CSCI 232:
Data Structures and Algorithms

Binary Search Trees (BST)

Reese Pearsall

Spring 2024

Announcements

Lab 3 due **tomorrow** at 11:59

Program 1 will be posted very soon

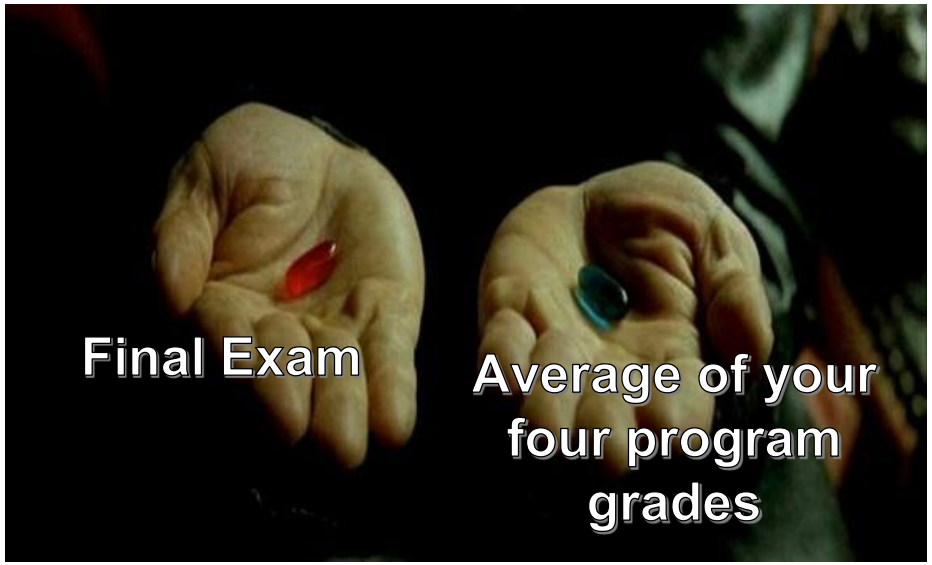
Final Exam

The final exam for 232 will be **optional**.

You can either:

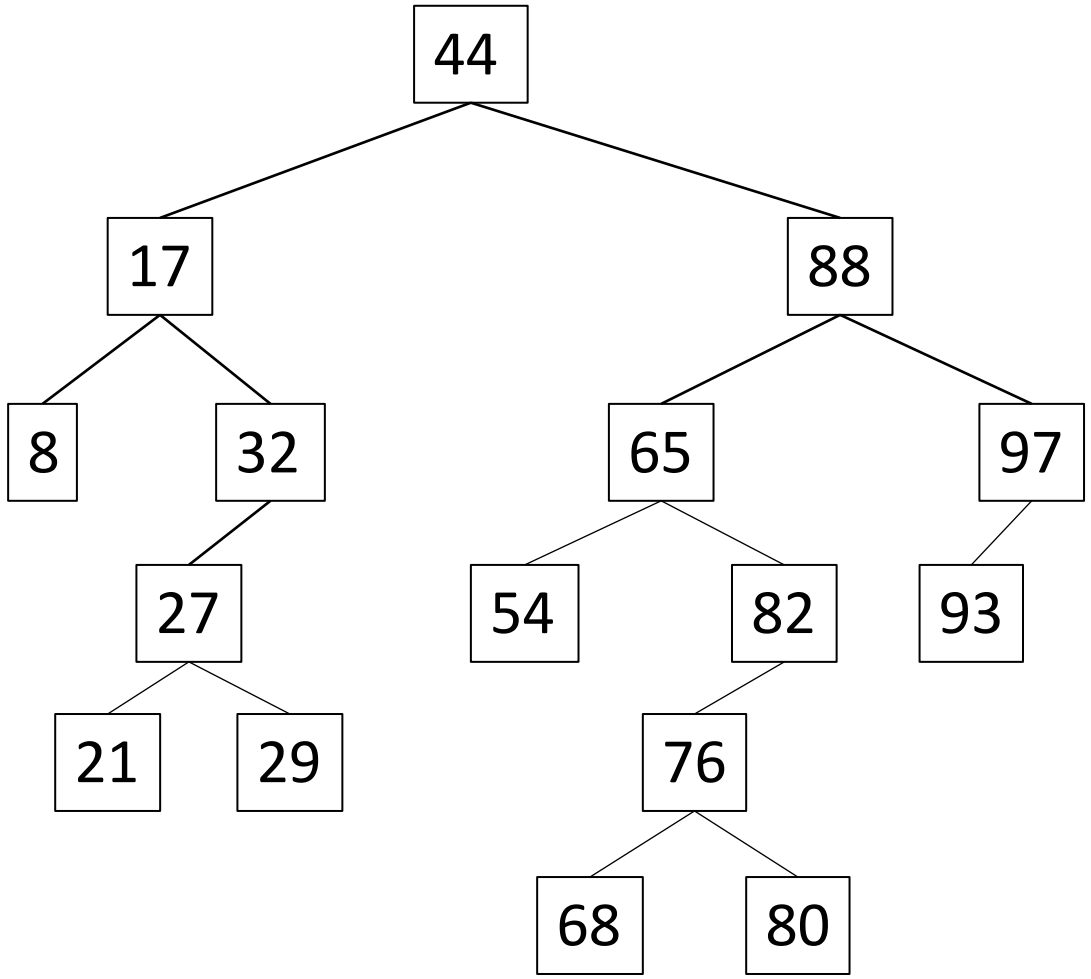
1. Show up and take the final exam normally

2. Don't show up, and your final exam grade will be the average of your four program grades



(If you show up, and you still do worse than the average of your four exam grades, I will give you the average of your program grades)

Binary Search Tree



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Binary Search Tree (BST) properties:

