[CENG 315 ALL Sections] Algorithms

THE7

Available from: Saturday, December 23, 2023, 12:00 PM
Due date: Sunday, December 24, 2023, 11:59 PM
Requested files: the7.cpp, test.cpp (Download)
Maximum number of files: 3
Type of work: Individual work

EDIT: the7.h is available here if you need it to work on your locale.

In your network security term project, you are tasked with planning a network attack. You propose
maximize the speed of infecting the whole network. Given a network, you will first calculate the ***in***
represents ***how fast the whole network will be infected if you only infect the selected node***.

The network is represented as a **directed, weighted graph**, where the **weights of each edge rep**
network to deliver a package between the two nodes, i.e. the vertices of that edge. For node cou
path distance in the graph between any pair *(i,j)* as *MaxDist*, ***infection_score*** "*IS*" is defined as fol

Infection score (IS) for node i:

$$IS(i) = \frac{1}{AIS(i)}$$

Average infection speed (AIS) for node i:

$$AIS(i) = \frac{\sum_{j=0, j\neq i}^{N} SP(i,j)}{N-1}$$

Definition of SP(i,j):

$$SP(i,j) = \begin{cases} MaxDist + 1 & \text{if there is no path between } (i,j) \\ \text{shortest distance between } (i,j) & \text{otherwise} \end{cases}$$

Problem

In this exam, you are asked to calculate the ***infection_scores*** given the ***network*** as a **directed, w**
the ***get_infection_scores()*** function defined below.

```
void get_infection_scores(const std::vector< std::vector<std::pair<int, int>>>
&network, std::vector<double> infection_scores));
```

- ***network*:** Graph adjacency list
- ***infection_scores*:** Calculated infection scores (*IS*) of each node, ordered by node ID.

Constraints and Hints:

- Carefully examine the definition of *SP(i,j)*. SP returns the shortest **directed** path distance betwe
  directed path between *(i,j)*, instead, it returns the maximum shortest distance in the network be
  nodes are penalized for not having a connection to other nodes.
- Be careful when calculating the average infection speed *AIS*. You should not include a self-path
  hence, you should divide the sum of *SP(i,j)* by **N**-1.
- Limits for **N** where 1 < **N** <= 500.
- The weight **w** of each edge is between 1 <= **w** <= 50

Evaluation:

- After your exam, black-box evaluation will be carried out. You will get full points if you return the
  node. The grade you see in the VPL contains 50% of your final grade. We will evaluate your grad
  of the exam.
- Note: If your implementation does not return before the given time limit per case, VPL will show
  believe your implementation is correct value-wise, please check if it runs below the time limit.

Example IO:

1)

Network Structure:

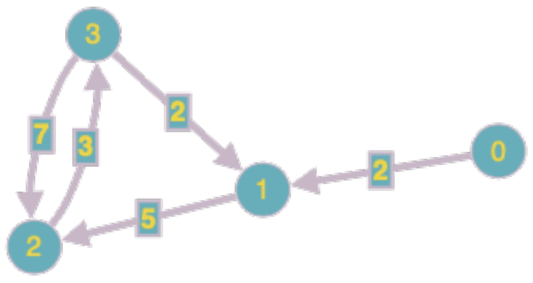
0: { (1, 2) }

1: { (2, 5) }

2: { (3, 3) }

3: { (1, 2) (2, 7) }

Infection scores: 0.157895 0.125 0.157895 0.15



2)

