COMP 352: Data Structures and Algorithms

Assignment 3

Summer 2020, sections AA

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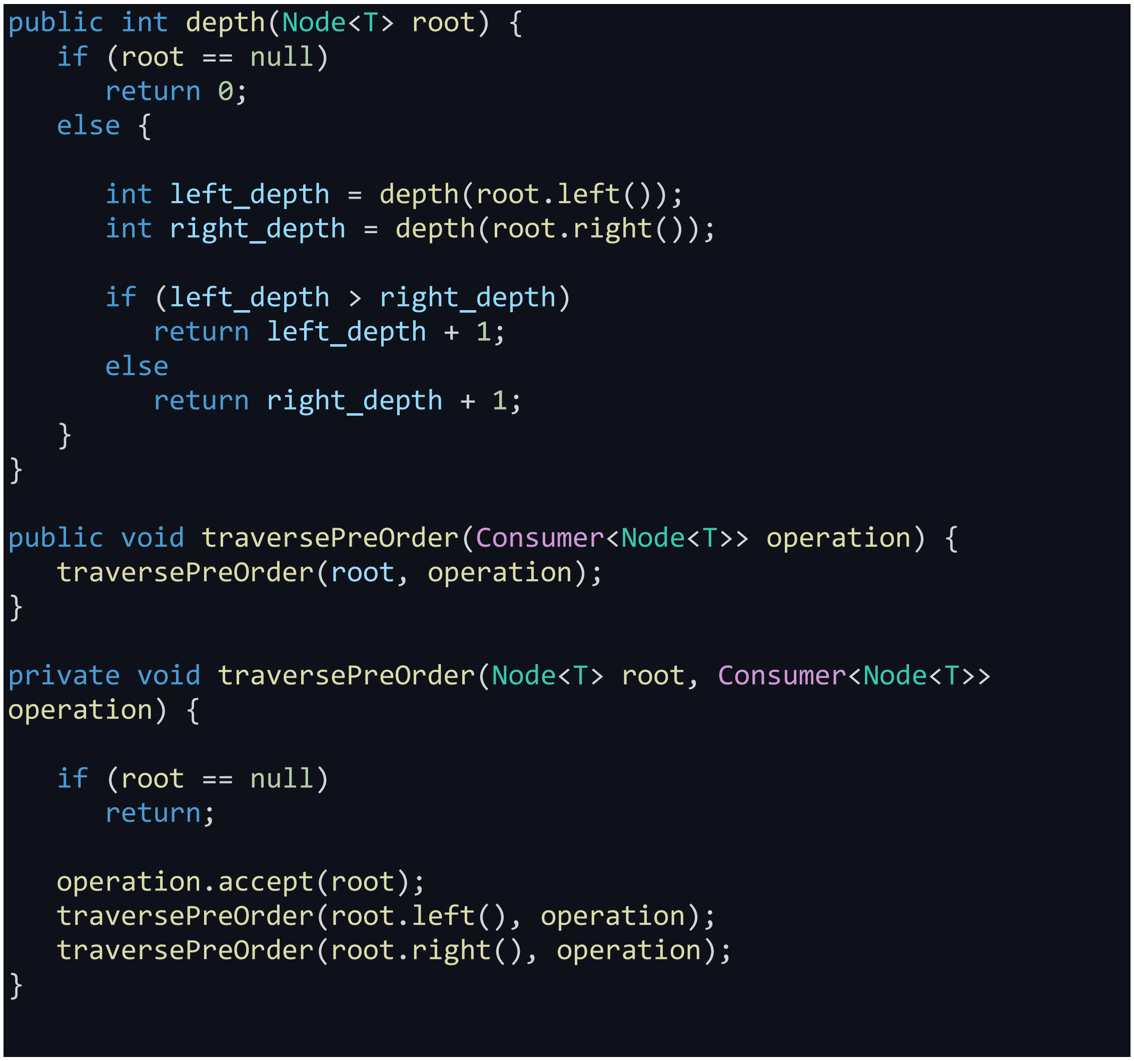
Shadi Jiha #40131284

