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Floor and Ceil from a BST

There are numerous applications we need to find floor (ceil) value of a key in a binary search tree or sorted array. For example, consider designing memory management system in which free nodes are arranged in BST. Find best fit for the input request.

Ceil Value Node: Node with smallest data larger than or equal to key value.

Imagine we are moving down the tree, and assume we are root node. The comparison yields three possibilities,

A) Root data is equal to key. We are done, root data is ceil value.

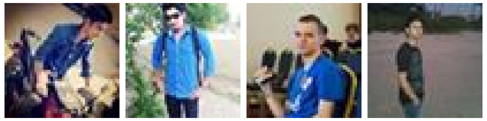
B) Root data < key value, certainly the ceil value can’t be in left subtree. Proceed to search on right subtree as reduced problem instance.

C) Root data > key value, the ceil value *may be* in left subtree. We may find a node with is larger data than key value in left subtree, if not the root itself will be ceil node.

Here is code in C for ceil value.

```
// Program to find ceil of a given value in BST
#include <stdio.h>
#include <stdlib.h>

/* A binary tree node has key, left child and right child */
struct node
{
    int key;
    struct node* left;
    struct node* right;
};
```



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```
/* Helper function that allocates a new node with the given key and
   NULL left and right  pointers.*/
struct node* newNode(int key)
{
    struct node* node = (struct node*)malloc(sizeof(struct node));
    node->key = key;
    node->left = NULL;
    node->right = NULL;
    return(node);
}

// Function to find ceil of a given input in BST. If input is more
// than the max key in BST, return -1
int Ceil(node *root, int input)
{
    // Base case
    if( root == NULL )
        return -1;

    // We found equal key
    if( root->key == input )
        return root->key;

    // If root's key is smaller, ceil must be in right subtree
    if( root->key < input )
        return Ceil(root->right, input);

    // Else, either left subtree or root has the ceil value
    int ceil = Ceil(root->left, input);
    return (ceil >= input) ? ceil : root->key;
}

// Driver program to test above function
int main()
{
    node *root = newNode(8);

    root->left = newNode(4);
    root->right = newNode(12);

    root->left->left = newNode(2);
    root->left->right = newNode(6);

    root->right->left = newNode(10);
    root->right->right = newNode(14);
```

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```
    for(int i = 0; i < 16; i++)
        printf("%d  %d\n", i, Ceil(root, i));

    return 0;
}
```

Output:

```
0  2
1  2
2  2
3  4
4  4
5  6
6  6
7  8
8  8
9  10
10  10
11  12
12  12
13  14
14  14
15  -1
```

Exercise:

1. Modify above code to find floor value of input key in a binary search tree.

2. Write neat algorithm to find floor and ceil values in a sorted array. Ensure to handle all possible boundary conditions.

— **Venki**. Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above.

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affiszerv Your example has two 4s on row 3, that's why it...

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sandeep void rearrange(struct node *head) {...

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Neha I think that is what it should return as, in...

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devil • 4 months ago

I think this is much better approach.
Do inorder traverasl and update Ceil & Floor as we iterate.
http://ideone.com/oswEpn

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Piyush Kapoor • 7 months ago

Your code doesn't even compile !!

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srb • 10 months ago

```
 /* Paste your code here (You may delete these lines if not writing c

int floor(node *root, int input)
{
    // Base case
    if( root == NULL )
        return -1;

    // We found equal key
    if( root->key == input )
        return root->key;

    // If root's key is bigger, floor must be in left subtree
    if( root->key> input )
        return floor(root->left, input);

    // Else, either right subtree or root has the floor value
    int floor = floor(root->right, input);
    return (floor <= input && floor!=-1) ? floor : root->key;
  }
  */
```

1 ^ | ˅ • Reply • Share ›

abhishek08aug • 11 months ago

Intelligent :D

^ | ˅ • Reply • Share ›

Amit • a year ago

```
 /* Paste your code here (You may delete these lines if not writing c
#include<stdio.h>
#include <limits.h>
#include<stdlib.h>
int floor = 0;
int ceil = 0;
struct node{
       int data;
       struct node *left;
       struct node *right;
};
struct node * newNode(int data ){
       struct node * node = (struct node *)malloc(sizeof(struct node)
       node->left = NULL;
       node->data = data;
       node->right = NULL;
       return node;
}
```

see more

Reply · Share ›

Nomind · a year ago

```
#include
#include
#include

/* A binary tree node has key, left child and right child */
struct node
{
int key;
struct node* left;
struct node* right;
};

/* Helper function that allocates a new node with the given key and
NULL left and right pointers.*/
struct node* newNode(int key)
{
struct node* node = (struct node*)malloc(sizeof(struct node));
node->key = key;
node->left = NULL;
```

see more

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Paparao Veeragandham · a year ago

```
    int ceil = INT_MIN;
    if(root->data > input) //with-out this condition it will go left-mos
   ceil = Ceil(root->left, input);
```

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kiran • 2 years ago

Good post !!! Just with minimal change in BST algo :-)

^ | v • Reply • Share ›

Venki ➦ kiran • 2 years ago

@Kiran, it is simple algorithm. We are just using the binary search tree However, this approach leads to linear search when the tree is skewed binary search tree.

Try yourself to write bug free code for the same algorithms on sorted a conditions.

^ | v • Reply • Share ›

a2 • 2 years ago

Could you please explain me why this has been added in the return statement Won't ceil always be less than root-key since it is in the left subtree ?

^ | v • Reply • Share ›

a2 ➦ a2 • 2 years ago

> ```
> ceil < root->key
> ```

^ | v • Reply • Share ›

Kartik ➦ a2 • 2 years ago

Thanks for sharing your thoughts. Your point is valid, we have r

^ | v • Reply • Share ›

Meghanath Macha ➦ Kartik • a year ago

Hey Ceil / Floor is similar to Successor / Predecessor r

^ | v • Reply • Share ›

spandan ➦ Meghanath Macha • a year ago

Yes

^ | ⌄ • Reply • Share ›

Kamal • 2 years ago

Cool! the floor program will be similar, only left right conditions will be reversec

^ | ⌄ • Reply • Share ›

vishal ➦ Kamal • 2 years ago

can you explain how conditions are changed and what is output

^ | ⌄ • Reply • Share ›

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