CS 225

Data Structures

Oct. 3 – Binary Search Tree (BST)

Wade Fagen-Ulmschneider

Traversal vs. Search

Traversal vs. Search:

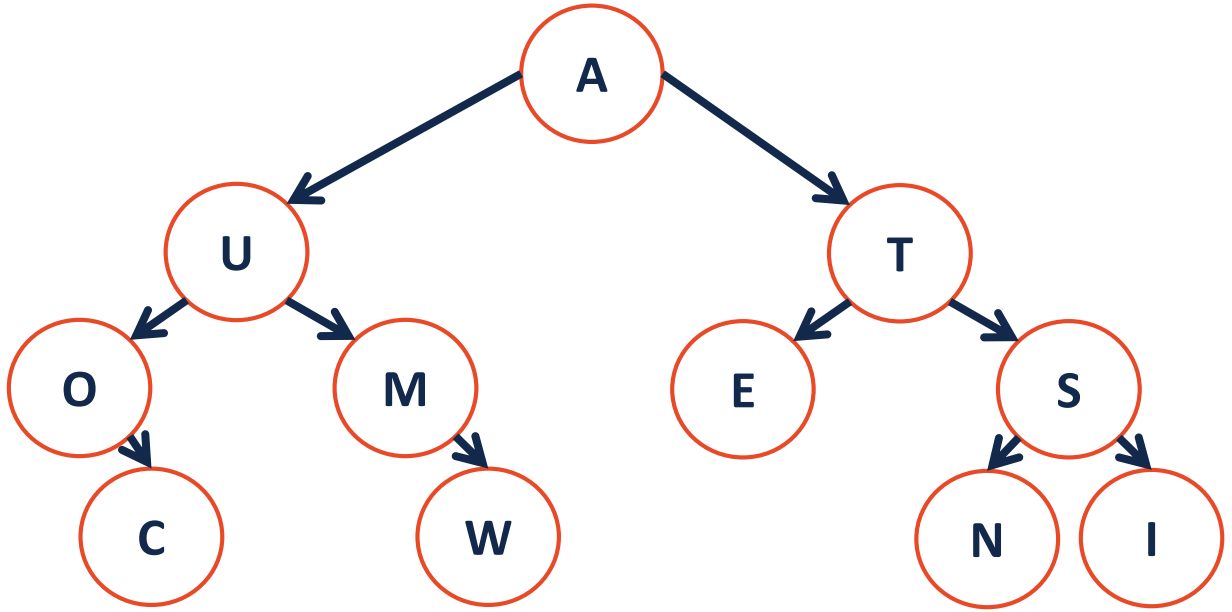
- **Traversal** visits every node in the tree exactly once.
- **Search** finds one element in the tree.

Search: Breadth First vs. Depth First

Strategy: Breadth First Search (BFS) / Traversal

Strategy: Depth First Search (DFS) / Traversal

Running Times on a Binary Tree



Dictionary ADT

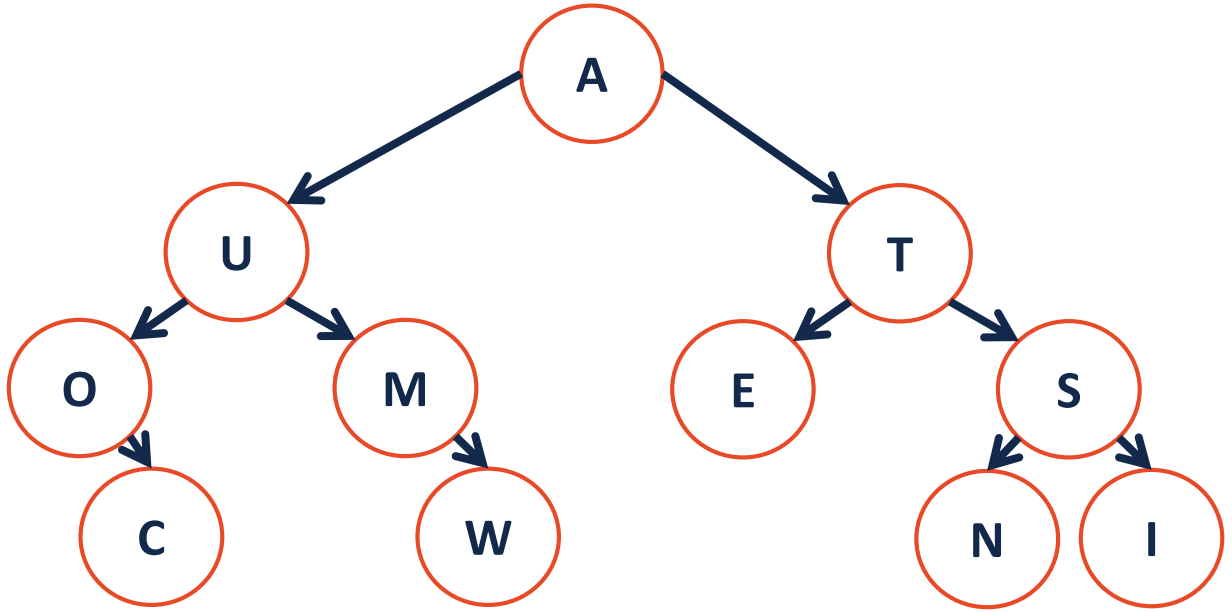
Data is often organized into key/value pairs:

UIN → Advising Record
Course Number → Lecture/Lab Schedule
Node → Incident Edges
Flight Number → Arrival Information
URL → HTML Page
…