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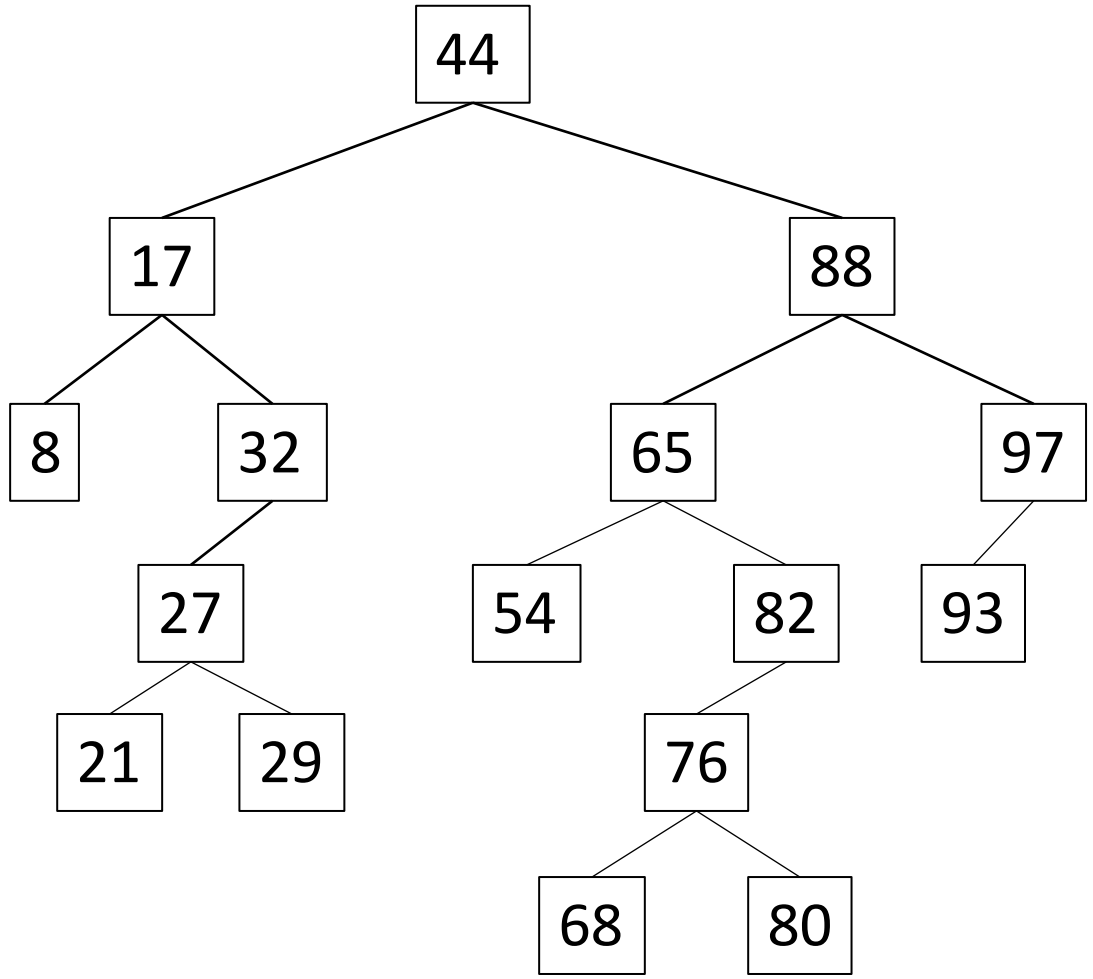

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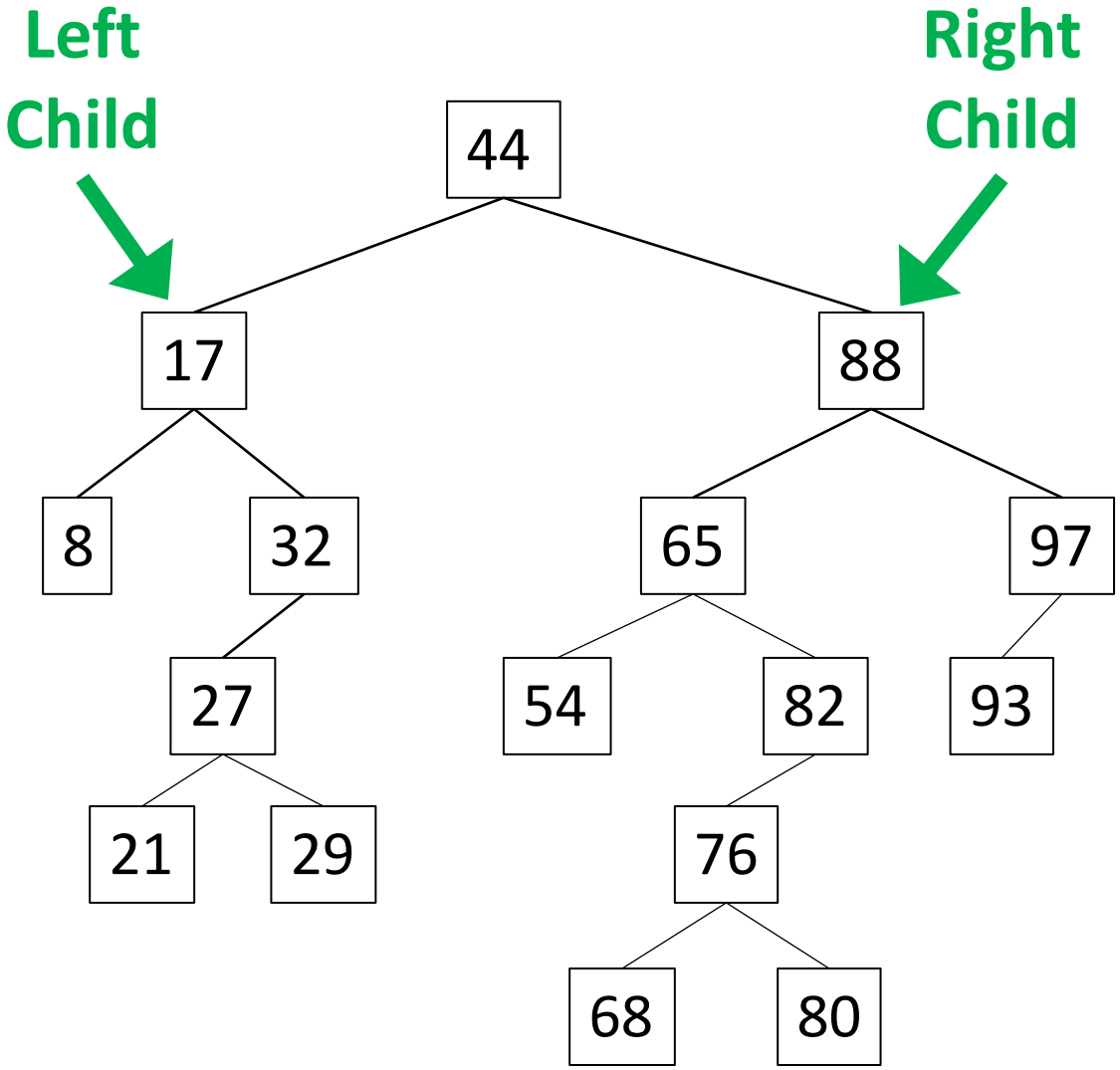

