

Midterm Exam

CS 311 Data Structures
Spring Quarter 2003

11:00am - 11:50am Monday May 5, 2002

THIS EXAM IS *CLOSED BOOK, CLOSED NOTES* .

Print your name neatly in the space provided below; print your name at the upper right corner of every page.

Name:

This booklet should have 4 pages (including this one). If it does not, report this to the instructor.

Work efficiently. Do not get stuck too long on any one problem.

Write short, succinct answers.

Try to answer every question.

Problem	Max. Points	Your Score
1	22	
2	18	
3	10	
Total	50	

1. (22 points) **Short answers**

- (a) What is the running time (in big-Oh notation) of the following loop? Briefly justify your answer.

```
for (x=0, i=1; i <= n; i*=2)
    for (j=1; j <= 2*n; j++)
        x++;
```

- (b) Describe two different situations when a copy constructor is used.
- (c) Are there any STL containers for which there are no iterators? Justify your answer.
- (d) If the number of level 3 nodes we expect to see in a skip list is 4, then how many level 1 nodes should we expect?
- (e) What is the minimum number of rotations that an AVL Delete() operation might require? What is the maximum number of rotations that it might require?
- (f) Which method for moving list nodes after a Find() operation in an unsorted self-organizing list can result in the largest change to the list after only a few Finds?

- (g) Can a binary search tree always be colored so that it becomes a valid red-black tree? If yes, explain how. If no, give an example to demonstrate why not.
- (h) If we remove the color off a red-black tree, will it become an AVL tree? If yes, explain why. If no, show an example to demonstrate why not.
- (i) We wish to maintain patient records in a hospital. The records of a patient who is in hospital are extremely active, being consulted and updated continually. When the patient leaves, the records become much less active, but may still be needed occasionally (i.e. they should not be deleted). If the patient is readmitted, then the records become active again. In addition, since this may be an emergency, the records should never be stored in backup, but they should be quickly available. What is the most suitable data structure to store all the patient records?
- (j) You want to write a program that can translate from English to Klingon. You want to be able to type any word in English and have the program find and print the corresponding word in Klingon. What is the most suitable data structure to store the Klingon words?
- (k) Now suppose that you want to use as little memory as possible regardless of how this would affect search or insertion time. Storing the English-Klingon dictionary in the hard disk is not an option. What is the best data structure for this situation?
- (l) You want to write an editor tool that parses C++ code and checks whether the curly braces are properly nested. What is the best data structure for this situation?

2. (18 points) **Converting data structures**

- (a) Describe (in pseudocode) an algorithm which, given a *perfect* skip list, creates an AVL tree. Make sure your answer is clear and concise. The AVL tree should be such that a search in it would access the same sequence of elements as a search in the skip list.

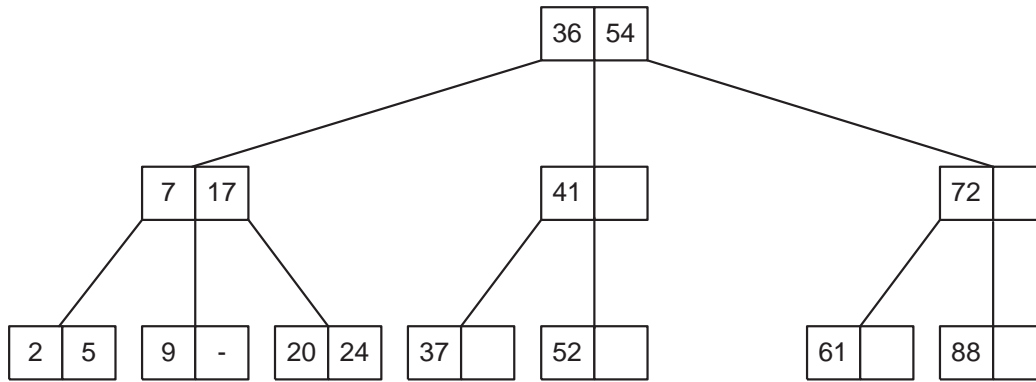
Hint: One possible way to solve this problem is by using recursion.

- (b) You are given a *complete* binary search tree and an initially empty AVL tree. Give an algorithm (in pseudocode) to insert all the elements of the binary search tree into the AVL tree so that **no rotations are necessary**.

Hint: Use another data structure to store elements temporarily.

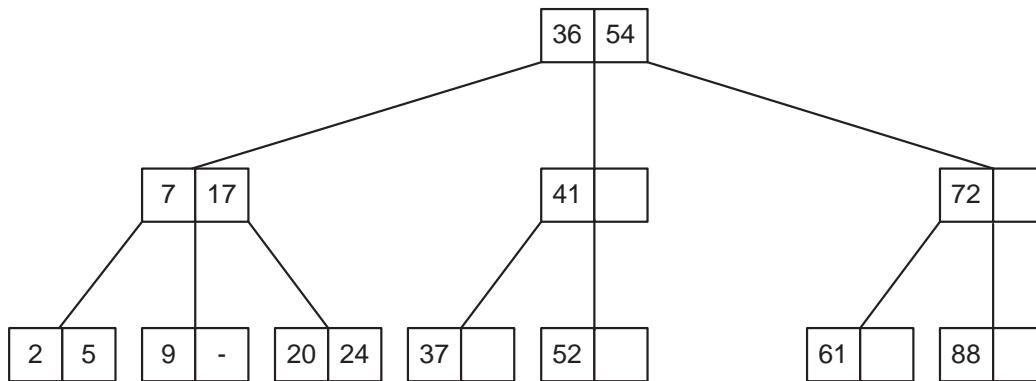
3. (10 points) **B-Trees**

Consider the following B-tree of order 3:



- (a) Show the resulting tree after inserting 6. If part of the tree remains the same, you may indicate so without redrawing it.

Consider the following B-tree of order 3:



- (b) Show the resulting tree after deleting 41. If part of the tree remains the same, you may indicate so without redrawing it.