Lab 2

RB Tree & Analysis

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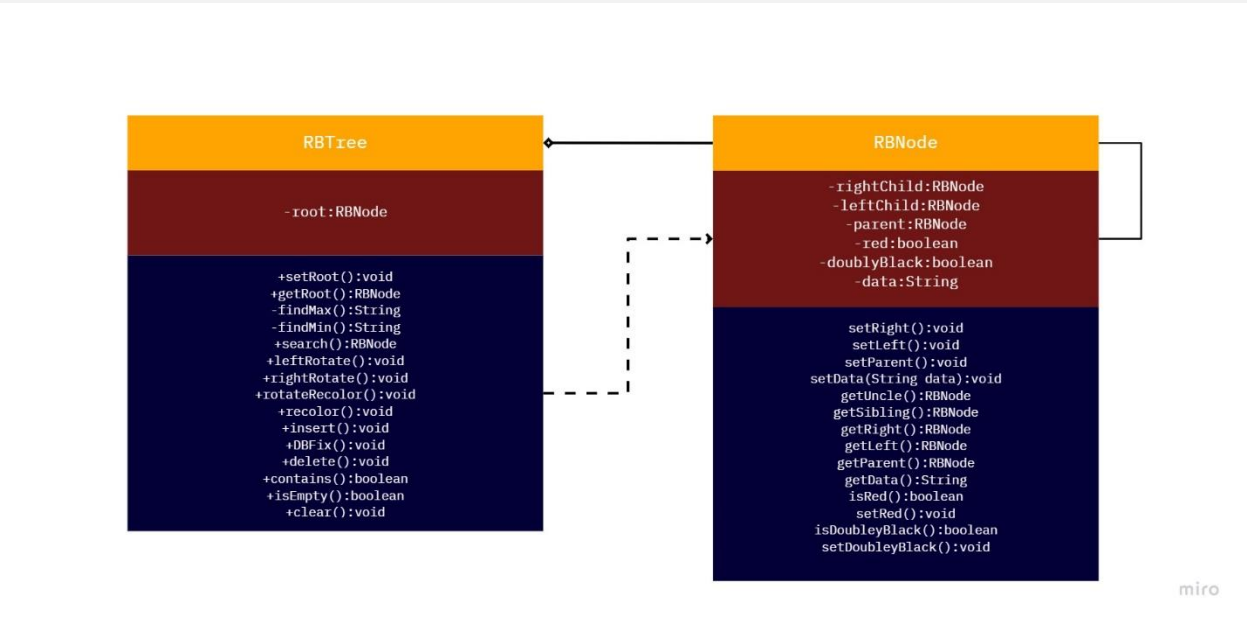
1. Problem Statement

Implement the following operation inside a red - black tree:

1. getRoot: return the root of the given Red black tree.
2. isEmpty: return whether the given tree isEmpty or not.
3. clear: Clear all nodes in the given tree.
4. search: return the node associated with the given key or null if no value is found.
5. contains: return true if the tree contains the given value and false otherwise.
6. insert: Insert the given value in the tree while maintaining the red - black tree properties, if the value is already present in the tree, reject its value.
7. delete: Delete the node associated with the given value. Return true in case of success, and false otherwise.