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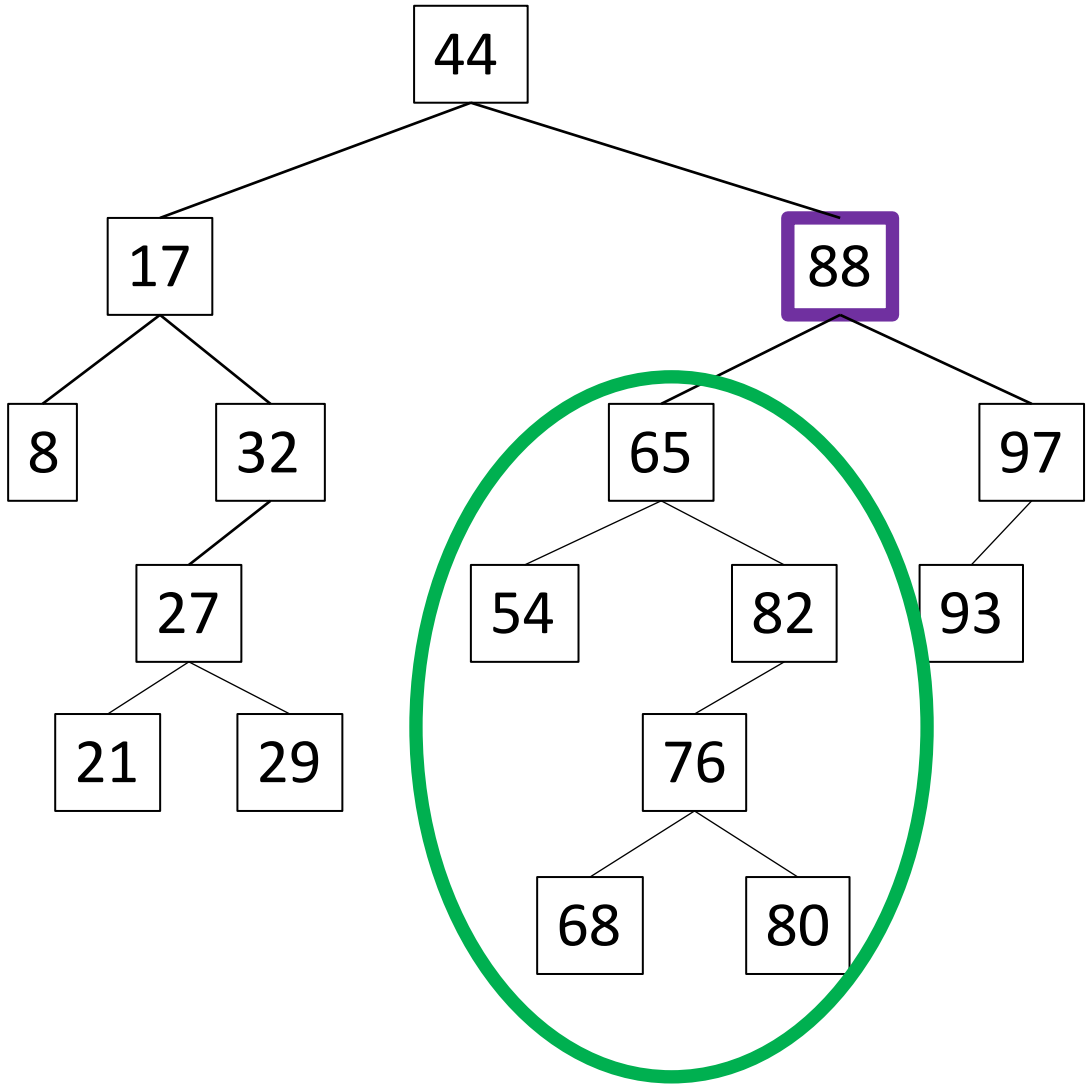

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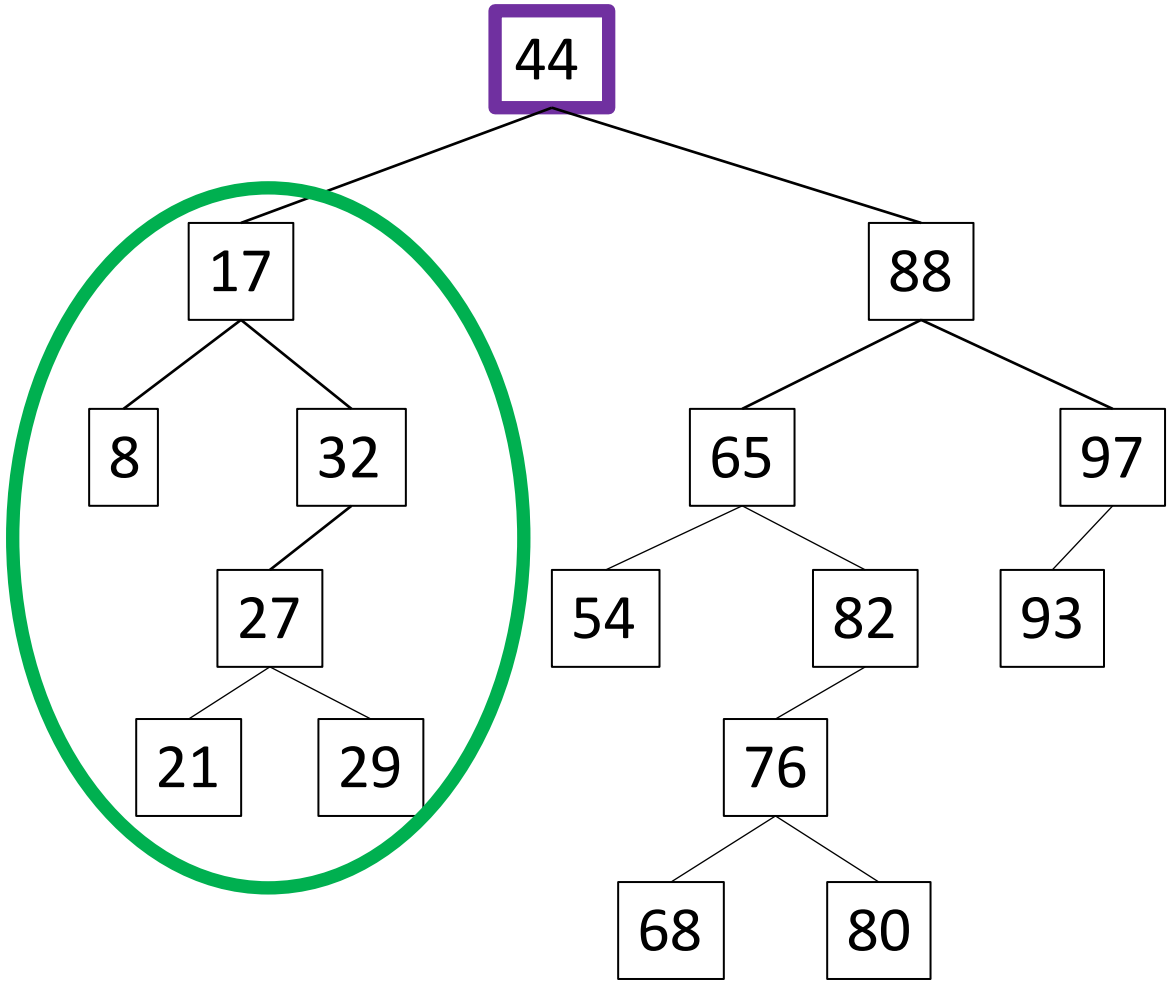

