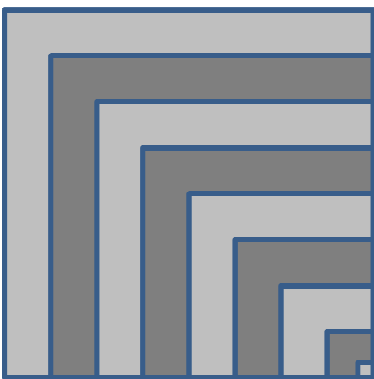


Read each question carefully. When writing code, note that not all questions require a complete class, or even a complete method. Keep in mind that this review is not intended to be comprehensive. While studying for the exam, it would be prudent to consider variations on the questions presented here.

Assume you want to implement a priority queue using a linked list of queues. 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,b)` which draws a square of size `s` pixels at position `(x,y)` on the screen w/ a given brightness (1.0 is white, 0.0 is black). Write a recursive method that takes a starting position and size & draws the pattern below to the screen. Assume each squares below are reduced by 20 pixels at each step. Don't worry about getting the colors exactly correct.



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()
```

```
SinglyLinkedListQueue with the front of the queue is at the head
// add element e to the queue
insert(e)
```

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

```
CircularArrayQueue
```

```
// add e element to the queue (assuming there is enough room)
insert(e)
```

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

```
LinkedHeap
```

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

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

```
LinkedBinarySearchTree
```

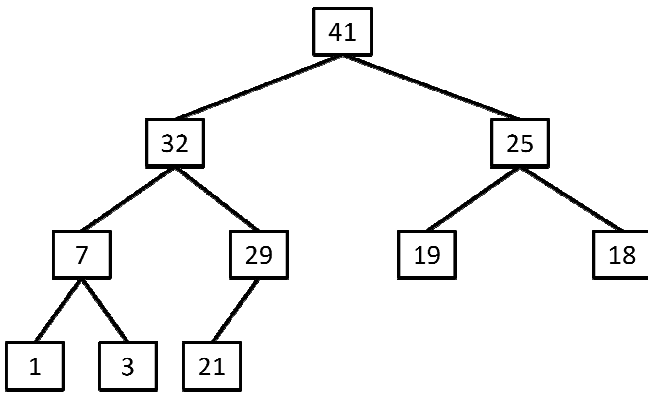
```
// determine if element e is in the tree
find(e)
```

```
// remove all occurrences of element e is in the tree
removalAll(e)
```

```
// remove all elements descending from & including the given node k
prune(k)
```

List the invariants of a heap.

Starting with heap shown below, diagram the steps required to remove the root element.

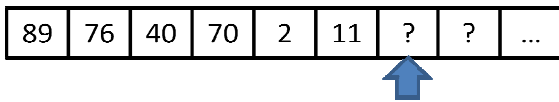


As formally as possible, define the sibling relationship as it pertains to nodes in a tree.

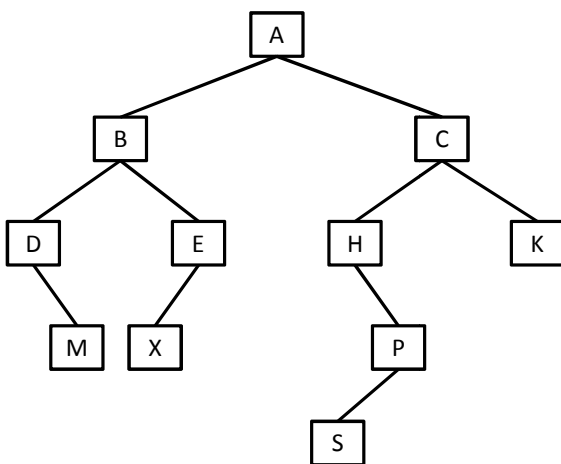
Define an inner node.

Define what it means for a binary tree to be complete.

Starting with the heap shown below as an array, diagram the steps required to add the element 90. Note: the arrow indicates the index marked by manyItems.



Write the pre, post & in-order traversals 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 queues?

- A. they are FIFO data structures
- B. they are LIFO data structures
- C. they can be used for heaps queues
- D. they can sort a list in linear time
- E. they support random access
- 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 BSP-Trees?

- A. they are binary trees
- B. all leaf nodes are at the same depth
- C. for a given node, data[j] >= 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 heaps?

- 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