CS 7353: Analysis of Algorithms Project: Red-Black Tree

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Contents

1	Pro	blem Introduction	2
2	Pro	ogram Platform and Submission Files	2
3	Pro	ogramming Approach	3
	3.1	Node Class	3
	3.2	Red-Black Tree Class	3
		3.2.1 Constructing the Problem	3
		3.2.2 Generating the Solution	3
		3.2.3 Printing the solution	3
4	Res	m sults	3
	4.1	Part 1.B: "Tree 1"	3
	4.2	Part 1.C: "Tree 2"	5
5	Par	et 2: Red-Black Discussion	5

1 Problem Introduction

2 Program Platform and Submission Files

This problem was solved using C++ on a Linux system. Attached with the submission is a zip folder that contains:

- A CMakeLists.txt file for compiling
- An "images" folder that contains:
 - 1. Various images included in this report
- A "src" folder that contains:
 - 1. A Node.cpp and Node.h file for the Node class and associated functions
 - 2. A Red-Black.cpp and Red-Black.h file for the Red-Black Tree class and associated functions
 - 3. The main file
- A "build" folder that contains:
 - 1. A build.sh script to simplify the build process
 - 2. A run.sh script to simplify running the program
 - 3. Various CMake files
 - 4. The compiled binaries for the program and associated libraries
- Various LaTeX files used in the generation of this report.

This program offers no guarantee of functionality on other Operating Systems. Testing was only conducted on the local Linux machine.

3 Programming Approach

- 3.1 Node Class
- 3.2 Red-Black Tree Class
- 3.2.1 Constructing the Problem
- 3.2.2 Generating the Solution
- 3.2.3 Printing the solution

4 Results

4.1 Part 1.B: "Tree 1"

Figure 1: Part 1.B: Initial Tree After Key Insertions

Figure 2: Part 1.B: Tree After Deleting Key 12

Figure 3: Part 1.B: Tree After Inserting Key 32

Figure 4: Part 1.B: Tree After Deleting Key 41

- 4.2 Part 1.C: "Tree 2"
- 5 Part 2: Red-Black Discussion

```
After insertion:
         .— 974(B)
            `--- 930(R)
      — 882(B)
         `--- 838(B)
    - 834(R)
        .- 822(B)
        - 807(B)
                 .- 806(R)
             .— 689(B)
            - 675(R)
              .—— 654(R)
               — 625(B)
512(B)
                 .— 381(R)
             .— 374(B)
            - 249(R)
              .— 234(R)
            `—— 221(B)
     .- 216(B)
     127(B)
             .--123(R)
            - 114(B)
            `--- 92(R)
         75(B)
```

6

Figure 5: Part 1.C: Initial Tree After Key Insertions

```
Deleting 127:
            – 974(B)
           `--- 930(R)
        - 882(B)
         — 838(B)
     834(R)
       .— 822(B)
        - 807(B)
                .--- 806(R)
             .--689(B)
            - 675(R)
              .—— 654(R)
              — 625(B)
512(B)
             .— 381(R)
         .— 374(B)
         249(R)
           .— 234(R)
         `— 221(B)
     216(B)
             .— 123(R)
         .— 114(B)
             `--- 92(R)
        - 75(B)
```

7

Figure 6: Part 1.C: Tree After Deleting Key 127

```
Deleting 221:
           — 974(B)
             `--- 930(R)
         882(B)
         `— 838(B)
     834(R)
         .- 822(B)
        - 807(B)
                 .---806(R)
             .- 689(B)
            - 675(R)
               .—— 654(R)
               — 625(B)
512(B)
             .— 381(R)
          — 374(B)
     .- 249(R)
     234(B)
       — 216(R)
                 .— 123(R)
              — 114(B)
                 `— 92(R)
             75(B)
```

8

Figure 7: Part 1.C: Tree After Deleting Key 221