CS231 Algorithms **Handout #23**
Prof Lyn Turbak **April 5, 2001**
Wellesley College

PROBLEM SET 6
Due: Thursday, April 12

Reading: Red-Black Tree notes (Handout #22) Chapter 14; Sections 15.1 & 15.2; Chapter 19

Suggested Problems: 14.1-4, 14.1-5, 14.3-1, 14.3-2, 14.3-5, 14.4-1; 19.1-3, 19-2.

Problem 1 [25]

a. Draw the sequence of 2-3 trees T_0, T_1, …, T_{12} that results from inserting the following letters one-by-one (from left to right) into an empty tree:

```
T H E Q U I C K Y A M S
```

b. Draw the sequence of 2-3 trees T_{12}, T_{13}, …, T_{24} that results from deleting the following letters one-by-one (from left to right) from the tree from part a.

```
T H E Q U I C K Y A M S
```

Problem 2 [25]

a. Draw the sequence of red-black trees T_0, T_1, …, T_{12} that results from inserting the following letters one-by-one (from left to right) into an empty tree:

```
T H E Q U I C K Y A M S
```

For eliminating red-red violations, use the simple algorithm presented in Handout #22, not the CLR version.

b. Draw the sequence of red-black trees T_{12}, T_{13}, …, T_{24} that results from deleting the following letters one-by-one (from left to right) from the tree from part a.

```
T H E Q U I C K Y A M S
```

Problem 3 [30] CLR Problem 14-2 (p. 278)

Problem 4 [20]

a. Describe how to augment each node of a red-black tree with extra fields so that calculating the predecessor and successor of any given node can be performed in constant time. (See Section 15.1 -- 15.2 on augmenting red-black trees.) You show that the new fields can be maintained efficiently during `Insert` and `Delete`. This requires showing two things: (1) maintaining the field after BST insertion or deletion takes time O(lg(n)) and (2) the fields can be updated in O(1) for each rotation during the fixup phase.

b. Describe how to augment each node of a red-black tree with extra fields so that calculating the minimum and maximum of any given node can be performed in constant time.

Problem Set Header Page
Please make this the first page of your hardcopy submission.

CS231 Problem Set 6
Due Thursday, April 12, 2001

Name:

Date & Time Submitted *(only if late)*:

Collaborators (*anyone you collaborated with in the process of doing the problem set)*:

*In the **Time** column, please estimate the time you spent on the parts of this problem set. Please try to be as accurate as possible; this information will help me to design future problem sets. I will fill out the **Score** column when grading your problem set.*

Part	Time	Score
General Reading		
Problem 1 [25]		
Problem 2 [25]		
Problem 3 [30]		
Problem 4 [20]		
Total		