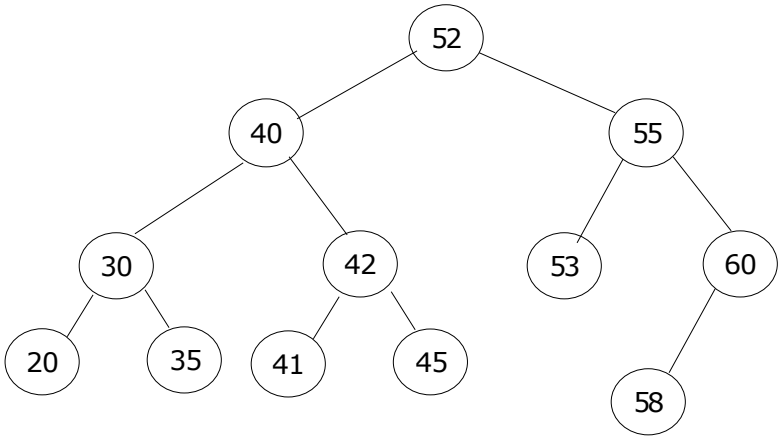
Programming & Data Structures - Final and Solutions- Dec 19, 2005

(I gave 5 points for each question, including 5 each for Questions 5a and 5b)

1. The post-order traversal of a binary search tree gives: 20 35 30 41 45 42 40 53 58 60 55 52. Draw a diagram of the tree.

Ans.



2. If a *complete binary tree* is to be constructed with height 10, what is the minimum and maximum # of leaves it can have? Count the root at height 0, the first two children at height 1, etc.

This is a **complete binary tree**, **not a search tree**. So the leaf nodes are all at the last level. If the tenth level is full, there will be 2^10 leaf nodes, which is the maximum # of nodes. The minimum you can have is just one node (left-most) at the 10th level.

Max: 2^{10}=**1024** **Min:** **1**

3. Consider a set S={12, 3, 23, 11, 7, 8, 33, 4, 17}. Using the first element as pivot, write the steps involved in running the Quicksort algorithm on the set. At each step, give the resulting set.

Step 1 : 3 11 7 8 4 **12** 23 33 17

Step 2 : **3** 7 8 4 11 **12 17** 23 33

Step 3 : **3** 4 **7** 8 11 **12 17 23** 33

Step 4 : **3 4 7 8** 11 **12 17 23 33**

Step 5 : **3 4 7 8 11 12 17 23 33**

Step 6:

4. A text file "in.txt" contains lines of words separated by spaces. Write a C++ program to read in the file, replace spaces by underscore, and write to another file "out.txt". A sample input and the corresponding output are as follows:

in.txt	*out.txt*
My Documents	My_Documents
Program Files	Program_Files
My unsaved school documents	My_unsaved_school_documents

Ans.

```
#include<iostream>
#include<string>
#include<fstream>
#include<cctype>
using namespace std;
int main() {
  ifstream IN;
  ofstream OUT;
  string s;
  char c;
  IN.open("in.txt");
  OUT.open("out.txt");
  while(!IN.eof()){
    getline(IN,s);
    for (int i=0;i<s.length();i++){
      c=s.at(i);
      if (!isspace(c))
          OUT<<c;
      else
          OUT<<'_';
    }
    OUT<<endl;
  }
  IN.close();
  OUT.close();
}
```

Almost all of you had a variation of the following program:

```
#include<iostream>
#include<fstream>
#include<cctype>
using namespace std;
int main() {
  ifstream IN;
  ofstream OUT;
  string s;
  char c;
  IN.open("in.txt");
  OUT.open("out.txt");
  while(!IN.eof()){
    IN.get(c);
    if(isspace(c))
     OUT.put('_');
    else
     OUT.put(c);
  }
  IN.close();
  OUT.close();
}
```

The problem with this program is that even the newline characters are replaced by underscore so that "out.txt" ends up being a single line file. Please check it out. The isspace() function reports true all spaces, tabs as well as newline characters.

Despite this, I gave credit for those who wrote this answer.

5. Consider a Binary SearchTree

```
class BTree {
  int key;
  BTree* left;
  BTree* right;
  BTree* parent;
  }
```

a)Write a *member* function *int sum_of_keys(int m)* that returns the sum of all key values in the tree less than a given value *m*. Just give the function implementation, nothing else.

```
int BTree::sum_of_keys(int m){
  int l=0, r=0;
  if(  (this->left==NULL) &&(this->right==NULL) ){
    return ((this->key)>m) ? (this->key) : 0 ;
  }
  else
    {
    if(this->left){
      l=(this->left)->sum_of_keys(m);
    }
    if(this->right){
      r=(this->right)->sum_of_keys(m);
    }
    return ((this->key) > m )  ?  (this->key)+l+r  :  l+r ;
  }
}
```

```
if( (this->key)>m)
    return this->key;
else
    return 0;
```

b) Write a *non-member* function *int sum_of_leaves(BTree* root)* that returns the sum of keys in the leaf nodes of the tree with root given in the argument. Just give the function implementation, nothing else.

```
int sum_of_leaves(BTree* root){
  int l=0, r=0;
  if ( (root->left == NULL) && (root->right == NULL)  ){
    return root->key;
  }else{
    if(root->left){
      l=sum_of_leaves(root->left);
    }
    if(root->right){
      r=sum_of_leaves(root->right);
    }
  }
  return l+r;
}
```