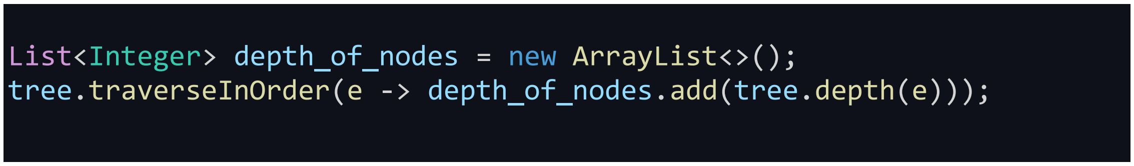
Question 1:

a) Complexity: $O(n)$



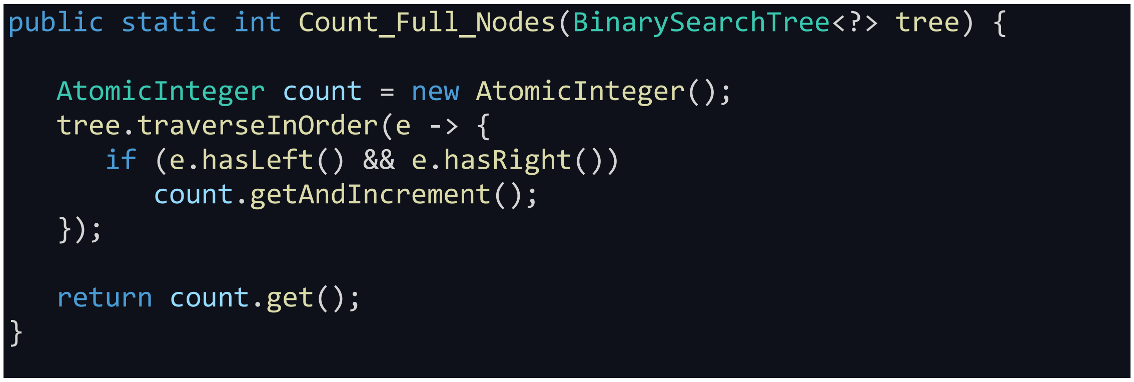
```java
public int depth(Node<T> root) {
   if (root == null)
      return 0;
   else {

      int left_depth = depth(root.left());
      int right_depth = depth(root.right());

      if (left_depth > right_depth)
         return left_depth + 1;
      else
         return right_depth + 1;
   }
}

public void traversePreOrder(Consumer<Node<T>> operation) {
   traversePreOrder(root, operation);
}

private void traversePreOrder(Node<T> root, Consumer<Node<T>>
operation) {

   if (root == null)
      return;

   operation.accept(root);
   traversePreOrder(root.left(), operation);
   traversePreOrder(root.right(), operation);
}
```

Then inside main we can call:



```
List<Integer> depth_of_nodes = new ArrayList<>();
tree.traverseInOrder(e -> depth_of_nodes.add(tree.depth(e)));
```

