Gebze Technical University
Computer Engineering

CSE 222
2017 Spring

HOMEWORK 8 REPORT

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Course Assistant:

Q1_and_Q2.pdf

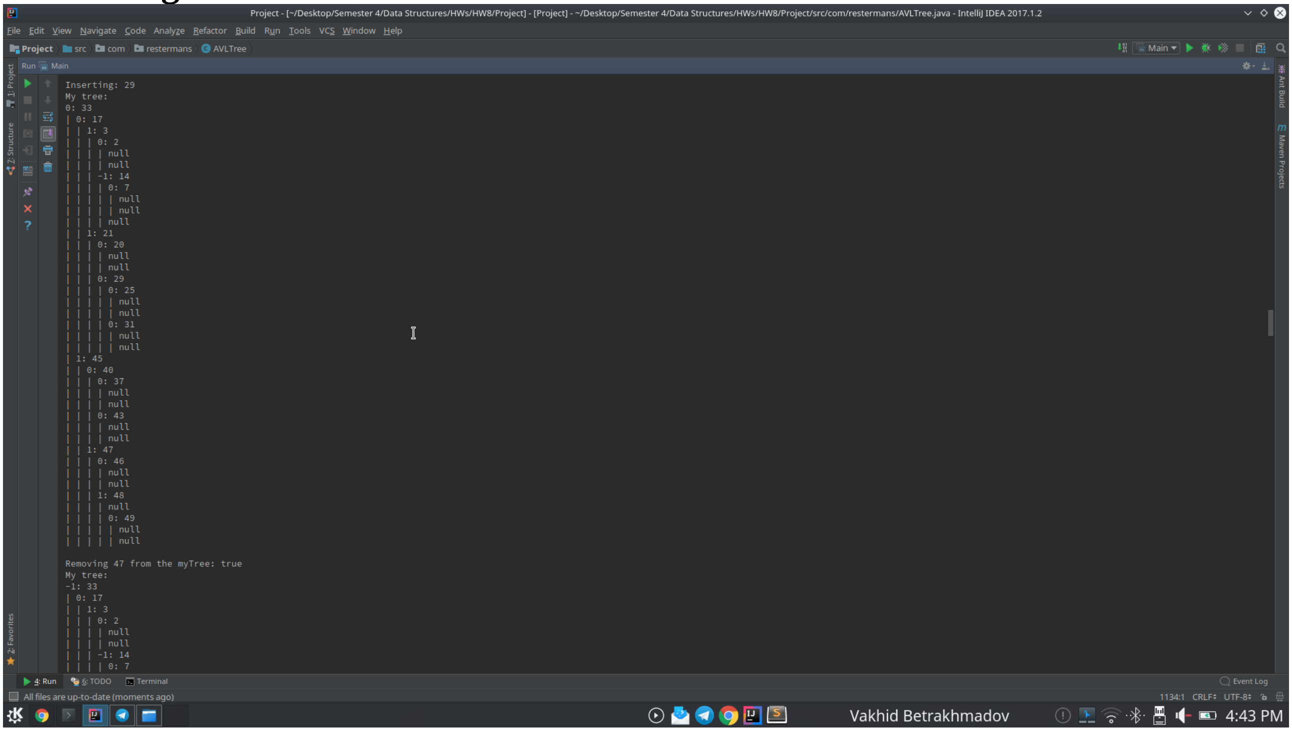
1. Problem Solutions Approach

In order to complete AVL Tree class as required, we had to provide missing methods for removal. In the book's source code found online, the author uses strategy where he manipulates both increase and decrease flags, in order to keep the tree balanced while removing elements from the tree, and provides extra helper methods (rebalanceLeftR, rebalanceRightL) . This source code turned out to be buggy, and didn't work as expected.
I decided to accomplish all the job using just decrease flag, and only 2 helper methods (rebalanceLeft and rebalanceRight) which are symmetric to each other.
While removing an element from the tree that causes the critical imbalance to occur, we might face two additional situations, when left-right (right-left) child is balanced or left (right) child is balanced. In the first case after the double rotation is performed, all balances are zero, so we add one extra condition to the rebalanceLeft and rebalanceRight methods. In the second case, after the single rotation is performed in rebalanceLeft method, old left child becomes right heavy, and the old root becomes left heavy (in the rabalaceLeft method old right child now is left heavy and the old root is now right heavy) .
