

HOMEWORK 1

NAME:

STUDENT ID:

- Reasoning and work must be shown to gain partial/full credit
- Please include the cover-page on your homework PDF with your name and student ID. Failure of doing so is considered bad citizenship.

1. (1–4 points) **Modeling question:** Indicate what kind of network model among the following
 1. Undirected, unweighted
 2. Undirected, weighted
 3. Directed, unweighted
 4. Directed, weighted
 5. Directed, labeled

you think is would be useful to study the following systems:

1. An ontology
2. Twitter retweet network
3. The Internet
4. The electric grid

and provide a short justification.

2. (1–4 points) **Bipartite graph question:** Assume Netflix’s movie library contains approximately 100,000 titles. Netflix keeps data on customer preferences using a big bipartite network connecting users to titles they have watched and/or rated. These data are represented as a bipartite weighted graph connecting customers with movie with edge weight equal to the rating.
 - (a) In the fourth quarter of 2013, Netflix reported having a set of 33 million users. Assume the average user’s degree in this network is 1000. Approximately how many links are in this network? Would you consider this network sparse or dense? Explain.
 - (b) Suppose that from 2013 to 2014 Netflix’s library has remained the same size (100,000 titles), while the number of users has increased. Further suppose that the average user’s degree in this network has remained constant. Has the density of this network increased, decreased, or stayed the same?

Hint: In lecture 2 we introduced the notionw of average degree, graph density and also the “Handshaking theorem”, which is what you need to use to answer these questions.

3. (1–4 points) **Python/NetworkX questions:** Please find two datasets in the attached files, i.e., `ieee30.edgelist` and `ieee123.edgelist`¹, and finish the follow questions using Python/NetworkX.
 - (a) Plot the 30-node graph, and find the density, the maximal degree of the graph.
 - (b) Plot the 123-node graph, and find the density, the maximal degree of such a graph? Is this graph connected?
 - (c) Does this graph have cycles? If yes, please give an example.
 - (d) Identify a cut of the 30 node bus system. Do they have a bridge?
 - (e) Verify the *Handshaking theorem* for both graphs.
 - (f) Use the function in NetworkX called `shortest_path`. Find the shortest path from node “1” to node “30” of the 30-node system and plot this path with another color in the graph.

Hint: The packages that you need to include are `networkx`, `matplotlib` and `numpy`.

¹Both these files represent the topologies of test cases of electric grids.