

BLG 335E - Analysis of Algorithms I

2020/2021 Fall

Homework 3

- Please write your own codes, copying code parts from books, websites or any other source including your friends is considered as plagiarism and results in penalty. Also disciplinary actions will be taken.
- Do not upload your codes to any public platform (e.g. Github) until the deadline of homework passes.
- Your code should be able to be compiled with default g++ compiler and run under Ubuntu OS. **Even if you write your code on a different OS, you should check it via ITU SSH.**
- Do not forget to comment your code.
- Submit your source codes and report files on Ninova before the deadline, late submissions and submissions via e-mail will not be accepted.
- You are **not** allowed to use STL.
- If you have any questions, please use the message board.

1 Red-Black Trees (70 pts)

Implementation

In this part, you are going to build a basketball player database with **Red-Black Tree**. The key for each of the nodes should be the corresponding player's name. Point, rebound and assist values should be kept as extra attributes within your nodes. Point, rebound and assist values should be updated for each season accordingly. Your insertion operation should insert a new node into the relevant position in the Red-Black Tree and then recolor and rotate existing nodes in order to meet the constraints and rebalance the tree. At the end of **each** season you should print all-time point, rebound, and assist leaders. You should use **pre-order** traversal to recursively print the nodes in red-black tree. The output should properly represent the depth of nodes by indentation as shown in sample run. You should print the tree **only** at the end of the first season. You must also state whether a node is black (BLACK) or red (RED). You are given **euroleague.csv** file which contains the information about players. Your code should take filename as an argument.

Sample Input File

```

1 Season , Name, Team, Rebound , Assist , Point
2 2016 – 2017, Ali Muhammed, FEN, 93 , 106 , 386
3 2016 – 2017, Ekpe Udoh, FEN, 241 , 68 , 376
4 2016 – 2017, Jan Vesely , FEN, 154 , 49 , 328
5 2016 – 2017, Bogdan Bogdanovic , FEN, 84 , 80 , 321
6 2016 – 2017, Gigi Datome, FEN, 122 , 35 , 303
7 2016 – 2017, Kostas Sloukas , FEN, 62 , 130 , 268
8 2016 – 2017, Nikola Kalinic , FEN, 101 , 51 , 249
9 2016 – 2017, James Nunnally , FEN, 67 , 58 , 192
10 2016 – 2017, Pero Antic , FEN, 75 , 19 , 130
11 2016 – 2017, Melih Mahmutoglu , FEN, 10 , 11 , 79
12 2016 – 2017, Ahmet Duverioğlu , FEN, 12 , 1 , 30
13 2016 – 2017, Anthony Bennett , FEN, 9 , 2 , 12
14 2016 – 2017, Baris Hersek , FEN, 0 , 0 , 4
15 2016 – 2017, Berk Ugurlu , FEN, 1 , 2 , 2
16 2016 – 2017, Egehan Arna, FEN, 0 , 0 , 0
17 2016 – 2017, Yordan Minchev , FEN, 2 , 0 , 0
18 2017 – 2018, Jan Vesely , FEN, 174 , 53 , 424
19 2017 – 2018, Brad Wanamaker , FEN, 97 , 138 , 408
20 2017 – 2018, Kostas Sloukas , FEN, 87 , 188 , 351
21 2017 – 2018, Gigi Datome, FEN, 117 , 38 , 336
22 2017 – 2018, Nicolo Melli , FEN, 179 , 62 , 320
23 2017 – 2018, James Nunnally , FEN, 59 , 39 , 269
24 2017 – 2018, Marko Guduric , FEN, 56 , 69 , 241
25 2017 – 2018, Jason Thompson , FEN, 140 , 30 , 180
26 2017 – 2018, Ali Muhammed, FEN, 23 , 25 , 146
27 2017 – 2018, Nikola Kalinic , FEN, 30 , 23 , 104
28 2017 – 2018, Ahmet Duverioğlu , FEN, 48 , 14 , 90
29 2017 – 2018, Melih Mahmutoglu , FEN, 10 , 5 , 35
30 2017 – 2018, Sinan Guler , FEN, 9 , 7 , 23
31 2017 – 2018, Egehan Arna, FEN, 0 , 1 , 2
    2017 – 2018, Baris Hersek , FEN, 0 , 0 , 0

```

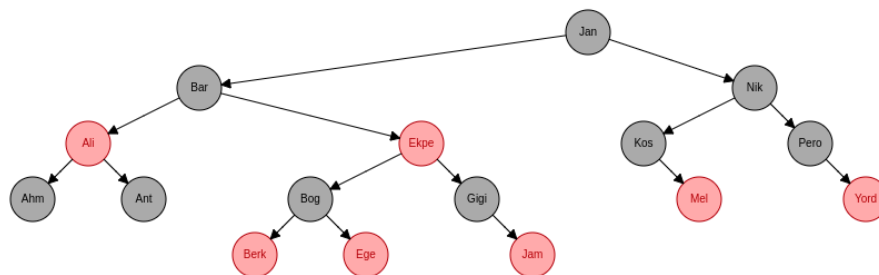


Figure 1: Red-Black Tree at the end of the first season

Sample Run

```
g++ studentID.cpp -o studentID
2 ./studentID sample.csv
End of the 2016–2017 Season
4 Max Points: 386 – Player Name: Ali Muhammed
Max Assists: 130 – Player Name: Kostas Sloukas
6 Max Rebs: 241 – Player Name: Ekpe Udoh
(BLACK) Jan Vesely
8 –(BLACK) Baris Hersek
—(RED) Ali Muhammed
10 —(BLACK) Ahmet Duverioğlu
—(BLACK) Anthony Bennett
12 —(RED) Ekpe Udoh
—(BLACK) Bogdan Bogdanovic
14 —(RED) Berk Ugurlu
—(RED) Egehan Arna
16 —(BLACK) Gigi Datome
—(RED) James Nunnally
18 –(BLACK) Nikola Kalinic
—(BLACK) Kostas Sloukas
20 —(RED) Melih Mahmutoglu
—(BLACK) Pero Antic
22 —(RED) Yordan Minchev
End of the 2017–2018 Season
24 Max Points: 752 – Player Name: Jan Vesely
Max Assists: 318 – Player Name: Kostas Sloukas
26 Max Rebs: 328 – Player Name: Jan Vesely
```

2 Report (30 pts)

Complexity [10 pts]

Write down the asymptotic upper bound for the insertion and search operations of Red-Black Tree for worst case and average case with detailed explanations.

RBT vs BST [5 pts]

Compare Red-Black Tree with Standard Binary Search Tree in your **own** words.

Augmenting Data Structures [15 pts]

Suppose that you are given the position (Point Guard **PG**, Shooting Guard **SG**, Small Forward **SF**, Power Forward **PF** or Center **C**) of the players. If you were to augment your Red-Black Tree with 5 new methods, i^{th} **PG**, i^{th} **SG**, i^{th} **SF**, i^{th} **PF** and i^{th} **C**, that return the name of the i^{th} Point Guard, i^{th} Shooting Guard, i^{th} Small Forward, i^{th} Power Forward and i^{th} Center, respectively, what will be your strategy? Provide a pseudocode with explanations to implement these methods but **do not implement** them.