CS 61B
Spring 2018

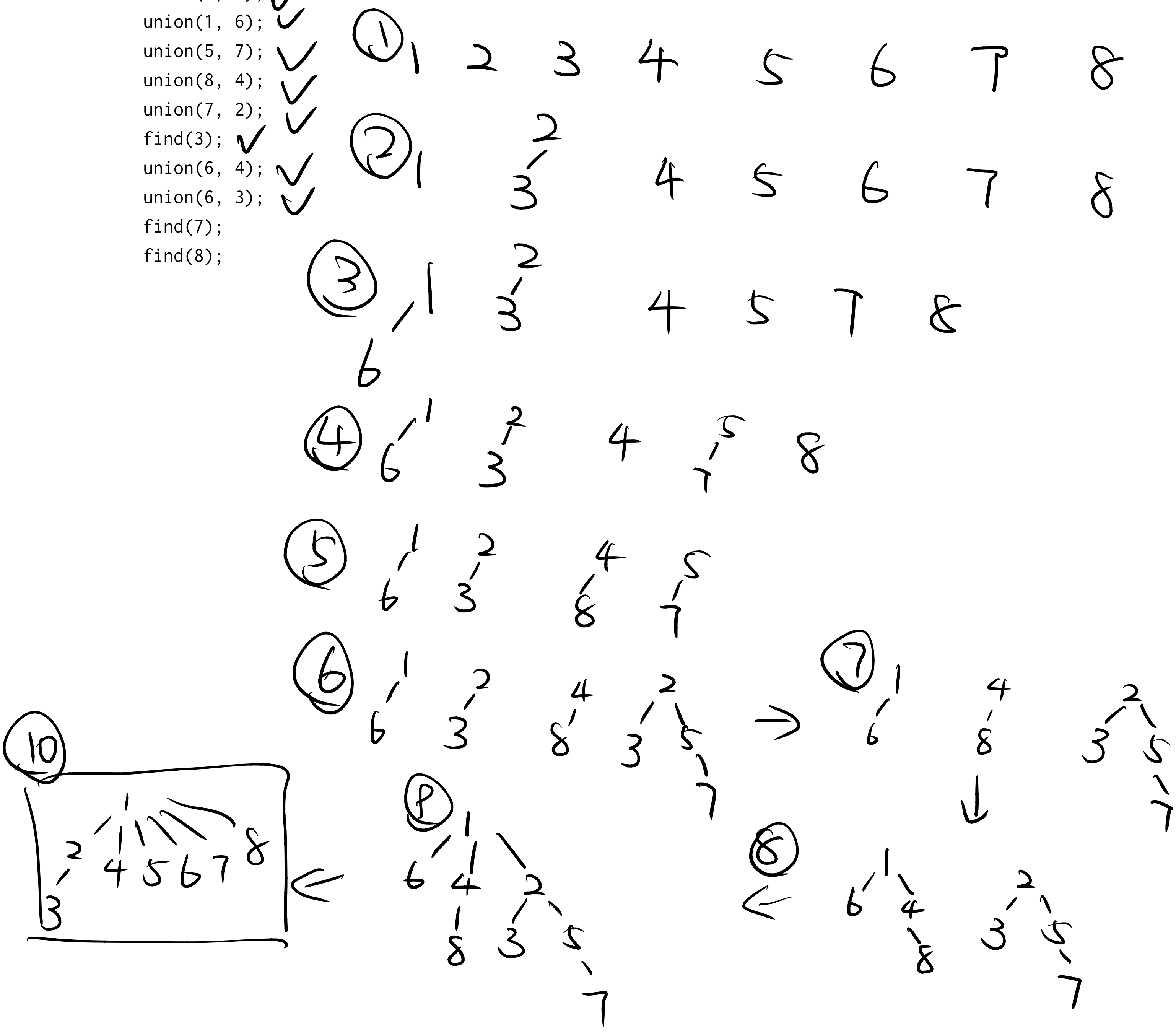
Disjoint Sets, Trees, Hashing

Discussion 9: March 12, 2018

1 WQU and Path Compression

Assume we have eight sets, represented by integers 1 through 8, that start off as completely disjoint sets. Draw the WQU Tree after the series of `union()` and `find()` operations with path compression. Write down the result of `find()` operations. Break ties by choosing the smaller integer to be the root.

```
union(2, 3); ✓
union(1, 6); ✓
union(5, 7); ✓
union(8, 4); ✓
union(7, 2); ✓
find(3); ✓
union(6, 4); ✓
union(6, 3); ✓
find(7);
find(8);
```



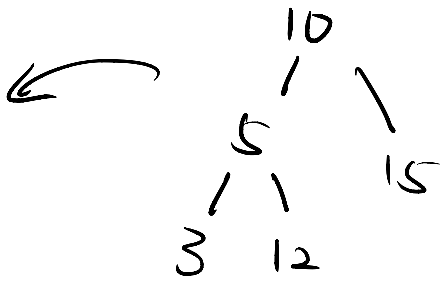
2 Is This a BST?