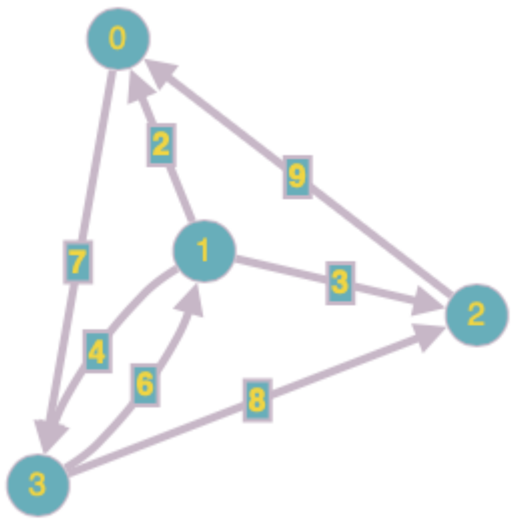
0: { (3, 7) }

1: { (3, 4) (2, 3) (0, 2) }

2: { (0, 9) }

3: { (2, 8) (1, 6) }

Infection scores: 0.0857143 0.333333 0.0638298 0.136364



Specifications:

- There is 1 task to be solved in **36 hours** in this take-home exam.
- You will implement your solutions in ***the7.cpp*** file.
- You are free to add other functions to *the7.cpp*
- **Do not change** the first line of the7.cpp, which is #include "the7.h"
- *<vector>, <queue>, <stack>, <climits>, <algorithm>, <utility> and <memory>* are included in "t use them freely.
- **Do not change** the arguments and the return value of the function ***get_infection_scores()*** in th
- **Do not include** any other library or write include anywhere in your the7.cpp file (not even in com
- You are given ***test.cpp*** file to test your work on **ODTUClass** or your **locale**. You can, and you ar add different test cases.
- If you want to test your work and see your outputs you can compile your work on your locale as:

```
>g++ test.cpp the7.cpp -Wall -std=c++11 -o test

> ./test
```

- You can test your the7.cpp on the virtual lab environment. If you click **run**, your function will be c
  with test.cpp. If you click **evaluate**, you will get **feedback** for your current work and your work
  a limited number of inputs.
- The grade you see in lab is not your final grade, **your code will be reevaluated with different i**

The system has the following limits:

- a maximum execution time of 3 second per test case
- a 1 GB maximum memory limit,
- an execution file size of 4M.
- Solutions with longer running times will not be graded.
- If you are sure that your solution works in the expected complexity, but your evaluation fails due
  constant factors may be the problem.

Requested files

the7.cpp

```
#include "the7.h"

// do not add extra libraries here

void get_infection_scores(const std::vector<std::vector<std::pair<int, int>>>& network
                          std::vector<float>& infection_scores){

                          }

```

test.cpp

```cpp
#include <iostream>
#include <fstream>
#include "the7.h"


void print_network(std::vector<std::vector<std::pair<int,int>>>& network) {
    int node_number = (int) network.size();
    if (node_number == 0) {
        std::cout << "There is no node in the network" << std::endl;
        return;
    }

    for (int idx=0; idx < node_number; idx++) {
        std::cout << idx << ":\t{";
        for (const auto& edge : network[idx]) {
            std::cout << " (" << edge.first << ", " << edge.second << ") ";
        }
        std::cout << "} " << std::endl;
    }
}

void read_from_file(std::vector<std::vector<std::pair<int, int>>>& network){
    int node_number, edge_number;
    char addr[]= "inp00.txt"; // 01-10 are available
    std::ifstream infile (addr);
    if (!infile.is_open()){
        std::cout << "File \'"<< addr
                  << "\' can not be opened. Make sure that this file exists." << std:
        return;
    }
    infile >> node_number >> edge_number;
    network.resize(node_number);
    for(int idy=0; idy < edge_number; idy++) {
        int source, dest, weight;
        infile >> source >> dest >> weight;
        network[source].push_back(std::make_pair(dest, weight));
    }
    infile.close();
}

int main(){
    std::vector<std::vector<std::pair<int, int>>> network;
    std::vector<float> infection_scores;
    read_from_file(network);
    print_network(network);
    get_infection_scores(network, infection_scores);
    std::cout << "Infection scores: ";
    for(const auto& score : infection_scores) std::cout << score << " ";
    std::cout << std::endl << "-------------------------------------------" << std::en
    return 0;
}
```