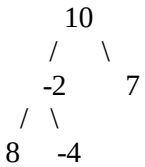
BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
HYDERABAD
CAMPUS,
Data Structures and Algorithms
CS F211 / IS F211
Homework Assignment – 12

1. Max doesn't want to go to physics class. So he decides to reach the class as late as possible. It is known to you that his school building is in form of a binary tree where each node represents the time taken to cross that building corresponding to that node. Max can start at any end building (or leaf) in his school and he has to reach the room located at root in most possible time. Help Max in finding such a path. (Time taken to pass a building or node can also be negative.)

   eg: in case like given below

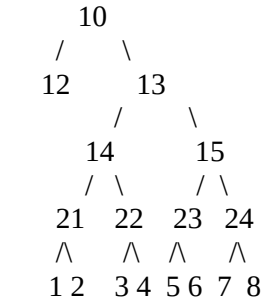


   Max will take a path 7---> 10

2. Tina goes for a movie. But while she is watching a movie, she receives a phone call. Tina is a good girl and doesn't want to disturb people watching movie by her phone call. So she rushes to go outside the hall. But sadly the hall is in the form of binary tree where leaves are the exit gates of the hall. Given an integer x specifying Tina's seat (or the node in binary tree), help Tina finding the closest exit to her seat. Output the no. of nodes she has to cross while exiting.

   Eg:

   Given x = 13



   Output : 2 (Tina takes path 13-->10-->12 (12 represents exit)) rest all path have 3 nodes.

3. Max is looking for special type of numbers in an array which he calls fixed point. Fixed Point in an array is an index i such that arr[i] is equal to i. He is given a sorted array in which he has to find the fixed points, if any, if no such point exits, he has to return -1. The array can also contain negative numbers. Help Max in finding the numbers in O(log n) time.
   Examples:

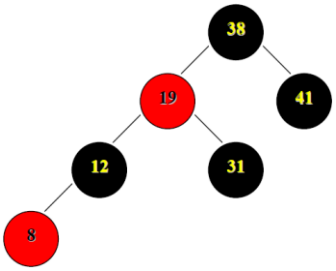
   Input: arr[] = {-10, -5, 0, 3, 7}
   Output: 3 // arr[3] == 3

   Input: arr[] = {0, 2, 5, 8, 17}

Output: 0 // arr[0] == 0

Input: arr[] = {-10, -5, 3, 4, 7, 9}
Output: -1 // No Fixed Point

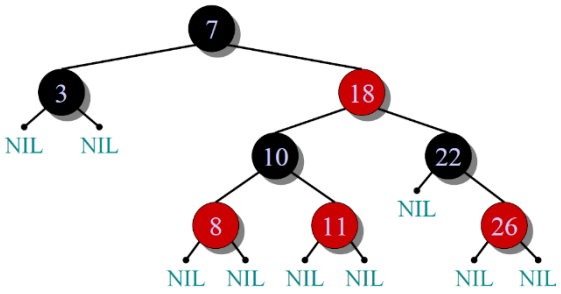
4. Write a C program to create the red-black tree from user given data (for ex: keys 41, 38, 31, 12, 19, and 8). The resultant red-black tree would be as shown in the following figure.



   Print all the leaf nodes (8, 31, and 41 in above example) of the red-black tree that is created. Your program must accept user inputs for the keys in the red-black tree.

5. Write a menu driven C program for the following operations on red-black tree.
   a. Insert a key in the red-black tree (initially empty). User input required for key.
   b. Print the height of a particular node in the tree. User input required for the node.
   c. Print the children of a particular node in the tree. User input required for the node.
   d. Exit

   Example:



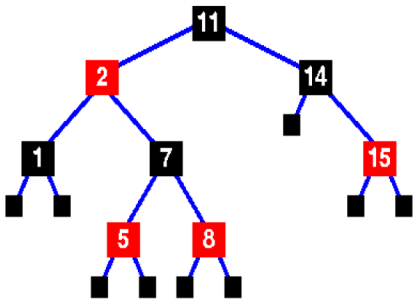
   Height (10) = 2, Height (7) = 4
   Children (10) – 8, 11
   Children (18) - 10, 8, 11, 22, 26

6. Write a menu driven C program for the following operations on red-black tree.
   a. Insert a key in the red-black tree (initially empty). User input required for key.
   b. Print the number of nodes at a level (Assume root at level 1) including the keys.
   c. Exit

   Example (from the fig. in problem 2):
   No. of nodes at level 2 are 2 and the keys are 3, 18.
   No. of nodes at level 4 are 3 and the keys are 8, 11 and 26.

7. Write a menu driven C program for the following operations on red-black tree.
    a. Insert a key in the red-black tree (initially empty). User input required for key.
    b. Find all the keys whose children are of different color
    c. Find all the keys whose children are red
    d. Find the black height of the tree
    e. Exit

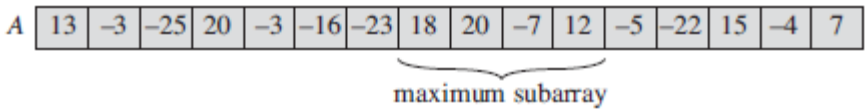
    Example:



    Keys whose children are of different color: 11
    Keys whose children are red: 7

8. You are given an array and you have to find out the maximum sub-array sum using divide-and-conquer (don't use dp) to solve this problem in O(nlogn) time.

    Ex :



    Maximum sub-array sum is 18 + 20 + -7 + 12 = 43

9. You all have used pow(a, n) function in C. Have you wondered how much efficient it is ? Is it O(n) or O(logn) ? Now you have to implement a similar kind of function call it power(a, n) where a and n is an integer and you have solve the problem in O(logn) time.

    Ex : power(2, 5) = 32

10. You are given an array of n elements and Q queries of form <I, J>. Each query <I, J> represents the start index and end index and you have to find the sum of all elements from index I to index J. Solve this problem in O(n + Q) time complexity.

11. You are given a matrix of dimension n X m which contains integer values and Q queries of form <x1,y1>, <x2,y2> (representing sub-matrix) where (x1,y1) represents top-left end of submatrix and (x2,y2) represents bottom right-end of the submatrix. Find the sum of all elements in the submatrix formed by (x1,y1) and (x2,y2). You have to solve this problem in O(nm + Q)

12. You are given n coins of denominations d_0, d_1, d_2, … d_{n-1}. Each coins are available in infinite supply. You have to make changes of N from available coins in such a way that minimum number of coins are used. Solve this problem in O(nN) time complexity.

13. John is learning about combinations where he want to compute nCr (n choose r). Given input n and r computer the value of it. **Note: You can't use formula to computer nCr**

14. You are given n points in 2D plane(i.e. (x,y)) and you need to find the distance of the closest points using divide and conquer. Distance between 2 points = $sqrt((x1-x2)^2 + (y1-y2)^2)$

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