CSCE 5150 – Analysis of Computer Algorithms

Assignment 4 (100points + 20bonus)

Due: 04/28/2024 11:59PM on Canvas

Introduction

In this assignment, you will be designing and implementing algorithms to store and search graphs. World Airline (WA) flies to many destinations worldwide including: Moscow, Seoul, Tokyo, Hong Kong, and London. Complete detailed information regarding airline flight routes can be found from the link *flight.txt*. The flight.txt contains a "from city" and its destination cities that WA flights to. Note that the flight.txt is a synthetically generated datasets by a graph data generator *graphGen.cpp*. You may want to download the assignment4 zip file from CANVAS and generate a few more graphs with different number of cities to test your algorithms.

Your task

Your task is to design and implement algorithms to answer the following questions:

1. I am in city "A", can I fly to city "B" with less than x connections? Give me the route with the smallest number of connections or tell me there is no such a route.
2. Give me the route with the smallest number of connections from city "A" to city "D" through city "B" and "C". (the order of "B" and "C" is not important). Or tell me there is no such a route
3. I want to start from city "A", visit all the cities that can be reached and then come back to "A" using as less connections as possible. Give me a route or tell me there is no such a route. (note: once you come back to "A", you do not go out anymore) [This is for the bonus points].
4. I am in city "A", my friend John is in a different city "B", and my other friend Ann is in yet another different city "C". We want to find a city different from the three cities we are in to meet so that the total number of connections among three of us is minimized. Tell me the city we should fly to and the routes for us or tell me there is no such a city.

You will need to process the documents and store their content in the data structures that you selected. Next, for every question, you will search your data structure using an algorithm of your choice. You have the freedom to select the data structures and algorithms that you consider to be more efficient for the tasks. Of course, you will have to justify your decisions. You program should take a few parameters with the first as the number of the question (1-4). The rest of the parameters and output of the four questions (1-4) are described as follows assuming your program is called routeSearch:

1. usage: routeSearch 1 <city_A> <city_B> <num_connection>
   sample output:
   city_A to city_x to city_y … to city_B
   total connection: 4

2. usage: routeSearch 2 <city_A> through <city_B> and <city_C> to <city_D>
   sample output:
   city_A to city_x to city_C to city_y … to city_B to city_D
   smallest number of connection: 4
3. usage: routeSearch 3 <city_A>
   sample output:
   city_A to city_x to city_y … to city_z to city_A
   smallest number of connection: 4

   Note: this query has been into an extra credit problem. 50 extra credits will be given if you do this query (algorithm design, analysis, implementation, optimization etc). The total 100 points does not include the 50 extra credits for this problem.

4. usage: routeSearch 4 <city_A> <city_B> <city_C>
   sample output:
   You three should meet at city_D
   Route for first person: city_A to city_x … to city_D (3 connections)
   Route for second person: city_B to city_y … to city_D (1 connections)
   Route for second person: city_C to city_y … to city_D (0 connections)
   Total number of connection: 4

Note: if it takes too long for your program to finish the tasks, try to generate smaller graphs using the provided graphGen.cpp.

What to turn in

There are two main parts in this assignment, all of them contributing to the final assignment grade. Submit all these two parts on Canvas in a zip file.

1. You will have to write a report (about 2-5 typed pages – single space – 12pt font) that includes:

- design issues, what are the problems and how you solve them
- data structures you use, the decision behind selecting them
- algorithms you employ, again with a justification of your decision
- particular emphasis should be placed on the running time of your algorithm, please show the asymptotic costs for each of your algorithm
- optimization issues: what could you do to further optimize your algorithm
- you need to specifically address the problem of scalability: would you implementation be efficient in the case of very large species collections for larger scale geographic area?
- any other remarks about your design and implementation
- **you need to take screenshot of your test running result and attach as appendix in the report**

2. You will have to send in a fully working program, written in C++. We will test your algorithms extensively by generating graphs with different characteristics. It is mandatory that you include a README file, as detailed as possible, including compilation and running instructions. Is it also mandatory that your programs are fully documented, that is they should include detailed comments on what is included in each file and what each method does. Create a zip file with name CSCE5150_assignment4_yourname.zip including all of your programs, report, README, etc. Submit your zip file to CANVAS by 04/28/2024 **before midnight**. Late submission will not be accepted.

Grading

Design issues, data structures efficiency, algorithms, other issues addressed in the written report	- 60 points
Program (should compile and run correctly, have an associated README file, should be fully documented)	- 40 points
Extra	- 20 points (for query 3)

Notes

* *No late submissions are accepted!*