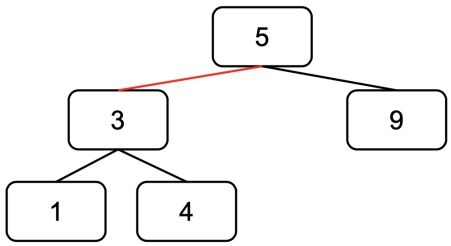
CS 61B Spring 2021

LLRBs and Hashing

Exam Prep Discussion 8: March 8, 2021

1 LLRB Insertions

Given the LLRB below, perform the following insertions and draw the final state of the LLRB. In addition, for each insertion, write the fixups needed in the correct order. A fixup can either be a rotate right, a rotate left, or a color flip. If no fixups are needed, write "Nothing".



1. Insert 7

   Nothing

2. Insert 6

   rotateRight(9)
   colorFlip(7)
   colorFlip(5)

3. Insert 2

   rotateLeft(1)

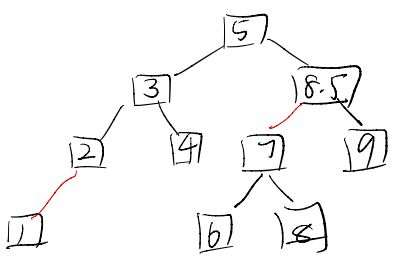
4. Insert 8

   Nothing

5. Insert 8.5

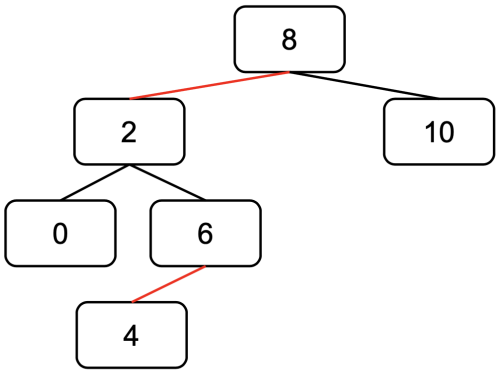
   rotateLeft(8)
   rotateRight(9)
   colorFlip(8.5)
   rotateLeft(7)

Final state:



2 LLRB Maximization

For this problem, we are working with the LLRB below. Determine an integer x such that the insertion of x into the LLRB requires exactly 6 fixups. A fixup can either be a rotate right, a rotate left, or a color flip. The solution must include the integer x and an enumeration of the fixups in the proper order.



1. Rotate 4 left
2. Rotate 6 right
3. Colorflip 5
4. Rotate 2 left
5. Rotate 8 right
6. Colorflip 5

3 Hashing Gone Crazy

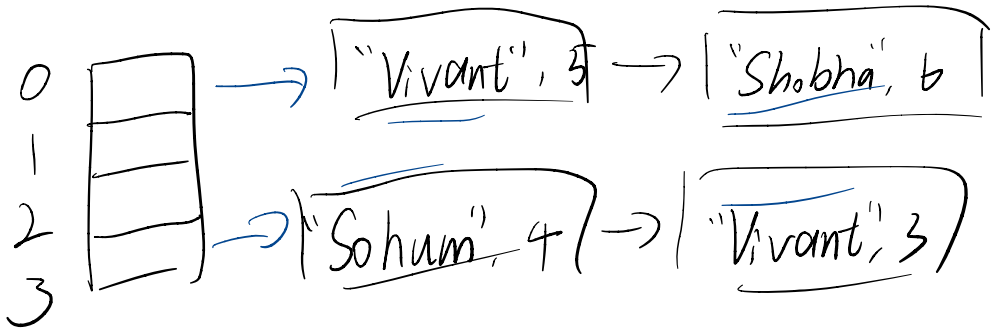
For this question, use the following `TA` class for reference.

```
1   public class TA {
2       int charisma;
3       String name;
4       TA(String name, int charisma) {
5           this.name = name;
6           this.charisma = charisma;
7       }
8       @Override
9       public boolean equals(Object o) {
10          TA other = (TA) o;
11          return other.name.charAt(0) == this.name.charAt(0);
12      }
13      @Override
14      public int hashCode() {
15          return charisma;
16      }
17  }
```

Assume that the `hashCode` of a `TA` object returns `charisma`, and the `equals` method returns `true` if and only if two `TA` objects have the same first letter in their `name`.

Assume that the `ECHashMap` is a `HashMap` implemented with external chaining as depicted in lecture. The `ECHashMap` instance begins at size 4 and, for simplicity, does not resize. Draw the contents of `map` after the executing the insertions below:

```
1   ECHashMap<TA, Integer> map = new ECHashMap<>();
2   TA sohum = new TA("Sohum", 10);
3   TA vivant = new TA("Vivant", 20);
4   map.put(sohum, 1);
5   map.put(vivant, 2);
6
7   vivant.charisma += 2;
8   map.put(vivant, 3);
9
10  sohum.name = "Vohum";
11  map.put(vivant, 4);
12
13  sohum.charisma += 2;
14  map.put(sohum, 5);
15
16  sohum.name = "Sohum";
17  TA shubha = new TA("Shubha", 24);
18  map.put(shubha, 6);
```



4 Buggy Hash

The following classes may contain a bug in one of its methods. Identify those errors and briefly explain why they are incorrect and in which situations would the bug cause problems.

```
1   class Timezone {
2       String timeZone; // "PST", "EST" etc.
3       boolean dayLight;
4       String location;
5       ...
6       public  int currentTime() {
7           // return the current time in that time zone
8       }
9       public int hashCode() {
10          return currentTime();
11      }
12      public boolean equals(Object o) {
13          Timezone tz = (Timezone) o;
14          return tz.timeZone.equals(timeZone);
15      }
16  }
```

```
1   class Course {
2       int courseCode;
3       int yearOffered;
4       String[] staff;
5       ...
6       public int hashCode() {
7           return yearOffered + courseCode;
8       }
9       public boolean equals(Object o) {
10          Course c = (Course) o;
11          return c.courseCode == courseCode;
12      }
13  }
```

Although equal objects will have the same hashcode, but the problem here is that hashCode() is not deterministic. This may result in weird behaviors (e.g. the element getting lost) when we try to put or access elements.

The problem with this hashCode() is that not all equal objects have the same hashcode. This may produce unexpected behavior, e.g. multiple "equal" objects may be exist in different buckets in the HashMap, the containsKey operation may return false, etc. One key thing to remember is that when we override the equals() method, we have to also override the hashCode() method to ensure equal objects have the same hashCode.