Dictionary.h

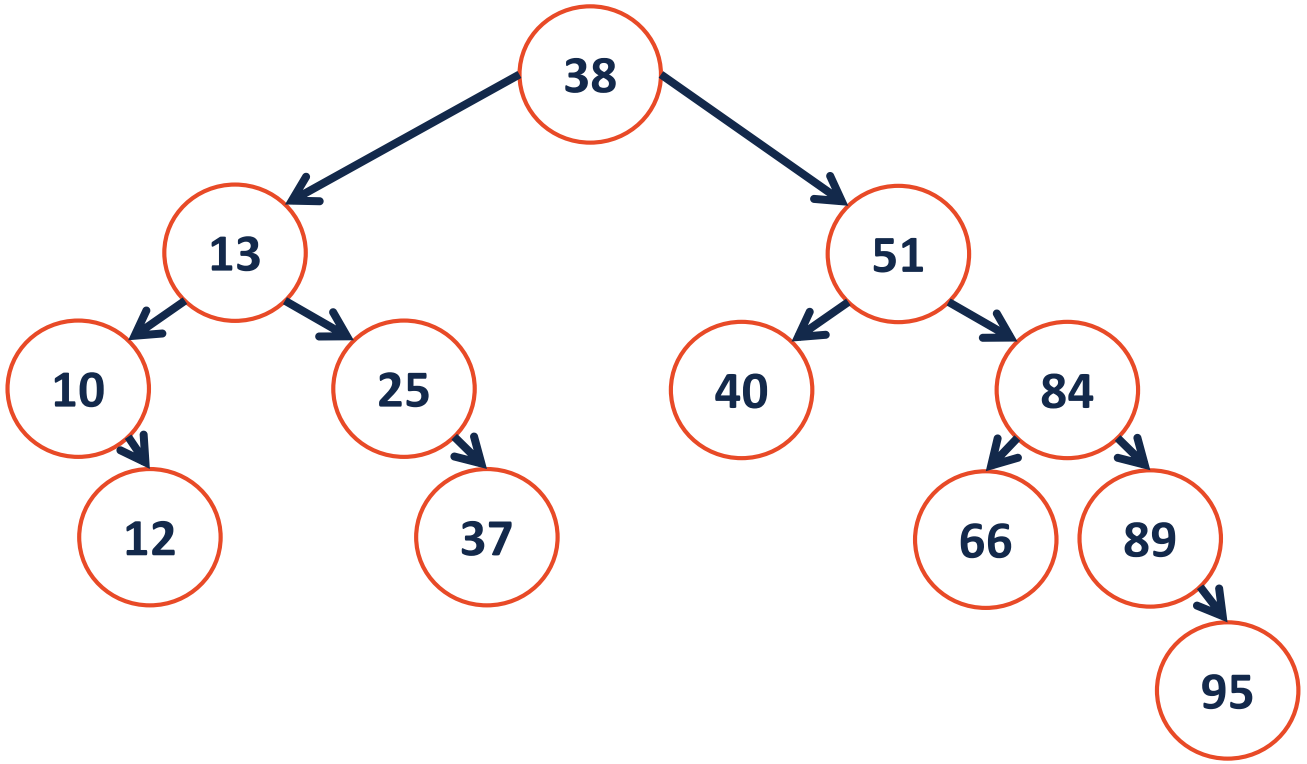
```
1  #pragma once
2
3
4  class Dictionary {
5    public:
6
7
8
9
10
11
12
13
14
15   private:
16
17
18
19 };
20
21 #endif
22
```

Binary Tree as a Search Structure



Binary _____ Tree (BST)

A **BST** is a binary tree **T** such that:



BST.h

```
 1 #pragma once
 2
 3 template <typename K, typename V>
 4 class BST {
 5   public:
 6     BST();
 7     void insert(const K key, V value);
 8     V remove(const K & key);
 9     V find(const K & key) const;
10     TreeIterator traverse() const;
11
12   private:
13     struct TreeNode {
14        TreeNode *left, *right;
15        K & key;
16        V & value;
17        TreeNode(K & k, V & v) : key(k), value(v), left(NULL),
18           right(NULL) { }
19     };
20
21     TreeNode *head_;
22 };
```

```
1  template<typename K, typename V>
2  _____________________ find(const K & key) const {
3
4
5
6
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18
19
20
21
22
23
24
25
26 }
```

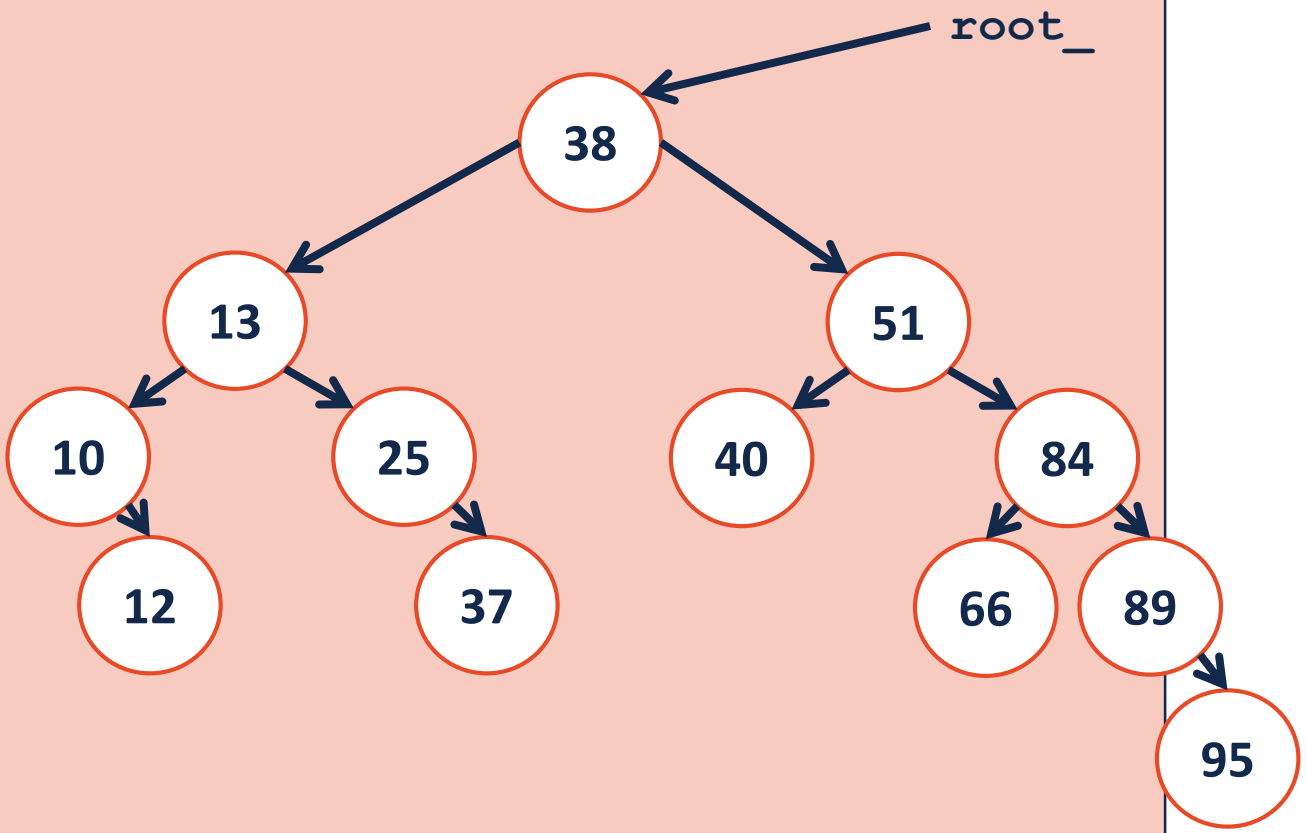

```
1  template<typename K, typename V>
2  _____________________________ _find(TreeNode *& root, const K & key) const {
3
4
5
6
7
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16
17
18
19
20
21
22
23
24
25
26 }
```

