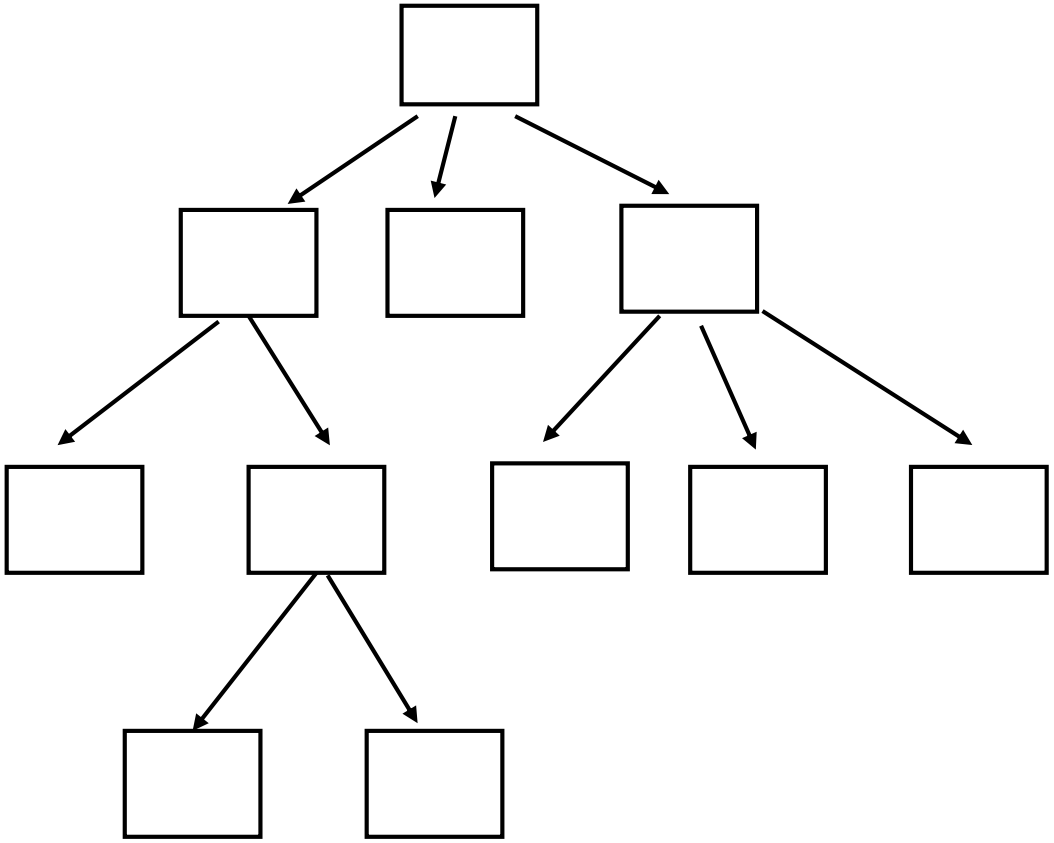
COMP 250

Lecture 18

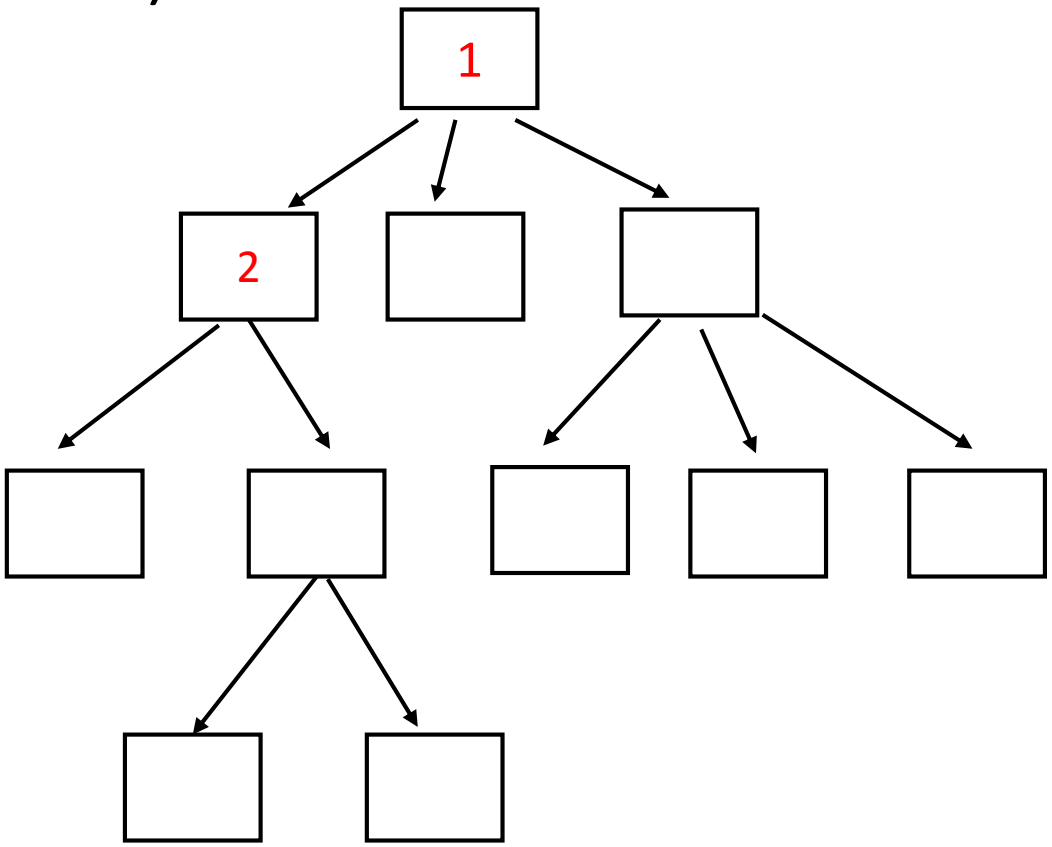
tree traversal

Oct. 21, 2016

How to enumerate/iterate through/traverse/visit/… the nodes of a tree ?



```
depthfirst (root){                    //        "preorder"
   if (root is not empty){
        visit root
        for each child of root
             depthfirst( child )
   }
}
```



