EE441 Data Structures

Example Questions-II

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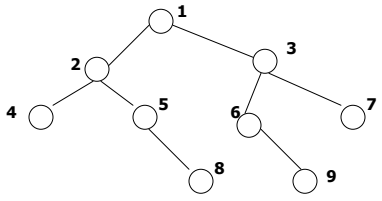
Example Questions

Q1) Consider the binary search tree given below:



The numbers do not indicate the contents of the nodes but simply label the nodes so that you can reference them.

a) In what order will an inorder traversal visit the nodes of this tree? Indicate this order by listing the labels of the nodes in the order that they are visited.

b) Assuming that the tree is composed of nodes from the usual template class `TreeNode`, write a global recursive C++ function

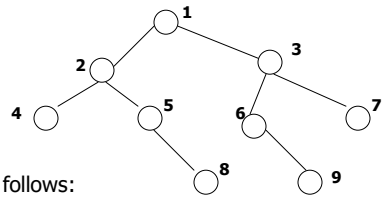
```
int Ancestor(TreeNode<T> *p, *q)
```

to determine whether a given node pointed by q is in the subtree rooted at another node pointed by p in an arbitrary binary tree. The function should return 1 if p is an ancestor of q and 0 otherwise.

Example Questions

A1)

a) 4 2 5 8 1 6 9 3 7



a) One possible solution is as follows:

```
int Ancestor(TreeNode<T> *p, *q)
{
   if (p !=NULL)
   {
            if (p==q) return 1;
            else if (Ancestor(p->left,q)) return 1;
            else if (Ancestor(p->right,q)) return 1;
            else return 0;
   }
   return 0;
}
```


Example Questions

Q2)

FibonacciTree={1,{1,{2},{3},{5,{8},{13},{21,{34},{55},{89}}}}}

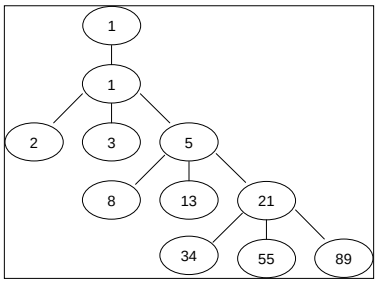
Draw the graphical representation and write down the values of the following properties (if applicable) of the tree given above:

Depth:
Level:
# of Leaves:
# of nodes with degree≤1:

Example Questions

A2)

FibonacciTree={1,{1,{2},{3},{5,{8},{13},{21,{34},{55},{89}}}}}



Depth:	4
Level:	NA
# of Leaves:	7
# of nodes with degree<=1:	8

Example Questions

Q3)

a) Show the intermediate states of the data set if QuickSort is applied to sort the following array in ascending order: A:[37,88,2,50,11,27,44]

b) Repeat part a) for the array B:[88,50,44,37,27,11,2]

c) Show how the elements in this array should be initially organized so that QuickSort succeeds in the shortest possible time

Example Questions

A3)

a) [37,88,2,50,11,27,44]
[2,11,27] 37 [88,50,44]
2 [11,27] 37 [50,44] 88
2, 11, 27, 37, 44, 50, 88

b) [88,50,44,37,27,11,2]
[50,44,37,27,11,2] 88
[44,37,27,11,2] 50,88
[37,27,11,2] 44, 50, 88
[27,11,2] 37, 44, 50, 88
[11,2] 27, 37, 44, 50, 88
2, 11, 27, 37, 44, 50, 88

c) [37,11,2,27,50,44,88]

Example Questions

Q4) Show schematically the data structure after the following integer keys are inserted into:

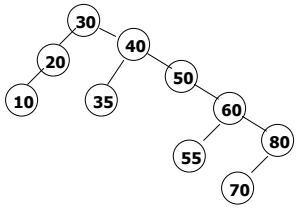
a) A Binary Search Tree. (Only the structure after all keys are inserted is required.)

b) A B-Tree of order 3. (Show the structure after the insertion of underlined keys only, i.e., you are required to draw only four B-Trees.)

