largest connected component relative to the number of nodes n (i.e., if the giant component consists of the whole graph its size is 1), as a function of p. For each p you should create 20 graphs and plot the mean value plus / minus the standard deviation of the giant component size.

(b) ***[10 points]*** What do you observe for $p \approx 1/n$? What happens for $p \approx \log(n)/n$? Provide a brief description of these phenomena in terms of what they imply for the graphs generated with these parameters (5 sentences).

(c) ***[20 points]*** For the same ER graphs you have generated in part (a), plot the number of triangles of the graph as a function of $c = p(n-1)$. For each c, use the 20 graphs generated in part (a) and only plot the mean of the number of triangles. Can you suggest a formula for the expected number of triangles in an Erdős Rényi graph with mean degree c for large n? Justify your answer!

1.022 Introduction to Network Models

Fall 2018