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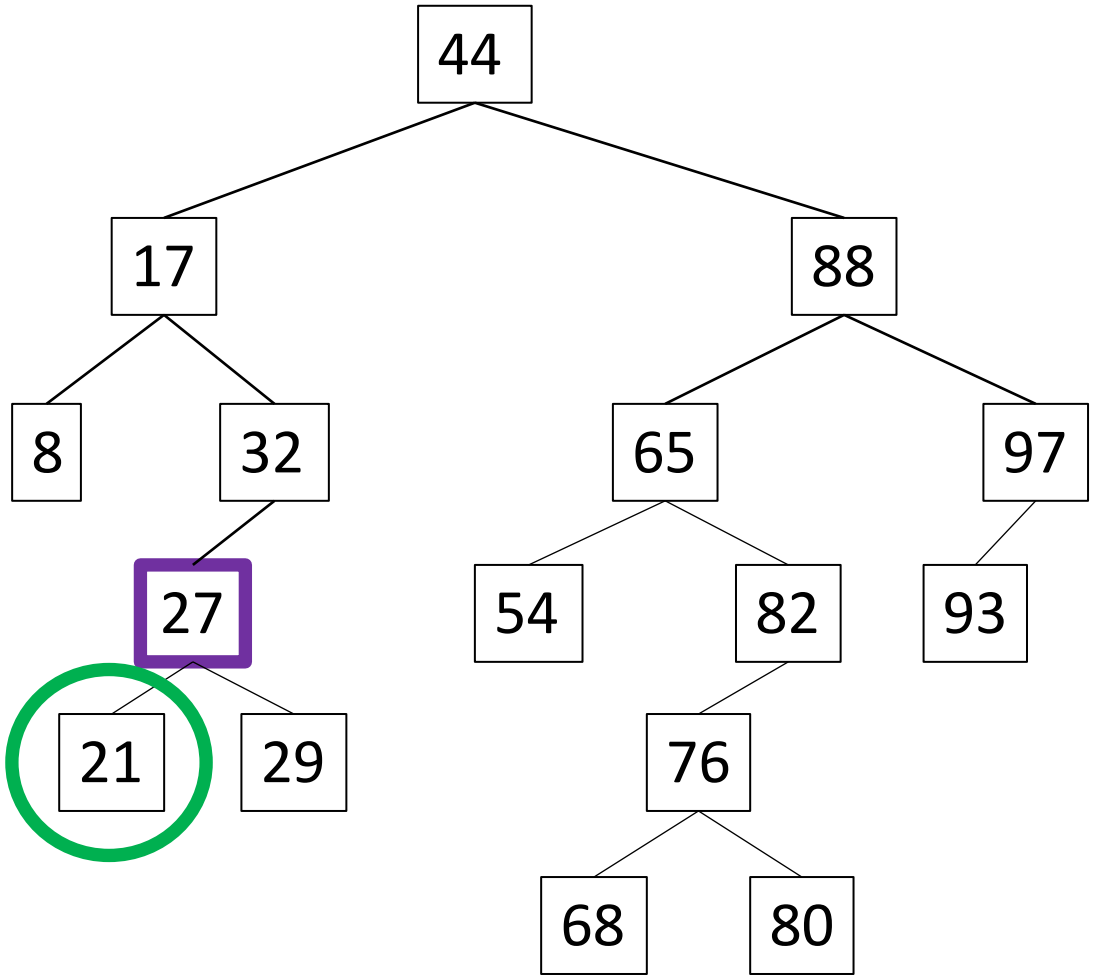

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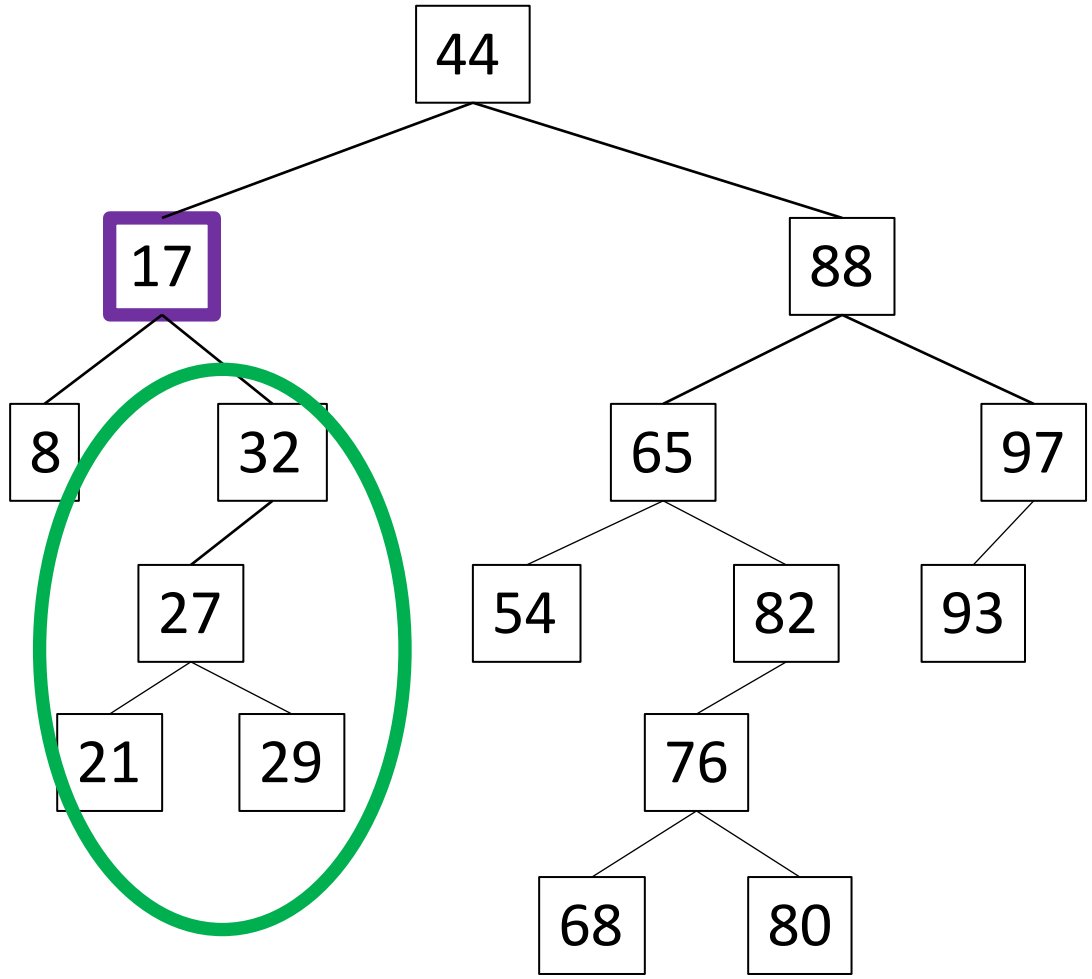

