**Project #3 – Algorithmic Experiments of Real-World Phenomena**

In this report write-up, we will be looking certain graph algorithms to determine properties of models of real-world networks. For this experiment, we will be looking at the diameters, clustering coefficients, and degree distributions of both Endocrania and Barabasi-Albert graph models of increasing sizes.

***Generation of Erdos-Renyi Graphs --------------------------------------------------------------------------------***

Text

Description automatically generatedErdos-Renyi graphs are characterized by a Poisson degree distribution as the size becomes large. Regarding the generation of such graphs, each pair of nodes has equal probability of being connected. The following is the pseudocode taken from lecture that I used to implement my Erdos-Renyi graph generation.

***Diameter (Erdos-Renyi) -----------------------------------------------------------------------------------------------***

Based on the data, we can assume that the diameter does not increase with the size of the graph.

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***Clustering Coefficient (Erdos-Renyi) -------------------------------------------------------------------------------***

We can see from the plots that in a Erdos-Renyi graph, that clustering coefficient, a value that measures the degree to which nodes cluster together, decreases with increasing sizes of graphs. The relationship between the clustering coefficient and the size of a graph could be said to be an exponential relationship. This also means that the clustering coefficient decreases according to log(n) it has a negative linear slope in the loglog plot.

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***Degree Distribution (Erdos-Renyi) ---------------------------------------------------------------------------------***

Based on the data collected, we were able to confirm that the degree distribution of Erdos-Renyi graphs follows a rough Poisson distribution when the size is large. Hence, the degree distribution of Erdos-Renyi graphs does not follow a power-law.

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***Generation of Barabasi-Albert Graphs ---------------------------------------------------------------------------***

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Description automatically generated with medium confidenceBarabbas-Albert graphs are characterized by power law degree distribution. The idea in the generation of such Barabasi-Albert graphs is that it is more likely that heavily connected nodes are connected with new nodes. This is like a rich-get-richer process. The following is the pseudocode taken from lecture that I used to implement my Erdos-Renyi graph generation.

***Diameter (Barabasi-Albert) -----------------------------------------------------------------------------------------***

Based on the data, we can assume that the diameter does not increase with the size of the graph.

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***Clustering Coefficient (Barabasi-Albert) -------------------------------------------------------------------------***

We can see from the plots that in a Barabasi-Albert graph, that clustering coefficient, a value that measures the degree to which nodes cluster together, decreases with increasing sizes of graphs. The relationship between the clustering coefficient and the size of a graph could be said to be an exponential relationship. This also means that the clustering coefficient decreases according to log(n) it has a negative linear slope in the loglog plot.

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***Diameter Distribution (Barabasi-Albert) -------------------------------------------------------------------------***

As seen from the plots showing the degree distributions of Barabasi-Albert graphs, the degree distribution follows a power-law as expected. What this means is that some few nodes are very connected to many other nodes, while most of the other nodes are not as connected. In addition, we affirmed that the value “c” in the power-law degree distribution truly does approximate around 3.

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