**Homework 2**
3134 - Data Structures in JAVA  
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**Out**: Wednesday Feb 26, 2004  
**Due**: Wednesday March 7\textsuperscript{th}, beginning of class.

**Theory (80 points)**

1)
   a. (5 points) In general, what is the expected running time of the stack data structure for push and pop and why??

   b. (5 points) How would you extend stack so that you can provide constant time lookup for the smallest item on the stack. That is anytime during \( n \) inserts, you want to be able to answer getMin() and return the smallest item (at that point) in \( O(1) \)…

2) Suppose you have a list of 10,000 names in alphabetical order in an array and you must frequently look up different names.

   a. (5 points) How would a binary search tree work over the array? What is its running time?

   b. (5 points) What is the advantage/disadvantage of using an array over any other data structure here?

   c. (6 points) It turns out that 20 percent of the names account for 80 percent of the retrievals. Instead of doing a binary search tree over all 10,000 names, consider what would happen if you split the list into two sets. A high frequency list of 2000 names, and a low frequency list of 8000 names. Assuming the 8000 stays as an array, what data structure would be good to use on each section of the list?

   d. (5 points) describe how finding a name would work, is this scheme worth the effort? Justify your answer.
3) There is a game, where N people sit in a circle, with each person numbered 1..N. Starting the game from position 1, we count M spots and eliminate that position from the circle, and the circle closes rank. We now count from the M+1 spot another M steps, and eliminate that person, over and over until one spot is left. That person (whatever number it is) is the winner. So for example, if N = 5 and M = 1, we run through the circle: 2, 4, 1, 5.

   a. (5 points) What data structures would you use to write such a program?
   b. (5 points) What is the running time of the program?

4) In many data structures, when it comes to deleting an item, there is a strategy called “Lazy deletion”. In such cases, instead of actually removing the item, we simply mark it as deleted (using some Boolean for example).

   a. (5 points) Why would be want to keep track of the number of deleted and undeleted items?
   b. (5 points) At what point does it make sense to actually delete those elements which are just marked?
   c. (2 points) List the main advantage of lazy deletion
   d. (2 points) List a disadvantage of implementing lazy deletion

5) (5 points) A binary search tree is created by inserting, in order, the following words: "but not a real green dress that's cruel." (one at a time). Draw the tree after "green" is inserted and after all the words are inserted (yes 2 pictures), ordering the inserted words alphabetically. Then give the pre-order, post-order and in-order traversals of the tree.

6) (5 points) Show the result of adding 3, 4, 5, 7, 1, 2, 9, 6 into an initially empty binary search tree. Then show the result of deleting the root.

7) (5 points) Show the results of inserting 2, 1, 4, 5, 9, 3, 6, 7, 99, 98, 90 into an initially empty AVL tree. (draw the tree after each number is inserted).

8) (5 points) Draw the B-tree with M=5, L=7 resulting from inserting the following keys (in this order) into an initially empty tree: 4, 40, 23, 50, 11, 34, 62, 78, 66, 22, 90, 59, 25, 72, 64, 77, 10, 12.

9) (5 points) If you represent a complete tree as an array, is there any way to count the number of nodes in the tree in O(1)? Describe how all the operations would work.
Programming Section (10 points)

Imagine you want to implement a spell checker program using n-ary tree. In order to play around the implementation you will need to create an interface java file to define what a dictionary will be doing.

Please write up a valid java interface of what a standard dictionary class might look like. That is create a DictionaryInterface.java interface class which if you were to write a dictionary program would ‘impliment DictionaryInterface” in a standard way.

Include a short readme.txt outlining what classes would be needed and what other stuff would be needed if you were to write an actual spell checking program, Make sure you have a way of allowing the dictionary to be updated with custom spell words (imaging adding your name to the dictionary). Also how would you handle foreign language spelling words (yes not everyone speaks English).