HOMEWORK 5

Problem 1: Bianconi-Barabási model (simulation)

In the Barabási-Albert model we assumed that the probability of linking a new node to an old node i is proportional to $k_i / \sum_{j=1}^{N(t)} k_j$. It guarantees that the growth rate of a node is solely proportional to its degree. In the Bianconi-Barabási model, we additionally assign an independent fitness parameter η_i for each new node i when it is first added into the network. We require that the probability of linking a new node to an old node i is now proportional to $\eta_i k_i / \sum_{j=1}^{N(t)} \eta_j k_j$. The parameter η_i is determined each time step in a completely random way, chosen from a given fitness probability distribution $\rho(\eta)$.

1. Generate a Bianconi-Barabási model with 10^4 nodes and $m = 2$ (i.e., a new node with two links is added in each time step), given that $\rho(\eta)$ is a uniform distribution $[0, 1]$.
2. Plot a histogram of the degree distribution, using logarithmic bins.
3. Determine the scale-free exponent γ of the network.
4. Randomly select 10^3 nodes and visualize the sub-network formed by them.

Problem 2: Bianconi-Barabási model (theory)

Suppose the fitness follows a double-delta probability function, $\rho(\eta) = \frac{1}{2}\delta(\eta - a) + \frac{1}{2}\delta(\eta - 1)$, assume $0 < a < 1$. Find the degree exponent γ in terms of a. (Hint: the double-delta function means nothing but a coin toss with two equiprobable outputs, a and 1.)

-Sean.