Assignment 5

Priority Queue and Hashing

Data Structures (Section A & B), Fall 2018

Due Date : 12:00 pm, 27th November, 2018

Late submissions will not be accepted.

Submission Location: Upload the zip file containing your solution on the Google classroom. The name of the ZIP file should be your Roll Number.

WEITAGE 5%

Problem

An international company with multiple branches around the world maintains an online repository of important and confidential files on its server. The files can be accessed by authorized employees from the different branches. The employees can read and write the files. The different employees (users) can try to *simultaneously* access the same file. This may pose a problem in some scenarios.

Let say user A and user B try to access File X from their computer systems.

- If both A and B wants to read the File X, then there is no problem
- If both A and B wants to update(write) the File X. This can create a problem, and system will be confused which value to retain.
- If A wants to write on the File X and B wants to read the File X. This is also problematic. As A is updating file X and B tries to read X, the user B can read some invalid values.

The most easy and simple solution is that we allow the different users to simultaneously read a file, but we do not allow them to simultaneously update a file. That is, if one user wants to write\update an existing file then other users must wait till he is done.

Note, if a user wants both read and write access to a file. Then he will just ask for write access as he can read while writing.

Question 1- We need a priority queue to maintain the list of users who want to access a file for reading or writing. Design and develop a template-based Priority Queue implemented as Max heap using dynamic array or STL vectors.

Each node in the queue should at least maintain the following information

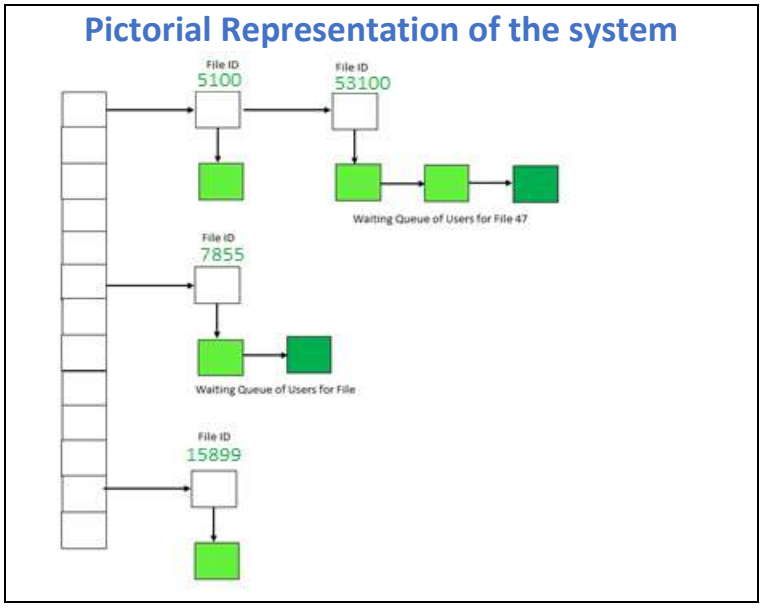
- Key (to maintains Priority)
- Information
  - Id of the user
  - Operation type (read or write)

Provide the following functions in your priority Queue class

- BuildQueue: Takes in an unsorted array and convert in to a priority queue
- ExtractMax: Remove and return the maximum element
- FindMax: Return the maximum value in O(1) time
- FindMin: Return the minimum value in O(1) time
- Insert: Insert a value with given priority
- size
- empty

Question 2 – **Build a generic template-based Hash Table to maintain a repository of the files. The hash table will use chaining to resolve collision. You have to use STL (standard template library) linked list for chaining.** In the hash table use file id as hashing index.

Each node in the linked list will have a pointer to a priority queue of the users who wants to access the file, we will call it waiting queue. If a user requests an access to a file. We will check the file's waiting priority queue. If queue is empty the user will be granted access otherwise, he will be inserted in the particular file's waiting queue with given priority.



Provide the following functionality

- **Insert a file in the hash table using a hash function based on file id**
- **Request File Access**
  - Get User Id and File Id as input
  - Get priority as input
    - user can either give a number for priority **or**
    - specify priority is high or low
      - If priority is high, then you will assign the user a number(priority) that is maximum in the given file's waiting queue. (use FindMax function in the priority queue)
      - If priority is low, then you will assign the user a number(priority) that is minimum value in the given file's current waiting queue. (use FindMin function in the priority queue)
  - Insert a user with given id in the file's waiting queue with given priority. If waiting queue is empty and no user is currently accessing the file, give the user immediate access to the file.
  - If file does not exist print error message
- **Release File**
  - If a user no longer needs to access a file, provide access to the next user with highest priority.
    - If the next highest priority user in waiting queue wants a **write** access, then he got ***exclusive*** access to the file.
    - However, if the next user with highest priority wants a **read** access then we grant access to all the top priority users in the queue that want read access till we find a user with write access.
      - For example: if there are 5 users in the waiting queue with following priorities and access requests
        - UserID 14, read access, priority = 10
        - UserID 55, read access, priority = 7
        - UserID 10, read access, priority = 7
        - UserID 12, write access, priority = 6
        - UserID 1, read access, priority = 5
      - We will grant read access to top 3 users. We will remove first three users from waiting priority queue, grant them access to the file and keep track of their IDs.
- **Print the Hash table:**

- Print the list of the files in Hash table along with the user's ids who are currently accessing the file and the next user to get the access.
  - **Output should be as follows:**

```
H1 → File 5001 … Access granted to User 1, read
            Next User 23, write
            Waiting 10 users

H2 → File 5012 … Access granted to User 12, write
            Next User 2, write
            Waiting 1 user
H2 → File 5051 … Access granted to User 1, User 2, read
            Next User 3, write
            Waiting 3 users
H3 → File 5111 … Access granted to none
            Next none
            Waiting none
```

- **Load the data regarding files and users from the given input file**
  - **Input File Format**
    1. File Id is a number between 5000-99999
    2. User Id is an integer in a range 0-10000
    3. Priority is an integer in a range 0-100
    4. File Access is a character R or W

```
File ID, User ID, Priority, Access (read or write)
7551, 10, 3, R
25551, 3, 10, W
32451, 4, 7, R
```

- **Provide a menu with following options:**
  - **Print Hash table with file information**
  - **Load data**
  - **Insert a file**
  - **Delete a file**
    - **Delete the file only if no one is currently accessing it**
  - **Request an access to a file by a user**
    - **Get user id, file id and access type (read or write) and perform the desire operation**
  - **Release the file by a user**
    - **Get user id and file id and perform the desire operation**

CODE DESIGN GUIDLEINES

- Do template-based programming
- Code should be properly intendent and commented (2 marks for this)
- Make sure there are no memory leaks or dangling pointers
- Don't cheat or take too much unnecessary help from your friends