Delete method is almost the same as in the Binary Search Tree class, except for that we use extra flag 'decrease' to track changes in the tree, and rebalace it on run when necessary. After each return from the recursive call, we check if the decrease flag is true, if so, that means that the height of the sub-tree has changed, and we decrease (increase) local root's balance. If now balance of the local root is 0 we leave decrease flag true, if it has changed to 1 or -1 we set it false, if it has caused critical imbalance (-2 or +2) we set decrease to false and rebalance the sub-tree starting from the local root. We check again after rebalancing if the local root is now balanced (0) , if so we set decrease flag to true again and return.

2. Test Cases

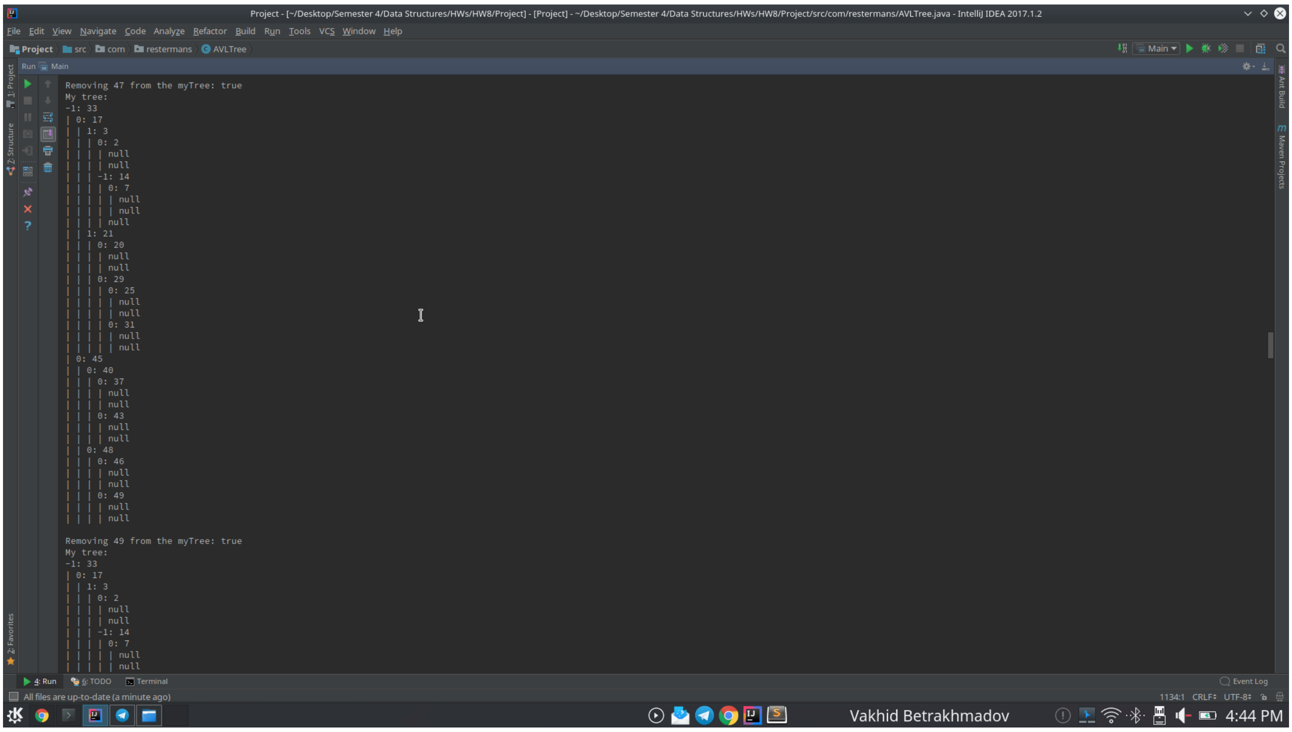
I have extensively tested the program, found and solved all bugs I have noticed.
As a test case I provided a piece of code which builds an AVL Tree from scratch with 20 random elements in the range from 1 to 50. It prints the state of the tree to the screen after each insertion. Then it removes 20 random elements from the same range and prints the tree state to the screen after every removal.