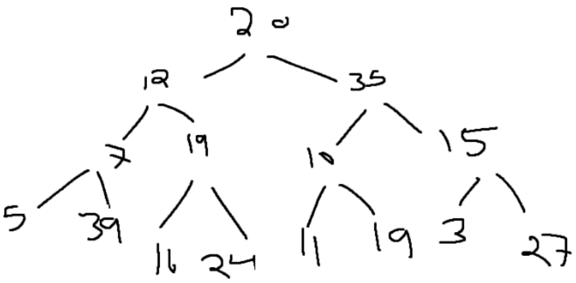
b) Complexity: $O(n)$



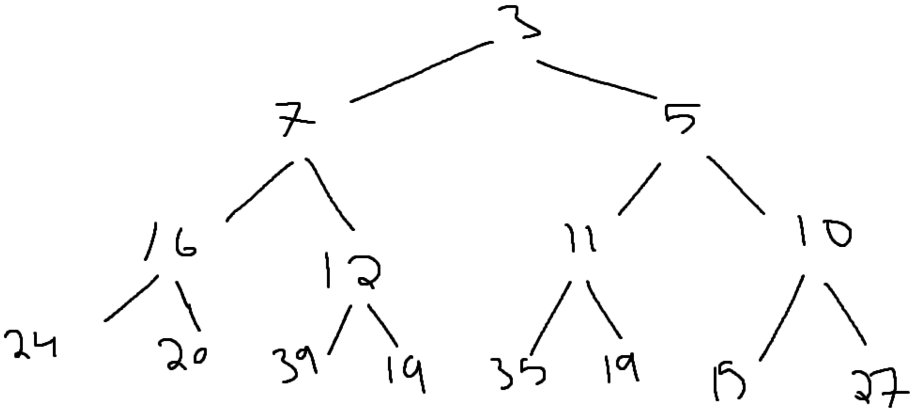
```
public static int Count_Full_Nodes(BinarySearchTree<?> tree) {

   AtomicInteger count = new AtomicInteger();
   tree.traverseInOrder(e -> {
      if (e.hasLeft() && e.hasRight())
         count.getAndIncrement();
   });

   return count.get();
}
```

Question 2:

