

National Institute of Technology Calicut
Department of Computer Science and Engineering
Fourth Semester B. Tech.(CSE)-Winter 2021-22
CS2094D Data Structures Laboratory
Assignment #3 - Part B

Submission deadline (on or before): 28.02.2022, 9:00 AM

Policies for Submission and Evaluation:

- You must submit your assignment in the Eduserver course page, on or before the submission deadline.
- Ensure that your programs will compile and execute without errors using gcc compiler.
- During the evaluation, failure to execute programs without compilation errors may lead to zero marks for that evaluation.
- Your submission will also be tested for plagiarism, by automated tools. In case your code fails to pass the test, you will be straightaway awarded zero marks for this assignment and considered by the examiner for awarding F grade in the course. Detection of ANY malpractice related to the lab course can lead to awarding an F grade in the course.

Naming Conventions for Submission

- Submit a single ZIP (.zip) file (do not submit in any other archived formats like .rar, .tar, .gz). The name of this file must be

ASSG<NUMBER>_<ROLLNO>_<FIRST-NAME>.zip

(Example: *ASSG1_BxyyyyCS_LAXMAN.zip*). DO NOT add any other files (like temporary files, input files, etc.) except your source code, into the zip archive.

- The source codes must be named as

ASSG<NUMBER>_<ROLLNO>_<FIRST-NAME>_<PROGRAM-NUMBER>.c

(For example: *ASSG1_BxyyyyCS_LAXMAN_1.c*). If you do not conform to the above naming conventions, your submission might not be recognized by our automated tools, and hence will lead to a score of 0 marks for the submission. So, make sure that you follow the naming conventions.

Standard of Conduct

- Violation of academic integrity will be severely penalized. Each student is expected to adhere to high standards of ethical conduct, especially those related to cheating and plagiarism. Any submitted work MUST BE an individual effort. Any academic dishonesty will result in zero marks in the corresponding exam or evaluation and will be reported to the department council for record keeping and for permission to assign F grade in the course. The department policy on academic integrity can be found at: http://cse.nitc.ac.in/sites/default/files/Academic-Integrity_new.pdf.

QUESTIONS

1. A Red-Black tree is a self-balancing binary search tree where every node obeys the following rules.

- (a) Every node is either red or black
- (b) The root is always black
- (c) There are no two adjacent red nodes (A red node cannot have a red parent or red child)
- (d) All paths from a node to descendant nodes contain the same number of black nodes

Write a program to create a Red Black Tree from the given input. Your program should include the following function

- INSERTREDBLACK(struct node* root, key) : Inserts a new node with the 'key' into the tree and prints parenthesized representation (with corresponding colors) of the created red-black tree.

Input Format:

- Each line of the input contains a positive integer 'key' or a character 't'. If the input is a positive integer then Call function INSERTREDBLACK(root, key). If 't' is encountered, terminate the program.

Output Format:

- For each line of the input, the corresponding line of the output should contain the PARENTHESIS REPRESENTATION (key value followed by color) of the current tree.

Sample Input:

```
25
18
50
80
12
100
34
t
```

Sample Output:

```
( 25 B ( ) ( ) )
( 25 B ( 18 R ( ) ( ) ) ( ) )
( 25 B ( 18 R ( ) ( ) ) ( 50 R ( ) ( ) ) )
( 25 B ( 18 B ( ) ( ) ) ( 50 B ( ) ( 80 R ( ) ( ) ) ) )
( 25 B ( 18 B ( 12 R ( ) ( ) ) ( ) ) ( 50 B ( ) ( 80 R ( ) ( ) ) ) )
( 25 B ( 18 B ( 12 R ( ) ( ) ) ( ) ) ( 80 B ( 50 R ( ) ( ) ) ( 100 R ( ) ( ) ) ) )
( 25 B ( 18 B ( 12 R ( ) ( ) ) ( ) ) ( 80 R ( 50 B ( 34 R ( ) ( ) ) ( ) ) ( 100 B ( ) ( ) ) ) )
```

2. Write a program to create a Red Black Tree from the given input. After creating the tree, find the number of BEAUTIFUL NODES in the tree. A BEAUTIFUL NODE is a node (can be red or black) which has minimum one black vertex at "X" distance in any direction.

Input Format:

- First line of input will be an integer "X" which is a beautiful distance.
- Second line of input will be an integer "N" which is the number of nodes in the tree.
- After which N integer inputs will be given subsequently which will be nodes of the tree.

Output Format:

- Output will be the number of BEAUTIFUL NODES.

Sample Input 1:

2
8
9
18
5
15
17
25
40
80

Sample Output 1:

5

Explanation: At beautiful distance 2, only 17, 5, 15, 18, 40 are having at least 1 black node. So all five of these nodes are beautiful nodes.