Yu Feng

Douglas Stewart

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Part 1 Report:

The output file for a 2,000-node graph generated by this application yields the histogram below (raw output see output.csv and histogram.csv, Excel spreadsheet see histogram.xlsx):

As shown in the two graphs above, there is strong statistical evidence that there is a power relationship between the total neighbor count of a node and the number of nodes that have that specific neighbor count. R2 of the fitted line on the logarithm scale is over .93, which indicates that over 93% of the data could be directly explained by the fitted power trend line.

This is strong statistical evidence indicating that the graph generated by our program is indeed a scale-free network.

The format for the direct output file (used for analysis in Part 2) is standard CSV, where commas indicate separation between different cells in the same row, and the newline character ‘\n’ indicates the separation of lines. Each line represents one node and its neighbors: the first cell being the node number itself, and the remaining cells being the direct neighboring nodes.

For instance, a fully connected 3-node graph would be represented as the following CSV file:

0,1,2\n

1,2,0\n

2,0,1\n

Part 2 Report:

After running the analysis application on the scale-free networks generated using the application above for 3, 20, 50, 100, 150, 200, 300, 500, and 2000 nodes, the diameter vs. node count graph is generated and shown below:

As shown in the graph above, the diameter rises very slowly as node count increases. Upon inspecting literal resources, Cohen and Havlin (2003) stated that the diameter is linearly related to log log (node count) when node count is large.

Below is the plot of graph diameter vs log log (Node Count), which shows a linear relationship with R2 of over .89 (indicating that over 89% of the data points could be explained by the fitted line). These statistics suggest that the theoretical results obtained by Cohen and Havlin match the results generated by this simulation of scale-free networks, further approving that our application for generating and analyzing graphs are coded correctly.

References:

Cohen, R., & Havlin, S. (2003). Scale-Free Networks Are Ultrasmall. *Physical Review Letters, 90(5).* doi:10.1103/physrevlett.90.058701