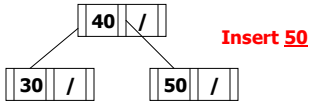
Data to be inserted, in the sequence below, from left to right:
(30, 40, 50, 20, 60, 80, 70, 10, 35, 55)

Example Questions

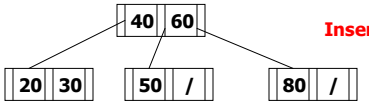
A4) a)



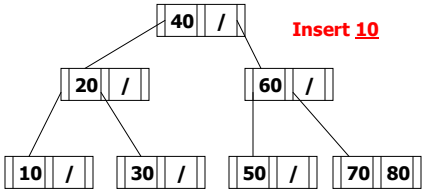
b)



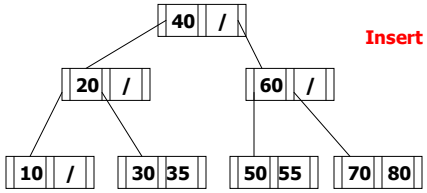
Insert 50



Insert 80



Insert 10



Insert 55

Example Questions

Q5) Consider a 13 element hash table for which f(key)= key mod 13 is used with integer keys. Assuming that linear probing is used for collision resolution, show the table of contents (key and status information) after the following operations are carried out in the given order:

a) The keys 661, 182, 24, 103 are inserted

b) The key 24 is deleted;

c) The keys 103, 24, 1312 are searched- indicate which addresses are probed and what is the search result in each case

d) What is the final loading factor?

Example Questions

A5)

key	f
661	11
182	13->0
24	11
103	12
1312	12

c) 103-> probe 12, 0, 1 found

24->probe 11, 12, 0, 1, 2 not found

1312-> probe 12, 0, 1, 2 not found

d) lf= 3/13

a)

location	key
0	182
1	103
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	661
12	24 b)

Example Questions

HT

	key	status
0		
1		
2		
3		
4		
5		
6		

Q6) Consider the hash table HT given above and the hash function

f(key)=(key*key) mod 7

Hash table entries consist of the key value and a status field in which

0=empty, 1=full, -1=deleted.

a) Show the content of HT after insertion of 3, 7, 1, 5, 6, 4, 8. Assume linear probing in the case of collision.

b) Repeat part (a) assuming random probing where the pseudo-random number generator PRN returns PRN(0)=3, PRN(3)=5, PRN(5)=2, PRN(2)=1, PRN(1)=4, PRN(4)=6, PRN(6)=0.

Example Questions

A6)

a)

HT

	key	status
0	7	1
1	1	1
2	3	1
3	6	1
4	5	1
5	4	1
6	8	1

b)

HT

	key	status
0	7	1
1	1	1
2	3	1
3	4	1
4	5	1
5	8	1
6	6	1

Example Questions

Q7)

```
void Xsort (int &IA[ ], int low, int high)
{
   int lo=low+1;
   int hi=high;
   int elem=IA[low];
   while (True)     {
            while (IA[lo]<elem) && (lo<high) {lo++};
            while (IA[hi]>elem) && (low<high) {hi--};
            if (lo<hi) swap(IA[lo],IA[hi]);
            else break;
   }
   swap(IA[low],IA[hi]);
   /* Execution point X */
   if (low<(hi-1)) Xsort(IA,low,hi-1);
   if ((hi+1)<high) Xsort(IA,hi+1,high);
}
```

a) Consider the call Xsort(A,0,6) where

A=[30 12 25 7 9 15 48]

Write the content of the array `IA` at the `execution point X` as the function is executed recursively. Indicate also the current values of the variables `low` and `high` at that point.

b) Consider the call Xsort(B,0,n-1) where n>8 and

B=[1 2 3 4 … n-3 n-2 n-1 n]

Write the content of the array `IA` at the `execution point X` for the first 3 passes. Indicate also the current values of the variables `low` and `high` at that point. How many times will the function Xsort be called to sort B?

Example Questions

A7)

a) [30 12 25 7 9 15 48]
[15 12 25 7 9] 30 [48], low=0, high=9
[7 12 9] 15 [25] 30 [48], low=0, high=4
7 [12 9] 15 [25] 30 [48], low=0, high=2
7 [9] 12 15 25 30 [48], low=1, high=2

b) [1 2 3 4 … n-3 n-2 n-1 n]
1 [2 3 4 … n-3 n-2 n-1 n], low=0, high=n-1
1 2 [3 4 … n-3 n-2 n-1 n], low=1, high=n-1
1 2 3 [4 … n-3 n-2 n-1 n], low=2, high=n-1