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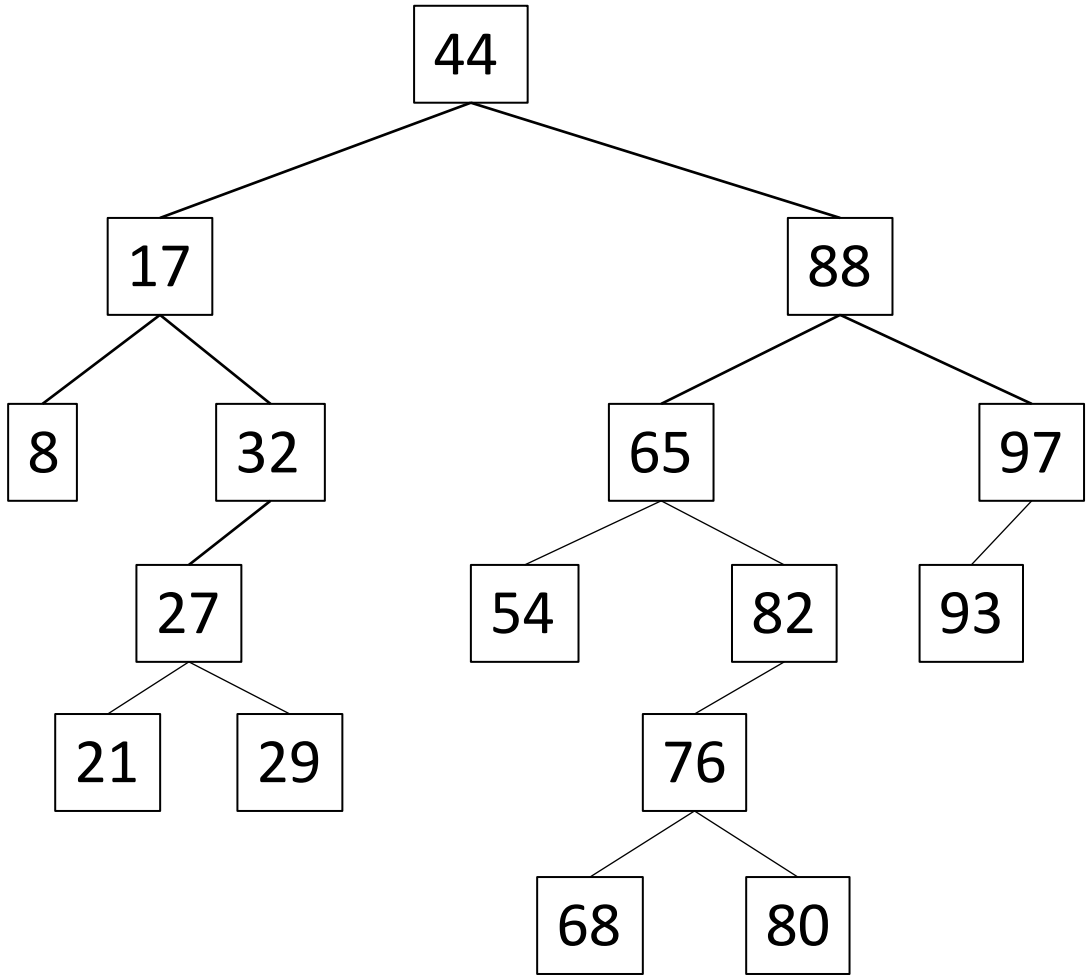

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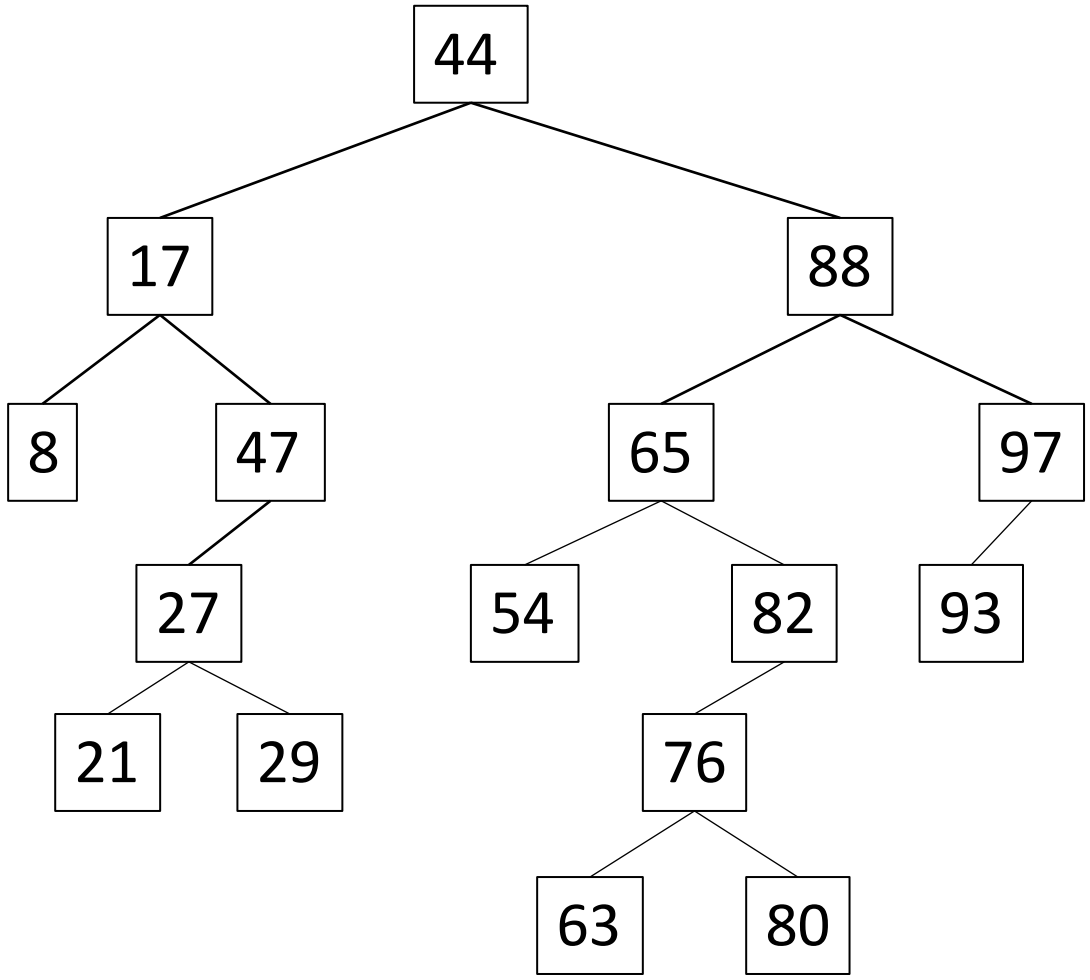

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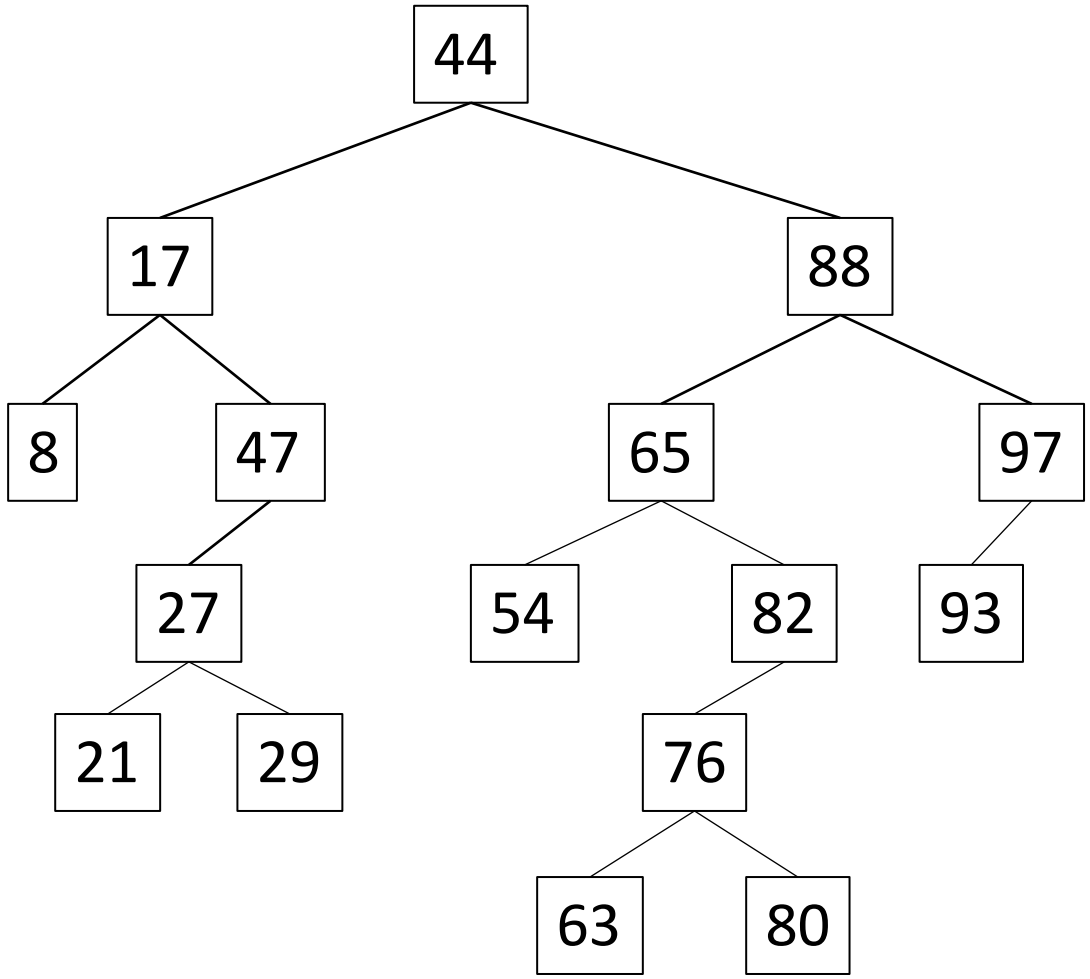

