Third mini-project: Connectivity in directed graphs

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I. Measures of connectivity

A measure of the robustness of a network is the number of nodes whose failure prevents network-wide communications. A network is modeled as a graph. The *connectivity* of a network is the minimum size of a set of nodes the removal of which prevents the network from being connected.

The connectivity of a network is a global parameter. In order to compute the connectivity of a network, we may start by analyzing the connectivity between pairs of nodes. Oftentimes, the connectivity between pairs of nodes is interesting in its own right. A set of nodes *separates* a source node from a destination node if neither the source nor the destination is in the set and the removal of the nodes of the set from the network does not leave a path from the source to the destination. It is well-known that the minimum number of nodes that separates a source node from a destination node equals the maximum number of independent paths from the source to the destination. Two paths are *independent* if they have in common only the source and the destination.

II. Your assignment

What you have to do.

- Design and implement an algorithm to compute the minimum number of nodes that separates a source node from a destination node. The network is given in a file where each line identifies an edge. The source and destination nodes are given online. You may assume that there are no more than 100 nodes with identifiers between 0 and 99. (50% of the grade.)
- Given a network in the format above, produce the complementary cumulative distribution of the minimum number of nodes that separates one node from another. That is, for every natural number k, compute the fraction of pairs of nodes such that more than k nodes separates the first node from the second. (25% of the grade.)
- Given a network in the format above, compute the connectivity of the network. In order to convince a user of your program that the value presented is the correct one, you may exhibit a set of nodes that prevents the network from being connected. (25% of the grade.)

What do you have to deliver, how, and when.

- You have to deliver your code and a report with a cover page and no more than three other pages containing a text explanation of your algorithms, their pseudo-codes, their asymptotic complexities, the statistics required, and a short discussion.
- The code and the report should be sent in a .zip file to my email address with subject p3.<group number>.zip where <group number> is your group number.

- The deadline is December 4, 2015, 23:59.

How I will evaluate your assignment.

- Write your report and your pseudo-code clearly, and present a commented code.
- Be sure to test your code for correctness. I will take into consideration the efficiency of your algorithms.
- I will have a discussion with you about your report and will test your code at the end of the semestre, jointly with the other assignments.