

Network Science, Fall 2016

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Homework 1, due by September 30th, 9:00am (before the class)

Write your name at the top of your homework before handing it in. Staple all pages together.

1. Examples of real networks

- a) List three different real networks and state the nodes and links for each of them.
- b) Tell us of the network you are personally most interested in. Address the following questions:
 - i. What are its nodes and links?
 - ii. How large is it?
 - iii. Can be mapped out?
 - iv. Why do you care about it?

2. Matrix formalism

Let \mathbf{A} be the $N \times N$ adjacency matrix of an undirected unweighted network, without self-loops, of size N . Let be $\mathbf{1}$ a column vector of N elements all equal to 1, that is $\mathbf{1} = (1, 1, \dots, 1)^T$, where the superscript T indicates the operation *transpose*. In terms of these quantities and by using the matrix formalism (multiplicative constants, multiplication row by column, simple matrix operations like transpose and trace, etc. No sum symbol \sum allowed!), write expressions for:

- a) the vector \mathbf{k} whose elements are the degrees k_i of the nodes $i = 1, 2, \dots, N$;
- b) the total number L of links in the network;
- c) the matrix \mathbf{N} whose element N_{ij} is equal to the number of common neighbors of nodes i and j ;
- d) the number of triangles T present in the network, where a triangle means three vertices, each connected by edges to both of the others (Hint: you can use the trace of a matrix).