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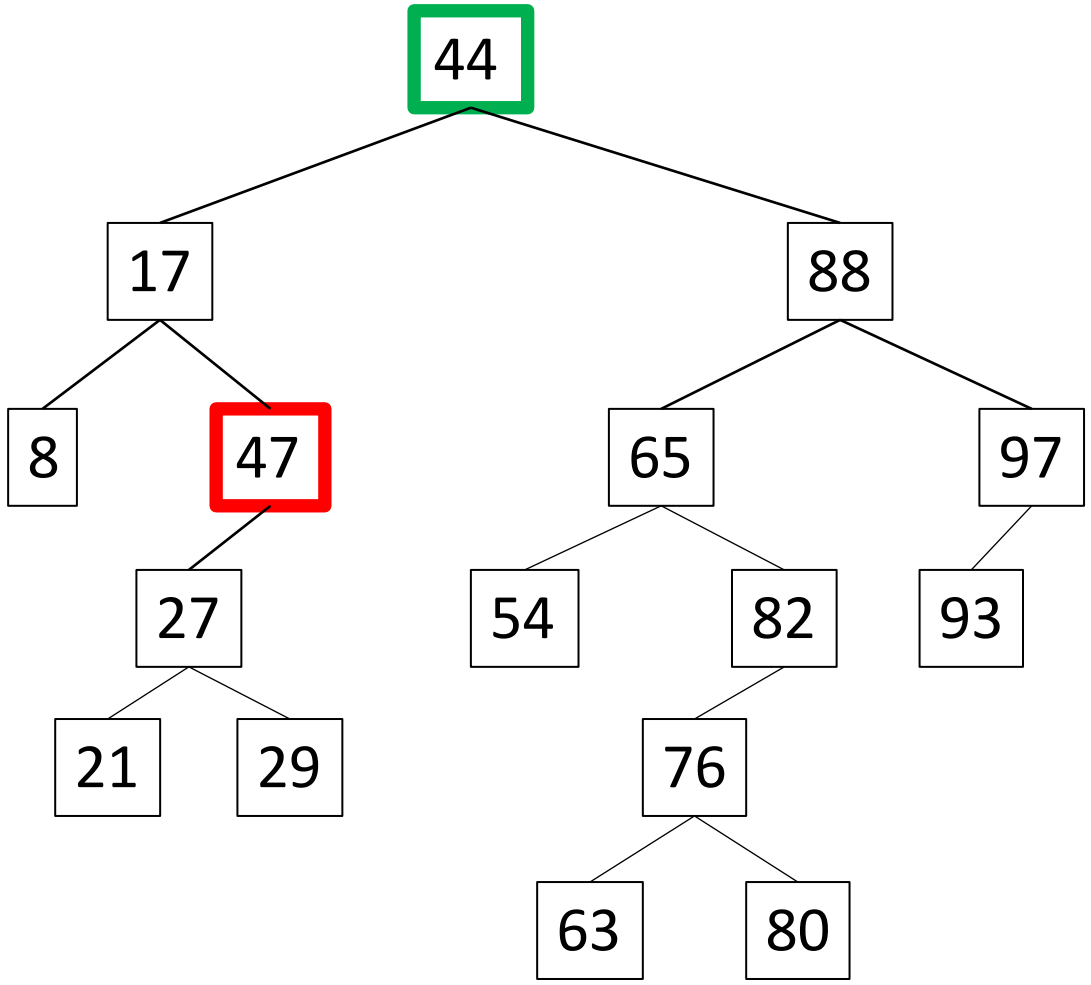

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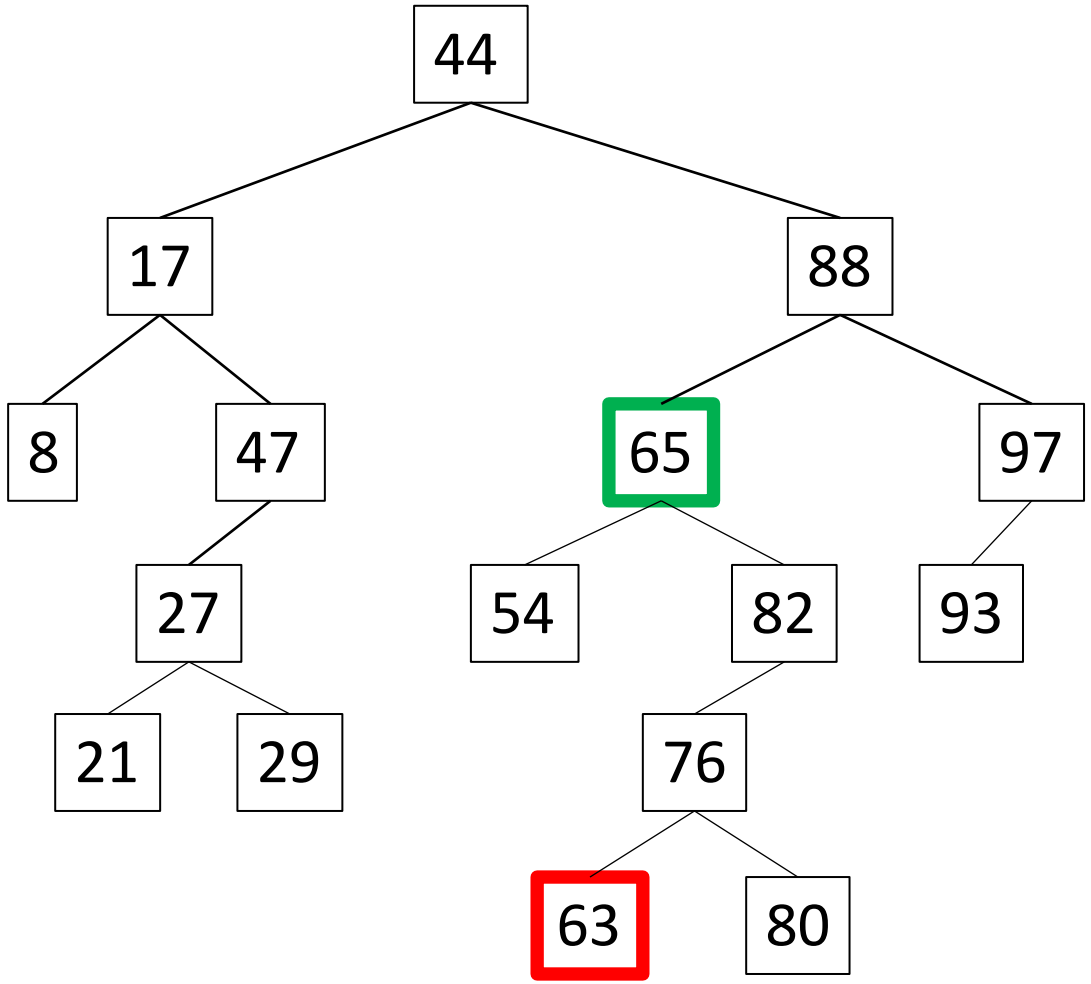

