Review Questions
1. Java has an AbstractList class and a Comparable interface. Why is one an abstract class and the other an interface?
2. Give an algorithm for deleting a node in a binary search tree. The algorithm should be able to handle nodes such as 24 (no children), 42 (one child) or 17 (two children) in the following tree:
3. A grocery store hires you to maintain their inventory in a database. You need to use as keys the Universal Product Code stored in the barcode. The UPC consists of 12 numeric decimal digits, such as the following one for Kellogg’s Raisin Bran: 038000596636. The value corresponding to each key is the number of items of this product that you have on hand. Here are some options:

You could store the counts in an array indexed by the UPC; for example, if the store has 20 boxes of Kellogg’s Raisin Bran the entry at index 38000596636 would be 20.

You could make an array of base type Entry, which has a UCP-count pair, with an entry for each of the 10,000 products stocked in the store.

You could make a HashMap where the keys are UPC’s and the values are Integer counts.

You could make a TreeMap where the keys are UPCs and the values are Integer counts.

Which would you use, and why?
4. Here is a Node type for a binary search tree that holds integer data:
   ```
   class Node {
       int data;
       Node leftChild, rightChild;
   }
   ```
   Give a definition of a recursive function
   ```
   Node insert( int x, Node p)
   ```
   that inserts value x into the tree rooted at p.
5. I have a large collection of n data items already stored in an AVL tree. I want to use this tree as a Priority Queue. How long will each of these queue operations take?
   Peek (i.e., find the maximum element)
   Poll (find, remove and return the maximum element)
   Offer (x) (insert x into the queue)
6. Here is a recursive function:

```c
int f(int n) {
    if (n == 0)
        return 1;
    else if (n == 1)
        return 3;
    else
        return 2*f(n-2) + 3*f(n-1) + 5;
}
```

Give a dynamic programming version of `f`.
7. Your boss gives you a dataset of 1,000,000 items. He wants you to find the 100 largest values in this dataset as quickly as you can. If your program runs quickly enough you get promoted and get to take that dream vacation to Fiji. If your program runs too slowly you get fired and go to work at MacDonalds. What technique will you use to find the 100 largest values? What is your estimate of its running time in terms of the number of items in the dataset?
8. Here is an algorithm for finding the kth smallest element in an unsorted array of values. It works much like Quicksort – we choose a pivot value and rearrange the data so that all of the values less than the pivot are to its left and all of the values greater than the pivot are to its right:

If the index of the pivot > k recurse on the portion of the array between index 0 and the index of the pivot. If the index of the pivot < k look for the k-index(pivot) smallest value in the portion of the array to the right of k. Of course, if index(pivot) == k you are done.

What is the big-Oh worst-case running time of this on an array of size n?
What is the average case running time on an array of size n?
Give an argument that your answer for (ii) is correct.
9. I have a tree based on the following Node class:
   
   ```
   class Node {
       int data;
       Node leftChild, rightChild;
   }
   ```

   Give a procedure void Print( Node p) that prints this tree in breadth-first order: print the root, print the root’s children, print the children of the root’s children, and so forth. For the tree

   ![Tree Diagram]

   It prints 1 5 3 4 9 8 7 6