3. Running and Results


Project - [~/Desktop/Semester 4/Data Structures/HWs/HW8/Project] - [Project] - ~/Desktop/Semester 4/Data Structures/HWs/HW8/Project/src/com/restermans/AVLTree.java - IntelliJ IDEA 2017.1.2
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Project src com restermans AVLTree
Main
Run Main
4: Run 6: TODO Terminal
Event Log
All files are up-to-date (moments ago)
1134:1 CRLF UTF-8
Vakhid Betrakhmadov
4:43 PM

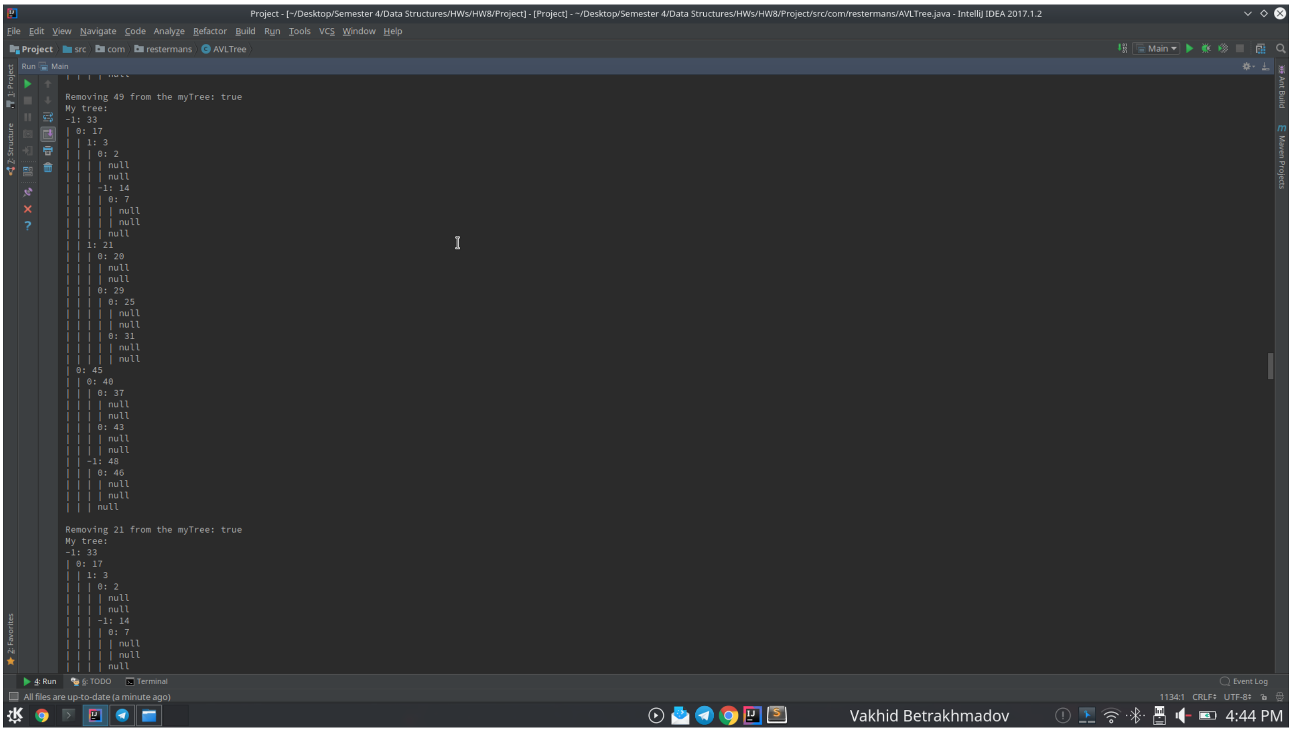
```
Inserting: 29
My tree:
0: 33
| 0: 17
| | 1: 3
| | | 0: 2
| | | | null
| | | | null
| | | -1: 14
| | | | 0: 7
| | | | | null
| | | | | null
| | | | null
| | 1: 21
| | | 0: 20
| | | | null
| | | | null
| | | 0: 29
| | | | 0: 25
| | | | | null
| | | | | null
| | | | 0: 31
| | | | | null
| | | | | null
| 1: 45
| | 0: 40
| | | 0: 37
| | | | null
| | | | null
| | | 0: 43
| | | | null
| | | | null
| | 1: 47
| | | 0: 46
| | | | null
| | | | null
| | | 1: 48
| | | | null
| | | | 0: 49
| | | | | null
| | | | | null

Removing 47 from the myTree: true
My tree:
-1: 33
| 0: 17
| | 1: 3
| | | 0: 2
| | | | null
| | | | null
| | | -1: 14
| | | | 0: 7
```