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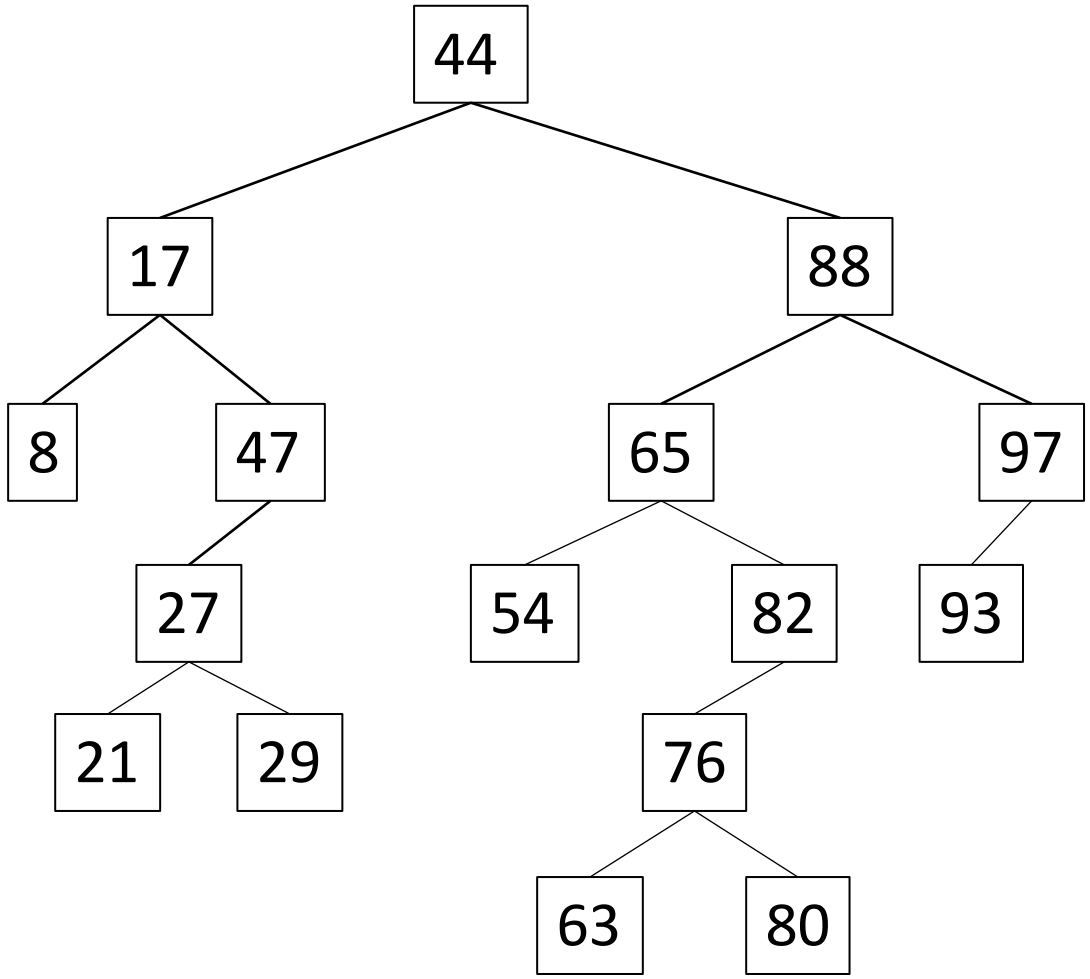

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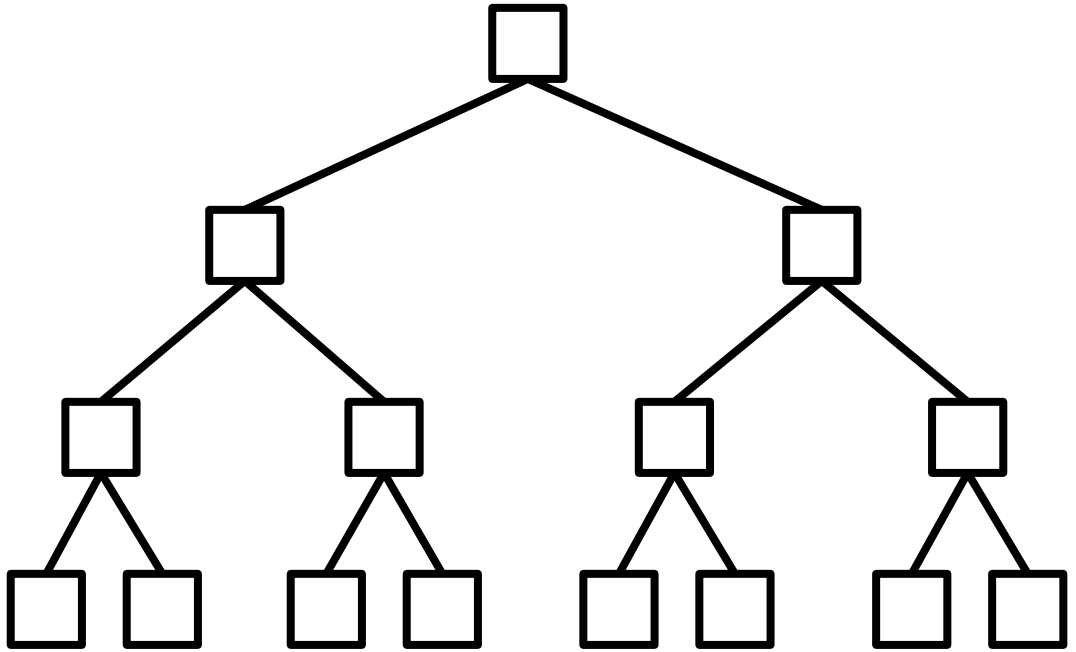

