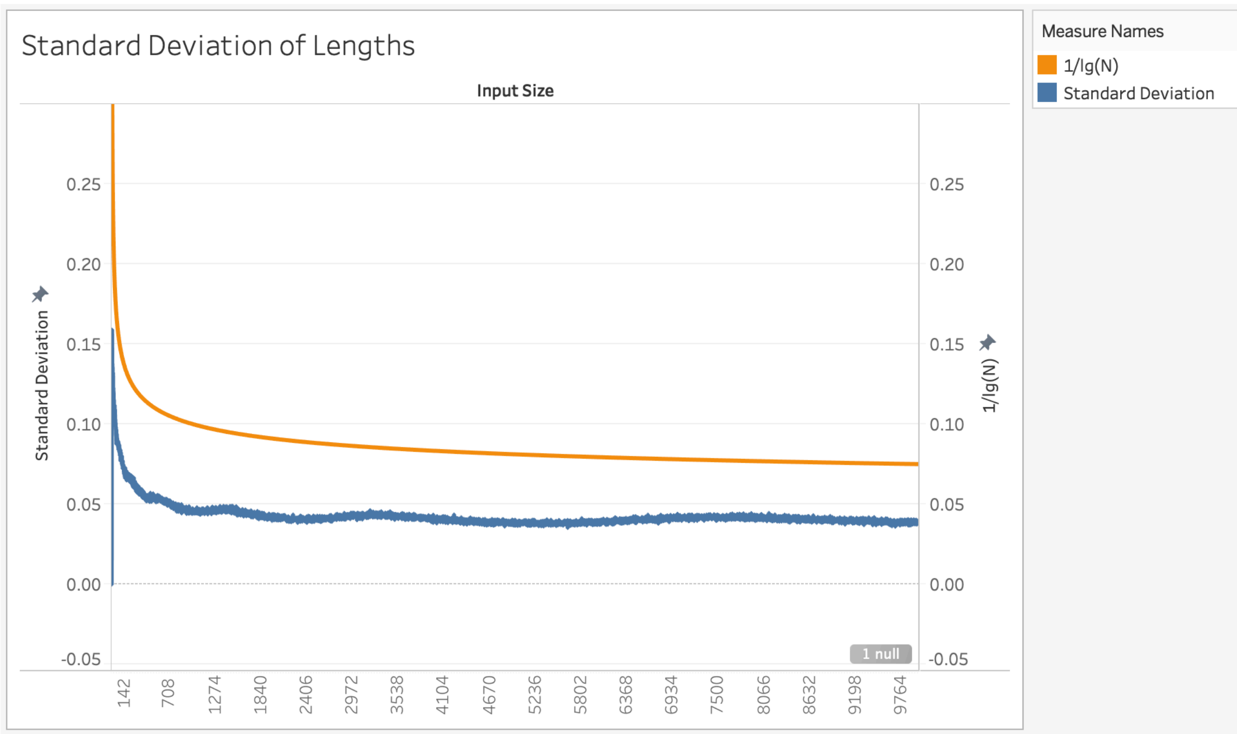
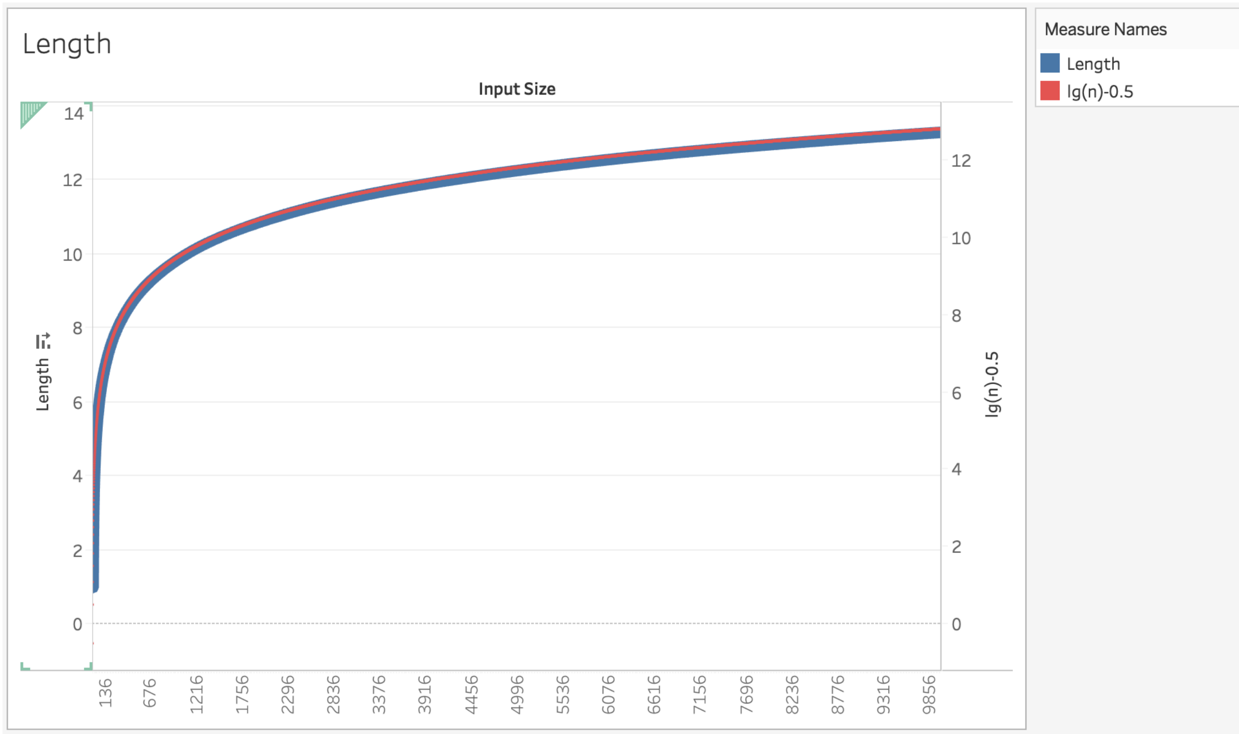
Program 4