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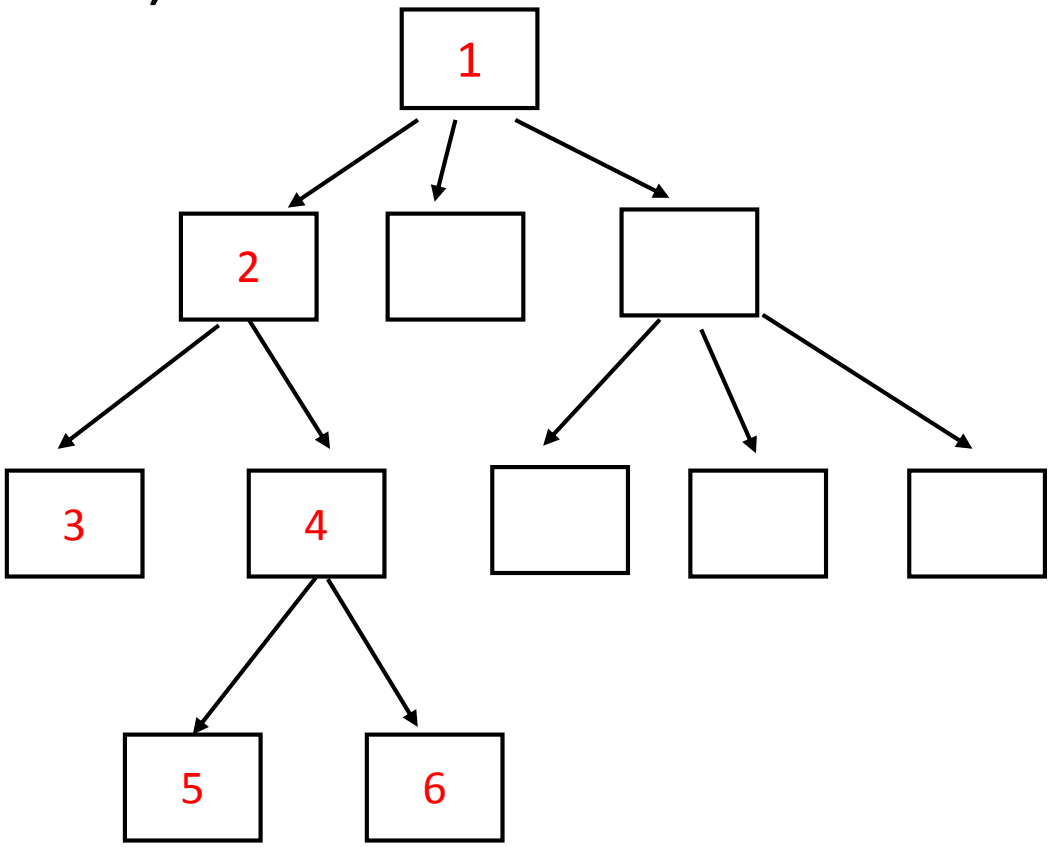

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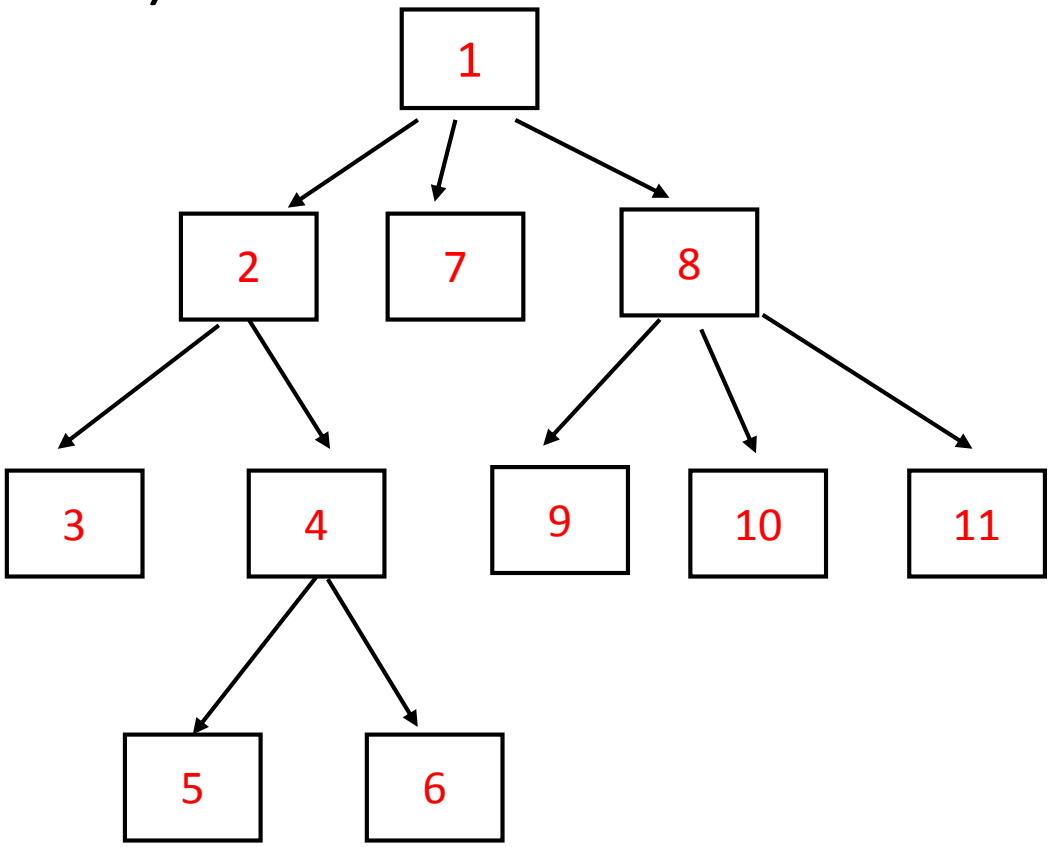
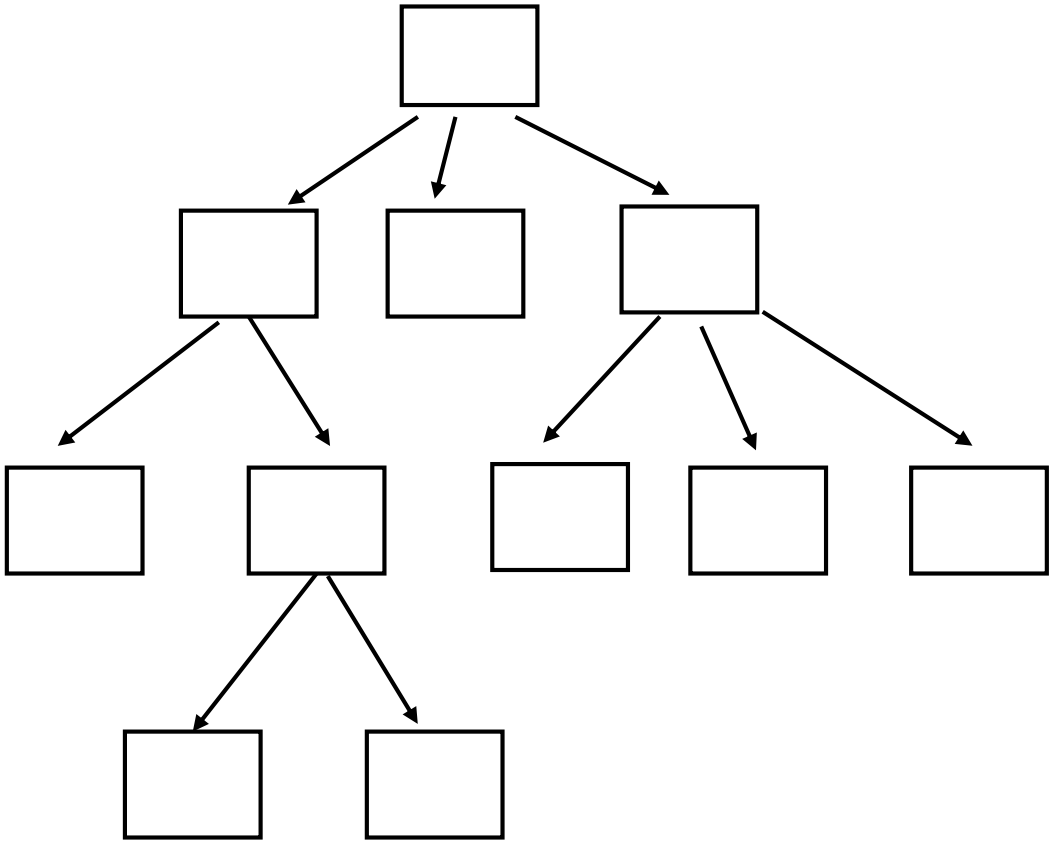


“Visit” implies that you do something at that node.

