# BLG335E - Analysis of Algorithms
# Assignment #3 RB Tree

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## Important Notes

- Please write your own codes, copying code parts from books, websites or any other sources including your friends is considered as plagiarism and will be treated seriously. You are expected to act according to the Code of Honor.
- Do not upload your codes to any public platform (e.g. Github) until the deadline of homework passes.
- Use C++ language and do not forget to compile your codes on Linux using g++ command before sending them.
- You may use STL but do not use built-in sorting functions.
- Do not forget to comment your code when needed. You will be graded for your comment quality.
- Submit your source codes and report files on Ninova before the deadline. Late submissions and submissions via e-mail may not be accepted.
- For any issues regarding the assignment, please use the Q&A on Assignment 3 message board on Ninova or contact Abdullah Sadık Satır (satir17@itu.edu.tr).

## I. Implementation[55 pts]

It is given a dataset containing the number of sales of video games and their publisher between 1980-2020 according to years in three different marketplaces. You are going to build publishers' games sales dataset with **Red-Black Tree**. The dataset has seven features which are given below;

- **Name:** Name of the video game.
- **Platform:** Environment which is the game played e.g.: Atari, Play Station(PS), XBOX etc.
- **Year_of_Release:** Publication year (1980-2020).
- **Publisher:** Name of the publisher.

- **NA_Sales:** North America sales (in million unit).
- **EU_Sales:** Europe sales (in million unit).
- **Other_Sales:** Rest of the world sales (in million unit).

You should use the publisher's name as the key value for the corresponding tree's node. The number of sales in three different markets place (**NA_Sales, EU_Sales, Other_Sales**) should be kept in extra node's attributes. During the insertion, you should insert a new node into the relevant position in the Red-Black Tree and then recolor and rotate existing nodes to meet the constraints and rebalance the tree. **Be careful** when you are inserting already existing publisher names, you should update the number of sales according to the calculated cumulative number of sales. The dataset was sorted increasing order according to year. At the end of each decade, that is, the end of 1990, 2000, 2010, 2020, you should print all-time best sellers publishers in the three marketplaces. You should use pre-order traversal to print the red-black tree nodes recursively. The output should properly represent the depth of nodes by indentation, as shown in the sample run. You should print the tree **only at the end of 2020**. You must also state whether a node is black (BLACK) or red (RED). You are given **VideoGames.csv** file, which contains the sales number of the publishers. Your code should take the filename as an argument.

You can follow the steps below when you are building Red-Black Tree;

- Read the lines from the given dataset by considering the year, publisher, NA_Sales, EU_Sales and Other_Sales columns.
- Insert the line into tree by taking publisher name as key value of node and the number of sales as attributes of node. (If you encounter the same publisher's name, you should sum the node's sales with new sales. Don't use delete operation. Do all operation in same tree.)
- If you have inserted the data belonging to the past decade, print the best seller for three marketplace, that is, print the best seller at the end of years 1990, 2000, 2010, 2020. (In this phase, don't print the tree. It will be printed lastly.)
- When you finish the insertion of all lines in the data, print the three by considering sample run indentation.

## Sample Input File

```
Name,Platform,Year_of_Release,Publisher,NA_Sales,EU_Sales,Other_Sales
Asteroids,2600,1980,Atari,4,0.26,0.05
Missile Command,2600,1980,Atari,2.56,0.17,0.03
Kaboom!,2600,1980,Activision,1.07,0.07,0.01
Defender,2600,1980,Atari,0.99,0.05,0.01
Boxing,2600,1980,Activision,0.72,0.04,0.01
Ice Hockey,2600,1980,Activision,0.46,0.03,0.01
Freeway,2600,1980,Activision,0.32,0.02,0
Bridge,2600,1980,Activision,0.25,0.02,0
Checkers,2600,1980,Atari,0.22,0.01,0
Pitfall!,2600,1981,Activision,4.21,0.24,0.05
Frogger,2600,1981,Parker Bros.,2.06,0.12,0.02
Demon Attack,2600,1981,Imagic,1.99,0.12,0.02
E.T.: The Extra Terrestrial,2600,1981,Atari,1.84,0.11,0.02
```

```
Ms. Pac-Man,2600,1981,Atari,1.54,0.1,0.02
River Raid,2600,1981,Activision,1.49,0.09,0.02
Donkey Kong,2600,1981,Coleco,1.36,0.08,0.02
Centipede,2600,1981,Atari,1.26,0.08,0.01
Atlantis,2600,1981,Imagic,1.18,0.08,0.01
Megamania,2600,1981,Activision,1.03,0.06,0.01
Cosmic Ark,2600,1981,Imagic,0.99,0.05,0.01
Donkey Kong Junior,2600,1981,Atari,0.9,0.05,0.01
Spider-Man,2600,1981,Parker Bros.,0.87,0.05,0.01
Custer's Revenge,2600,1981,Mystique,0.76,0.05,0.01
Alien,2600,1981,20th Century Fox Video Games,0.74,0.04,0.01
Air Raid,2600,1981,Men-A-Vision,0.72,0.04,0.01
Berzerk,2600,1981,Atari,0.68,0.04,0.01
King Kong,2600,1981,Tigervision,0.65,0.04,0.01
Adventures of Tron,2600,1981,Mattel Interactive,0.63,0.03,0.01
BurgerTime,2600,1981,Mattel Interactive,0.55,0.03,0.01
Smurf: Rescue In Gargamel's Castle,2600,1981,Coleco,0.55,0.03,0.01
Raiders of the Lost Ark,2600,1981,Atari,0.46,0.03,0.01
Grand Prix,2600,1981,Activision,0.45,0.03,0
Phoenix,2600,1981,Atari,0.42,0.02,0
Jawbreaker,2600,1981,Tigervision,0.42,0.03,0
Barnstorming,2600,1981,Activision,0.4,0.02,0
Mouse Trap,2600,1981,Coleco,0.38,0.02,0
Laser Blast,2600,1981,Activision,0.37,0.02,0
Airlock,2600,1981,Data Age,0.36,0.02,0
Dragonfire,2600,1981,Imagic,0.35,0.02,0
Frogs And Flies,2600,1981,Mattel Interactive,0.33,0.02,0
Fantastic Voyage,2600,1981,20th Century Fox Video Games,0.32,0.02,0
Carnival,2600,1981,Coleco,0.32,0.02,0
Fireball,2600,1981,Starpath Corp.,0.3,0.02,0
Astroblast,2600,1981,Mattel Interactive,0.29,0.02,0
RealSports Football,2600,1981,Atari,0.24,0.01,0
Front Line,2600,1981,Taito,0.22,0.01,0
Dark Cavern,2600,1981,Mattel Interactive,0.22,0.01,0
Deadly Duck,2600,1981,20th Century Fox Video Games,0.21,0.01,0
Reactor,2600,1981,Parker Bros.,0.21,0.01,0
Crazy Climber,2600,1981,Atari,0.21,0.01,0
RealSports Baseball,2600,1981,Atari,0.2,0.01,0
International Soccer,2600,1981,Mattel Interactive,0.18,0.01,0
Armor Ambush,2600,1981,Mattel Interactive,0.15,0.01,0
RealSports Volleyball,2600,1981,Atari,0.12,0.01,0
```