Nishil Shah, Vikramaditya Pandey

March 11, 2019



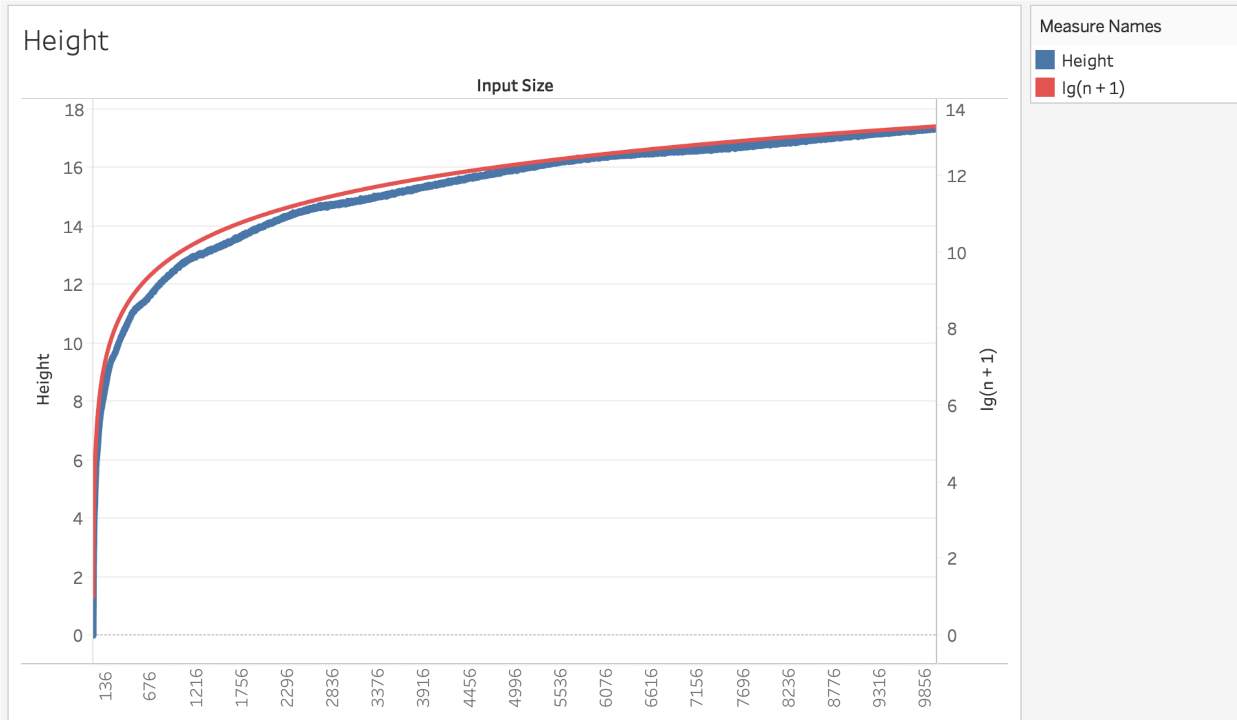
The standard deviation decreases as the input size increases. This is because as the input size increases, the total length increases and so the variation in the average length decreases. This follows O(1/lg(N)) in our empirical example.