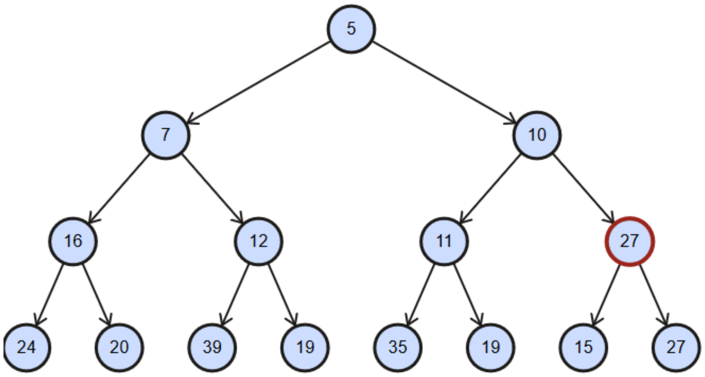
a) Initial Tree

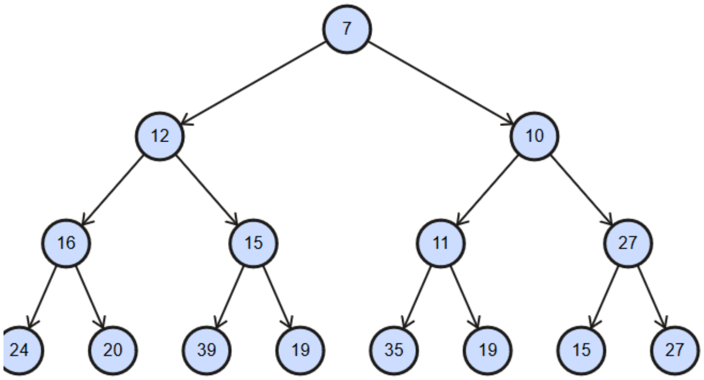


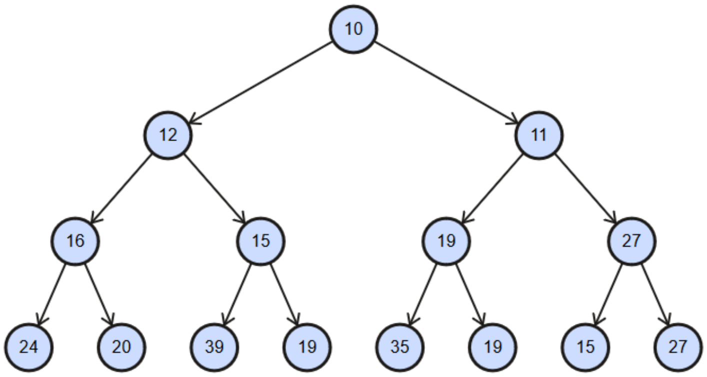
After Mini-Heap tree

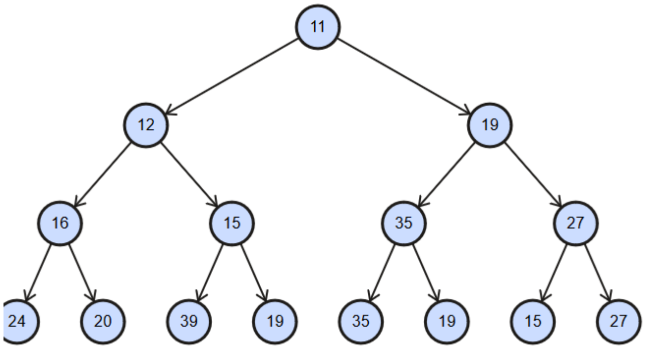


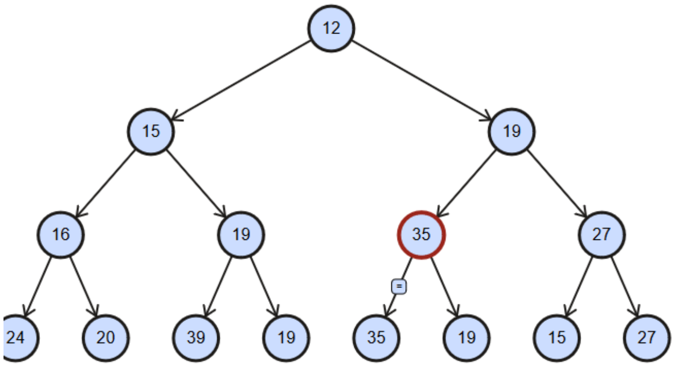
Here I used a tree drawer after each step:

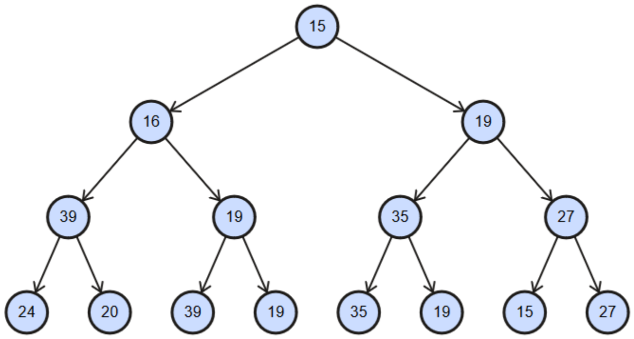






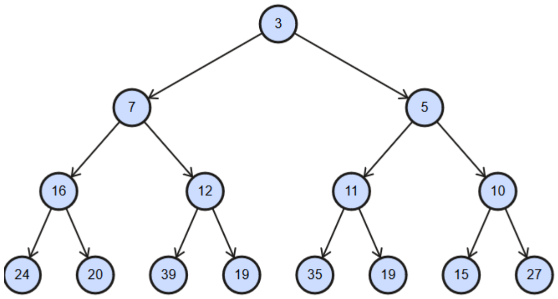






b) Since it will take too much space, I will show them as arrays
[20, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
[12, 20, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
[12, 20, 35, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
[12, 19, 35, 20, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
[7, 12, 35, 20, 19, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
[7, 12, 10, 20, 19, 35, 0, 0, 0, 0, 0, 0, 0, 0, 0]
[7, 12, 10, 20, 19, 35, 15, 0, 0, 0, 0, 0, 0, 0, 0]
[7, 12, 10, 20, 19, 35, 15, 24, 0, 0, 0, 0, 0, 0, 0]
[7, 12, 10, 16, 19, 35, 15, 24, 20, 0, 0, 0, 0, 0, 0]
[7, 12, 10, 16, 19, 35, 15, 24, 20, 39, 0, 0, 0, 0, 0]
[5, 7, 10, 16, 12, 35, 15, 24, 20, 39, 19, 0, 0, 0, 0]
[5, 7, 10, 16, 12, 19, 15, 24, 20, 39, 19, 35, 0, 0, 0]
[5, 7, 10, 16, 12, 11, 15, 24, 20, 39, 19, 35, 19, 0, 0]
[3, 7, 5, 16, 12, 11, 10, 24, 20, 39, 19, 35, 19, 15, 0]
[3, 7, 5, 16, 12, 11, 10, 24, 20, 39, 19, 35, 19, 15, 27]

Here’s the final tree



Question 3:

i) [195=0, 91=0], [16=0, 94=0, 81=0], [147=0], [265=0], [32=0, 162=0], [189=0, 202=0], [21=0], [48=0], [75=0], [180=0, 37=0], [207=0, 77=0]

ii) 7 Collisions

Question 4:

No, it doesn’t. The collision number went from 7 to 8.