The following method `isBSTBad` is supposed check if a given binary tree is a BST, though for some binary trees, it is returning the wrong answer. Think about an example of a binary tree for which `isBSTBad` fails. Then, write `isBSTGood` so that it returns the correct answer for any binary tree. The `TreeNode` class is defined as follows:

```
class TreeNode {
    int val;
    TreeNode left;
    TreeNode right;
}
```

Hint: You will find `Integer.MIN_VALUE` and `Integer.MAX_VALUE` helpful when writing `isBSTGood`.

```
public static boolean isBSTBad(TreeNode T) {
    if (T == null) {
        return true;
    } else if (T.left != null && T.left.val > T.val) {
        return false;
    } else if (T.right != null && T.right.val < T.val) {
        return false;
    } else {
        return isBSTBad(T.left) && isBSTBad(T.right);
    }
}
```



this return true

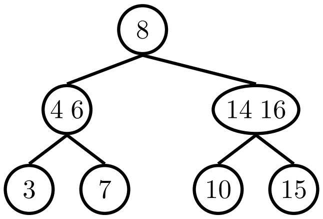
```
public static boolean isBSTGood(TreeNode T) {
    return isBSTHelper(                                        );
}

public static boolean isBSTHelper(                                        ) {
```

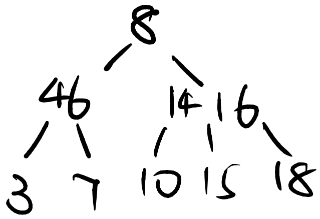
see discussion repository.

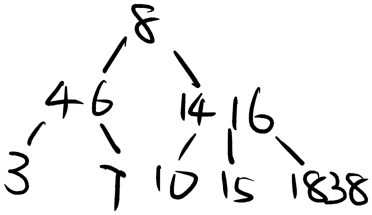
```
}
```

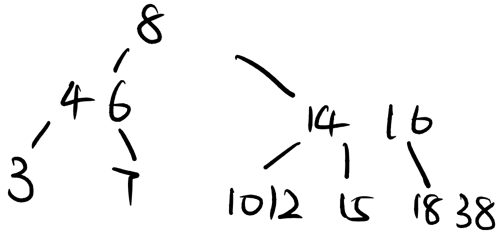
3 2-3 Trees and LLRB's

3.1 Draw what the following 2-3 tree would look like after inserting 18, 38, 12, and 13.

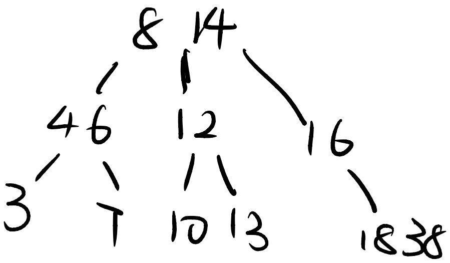


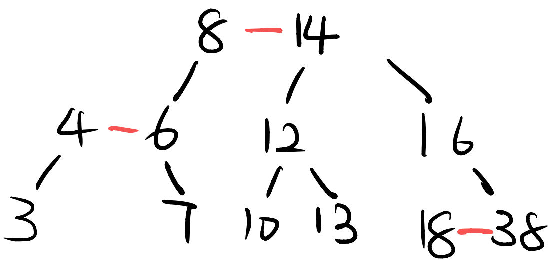






3.2 Now, convert the resulting 2-3 tree to a left-leaning red-black tree.





3.3 *Extra:* If a 2-3 tree has depth H (that is, the leaves are at distance H from the root), what is the maximum number of comparisons done in the corresponding red-black tree to find whether a certain key is present in the tree?

2H.

4 Hashing

4.1 Here are three potential implementations of the `Integer`'s `hashCode()` function. Categorize each as either a valid or an invalid hash function. If it is invalid, explain why. If it is valid, point out a flaw or disadvantage.

```
public int hashCode() {
    return -1;
}
```

valid as for same int, it returns same hashCode(), but a terrible one, 100% collision

```
public int hashCode() {
    return intValue() * intValue();
}
```

valid.

but for numbers that have the same abs, it returns the same hashnumber. better to just return intValue()

```
public int hashCode() {
    return super.hashCode();
}
```

Invalid, as same ints may not have the same hashnumber (it returns the address of the object)

4.2 *Extra, but highly recommended:* For each of the following questions, answer **Always**, **Sometimes**, or **Never**.

(a) When you modify a key that has been inserted into a `HashMap` will you be able to retrieve that entry again? Explain.

Sometimes ⇒ if the change of the key modifies the hash code of the key, we may not retrieve it

(b) When you modify a value that has been inserted into a HashMap will you be able to retrieve that entry again? Explain.

Always ⇒ values do no matter in a hash table, it is key that decide how we find a value.