National University of Computer and Emerging Sciences

School of Computing Fall 2019 Islamabad Campus

CS201/CS218: Data Structures (Fall 2019)

Final Project

(Deadline: 03rd December, 2019 09:00 PM)

Project groups: This project can be done within a group of three (3) students. The groups and rules for the creation of groups are already announced on Slate.

Submission: All submissions MUST be uploaded on slate. Solutions sent to the emails will not be graded. To avoid last minute problems (unavailability of slate, load shedding, network down etc.), you are strongly advised to start working on the project from day one.

You are required to use Visual Studio 2010 for the project. Only submit the source code files (i.e, .cpp and .h files) combined in one .zip file. Submit zip file on slate within given deadline.

Deadline: Deadline to submit project is **3rd December, 2019 09:00 PM**. No submission will be considered for grading outside slate or after **3rd December, 2019 09:00 PM**. Correct and timely submission of project is responsibility of every group; hence no relaxation will be given to anyone.

Plagiarism: -50% marks in the project if any significant part of project is found plagiarized. A code is considered plagiarized if **more than 20%** code is not your own work.

AIRLINE RESERVATION SYSTEM

The airline reservation system facilitates users (or passengers) in finding suitable itinerary across several airliners and destinations.

The passengers usually provide the following information to the airline reservation system for planning their air travel.

- Origin of the air travel.
- Destination of the air travel.
- Date of the travel: Passenger specifies tentative date of the travel. It is important to note that if no flight is available on the specific date, the reservation system provides the flight options within 1 day (before and after) of the tentative date. For example, if there is no flight on 9th June from Islamabad to London, the system will provide the flight options on 8th and 10th June.
- Transits locations: A passenger can optionally specify transit locations along with the preferred transit duration. For example, a passenger can specify that s/he want to have a transit of 19 hours in Dubai while travelling from Islamabad to London.

  It is important to note that a travel to a certain destination might require a transit, i.e., a connecting flight (even if no transit preference is specified by the passenger). For example, in the absence of any direct flight from Islamabad to London, the only possibility might be to have a flight from Islamabad to Dubai and afterwards a connecting flight from Dubai to London. Clearly, in this case the passenger has to stay in Dubai for some hours before boarding on the flight from Dubai to London.

  In the absence of transit preferences, the reservation system try to minimize the transit time.

- Airline of choice: A passenger can optionally specify the preferred airline for the travel.
- Cost or travel time: A passenger specify the criteria to be used by the reservation system for calculating the possible travel options.

On receiving the passenger query (with the above mentioned options), the reservation system calculates the possible travels options according to the criterion selected by the passenger, i.e.,

- Cost: The cost of travel should be minimized. The cost of a connected flight includes the cost of travelling (i.e., ticket price) on each leg of the journey and additionally cost of hotel (if transit time is more than 12 hours).
- Travel time: The travel time should be minimized. The travel time also includes the time of transit.

In addition to the cost and travel time criteria, the travel options calculated by the reservation system also satisfies the constraints specified by the passenger, i.e., preferred airline, transit time preferences etc.

Following table presents some of the use cases that must be handled by airline reservation system:

Passenger Query	Reservation System
Scenario 1: Passenger wants to book a flight of a certain airline going to a certain destination on a specific date with minimal travel cost.	
Origin Destination Date Airline of choice Criterion: Travel cost	Sorted list of flights of the specified airline matching origin, destination as well as date. The list also includes the travel options with connected flights. List will be sorted on the basis of travel cost (including all possible charges explained above). Additionally, the travel time of each option is also specified for information purpose.
Scenario 2: Passenger wants to book a fight going to a certain destination on a specific date with minimal travel time.	
Origin Destination Date of travel Criterion: Travel time	List of all possible flights (may be with connecting flights from different airlines) sorted according to the travel time (including the transit time if any). Additionally, the travel cost of each flight option is also specified for information purpose.
Scenario 3: Passenger wants to book a connecting flight going to a certain destination on a specific date with a transit stay.	
Origin Destination Date of travel Transit location	List of flights matching the constraints (origin, destination, date of travel, transit location). Additionally, the travel cost and travel time of each flight option is also specified for

	information purpose.
Scenario 4: Passenger wants to book a connecting flight going to a certain destination on a specific date having a particular transit time with minimum travel time.	
Origin Destination Date of travel Transit location Min and max transit duration Criterion: Travel time	Sorted list of flights matching the constraints (origin, destination, date of travel, transit location and transit time). The list will be sorted on the basis of travel time (including the transit time). Additionally, the travel cost of each flight option is also specified for information purpose.
Scenario 5: Customer wants to book a non-connecting (i.e., direct) flight going to a certain destination on a specific date and time.	
Origin Destination Date of travel	List of direct flights matching the constraints (origin, destination, date of travel). Additionally, the travel cost and travel time of each flight option is also specified for information purpose.

Above scenarios are only a few possible passenger booking request scenarios in an airline reservation system. Students are supposed to handle any combination of requirements mentioned above.

Instructions

The Flights.txt file contains information about the flights. In particular, each entry in the file contains the following information (in the same order, separated by space)

- Origin
- Destination
- Date of travel
- Flying time
- Landing time
- Ticket price
- Name of airline

It is important to note that the flying and landing times are added in the flight data however the passengers are not give the option to choose the preferred time of fly (rather passengers are can only choose the preferred date of travel). The flying and landing times are included in the flight data for the correct identification of connecting flights and transit times. For example, if a PIA flight from Islamabad to Karachi is from 9:00 AM to 11:00 AM. A passenger cannot take a connecting flight from Karachi with flying time earlier than 11:00 AM. Likewise, a passenger has a transit time of 6 hours in Karachi, if the connecting flight from Karachi is scheduled to fly at 5:00 PM

Moreover, the HotelCharges_perday.txt file contains information about the hotel price if stay is more than 12 hours (or passenger preferred to have a longer transit stay).

Generate a main graph by reading the data provided in Flights.txt and HotelCharges_perday.txt files. For example, the vertices in the graph will be cities and edges represent availability of flights between the cities. Moreover, edges store information about the flights between the two adjacent vertices, e.g., name of airline, ticket price, date of travel, flying time, landing time etc. The hotel price information can also be stored in the vertices of the respective cities.

Given a passenger query, you might generate a sub-graph (that only contains the information relevant to the query) OR/AND adjacency matric/adjacency list to calculate the results of the query. For example, if the passenger has selected Emirates as preferred airline then the cities without Emirate flights are not required to calculate the results of the query.

From the algorithmic perspective, the above mentioned queries (in the table) can be divided into easy and difficult categories.

The easy category include queries (i) related to direct flights or (ii) where passenger has specified preferred airline (e.g., Emirates or Qatar etc.). The queries in this category can be answered using the slight modifications to the algorithms discussion during the lectures.

The difficult category include queries (i) where flights from multiple airlines can be used to generate a travel journey or (ii) where passenger has specified preferred transit location and duration. The queries in this category cannot be answered by the direct use of algorithms from the lectures. We expect students to think about the possible data structures and algorithms to solve the queries in this category. Clearly, the queries in this part has more weightage in the overall project grade.

What to submit

Submit your code according to the guidelines given above. Moreover, you are supposed to submit a detailed report summarizing the data structures and algorithms. In particular, you have to justify the algorithm for answering the queries in difficult category. Your justification should be scientific and focus on the time and space complexities as well as correctness of the algorithm.

Good Luck!