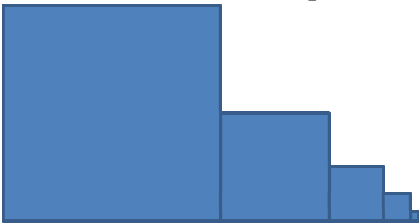


Read each question carefully. When writing code, note that not all questions require a complete class, or even a complete method. Keep in mind that this review is not intended to be comprehensive. While studying for the exam, it would be prudent to consider variations on the questions presented here.

Assume you want to implement a priority queue using an array of arrays. Using Big-O expressions, explain the advantages & disadvantages of this approach regarding both speed & storage requirements.

Assume you have access to a method `Draw.square(x,y,s)` which draws a square of size `s` pixels at position `(x,y)` on the screen. Write a recursive method that takes a starting position and size & draws the pattern below to the screen (don't worry about things like drawing off the edge of the monitor).



In big O notation indicate the performance of the following operations on the indicated data structures:

SinglyLinkedListQueue with the front of the queue is at the tail

```
// add element e to the queue  
insert(e)
```

```
// remove element from the queue  
remove()
```

CircularArrayQueue

```
// add e element to the queue (assuming there is not enough room)  
insert(e)
```

```
// remove element from the queue  
remove()
```

ArrayHeap

```
// add e element to the heap  
insert(e)
```

```
// add element to the heap (assuming there is not enough room)  
insert(e)
```

LinkedHeap

```
// add e element to the heap  
insert(e)
```

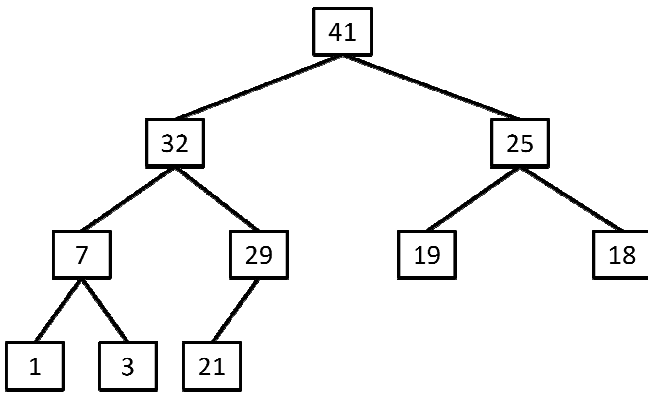
```
// remove element from the heap  
remove()
```

LinkedBinarySearchTree

```
// determine if element e is in the tree  
find(e)
```

List the invariants of a binary search tree.

Starting with heap shown below, diagram the steps required to add the element 45.

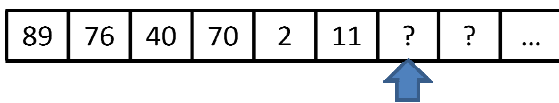


Define the depth of a node as it applies to trees.

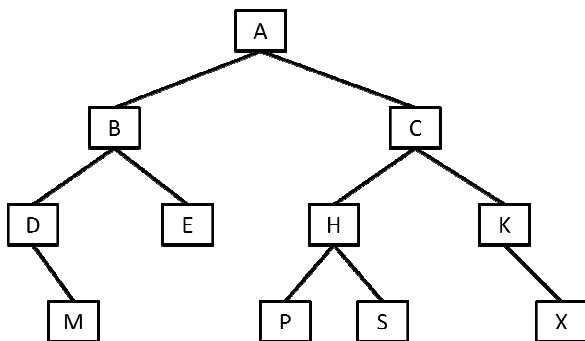
Define a leaf node.

Define what it means for a tree to be full.

Starting with the heap shown below as an array, diagram the steps required to remove the largest element. Note: the arrow indicates the index marked by manyItems.



Write the preorder traversal for the tree shown below:



Entries in a binary search tree are "ordered". What is the meaning of this statement?

- A. Parent > LeftChild, Parent > RightChild
- B. Parent < LeftChild, Parent < RightChild
- C. Parent > LeftChild, Parent < RightChild
- D. Inorder traversal yields an ordered list
- E. both D & B
- F. both D & A

Which of the following is true of heaps?

- A. they are FIFO data structures
- B. they are LIFO data structures
- C. they can be used for priority queues
- D. they can sort a list in linear time
- E. they are always full
- F. none of the above

Which of the following is true about tail recursion?

- A. it is generally faster than looping
- B. it is generally slower than looping
- C. it can always be replaced with looping
- D. both A & C
- E. both B & C
- F. none of the above

Which of the following is true about B-Trees?

- A. they are binary trees
- B. all leaf nodes are at the same depth
- C. for a given node,  $data[j] \geq$  all elements in subtree[j]
- D. for a given node, the # of subtrees == the number of elements
- E. the tree is symmetric
- F. None of the above

Which of the following is true of queues?

- A. they are FIFO data structures
- B. they are LIFO data structures
- C. they are non linear data structures
- D. both A & C
- E. both B & C
- F. none of the above