

Assignment 3 -- Programming Project

Design and Analysis of Algorithms (CS 4071) – Spring 2017

Diameter and Connected Components of a Network

Electronic copy of source code due Sunday, March 19 at 12:00 midnight. Hard copy due at beginning of class on Monday, March 20. Include your group number and members of the group as a comment at the beginning of the program and submit only ONE hard copy and ONE electronic copy (have ONE group member upload electronic copy).

Topics covered: *Graphs, BFS, distance matrix, diameter, connected components.*

The topology of a network is modeled with a graph. Write a C++ program that inputs a graph G by first inputting the number of vertices n followed by a sequence of pairs $i\ j$ where i and j are integers between 0 and n , inclusive, representing the edges of the graph, and ending with a negative integer sentinel to indicate the end of the input. For example,

5 0 1 1 4 2 3 1 3 3 4 -1

represents the graph $G = (V, E)$ given by:

$$V = \{0, 1, 2, 3, 4\}$$

$$E = \{\{0, 1\}, \{1, 4\}, \{2, 3\}, \{1, 3\}, \{3, 4\}\}.$$

Your program will compute the **distance matrix** of G , which you will use to compute the **diameter** of G in the case when G is connected and the **connected components** of G , otherwise.

You can proceed as follows:

- Implement the graph G with its **adjacency matrix**
- Implement the function $\text{BFS}(G, v)$ for performing a **breadth-first search** where the visit operation involves computing the distance from v to the vertex being visited. This will require a queue, which you can get from the Standard Template Library (STL).
- Implement a function $\text{DistanceMatrix}(G)$, which computes the **distance matrix** of G , where entry ij is assigned the distance from i to j if i and j are connected and -1 otherwise. Have $\text{DistanceMatrix}()$ also return a Boolean value that is true if G is connected and false, otherwise. $\text{DistanceMatrix}()$ will call $\text{BFS}()$.
- Implement a function $\text{Diameter}(G)$ that returns the **diameter** of G if G is connected and -1, otherwise. $\text{Diameter}(G)$ will call $\text{DistanceMatrix}()$.

- Implement a function `Components (G)` for computing the vertex sets of the connected components of `G`. `Components ()` will call `DistanceMatrix ()`.

Store the entire source code for your program in a **single** file. Your program should run using `g++` on a UNIX platform.

Have your program output the adjacency matrix of the graph as well as the distance matrix, the diameter in the case when `G` is connected and the connected components, otherwise. Output the connected components by outputting the vertex set of each connected component.

Your program should be **user-friendly, well-commented**, with the output **well-documented**.

Submit the source code for your program on-line by uploading to Blackboard (have ONE member of your group upload. Make sure to include a comment in your program with your Group Number and Group Members). Also submit a **hard copy** of your program with output for **two** sample runs, one with a connected graph `G` and one with a disconnected graph `G` (ONE hard copy per group submitted at the beginning of class on the due date).