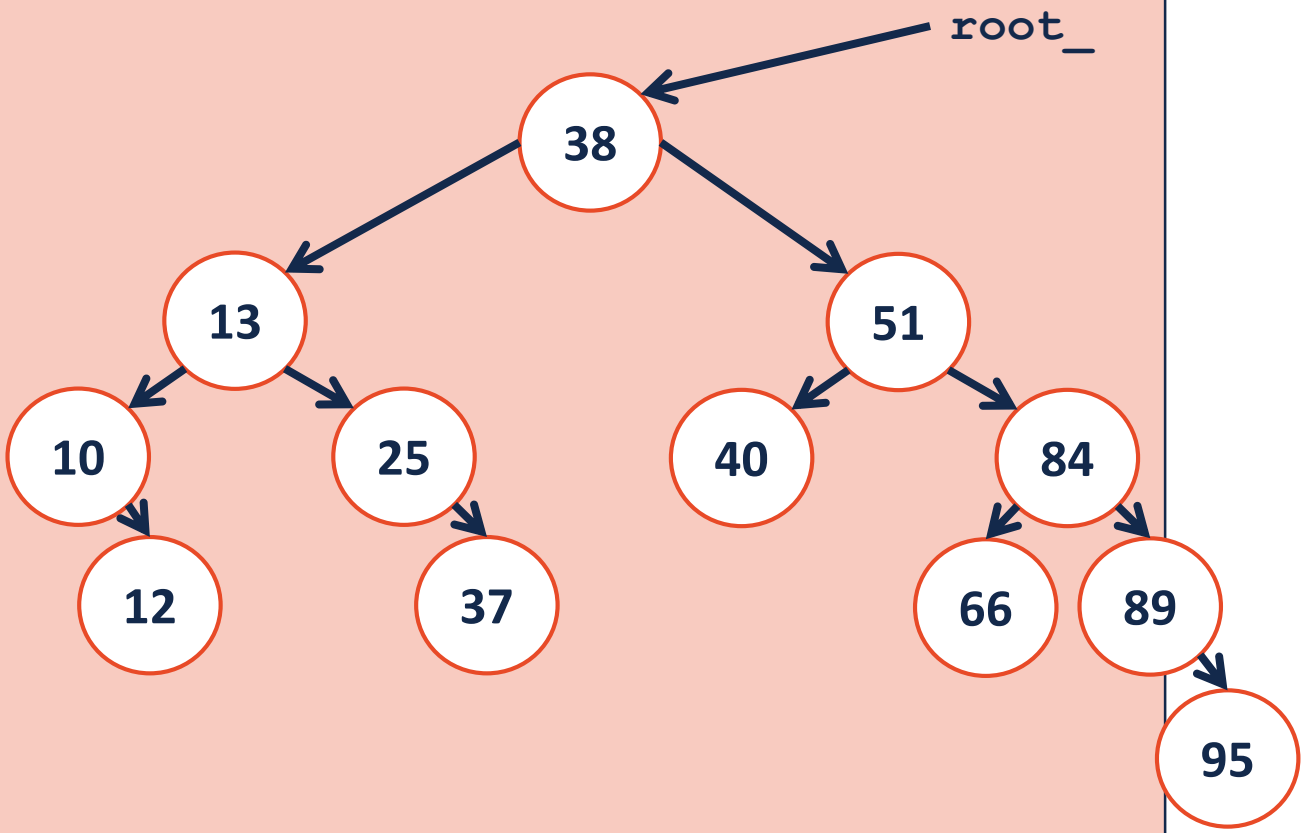

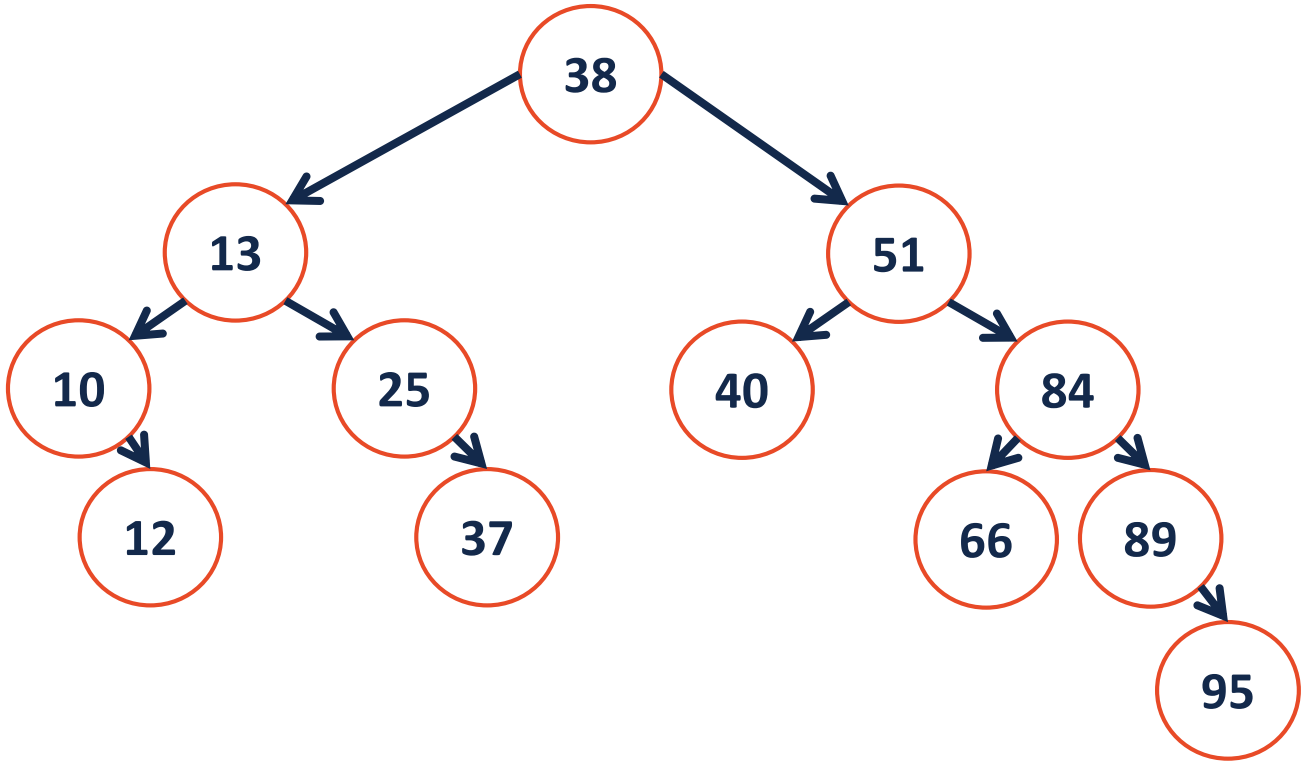
38
13
51
10
25
40
84
12
37
66
89
95

```
1  template<typename K, typename V>
2  ____________________________ _insert(TreeNode *& root, const K & key) {
3
4
5
6
7
8
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16
17
18
19
20
21
22
23
24
25
26 }
```