Analogy: you aren’t visiting London UK if you are just flying through Heathrow.

e.g. Printing a file hierarchy

```
depthfirst (root){                    //        "postorder"
    if (root is not empty){
         for each child of root
              depthfirst( child )
         visit root
    }
}
```



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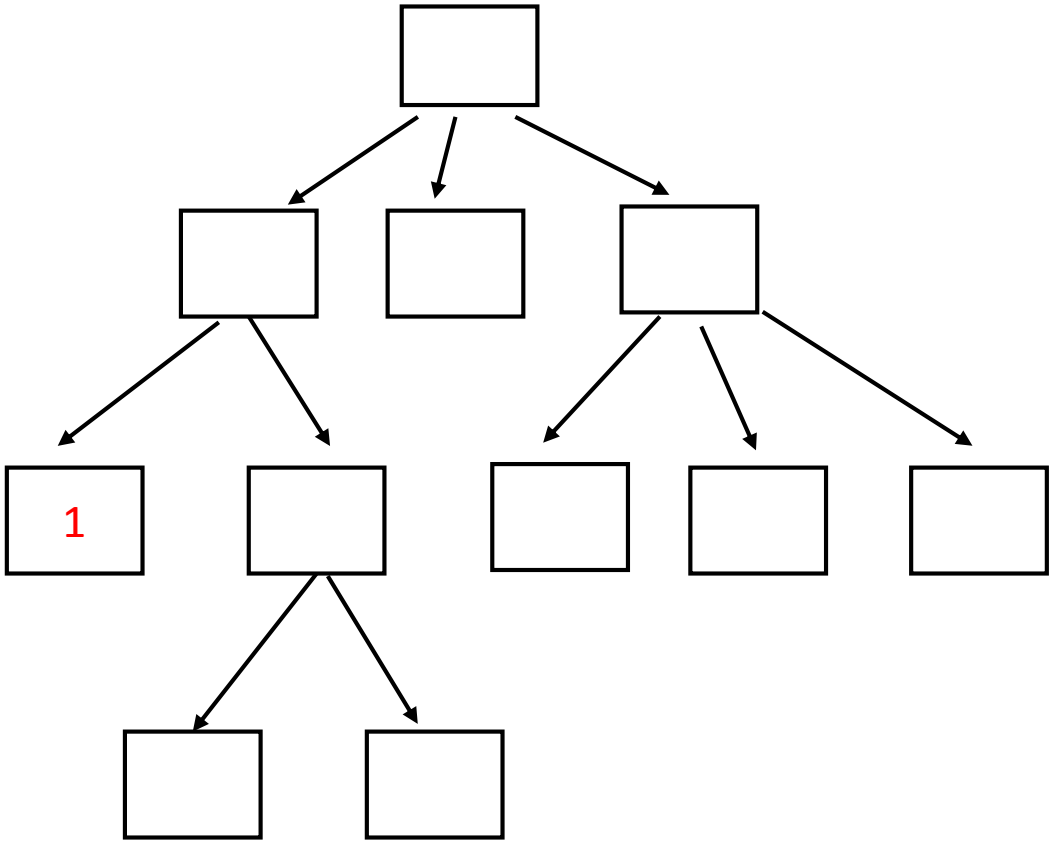

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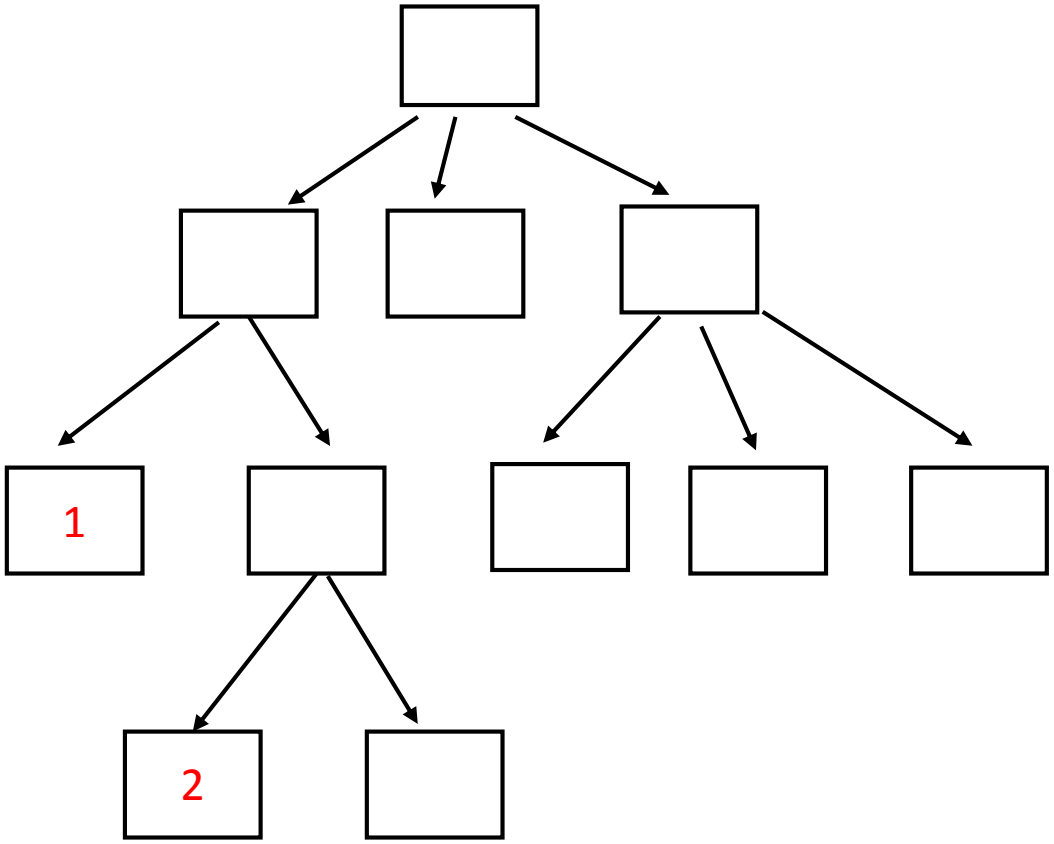