Project - [~/Desktop/Semester 4/Data Structures/HWs/HW8/Project] - [Project] - ~/Desktop/Semester 4/Data Structures/HWs/HW8/Project/src/com/restermans/AVLTree.java - IntelliJ IDEA 2017.1.2
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Project src com restermans AVLTree
Main
Run Main
4: Run 6: TODO Terminal
Event Log
All files are up-to-date (a minute ago)
1134:1 CRLF UTF-8
Vakhid Betrakhmadov
4:44 PM

```
Removing 47 from the myTree: true
My tree:
-1: 33
| 0: 17
| | 1: 3
| | | 0: 2
| | | | null
| | | | null
| | | -1: 14
| | | | 0: 7
| | | | | null
| | | | | null
| | | | null
| | 1: 21
| | | 0: 20
| | | | null
| | | | null
| | | 0: 29
| | | | 0: 25
| | | | | null
| | | | | null
| | | | 0: 31
| | | | | null
| | | | | null
| 0: 45
| | 0: 40
| | | 0: 37
| | | | null
| | | | null
| | | 0: 43
| | | | null
| | | | null
| | 0: 48
| | | 0: 46
| | | | null
| | | | null
| | | 0: 49
| | | | null
| | | | null

Removing 49 from the myTree: true
My tree:
-1: 33
| 0: 17
| | 1: 3
| | | 0: 2
| | | | null
| | | | null
| | | -1: 14
| | | | 0: 7
| | | | | null
| | | | | null
```



Project - [~/Desktop/Semester 4/Data Structures/HWs/HW8/Project] - [Project] - ~/Desktop/Semester 4/Data Structures/HWs/HW8/Project/src/com/restermans/AVLTree.java - IntelliJ IDEA 2017.1.2
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
Project src com restermans AVLTree
Main
Run Main
1: Project
7: Structure
2: Favorites
Ant Build
Maven Projects
4: Run
6: TODO
Terminal
Event Log
1134:1 CRLF UTF-8
Vakhid Betrakhmadov
4:44 PM

```
| | | | null

Removing 49 from the myTree: true
My tree:
-1: 33
| 0: 17
| | 1: 3
| | | 0: 2
| | | | null
| | | | null
| | | -1: 14
| | | | 0: 7
| | | | | null
| | | | | null
| | | | null
| | 1: 21
| | | 0: 20
| | | | null
| | | | null
| | | 0: 29
| | | | 0: 25
| | | | | null
| | | | | null
| | | | 0: 31
| | | | | null
| | | | | null
| 0: 45
| | 0: 40
| | | 0: 37
| | | | null
| | | | null
| | | 0: 43
| | | | null
| | | | null
| | -1: 48
| | | 0: 46
| | | | null
| | | | null
| | | null

Removing 21 from the myTree: true
My tree:
-1: 33
| 0: 17
| | 1: 3
| | | 0: 2
| | | | null
| | | | null
| | | -1: 14
| | | | 0: 7
| | | | | null
| | | | | null
| | | | null
```

All files are up-to-date (a minute ago)