CS202 - Data Structures and Algorithms

Programming Assignment 2

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Instructions

- Plagiarism is strictly prohibited. In case of violation, a zero will be awarded for this assignment as a warning and a quick F grade if repeated later.

- Submit the complete code as cs202assignment2.zip file with a Makefile.

- For Problems, make different cpp files for each problem. For example, prob1.cpp.

- For Problems, Makefile should contain targets for each problem. For example, make prob1 should compile and generate executable of prob1.cpp.

- You can lookup this link on how to make makefile : `https://stackoverflow.com/questions/2481269/how-to-make-a-simple-c-makefile`.

- You must not use STL library classes and functions.

- You must only use the hpp files for the questions of BST, AVL and RB-Tree.

- The deadline for submission is **Thursday, 17th October, 2019, 2355 HRS (11:55 pm)**. No late submissions will be entertained.

- Contact Pratyush (7807113433) or Daksh Thapar (9592563214) for any queries.

1 Binary Heap

1. Implement the min Binary Heap Data Structure, Write the following functions:-

   (a) Find minimum

   (b) insert a key

   (c) decrease key(Pointer to a key is given)

   (d) merge

   (e) remove minimum

2. Implement the Min-Priority Queue Data Structure using the above made Binary Heap.

3. Solve the following problem using the above created Priority Queue Data Structure.

   Given N bags, each bag contains Ai chocolates. There is a kid and a magician. In one unit of time, kid chooses a random bag i, eats Ai chocolates, then the magician fills the ith bag with $floor(Ai/2)$ chocolates.

   Given Ai for $1 \leq i \leq N$, find the maximum number of chocolates kid can eat in K units of time.

   For example, K = 3
   N = 2
   A = 6 5
   Return: 14
   At t = 1 kid eats 6 chocolates from bag 0, and the bag gets filled by 3 chocolates
   At t = 2 kid eats 5 chocolates from bag 1, and the bag gets filled by 2 chocolates
   At t = 3 kid eats 3 chocolates from bag 0, and the bag gets filled by 1 chocolate
   so, total number of chocolates eaten: 6 + 5 + 3 = 14

   Note: Return your answer modulo $10^9 + 7$

   PS:- More marks will be awarded for better time and space complexity

2 RB Tree

The tasks to be done are:

1. Implement the Dictionary Data-Structure.Details are given below.

2. Write a pseduo-random number generator to n numbers, n taken as user input.

3. Insert the n numbers generated in task 2 into each of the AVL and RBTree.

4. Record the number of comparisons and the depth of the trees after each insertion in a 2-3 page report. The report must contain your observations.

2.1 Instructions for task 1

Implement the Dictionary data structure using AVL tree and RB Tree.

1. Create and Use a "Node" class to implement a node of a tree. (Do not use structure (struct))

2. Interfaces for the Dictionary and AVL tree are given.
   Dictionary.hpp: abstract Dictionary interface.
   AVL.hpp: Interface for AVL tree
   RBTree.hpp: Interface for RB tree

3. Your main program should ask the user to select an AVL or RB Tree at run-time. Also, it should ask the user to input the key each time new key is inserted.
   Your main program should have the following menu of operations and this menu should be displayed each time after the completion of an operation:

   (a) Insert a key

   (b) Search for a key

   (c) Delete a key

   (d) Display all the keys as observed in inorder traversal

   (e) Display all the keys as observed in preorder traversal

   (f) Display all the keys as observed in postorder traversal

   (g) Display all the keys as observed in levelorder traversal

   (h) Display the minimum key in a tree

   (i) Display the maximum key in a tree

   (j) Display the succesor of a key

   (k) Display the predecessor of a key

   (l) Display the height of a tree

   (m) Exit