2. UML Diagram



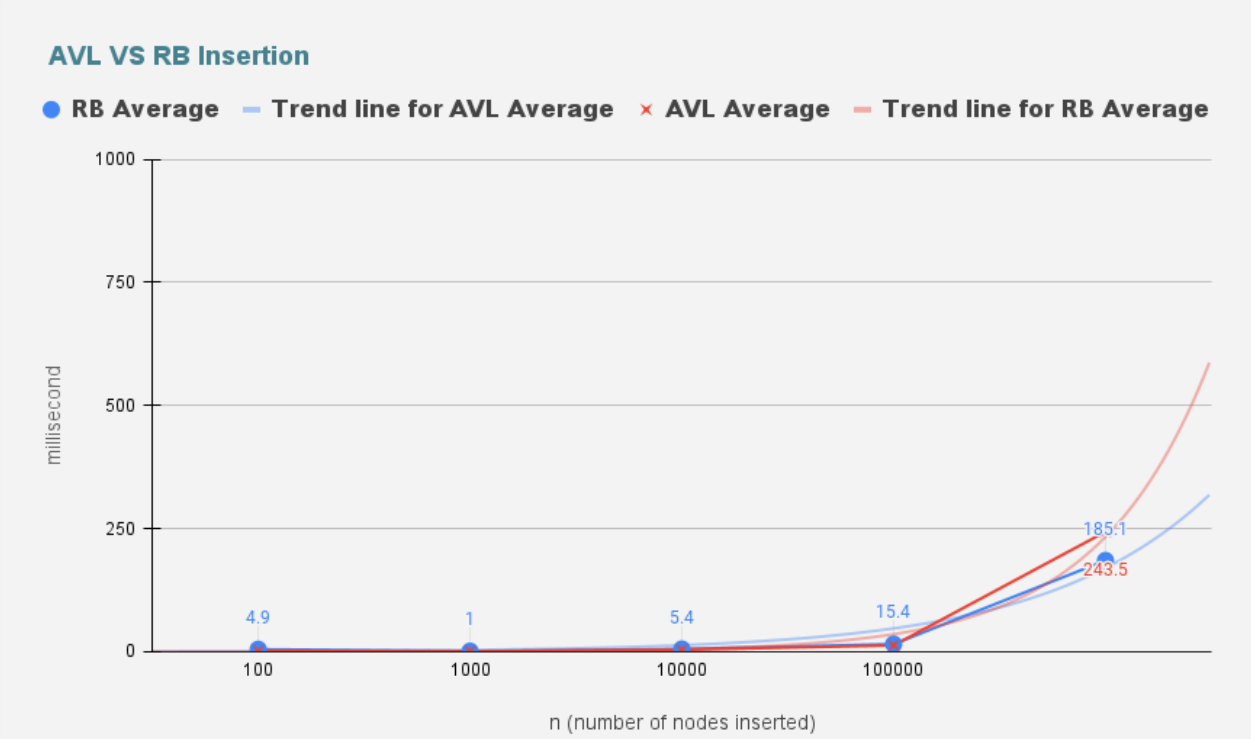
3.Analysis

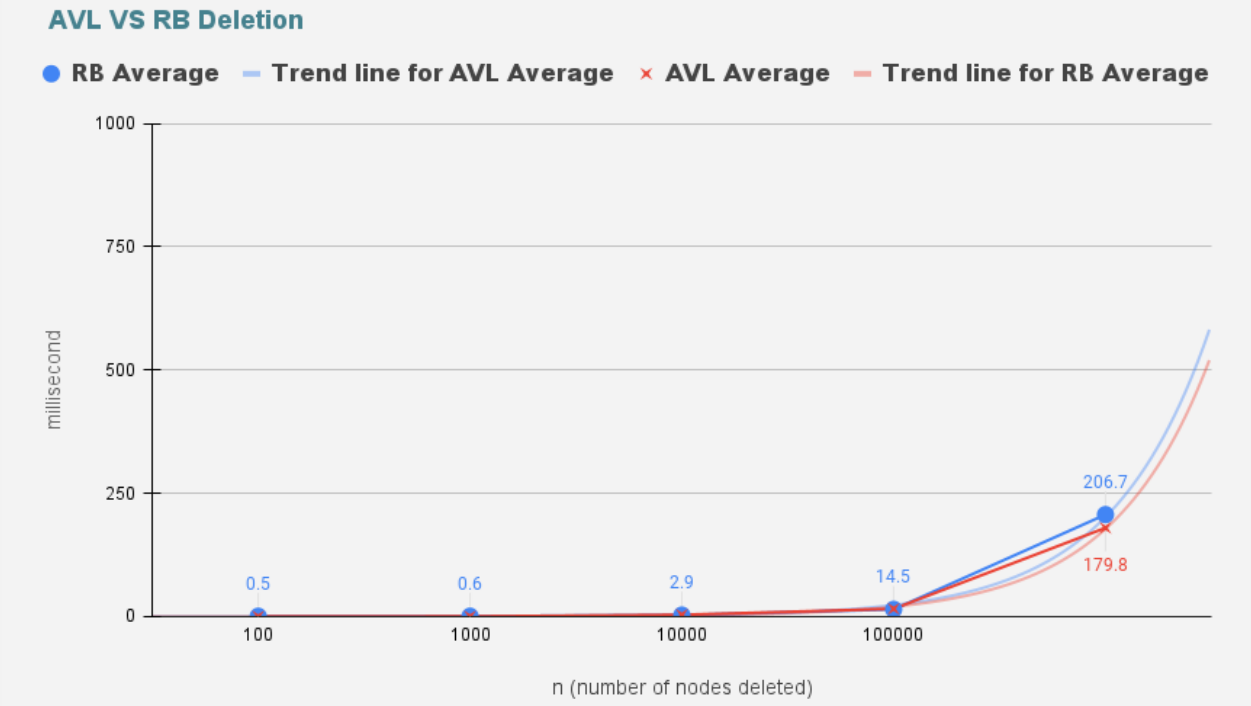
- Analysis was performed on 5 random generated batches (10, 100, 1000, 10000, 100000) nodes.
- The time for inserting and deleting every batch of random generated nodes was estimated 10 times and the average value was calculated at the end.

Analysis Table:

n					AVL Insertion						AVL Average
10	1	0	6	1	2	1	1	2	1	1	1.6
100	1	1	0	0	0	1	1	1	0	1	0.6
1000	4	5	3	4	3	3	3	4	5	4	3.8
10000	19	19	6	12	11	11	11	9	13	17	12.8
100000	194	672	142	117	194	198	204	161	250	303	243.5
n					AVL Deletion						AVL Average
10	0	1	0	0	0	0	0	0	0	0	0.1
100	1	0	0	1	0	1	0	0	0	0	0.3
1000	4	2	4	3	4	4	3	4	3	4	3.5
10000	15	9	11	14	13	25	11	19	14	25	15.6
100000	155	207	199	141	167	128	134	194	225	248	179.8
n					RB Insertion						RB Average
10	8	21	0	13	2	1	1	1	1	1	4.9
100	1	1	1	1	1	1	1	1	1	1	1
1000	3	7	5	4	6	3	7	7	6	6	5.4
10000	15	16	18	11	18	13	16	16	15	16	15.4
100000	218	175	163	145	252	154	169	232	152	191	185.1
n					RB Deletion						RB Average
10	1	1	1	0	0	0	0	1	1	0	0.5
100	0	0	1	0	1	0	2	0	0	2	0.6
1000	3	2	3	4	3	2	3	4	2	3	2.9
10000	10	8	16	23	14	15	15	16	13	15	14.5
100000	173	125	175	206	173	263	191	234	244	283	206.7

Charts:


AVL VS RB Insertion
RB Average
Trend line for AVL Average
AVL Average
Trend line for RB Average
1000
750
500
250
0
millisecond
4.9
1
5.4
15.4
185.1
243.5
100
1000
10000
100000
n (number of nodes inserted)


AVL VS RB Deletion
RB Average
Trend line for AVL Average
AVL Average
Trend line for RB Average
1000
750
500
250
0
millisecond
0.5
0.6
2.9
14.5
206.7
179.8
100
1000
10000
100000
n (number of nodes deleted)