



COMSATS University, Islamabad

Islamabad Campus

Department of Computer Science TERMINAL EXAMINATION - SPRING 2023

Class: BS(CS/SE/AI/DS)

Subject: Data Structure and Algorithm

Time Allowed: 80 mints

Instructors: Dr. Inayat Ur-Rehman/ Mr. Mustafa Khattak/ Dr. Zobia Rehman/ Dr. Nusrat Shaheen/ Mr. Syed Ahmed

Date: June 22, 2023

Total Marks: 50

Section: _____

Registration Number: _____

(CLO-1: Employ linear data structures to solve computing problems).

QUESTION 1:

Marks: 7.5

A user has a list of Naats stored on his handheld device. User can listen Naat randomly either from forward or backward with reference to the current Naat e.g., If there are 100 Naats stored in device and user is listening 45th Naat and calls the library method rand() which returns any number, say 5, then it will play 50th Naat but if the rand method returns 65 then the system will switch to 10th (to complete the counting, it will move to 1st and then 10th). For case of backward same rule will be applied e.g. if current Naat is 15th and rand() method returns 10 then the next Naat will be 5th, however, if rand() method returns 30 then it will select 15th Naat.

You have to store following information of Naat:

NaatID, Naat title, Singer, year

Conditions:

- You don't know how many Naats to be stored.
- rand() method is already in library, so just call it and use.
- To achieve the optimal solution, suggest what data structure you will prefer to use. You just have to write the method Play() to select the next Naat.

QUESTION 2:

Marks: 7.5

Suppose you have to implement C language program for Microsoft Word Processor in which you have to store the following information:

File Id, operation performed, time of operation.

Conditions:

- Record of operations is stored on first-in-first-out basis.
- Undo is done on a last-in-first-out basis.
- We do not want to allow users to undo indefinitely, for this it maintains maximum of 20 previous records.
- In addition to the above, we would also like to remove the oldest history on a first-in-first-out basis.

(CLO-2: Use non-linear data structures to solve computing problems).

QUESTION 3:

Marks: 10 (5+2.5+2.5)

Part-1: Assume that you have to computerize a doctor clinic. There can be hundreds of patients in waiting queue. When a patient arrives at the emergency room, following information is entered in the system:

Patient ID, Patient name, age, blood pressure value (upper limit only), priority level (based on blood pressure value, patient with highest blood pressure will be assigned highest priority).

The patient is then added to the priority queue, with their priority level determining their position in the queue. As medical staff become available to see patients, they retrieve the next patient from the priority queue based on their priority level.

Write the C language program to handle this scenario.

Part-2:

Taking 51 as root, apply the BST algorithm on following data to insert the values:

51, 26, 11, 6, 8, 4, 31

Part-3:

Apply the AVL algorithm on part-2 and justify how AVL is better approach. Show each rotation.

QUESTION 4:

Marks:15 (3+2+2+3+5)

In real-life, we have to find the distances in Google Maps, from one city to another, or from your location to the nearest desired location. This issue is regarded as a Shortest Path Algorithm, as there are various routes/paths connecting them but needs to find the minimum distance between source node and the destination node. Assume that you are working in a head office located in Islamabad and have to visit different other cities. The information of regarding these cities is:

- Distance from Islamabad to Taxila is 50 km.
- Distance from Islamabad to Abbottabad is 150 km.
- Distance from Taxila to Haripur is 40 km.
- Distance from Haripur to Abbottabad is 20 km.
- Distance from Islamabad to Khanpur is 40 km.
- Distance from Khanpur to Haripur is 30 km.

Considering the above given information, answer the following questions:

Part-1: Generate the Graph from above given information.

Part-2: Represent the Graph of part-1 with Adjacency Matrix.

Part-3: Represent the Graph of part-1 with Adjacency List.

Part-4: Suppose I live in Islamabad and want to visit other cities, which algorithm do you prefer to find the shortest path? Apply that algorithm by showing each step.

Part-5: Write the C language code of Dijkstra Algorithm with description of code (by using // as comments).

CLO-3: (Analyze the time complexity of various algorithms). 2.5 2.5

QUESTION 5:

Marks:15 (5+2.5+2.5+5)

Part-1: To attend a conference, suppose I stay in a hotel for few days. At the end of the day, when I return to the hotel, I ask the desk clerk if there are any messages for me. Behind his back is a dovecot-like cupboard, with 26 entries, labeled A to Z. Because he knows my last name, he goes to the slot labeled R, and takes out three letters. One is for Rashid Ahmed, one is for Raheem, and one is for me. Write the optimal solution in C language for this scenario.

Part-2: Take an initially empty hash table with five slots and hash function $h(x)=x \bmod 5$. In case of any collisions, it is resolved by chaining method. Draw a sketch of what happens when inserting the following sequence of keys into it: 35, 2, 18, 6, 3, 10, 8, 5. [You are not requested to draw the intermediate stages as separate figures, nor to show all the fields of each entry in detail].

Part-3: Repeat part (b) but with the following three changes: the hash table now has ten slots, the hash function is $h(x)=x \bmod 10$, and collisions are resolved by linear probing.

Part-4: Suppose you have to computerize the record of students having attributes *Student ID*, *Name* and *Marks*. You preferred to store the data in linked list as there is no restriction on number of students to be enrolled. Analyze the algorithm and answer which sorting technique you prefer to apply on this data. Write the C language function to sort linked list with minimum complexity.