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| CE88/CP88 Assignment 2(Total 15 points due: February 17th, grace period 48hrs) |

**Building Networks and Analyzing their structure**

In this exercise we will experiment building social networks from the set of 61 students present in the roster in the first week. We will use different criteria to define the links, and then compare the properties of the resulting networks. Use your node ID as source and select other students node IDs as target

**At Random:** links are created by selecting 4 people at random.

**Acquaintances**: links are created if you know the person and have talked to them. Select as many as it applies.

Everyone can analyze the resulting networks and do the homework assignment even if are not in this list.

**Network Construction:**

**Nodes:**

**c88-2023\_nodes.csv** you can find your name, major and a unique node\_id

**Random Links:**

**c88-2023\_links\_random.csv**

**Acquaintances:**

**c88-2023\_links\_acquaintances.csv**

**Basic Network Analysis**

Work with the largest component of the data.

1. How many nodes and links each network has? (**1pt**)
2. What is the maximum in-degree in each network and the node id/s of the student/s that corresponds to it (**2pt**)

**Networks vs. Models (12 pts)**

1. For each of the two empirical networks **seen as an undirected graph**, fill the information of the table below with their properties

Average Clustering Coefficient (<C>), average degree (<K>), average shortest path <l>, number of nodes and number of links (**1pt**)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Network | <C> | <K> | <l> | #nodes | #Links |
| ClassNetwork\_Random |  |  |  |  |  |
| Random Graph Model (p=\_\_,N=\_\_) |  |  |  |  |  |
| Small World Model (p,k,n)  (p=\_\_,N=\_\_\_,k=\_\_\_) |  |  |  |  |  |
| Barabasi Albert Model  (N=\_\_\_,Kmin=\_\_\_\_) |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Network | <C> | <K> | <l> | #nodes | #Links |
| ClassNetwork\_Acquaintances |  |  |  |  |  |
| Random Graph Model (p=\_\_,N=\_\_) |  |  |  |  |  |
| Small World Model (p,k,n)  (p=\_\_,N=\_\_\_,k=\_\_\_) |  |  |  |  |  |
| Barabasi Albert Model  (N=\_\_\_,m=\_\_\_\_) |  |  |  |  |  |

When generating the models use the analytical properties as a function of their parameters. Fill the table with the parameters and resulting values of the model and while data answering the questions below.

1. Generate a Random Graph to model the data selecting parameters N (the same number of nodes of the data) and p. The probability p should be selected to get a similar average degree than the data (use the expression K(p,N) seen in Lecture 3). After generating a model with N and p, fill the table below with the values of the random graph model you created. (**2pt**)
2. For the Small World graph write the expression of the clustering coefficient as a function of the parameter value C(p). (**1 pt**) (seen in Lecture 3).
3. Generate a Small World graph to model the data selecting its parameters (N,k,p). Select N (to match the same number of nodes of the data), k the number of neighbors close to the <K> of the data, and p such that the clustering coefficient of the model resembles the data, to that end, use the expression of part 3. Fill the table with the values of the model you generated (**1 pt**)
4. Generate a Barabasi Albert graph to model the data. Use the same number of nodes and the expression of <K>(m) for the Barabasi Albert graph to select the parameter m such that the average of the model is similar to the data. Fill the table with the values of the model you generated (**2 pt**)
5. In the same figure compare the histograms of the degrees of the empirical network, and the three models generated in steps

2) - 5) (**1pt**)

1. Which models (SW, Random, Barabasi-Albert) resembles more the empirical network based both on the histogram of the degree and table comparisons? (**2pt**)
2. Do the empirical networks have the Small World network property?

Why you think that is? (**2pt**)

**ipynb code and the answers to each question in a pdf file format.**