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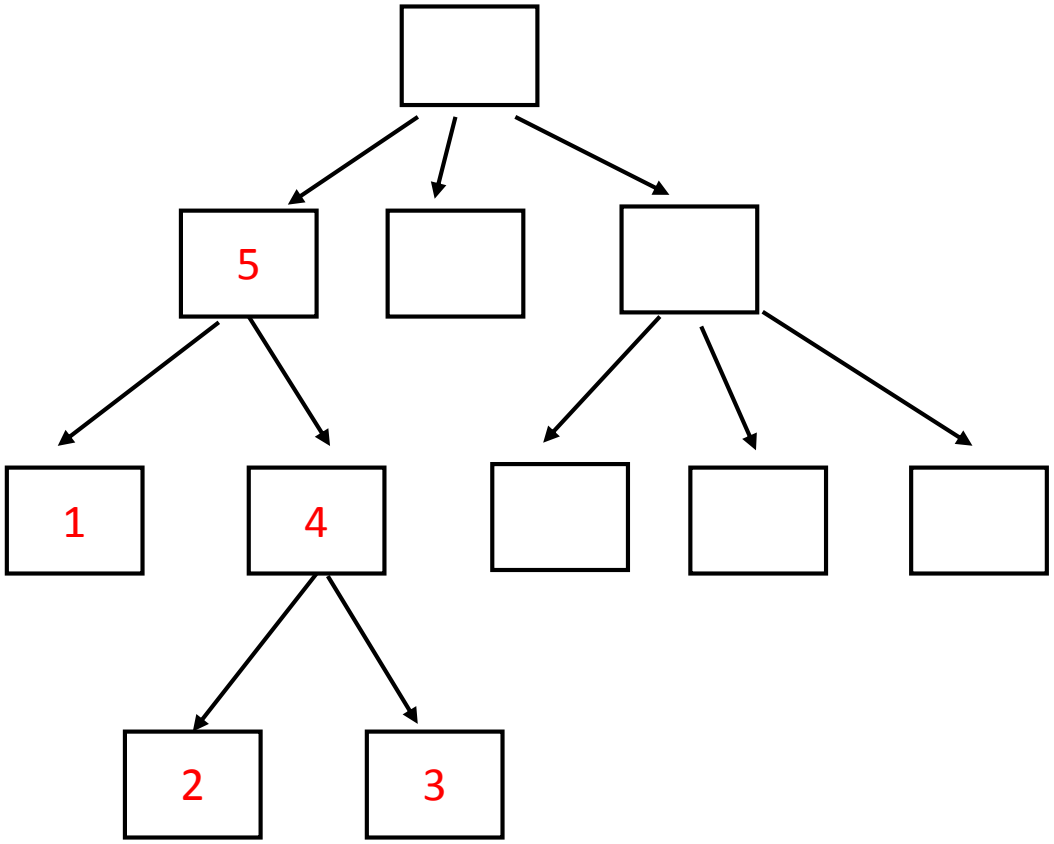

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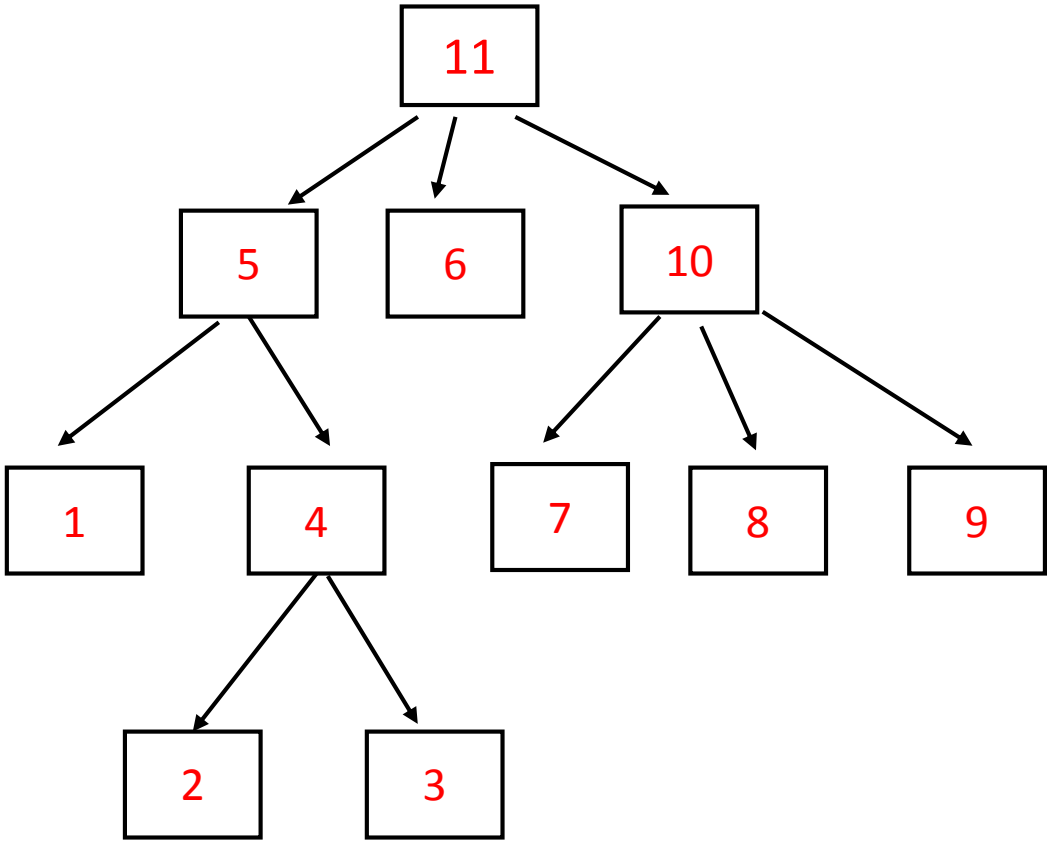


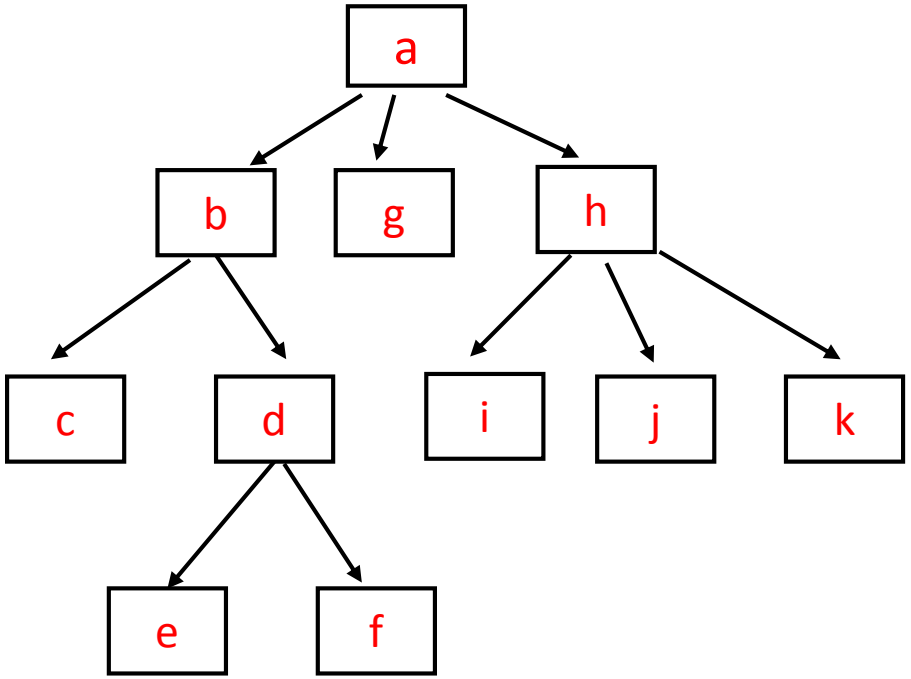
e.g. What is the total number of bytes in all files?

```
numBytes(root){
   if root is a leaf
      return number of bytes at root
   else {
      sum = 0
      for each child of root{
            sum += numBytes(child)
      }
      return sum
    }
}
```

Q: What do we mean by visit here ?

