CSC 4170
Web Intelligence and Social Computing

Programming Assignment #1
Date: Monday, 5 October 2009
Due Date: Monday, 19 October 2009 at 6:30 pm

`http://wiki.cse.cuhk.edu.hk/irwin.king/teaching/csc4170/2009`

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1. You may form a group of no more than two persons to do the homework assignments.
2. If you decided to form a group with two persons, the final score for the assignment will be given to both persons. Moreover, since it is done by two persons, you are expected to do more than just a single person group.
3. Once the group has been formed, you should stay together throughout the class, including the class project as well.
4. Lastly, the final examination will be assessed individually.

Programming Assignment

Problem Statement

The Betweenness Centrality is a measure of a vertex within a graph. Vertices that occur on many shortest paths between other vertices have higher betweenness than those that do not. Hence, Betweenness Centrality of a node counts the number of times that a node lies along the shortest path between two other vertices in the graph. It is defined as $C_B(v) = \sum_{s \neq v \neq t \in V} \frac{\sigma_{st}(v)}{\sigma_{st}}$, where σ_{st} is the number of shortest paths from s to t and $\sigma_{st}(v)$ is the number of shortest paths from s to t that pass through a vertex v. We define $\frac{\sigma_{st}(v)}{\sigma_{st}} = 0$ if there is no path from vertex s to vertex t. The normalized betweenness centrality of directed graphs is given by $C'_B(v) = \frac{C_B(v)}{(n-1)(n-2)}$. The problem for this programming task is to calculate the normalized betweenness centrality for each vertex of a directed graph.

Input

The first line is an integer n, which is the number of vertices. Followed are n lines, and each line contains n columns separated by the tab $\backslash\ t$. The n lines and n columns form a $n \times n$ matrix M. The value in $M_{ij}, row = i, column = j$ is the weight of arc from vertex v_i to vertex v_j.

- M_{ij} is a small positive integer value ($M_{ij} \in [1, 10]$) if there is an arc from vertex v_i to v_j, and $i \neq j$.
- $M_{ij} = 0$, if $i = j$.
- $M_{ij} = 10000$, if there is no arc from v_i to v_j.

Output

There will be n lines of output, and each line contains the normalized betweenness centrality value of this vertex. The number of decimal places in the return values should be 4. (E.g.: 0.0121,0.0021).

Example

Input:
3
0 1 5
10000 0 1
10000 10000 0
Output:
0
0.5
0