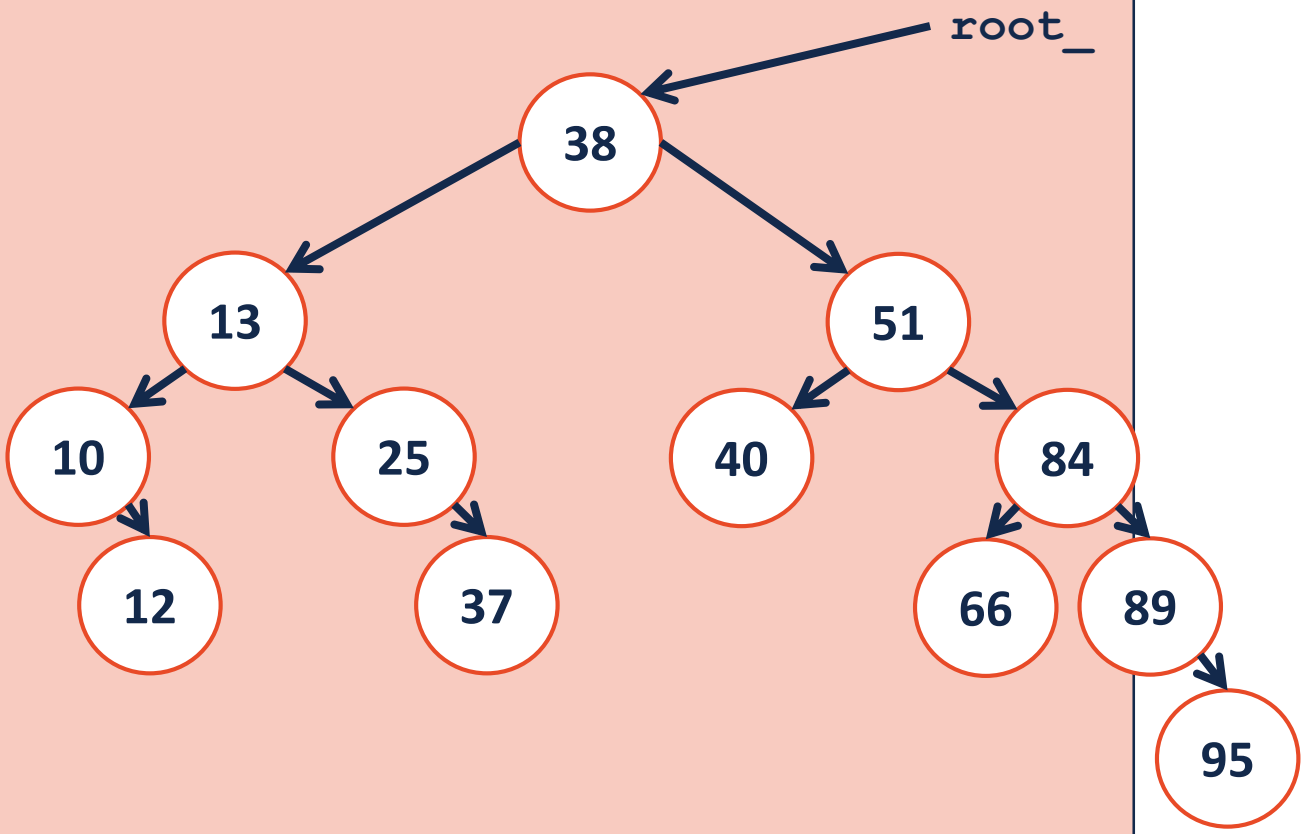

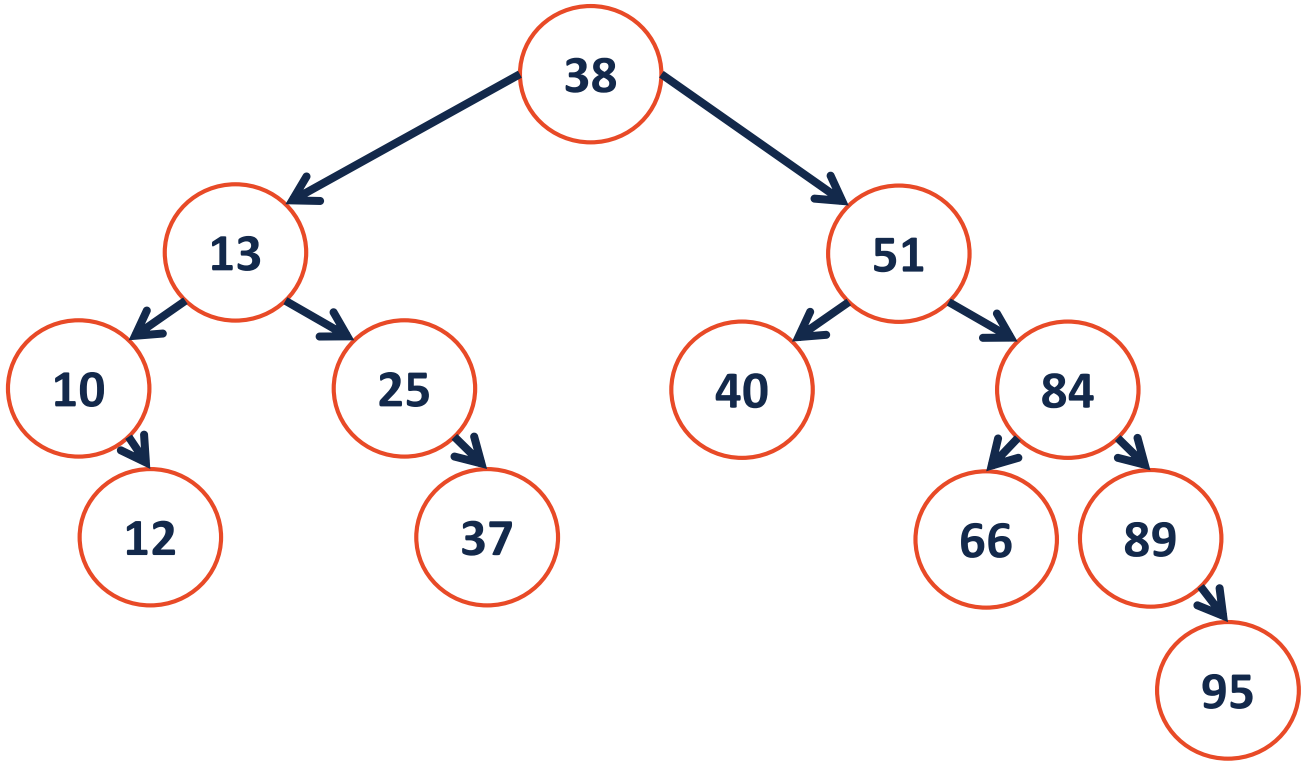
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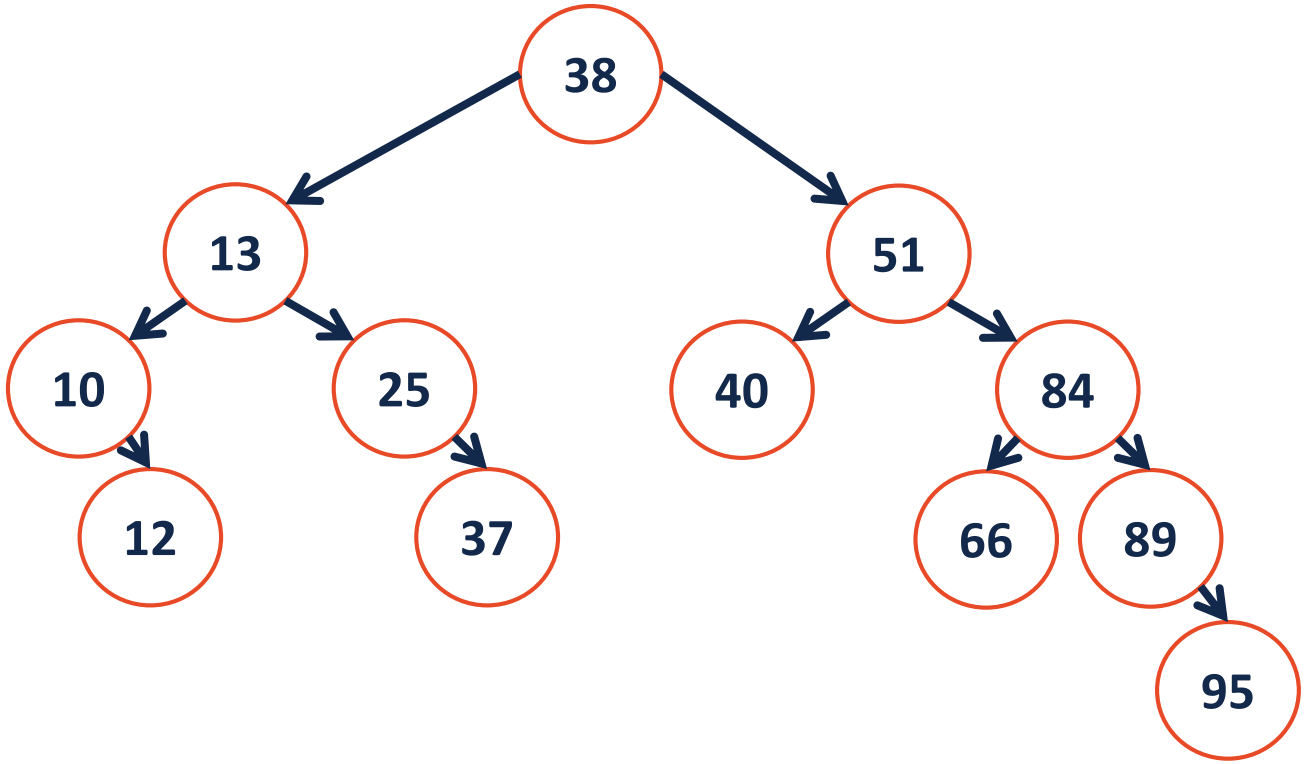