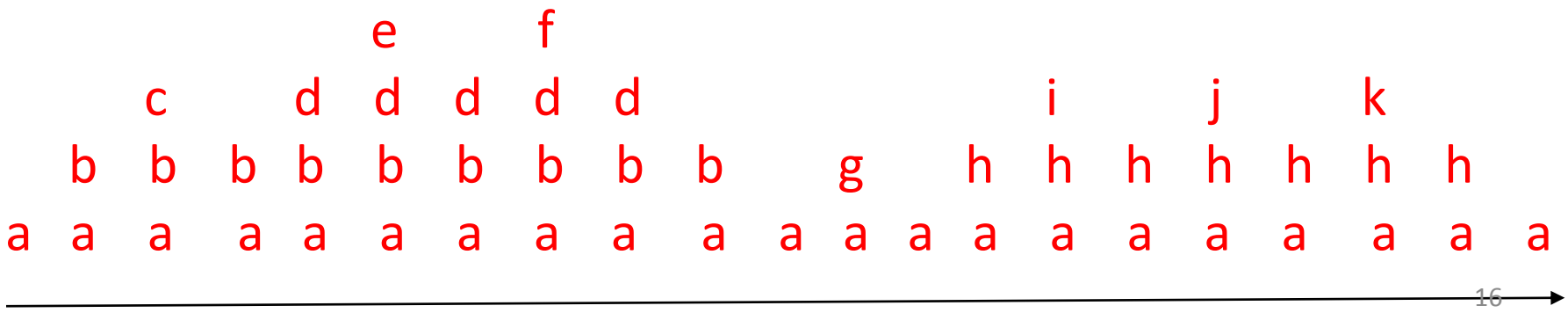
A: Determining the number of bytes for a node, e.g. If we were to store 'sum' at the node.

Call stack for depthfirst()



Letters are names of nodes (happen to be ordered by calls).

Same call sequence occurs for preorder vs postorder.



Tree traversal

Recursive

- depth first (pre- versus post-order)

Non-Recursive

- using a stack
- using a queue

```
treeTraversalUsingStack(root){
    initialize empty stack s
    s.push(root)
    while s is not empty {
        cur = s.pop()
        visit cur                    //  moving  'visit cur' to be
        for each child of cur        //  after for loop
            s.push(child)            // changes nothing
    }
}
```

```
treeTraversalUsingStack(root){
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    while s is not empty {
        cur = s.pop()
        visit cur
        for each child of cur
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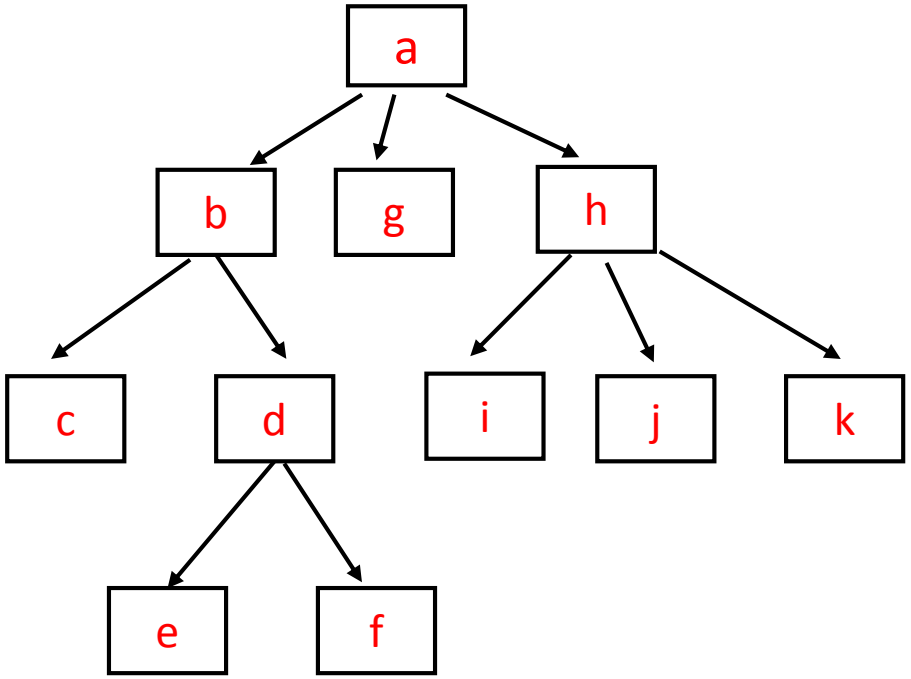

a

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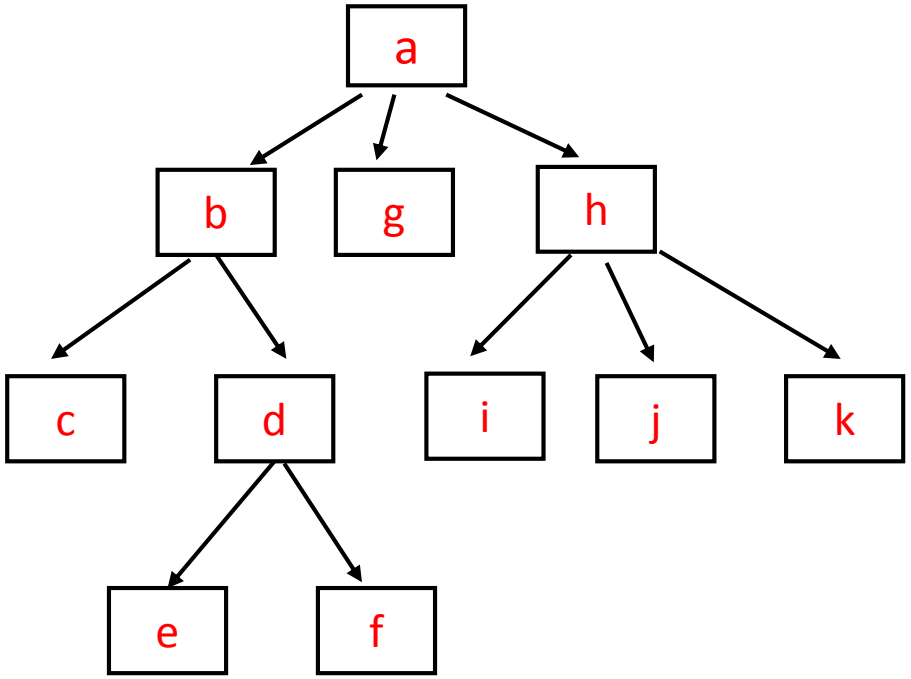

Here I am using same label nodes as in the pre-order recursive depthfirst() example.

h

g

a b