Question 5:

i) [39, 29, 42, 31, 25, 25, 48, 35, 12, 35, 29, 31, 18]

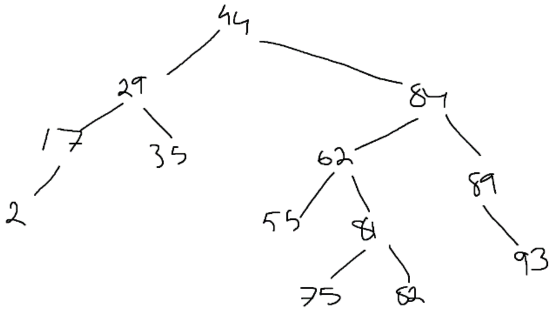
ii) 5

iii) 11

iv) Load factor = $\frac{13}{19} = 0.6842$

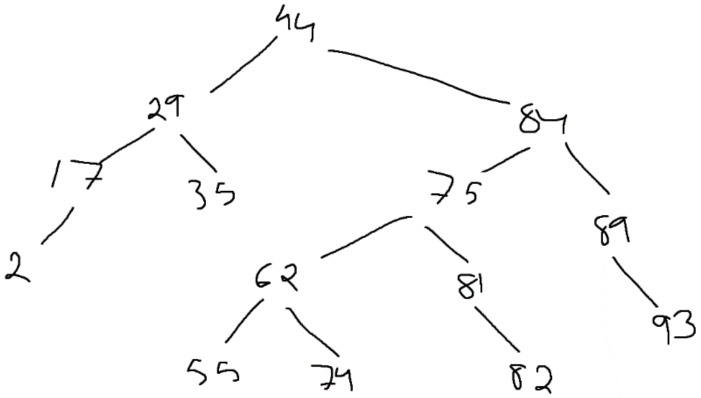
Question 6:

i) Here’s the correct balanced tree:

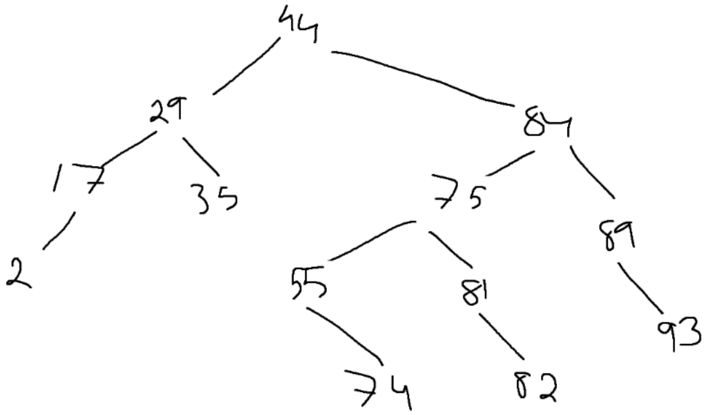


Wrong rotations, 82 has more than 2 height difference with 81
2 is inserted in the wrong place

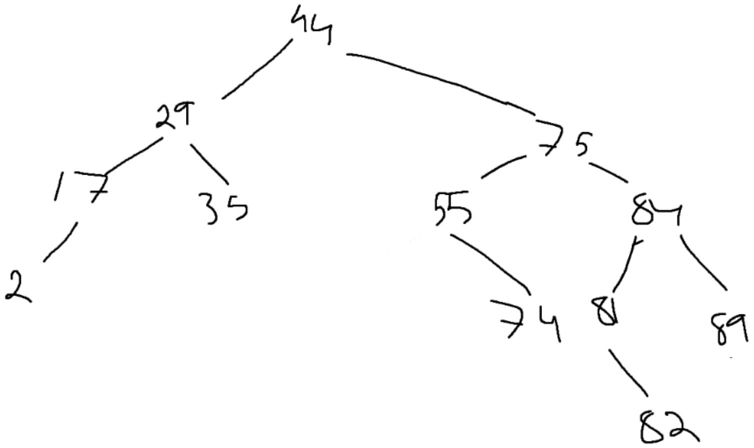
ii) $O(\log n)$:



iii) $O(\log n)$



iv) $O(\log n)$



PART2:

Part 2 was submitted separately in moodle