CSCE 3110 Data Structures Project
World Airline Route Search

Due: 05/02/2023 on Canvas
(100 points + 50 bonus points)

Introduction

In this project, 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.

In the public.zip, we are providing you with the following files:

```
public/
 city.name    <-input file for building the graph in a adjacency matrix
 flight.txt   <-input file for building the graph in a adjacency matrix
 minheap_pair.h   <-minheap implementation (each element is a pair of
distance and node ID)
  WA.cpp      <-implementation of graph and route search(only file you
need to modify)
```

In the WA.cpp file, task 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) has been implemented (see the routeSearch_1 function). Please use this as reference to implement the following two tasks.

Your task

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

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 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.

Specifically, you need to complete the routeSearch_2 function:

```
253 //Task 2
254 void routeSearch_2(Graph graph, int city_A, int city_B, int city_C, int city_D) {
255
256 }
```

[hint: Let's assume that we want to find the route with the smallest number of connections from city "A" to city "C" through city "B". This question can be divided into two parts: 1. Find the route1 with the smallest number of connections from "A" to "B" (Similar to task 1). 2. Find the route2 with the smallest number of connections from "B" to "C" (Similar to task 1). If route 1 and route 2 exist, then combine these two routes is our final output.]

And you need to complete routeSearch_3 function:

```
258 //Task 3
259 void routeSearch_3(Graph graph, int city_A, int city_B, int city_C) {
260
261
262 }
```

[hint: using "A" as source, the shortest path from "A" to all other cities can be found with Dikjstra algorithm. Similarly, the shortest path from city "B" and city "C" to all other cities can be calculated. After you get this information, you can answer this question.]

You can choose to work alone or work with another student as a team of two. If you choose to work in a team, both of you will receive the same score for the project. However, you will need to explicitly specify each person's portion of work in the your written report. This information is used only when a student's final letter grade is on the boundary.

Sample output:

```
bj0141@cell06-cse:~/csce3110/project$ g++ WA.cpp
bj0141@cell06-cse:~/csce3110/project$ ./a.out

The graph generated can be represented by the following adjacent matrix :
--------------------------------------------------------------------------------
```

……

```
Please choose the type of the questions:
1: From city 'A' to city 'B' with less than x connestions?
2: Route with the samllest number of connections from city 'A' to city 'D' through city 'B' and 'C'?
3: Find intermediate city, I, makes the total number of connections (A to I, B to I and C to I) the smallest.
2
Please enter the city A: 0
Please enter the city D: 139
Please enter the city B: 1
Please enter the city C: 2
No such route.
```

```
bj0141@cell06-cse:~/csce3110/project$ ./a.out
```

……

```
Please choose the type of the questions:
1: From city 'A' to city 'B' with less than x connestions?
2: Route with the samllest number of connections from city 'A' to city 'D' through city 'B' and 'C'?
3: Find intermediate city, I, makes the total number of connections (A to I, B to I and C to I) the smallest.
2
Please enter the city A: 0
Please enter the city D: 126
Please enter the city B: 1
Please enter the city C: 2
city0 to city135 to city1 to city88 to city79 to city2 to city20 to city54 to city126
Total connection: 8
```

```
bj0141@cell06-cse:~/csce3110/project$ ./a.out
```

……

```
Please choose the type of the questions:
1: From city 'A' to city 'B' with less than x connestions?
2: Route with the samllest number of connections from city 'A' to city 'D' through city 'B' and 'C'?
3: Find intermediate city, I, makes the total number of connections (A to I, B to I and C to I) the smallest.
3
Please enter the city A: 1
Please enter the city B: 2
Please enter the city C: 3
You three should meet at city: 17
Route for the first person: city1 to city97 to city17
Total connection: 2
Route for the second person: city2 to city85 to city3 to city17
Total connection: 3
Route for the third person: city3 to city17
Total connection: 1
```

```
bj0141@cell06-cse:~/csce3110/project$ ./a.out
```

……

```
Please choose the type of the questions:
1: From city 'A' to city 'B' with less than x connestions?
2: Route with the samllest number of connections from city 'A' to city 'D' through city 'B' and 'C'?
3: Find intermediate city, I, makes the total number of connections (A to I, B to I and C to I) the smallest.
3
Please enter the city A: 1
Please enter the city B: 2
Please enter the city C: 139
No such a city.
```

What to turn in

There are two main parts in this project, all of them contributing to the final project grade.

1. You will have to write a project report (about 1 page – single space – 12pt font) that includes:
    - Team member names
    - Contributions of each team member
    - At least 4 screenshots of your test running result (2 for task 2 and 2 for task 3).

2. All files that are needed to compile and run your code. It is mandatory that you include a README file, including compilation and running instructions.

Please compress these two parts in a zip file and upload this zip file on Canvas.

Grading

Task 2: if you correctly implement task 2, you will get 100 points. Even if your program does not work properly, you can explain in the project report what you did, and we will grade accordingly to give you partial credit based on your program and explanation.

Extra points:

Task 3: if you correctly implement task 3, you will get 50 bonus points. Even if your program does not work properly, you can explain in the project report what you did, and we will grade accordingly to give you partial credit based on your program and explanation.