```
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}
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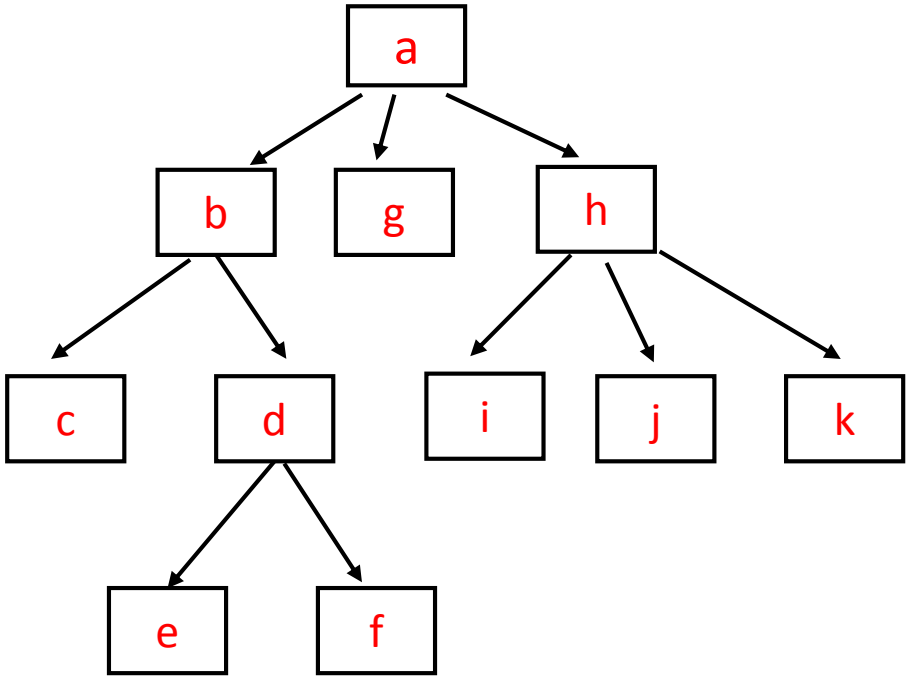

k
j
h i
g g
a b … b

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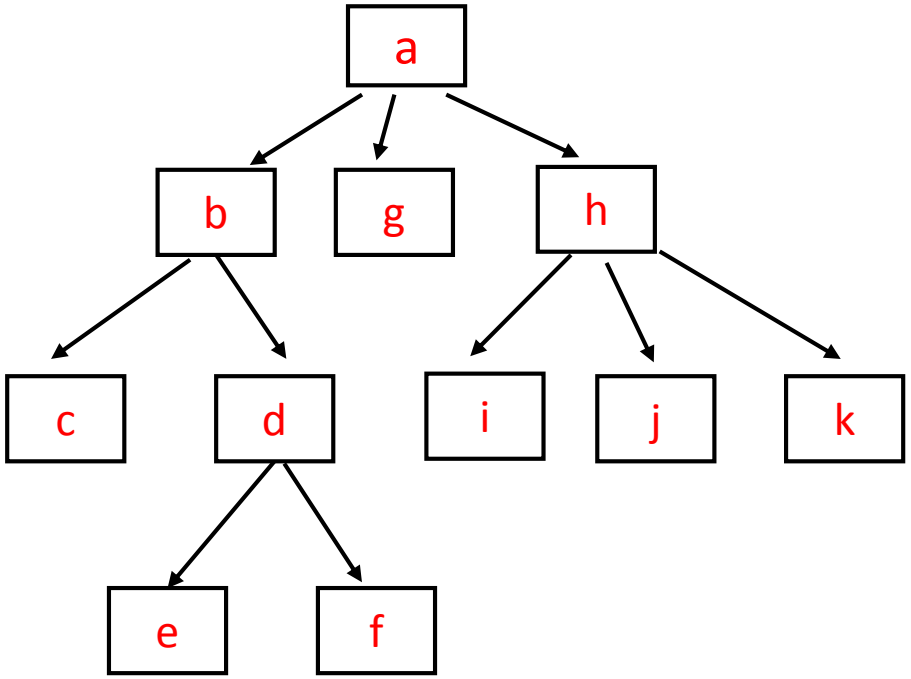
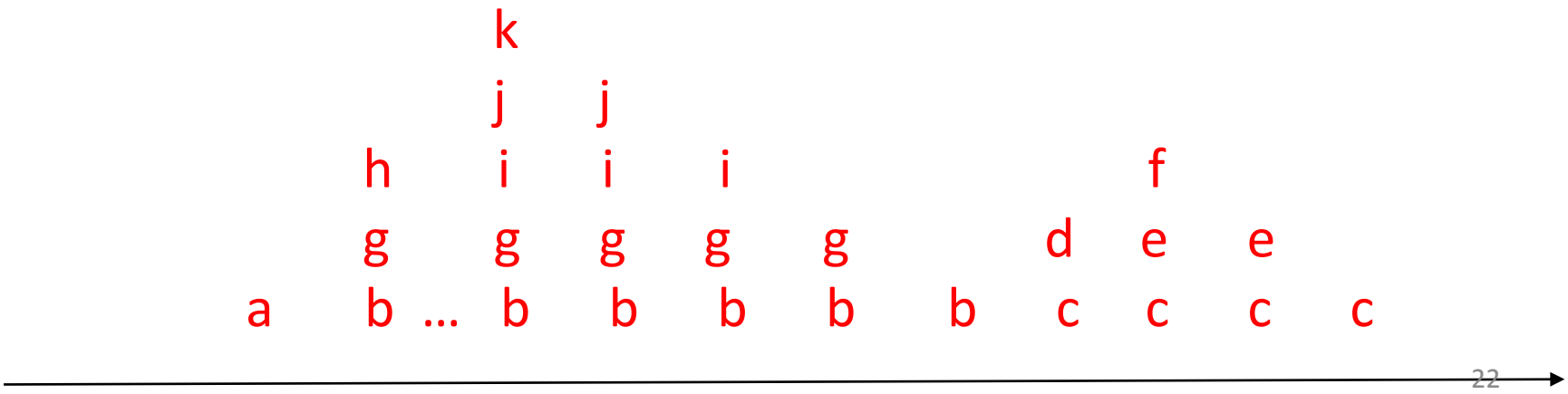
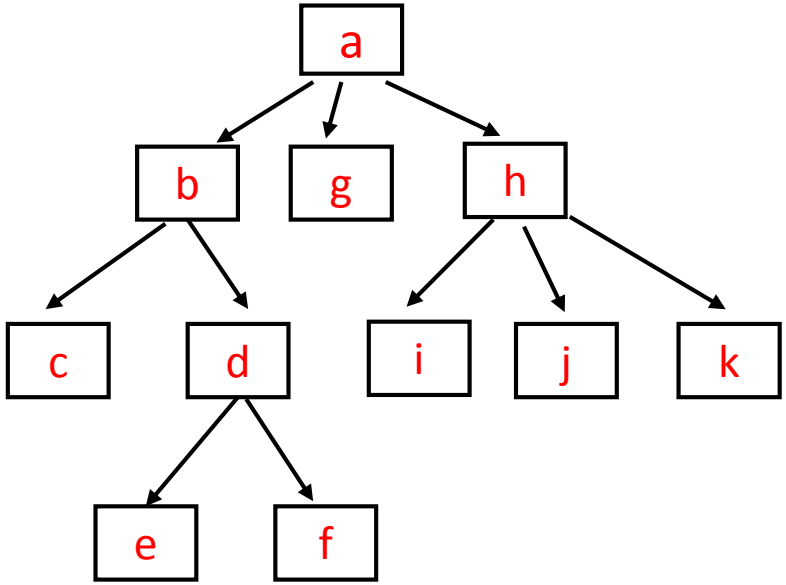




