National University of Computer and Emerging Sciences

Laboratory Manual

for

Data Structures Lab

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Objectives:

In this lab, students will practice:

1. Implementation of MaxHeap Using Arrays

Question 1:

a. Create a struct HeapItem as follows:

```
template<typename k, typename v>
struct HeapItem
{
	k key;
	v value;
};
```

b. Now create a MaxHeap class which contains:

1. A pointer to HeapItem, "arr".
2. An int variable "capacity" which stores the total capacity of heap.
3. An int variable "totalItems" which contains the count of current total number of items stored.

Provide the following member functions for your MaxHeap class:

1. A default constructor which assigns a capacity of 1 to the arr pointer.
   `MaxHeap()`

2. An overloaded constructor which takes as argument the value of capacity and allocates the memory of the required capacity to arr pointer.
   `MaxHeap(int_capacity).`

3. An insert function which takes as argument a key value pair. It then inserts the key value pair in the heap array such that, the resultant heap tree is a complete binary tree and it follows max heap ordering. If totalItems==capacity, then double the capacity of heap array and insert the key value pair. There must not be any memory leaks.
   `void insert(k key, v value)`

4. A getMaxfunction which assigns the value of that HeapItem, whose key is maximum, to the parameter passed by reference. It does not delete that HeapItem from the heap.
   `void getMax(v&_value)`

5. A deleteMax function which deletes the HeapItem which has the maximum key. The Heap must remain a complete binary tree and it must follow max heap ordering after deleteMax is called.
   `void deleteMax()`

6. A function isEmpty which returns true if the heap has no element. `bool isEmpty() const`

7. A destructor

Question 2:

a. Create a student class which contains rollNumber as int, name as string, and cgpa as float. Implement any constructors, getters and setters.

b. Overload the << operator to neatly print the student object on the screen.

c. Implement a global function buildStudentHeap which takes as argument a file name and an initially empty max heap object by reference. Your task is to read student data from the file and insert Student objects into the max heap. **The key will be roll number**.

```
void buildStudentHeap(string fileName, MaxHeap<int, Student>&stdHeap)
```

Question 3:

Run the following main program

```
int main()
{
   MaxHeap<int, Student> stdHeap;
   buildStudentHeap("students.txt", stdHeap);

   while (!stdHeap.isEmpty())
   {
         Student s;
         stdHeap.getMax(s);
         cout <<s<<endl<<endl;
         stdHeap.deleteMax();
   }

   system("pause");
}
```