Algorithms I (CS21003)

Autumn 2010

Assignment 4

A4. (September 7, 2010)

(a) Prepare a random binary matrix A of size $n \times n$, which represents the adjacency matrix of an *undirected graph* $G(V, E)$ having n nodes. It should be as follows.

To assign each element $A[i][j]$ with $i \leq j$, generate a random number r_{ij} in the interval $[0, 1]$. If $r_{ij} > \rho$, assign 1; otherwise assign 0. Next, assign $A[i][j]$ with $i > j$ from $A[i][j]$ with $i \leq j$.

Note: $\rho \in [0, 1]$ is a user-defined parameter for A.

[User input: n, ρ]

Output: File "`roll number_a4.txt`" that contains

- n (Line 1)
- ρ (Line 2)
- A (Lines $3, 4, \ldots, n + 2$)

All the diagonal elements of A must be 0, as G is undirected and hence no vertex has any self-loop.

(b) Construct the adjacency list A_L from A.

Using A_L, verify whether G is connected. If not, (iteratively) insist the user to re-enter (preferably a smaller value of) ρ until G is connected.

Append A_L in "`roll number_a4.txt`". (Lines $n + 3, \ldots, 2n + 2$)

(c) Find the diameter of G, which is defined as the maximum of the shortest path lengths over all node pairs of G. Let $p_d = \langle v_i, \ldots, v_j \rangle$ be the path representing such *a diameter*, d, such that $v_i < v_j$.

Append the following in "`roll number_a4.txt`":

- d (Line $2n + 3$)
- count of paths of length d (Line $2n + 4$)
- each diametric path, p_d (in subsequent lines—one for each path)

(d) Let the path length of a vertex $v_k \in V$ from p_d be

$$\delta_{\min}(v_k, p_d) = \min_{v \in p_d} \delta(v_k, v),$$

where $\delta(u, v)$ denotes the shortest path length from u to v. Report the diametric path(s) whose $\max_{v_k \in V}\{\delta_{\min}(v_k, p_d)\}$ are minimal in length.

Append the following in "`roll number_a4.txt`":

- count of minimal-δ diametric paths (new line)
- each diametric path with the smaller vertex first in the sequence (in subsequent lines—one for each path)