

# PHYS 597A: Graphs and networks in systems biology

## Homework assignment 2, due Tuesday Jan. 27

1. Construct a graph with 15 nodes and 20 edges. The edges can be undirected or directed; note that you will need to use the digraph framework if there is even one directed edge. Determine

(a) the degree distribution of the graph, or the in- and out-degree distributions if the graph is directed.

(b) the distribution of the clustering coefficients. The clustering coefficient of isolated nodes or of leaf nodes (nodes of degree one) is not defined.

2. (a)  $N$  nodes are connected by  $N$  edges such that they form a cycle (also called a ring lattice). How does the maximum distance between nodes (the diameter) depend on  $N$ ?

Tip: If dealing with  $N$  seems too abstract, do it for a few values (e.g.  $N=4,6,8,10$ ) and see if a pattern emerges. You do not need to determine the exact relationship between the diameter and the number of nodes, only the functional form of the dependence (i.e. is it logarithmic, linear, exponential etc.). This relationship is called scaling, and is used in sentences as “the maximum distance scales logarithmically with the number of nodes”.

(b) On the ring lattice from above every pair of nodes at distance two on the ring is connected by an edge. What is the clustering coefficient of the nodes? Does it depend on  $N$ ?

(c) Construct a square lattice (grid)  $L$  edges long and  $L$  edges wide. How does the maximum distance between nodes depend on  $L$ ?

Tip: again, focus on the scaling relationship.