## Sample Run

```
g++ studentID.cpp -o studentID
./studentID sample.csv
End of the 1981 Year
Best seller in North America: Atari - 15.64 million
Best seller in Europe: Atari - 0.96 million
Best seller rest of the World: Atari - 0.17 million
(BLACK) Imagic
-(BLACK) Atari
--(BLACK) Activision
---(RED) 20th Century Fox Video Games
--(BLACK) Coleco
---(RED) Data Age
-(BLACK) Mystique
--(BLACK) Men-A-Vision
---(RED) Mattel Interactive
```

```
--(RED) Starpath Corp.
---(BLACK) Parker Bros.
---(BLACK) Tigervision
----(RED) Taito
```

# II. Report

## RBT vs BST[10 pts]

1. Make the height of the Binary Search Tree given in Figure-1 shortest with **Left** and **Right** rotation operations. Draw your steps and define which node is rotated in which direction. (You can use rotation operations which you desire order).

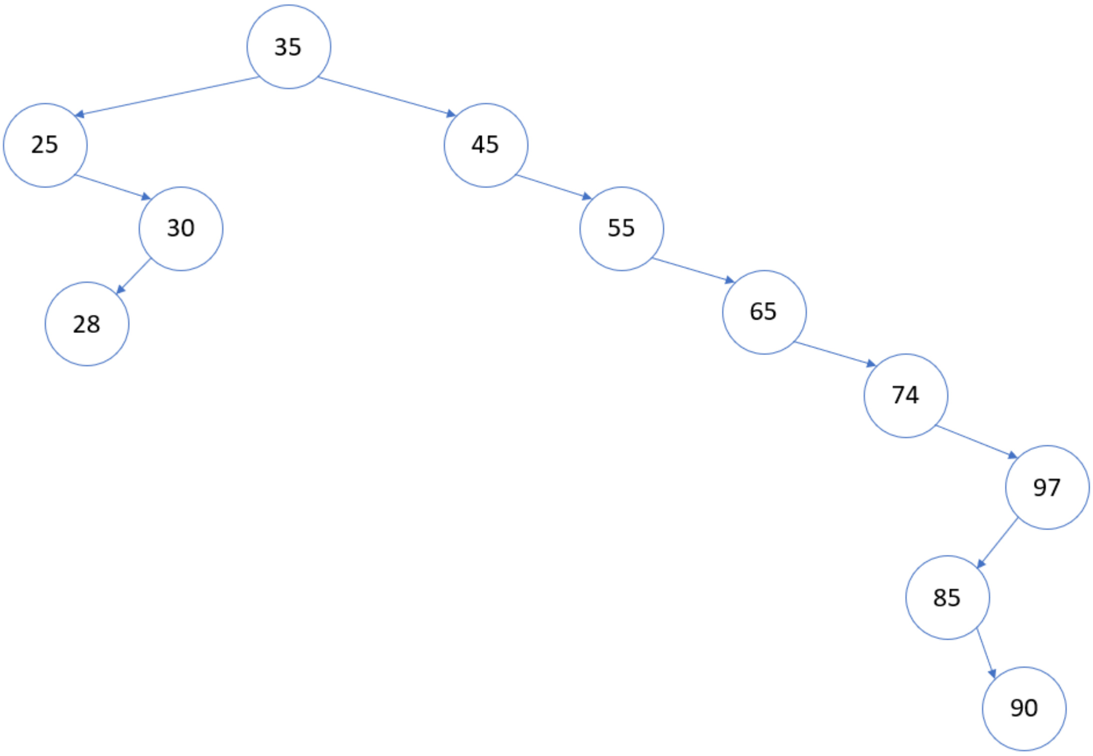

Figure 1: Binary Search Tree

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

## Complexity[10 pts]

3. 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.

## Augmenting Data Structures [15 pts]

4. Suppose that you are given the genre (Sports, Action, Role-Playing (RP), Racing, Strategy) of the publishers' video games. If you were to augment your Red-Black Tree with five new methods that return the name of the ith Sports, ith Action, ith RP, ith Racing, and ith Strategy publisher, what would be your strategy? Provide pseudocode with explanations to implement these methods but do not implement them.