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40
84
12
37
66
89
95

```
1  template<typename K, typename V>
2  _____________________________ _remove(TreeNode *& root, const K & key) {
3
4
5
6
7
8
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12
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15
16
17
18
19
20
21
22
23
24
25
26 }
```
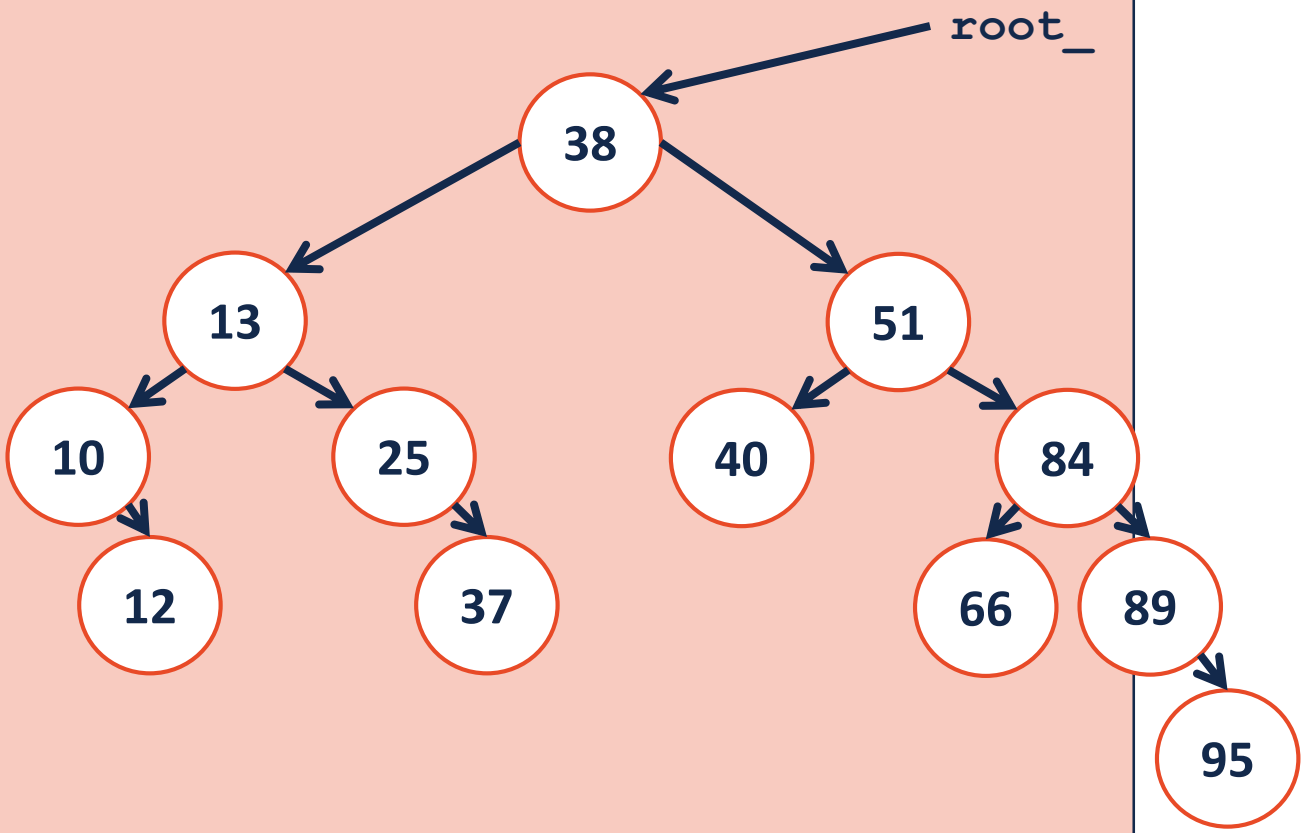
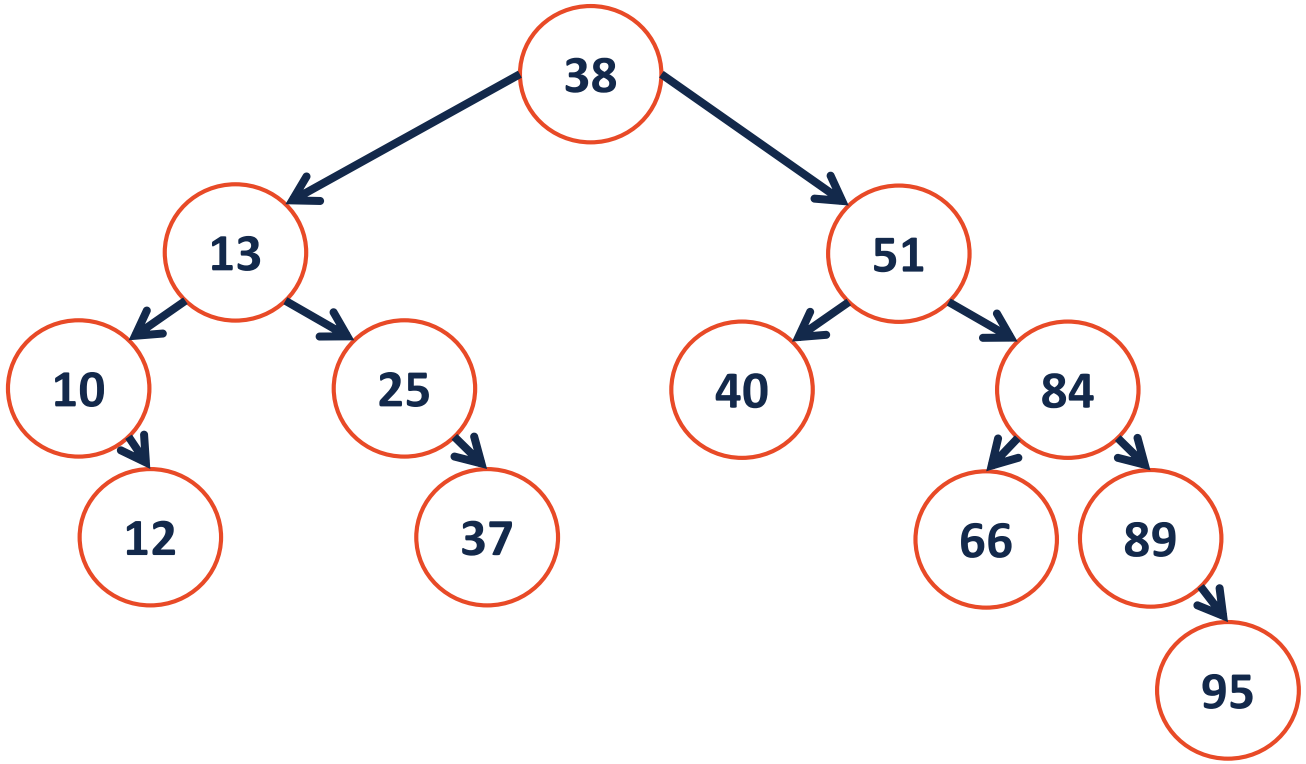
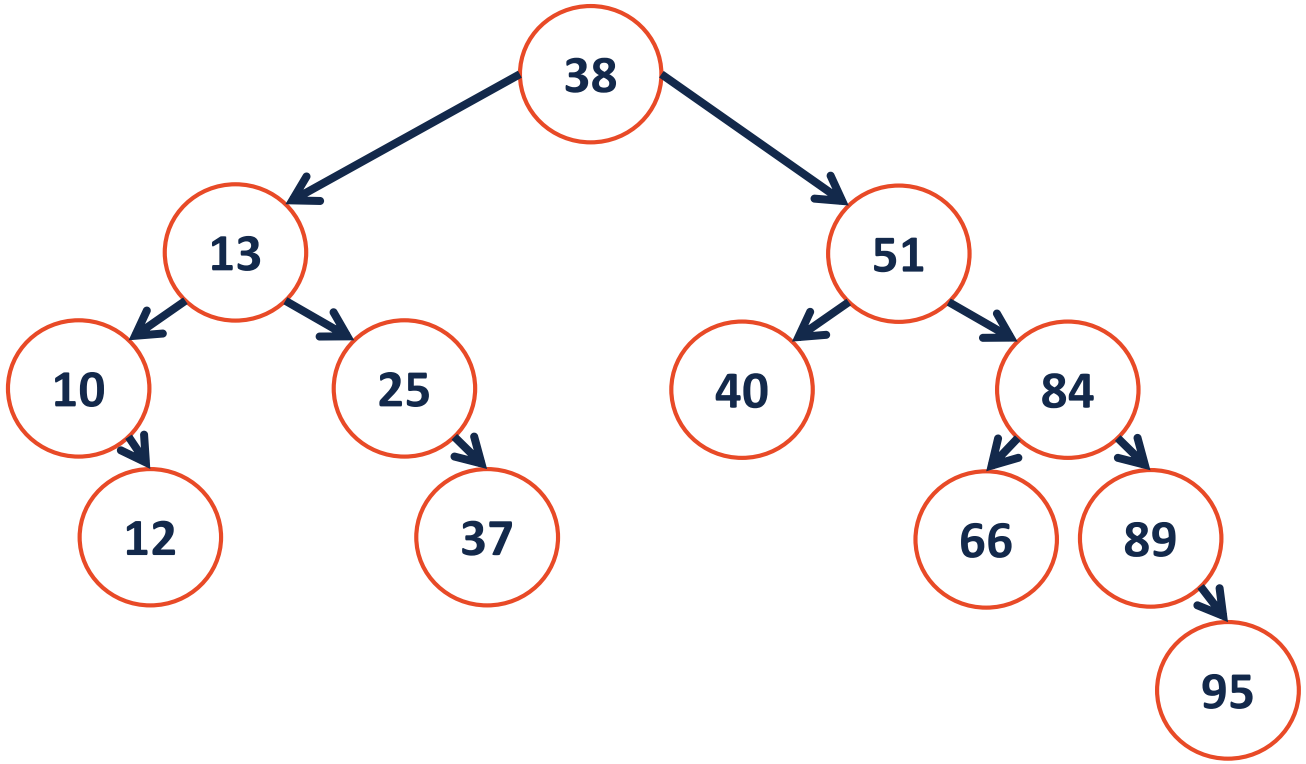
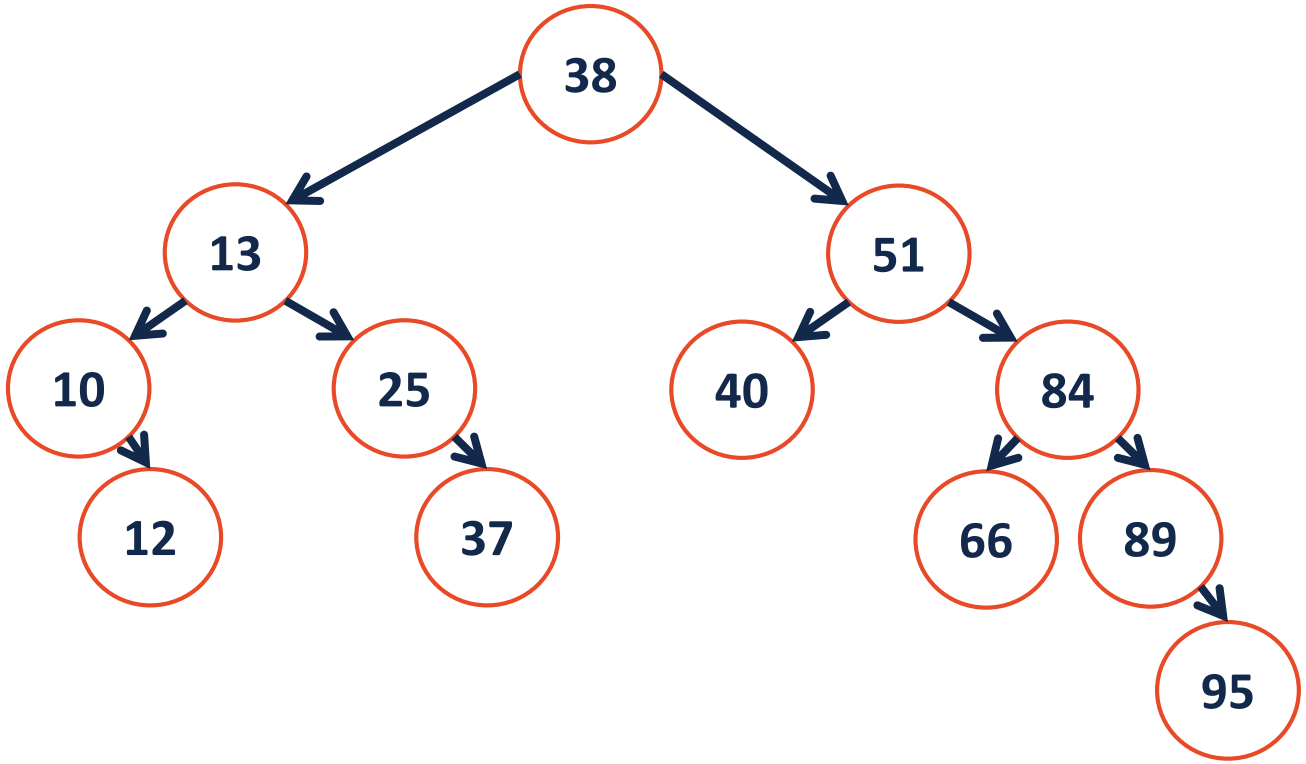