Stack based method is depth first but visits children from right to left



recursive abcdefghijk

non-recursive (stack) ahkjigbdfec

What if we use a queue instead?

```
treeTraversalUsingStack(root){
    initialize empty stack s
    s.push(root)
    while s is not empty {
        cur = s.pop()
        visit cur
        for each child of cur
            s.push(child)
    }
}
```

```
treeTraversalUsingQueue(root){
    initialize empty queue  q
    q.enqueue(root)
    while q is not empty {
        cur = q.dequeue()
        visit cur
        for each child of cur
            q.enqueue(child)
    }
}
```

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treeTraversalUsingQueue(root){
    initialize empty queue  q
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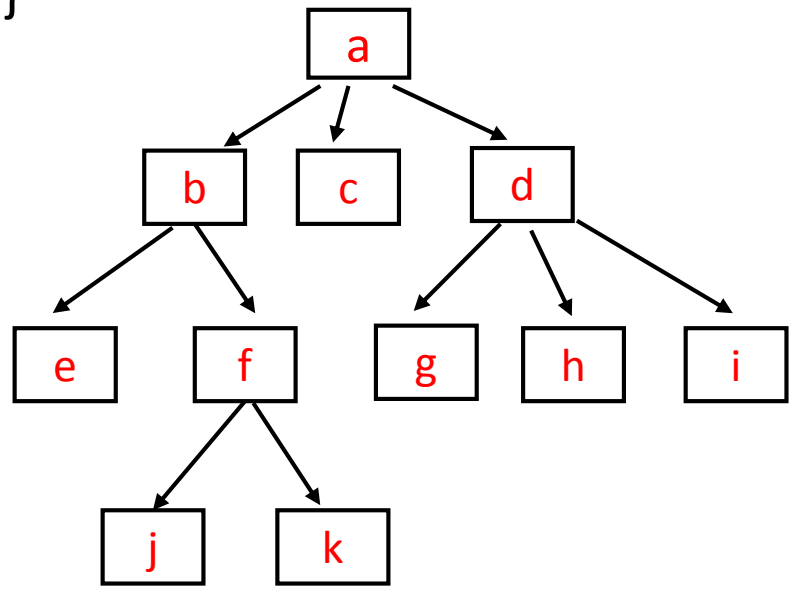