The average length follows log(N) – 0.5 as expected from our theory. This means that as the number of inputs (to be stores in the Red Black BST) increases, the average length first increases fast and then increases slowly (increases at a decreasing rate). This is expected. Since the number of nodes possible at each level increases at the order or 2^N, each level down the tree is able to store more and more nodes.

Thus, the height of the tree will first increase quickly as more nodes are added, but then increase slowly as each level can handle more and more nodes.

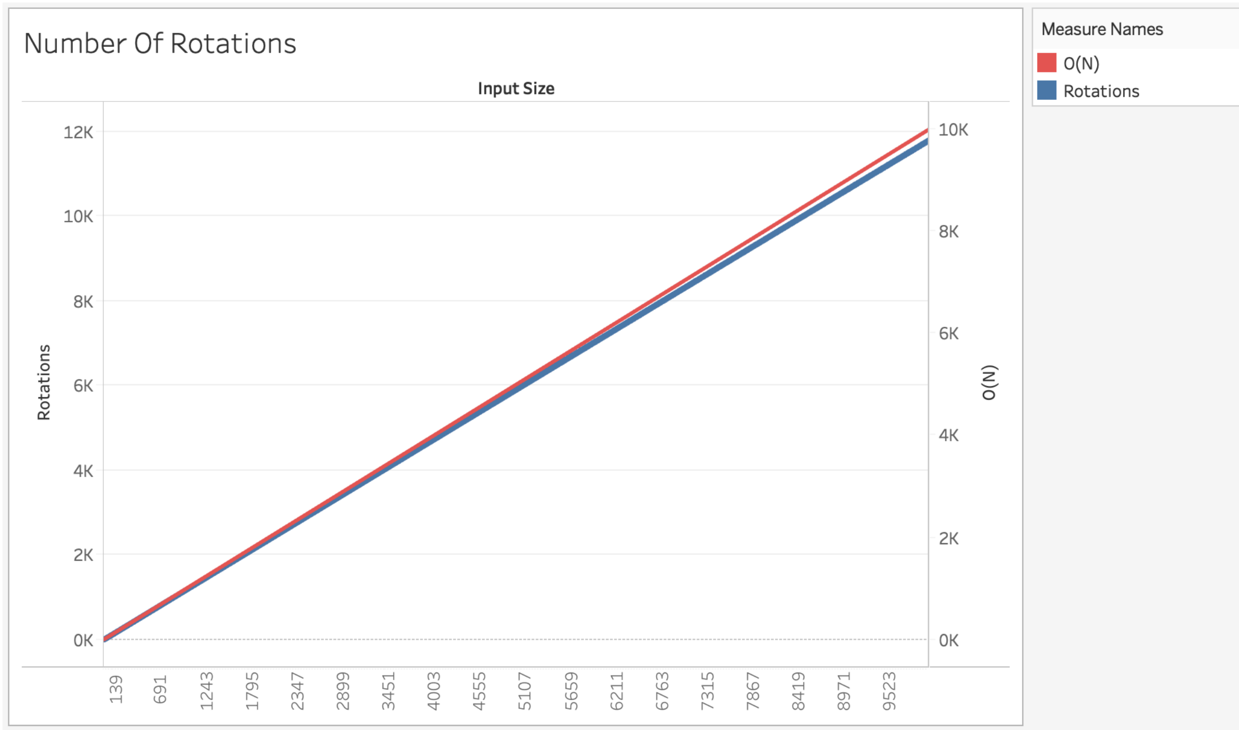
Thus, the average length will first increase quickly and then increase slowly as input size increases.



The average height follows lg(N+1) fairly closely.

This is expected. Since the number of nodes possible at each level increases at the order or 2^N, each level down the tree is able to store more and more nodes.

Thus, the height of a binary tree is lg(N) and since the Red Black Trees have extra null nodes, we expect there to be lg(N+1) in this case.



The number of rotations increases linearly O(N). This is because rotations required are to find the right spot for a random value and then balancing the tree also requires rotations.

As the size of the tree increases, the number of rotations required to find the right spot and balance the tree also increases.