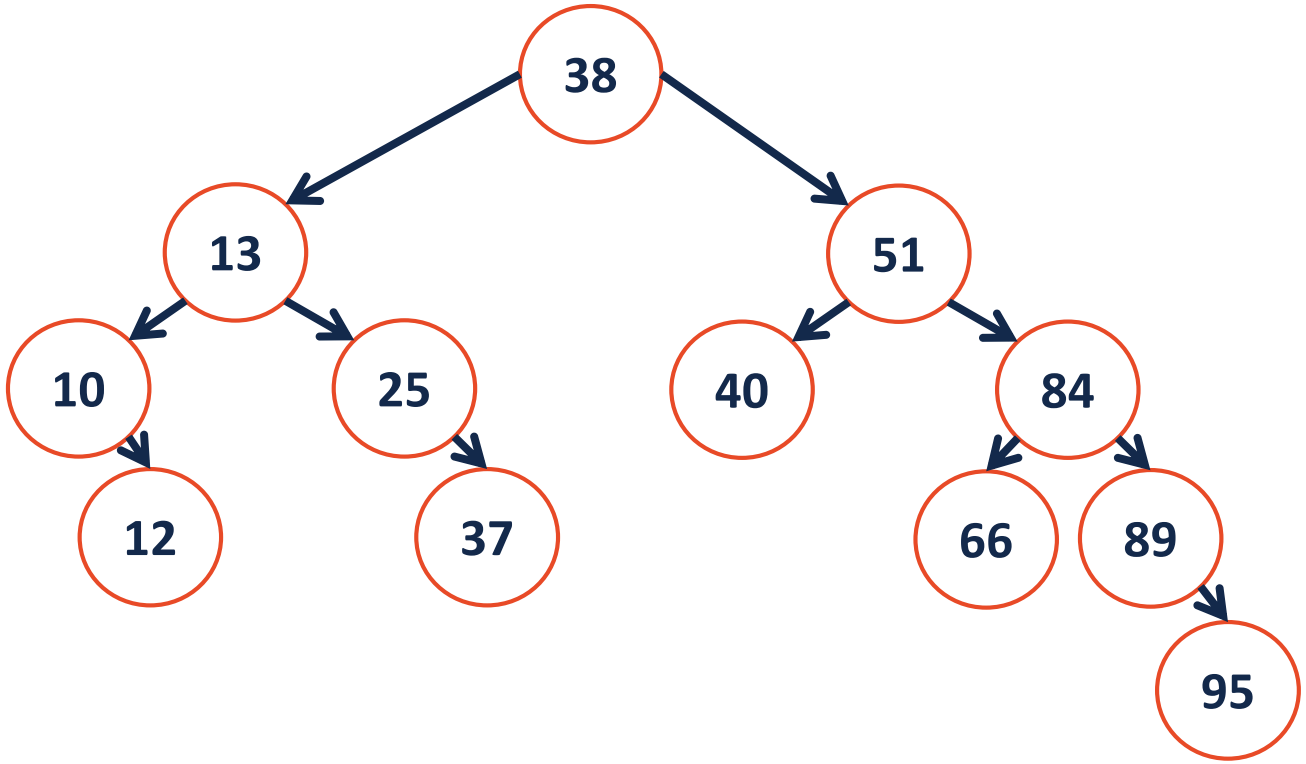

```
remove(40);
```




```
remove(25);
```




```
remove(10);
```




```
remove(13);
```