Queue state at start of the while loop

a

```
treeTraversalUsingQueue(root){
    initialize empty queue  q
    q.enqueue(root)
    while q is not empty {
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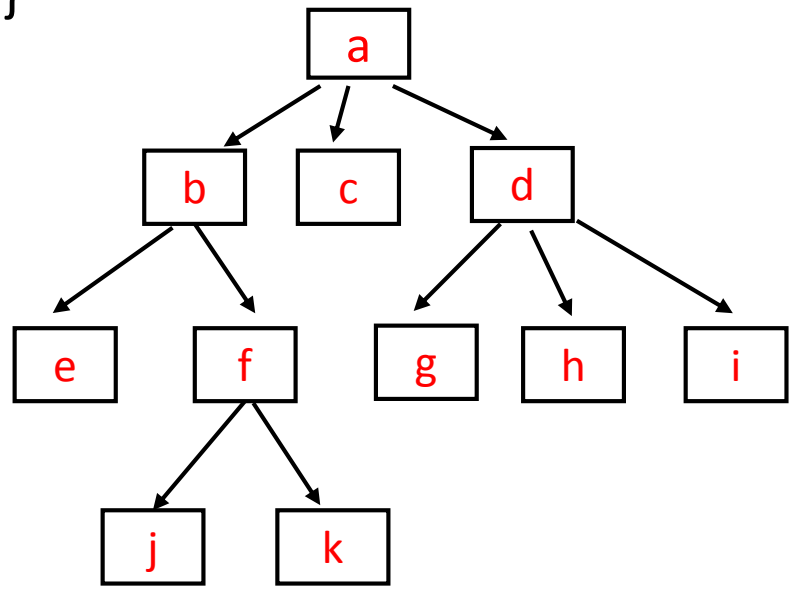

Queue state at start of the while loop

a

bcd

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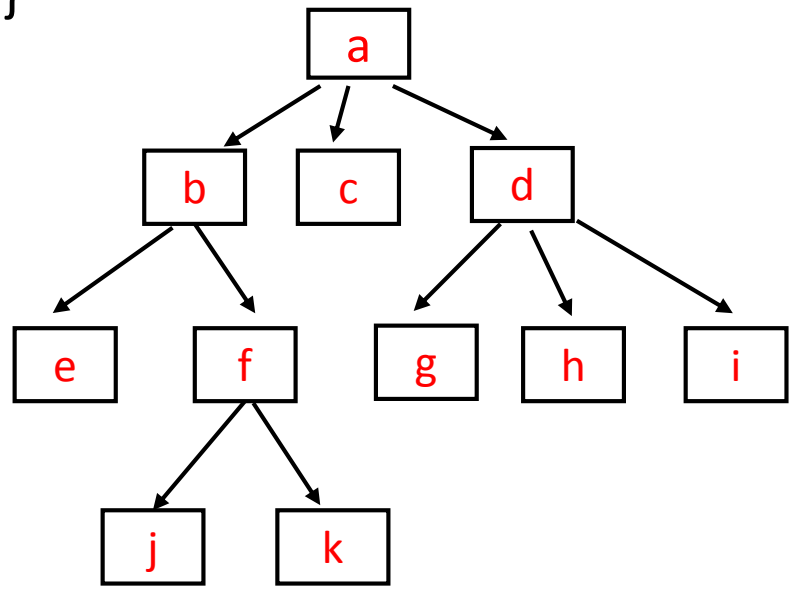

Queue state at start of the while loop

a

bcd

cdef

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}
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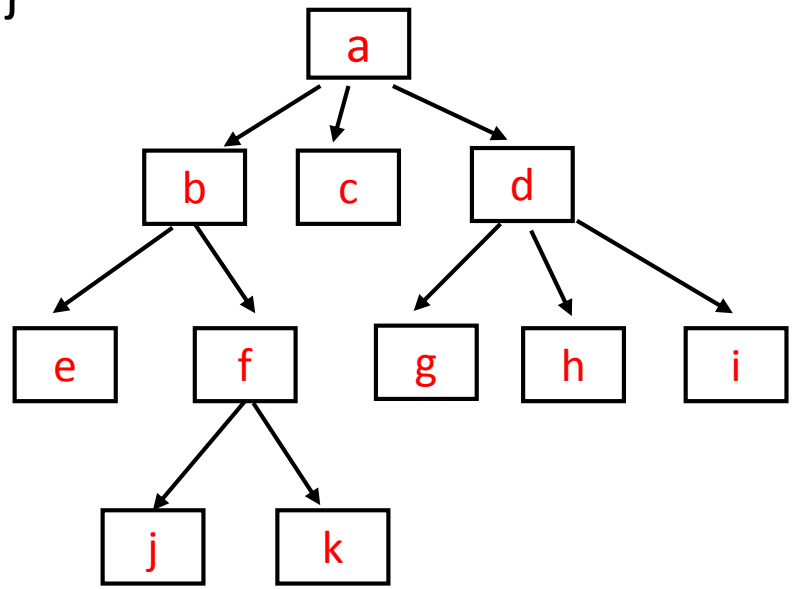

Queue state at start of the while loop

a

bcd

cdef

def

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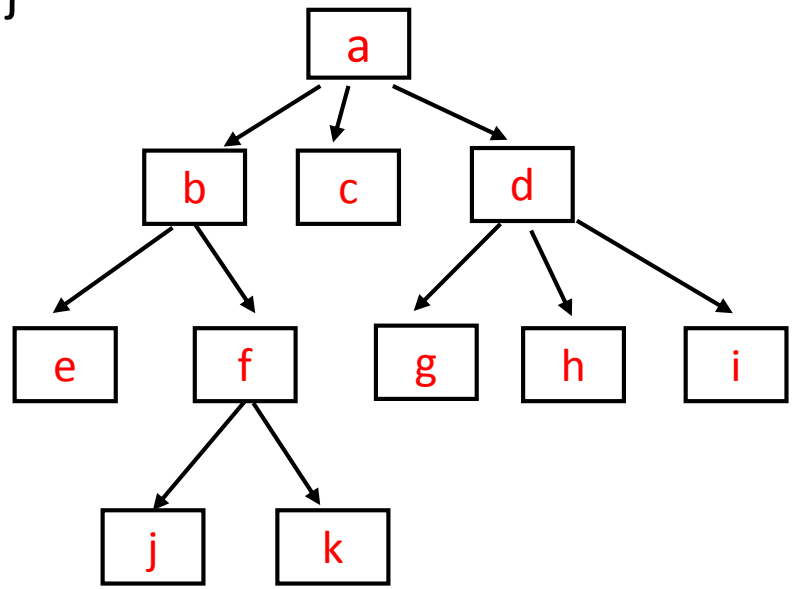

Queue state at start of the while loop

a

bcd

cdef

def

efghi

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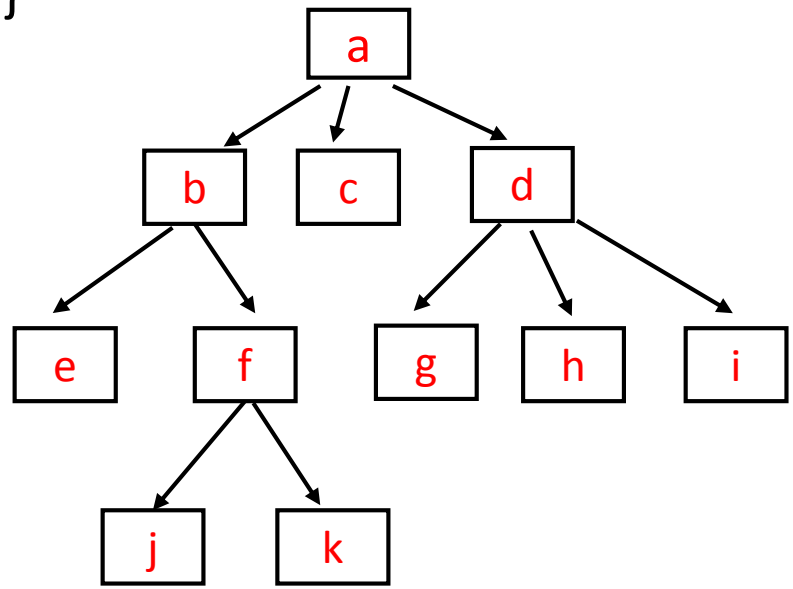
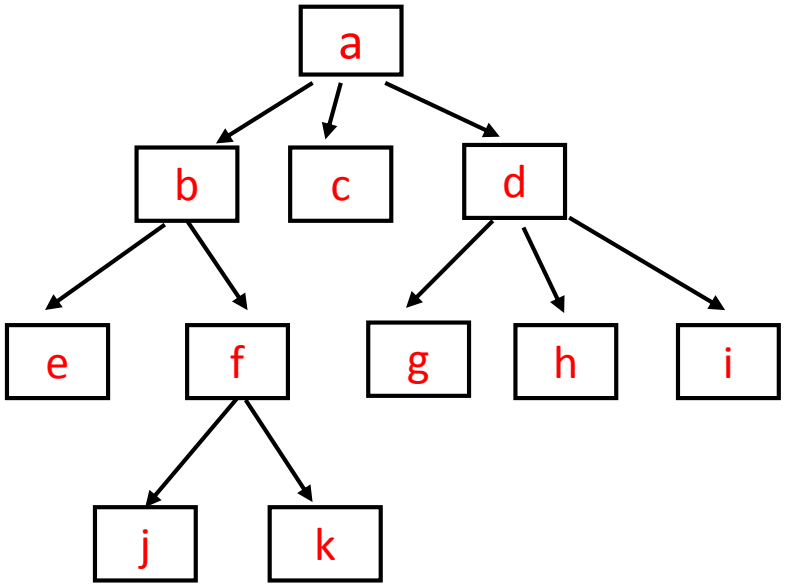


Queue state at start of the while loop

breadth first traversal

for each level i

visit all nodes at level i



order visited: abcdefghijk

Tree traversal

Recursive

- depth first (pre- versus post-order)

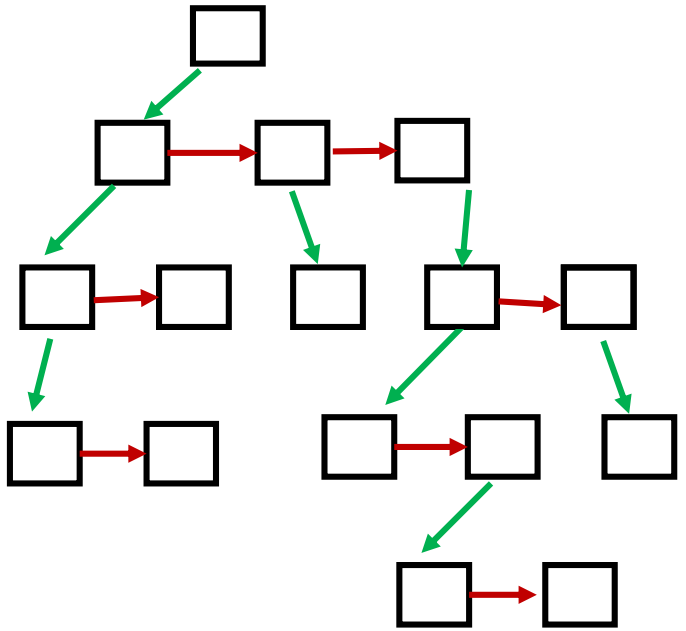
Non-Recursive

- depth first (uses a stack)
- breadth first (uses a queue)

Implementation Details
Recall: ‘first child, next sibling’

```
class  TreeNode<T>{
     T   element;
     TreeNode<T>   firstChild;
     TreeNode<T>   nextSibling;
       :
       :
}

class  Tree<T>{
    TreeNode<T>   root;
        :
        :
}
```



Recall: ‘first child, next sibling’

```
for each child{
    …
}
```

This means:

```
child = cur.firstChild
while (child  !=  null){
    …..
    child =  child.nextsibling
}
```