Prof. Lenore Cowen

HW 5: Autonomous Systems
due October 15

For this assignment, submit your answers for both parts as a single pdf file, alongside any code you may have written, using provide with the command:

```
homework% provide comp150ns hwk5 hwk5.pdf code-you-wrote
```

where code-you-wrote is replaced with any source files you may have written.

For Part I of this assignment, you will work with Autonomous Systems graphs from CAIDA, available as the caida data set on the course website.

1. Build a graph consisting only of the "peer" edges and nodes connected by those edges. Provide a visualization of this graph. Choose 400 nodes at random and calculate shortest paths from those nodes to all other nodes. What estimate of average shortest path length and diameter do you obtain? Include a histogram of the shortest path length distribution you obtain.
2. Take the 2-core of the previous network. Provide a visualization of the resulting graph. Calculate the average shortest path length and diameter of this network exactly.
3. Within the 2-core, simulate random node and edge removals at 5, 10, and 15%. Report average shortest path length and diameter of the resulting network. If removing an edge or node disconnects the network, report the values within the largest connected component, as well as the number of resulting connected components. Report results over 20 iterations.
4. Within the 2-core, choose 40 pairs of nodes at random. For each pair, determine the minumum set of edges that must be removed to disconnect the pair of nodes in the network. Report the distribution set sizes. In addition, report the minimum set of nodes that must be removed to disconnect the nodes 6140 and 8190. NetworkX provides functions for edge minimum cut you may find useful.

Part II: (on reverse)

Part II

Let G be a directed graph with source s and sink t. Suppose the capacities are specified not on the edges of G but on the vertices (other than s and t); so that for each vertex there is a fixed limit on the total flow through it. There is no restriction on flow through the edges. Show how to use the ordinary network flow theory to determine the maximum capacity of a feasible flow from s to g in the vertex-capacitated graph G.