Data Structures — Midterm Exam

2020/10/18

1. Please write the member function assignGrow of class template HashVec, and the member functions find, insert, bucket\_size and putIn of class template Hash, defined in the file xhash.h..
2. Please write the member functions insert, erase of class template Tree, and the member functions reBalance, LLRotation, RRRotation, eraseDegreeOne and fixUp of class template TreeVal. Note that in reBalance, only LLRotation and RRRotation need to be considered, and in Case 4 of fixUp, only Subcases 4-1-2 and 4-2-2 need to be considered.

Grading rule

1.

Correct

10 points find

10 points insert

10 points bucket\_size

10 points putIn

10 points assignGrow

Not correct

9 points find

9 points insert

9 points bucket\_size

9 points putIn

9 points assignGrow

2.

Correct

10 points insert

10 points erase

10 points reBalance

10 points LLbRotation and RRRotation

10 points eraseDegreeOne

10 points fixUp

Not correct

9 points insert

9 points erase

9 points reBalance

9 points LLbRotation and RRRotation

9 points eraseDegreeOne

9 points fixUp

**Rebalance Algorithm (for** fixUp**):**

Let *M* denote the node to be deleted.

If *M* does have an internal child, let *N* be the child; otherwise, let *N* be either external child.

Let *P* and *S* be the parent and sibling of *M*, respectively.

Let *SL* and *SR* be the left child and right child of *S*, respectively.

Case 1. *M* is red. The resulting tree is a red-black tree.

Case 2. *M* is black and *N* is red. Repaint *N* black

Case 3. Both *M* and *N* are black, and *M* is the root. The resulting tree is a red-black tree.

Case 4. Both *M* and *N* are black, and *M* is not the root.

Subcase 4-1. *N* is the left child of *P*

Subcase 4-1-1: *S* is red. Exchange the colors of *P* and *S*, and rotate left at *P*. Then go to Subcase 4-1-2, 4-1-3 or 4-1-4.

Subcase 4-1-2: *S* is black and *SR* is red. Rotate left at *P*, exchange the colors of *P* and *S*, and make *SR* black.

Subcase 4-1-3: *S* and *SR* are black, but *SL* is red. Rotate right at *S*, and exchange the colors of *S* and *SL*. Then go to Subcase 4-1-2.

Subcase 4-1-4: *S*, *SR* and *SL* are black, but *P* is red. Exchange the colors of *S* and *P*.

Subcase 4-1-5: *S*, *SR*, *SL* and *P* are black. Repaint *S* red. If *P* is the root, we are done. Otherwise, perform the rebalancing procedure on *P*.

Subcase 4-2. *N* is the right child of *P*

Subcase 4-2-1: *S* is red. Exchange the colors of *P* and *S*, and rotate right at *P*. Then go to Subcase 4-2-2, 4-2-3 or 4-2-4.

Subcase 4-2-2: *S* is black and *SL* is red. Rotate right at *P*, exchange the colors of *P* and *S*, and make *SL* black.

Subcase 4-2-3: *S* and *SL* are black, but *SR* is red. Rotate left at *S*, and exchange the colors of *S* and *SR*. Then go to Subcase 4-2-2.

Subcase 4-2-4: *S*, *SR* and *SL* are black, but *P* is red. Exchange the colors of *S* and *P*.

Subcase 4-2-5: *S*, *SR*, *SL* and *P* are black. Repaint *S* red. If *P* is the root, we are done. Otherwise, perform the rebalancing procedure on *P*.