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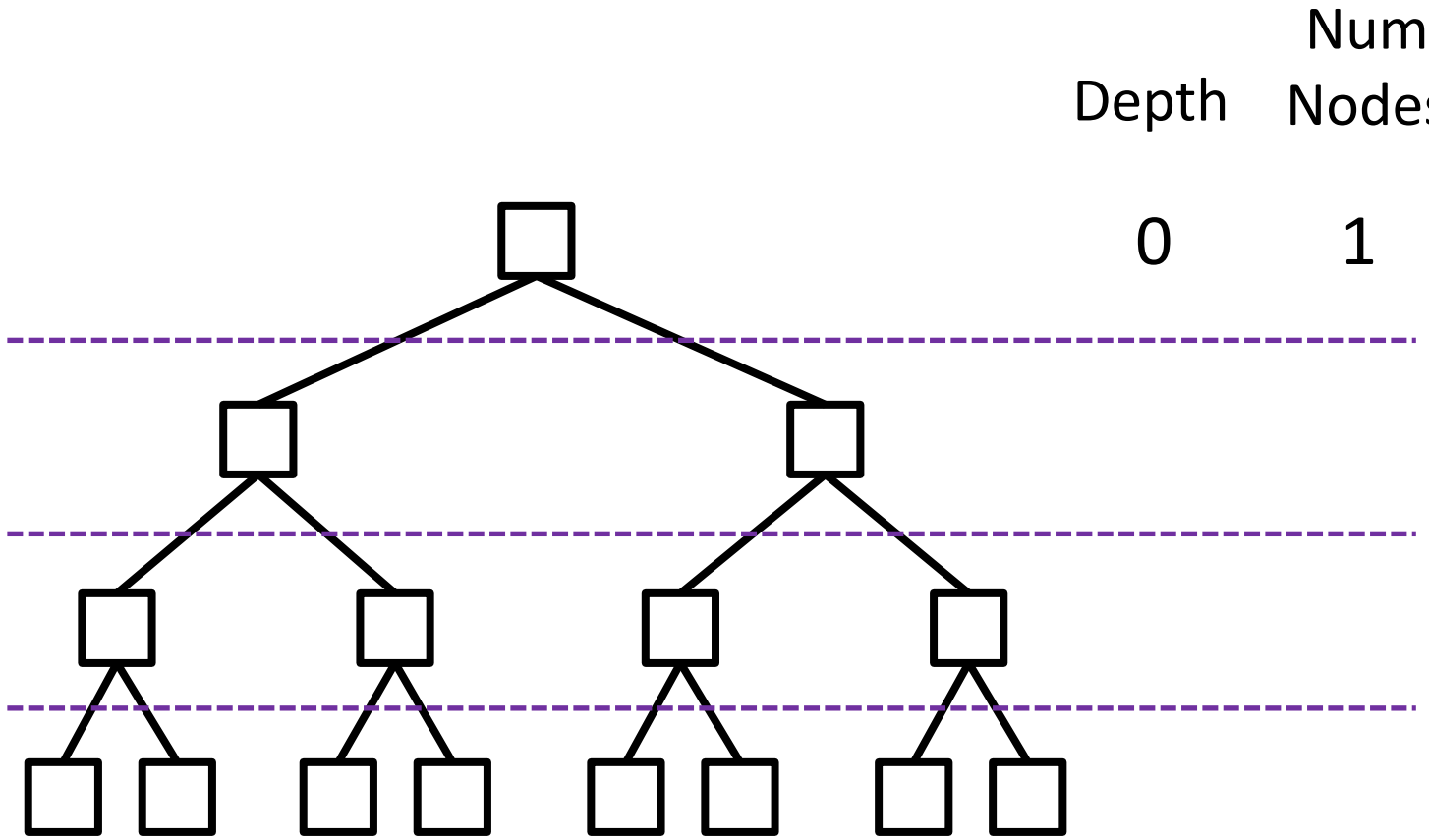

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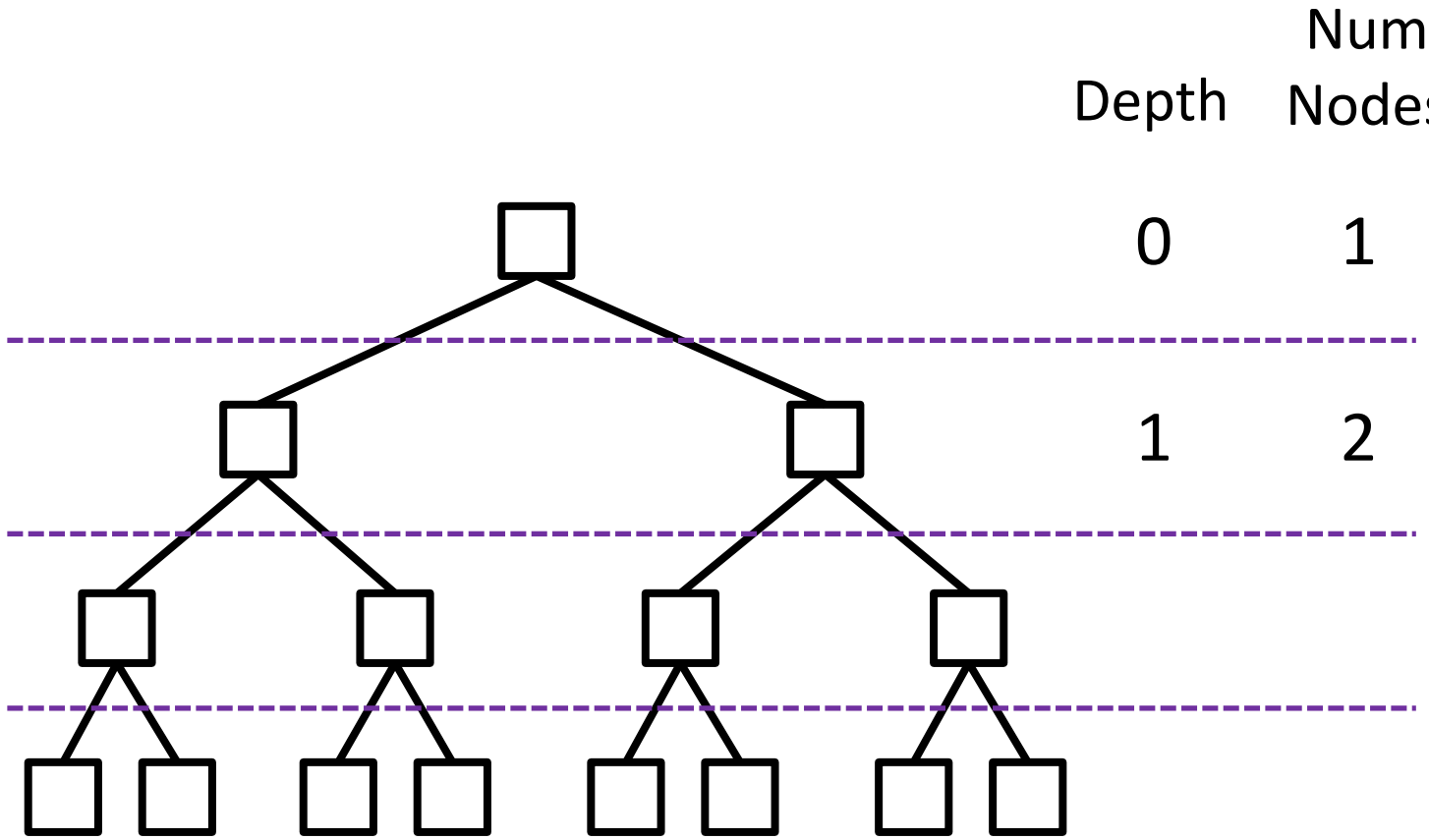

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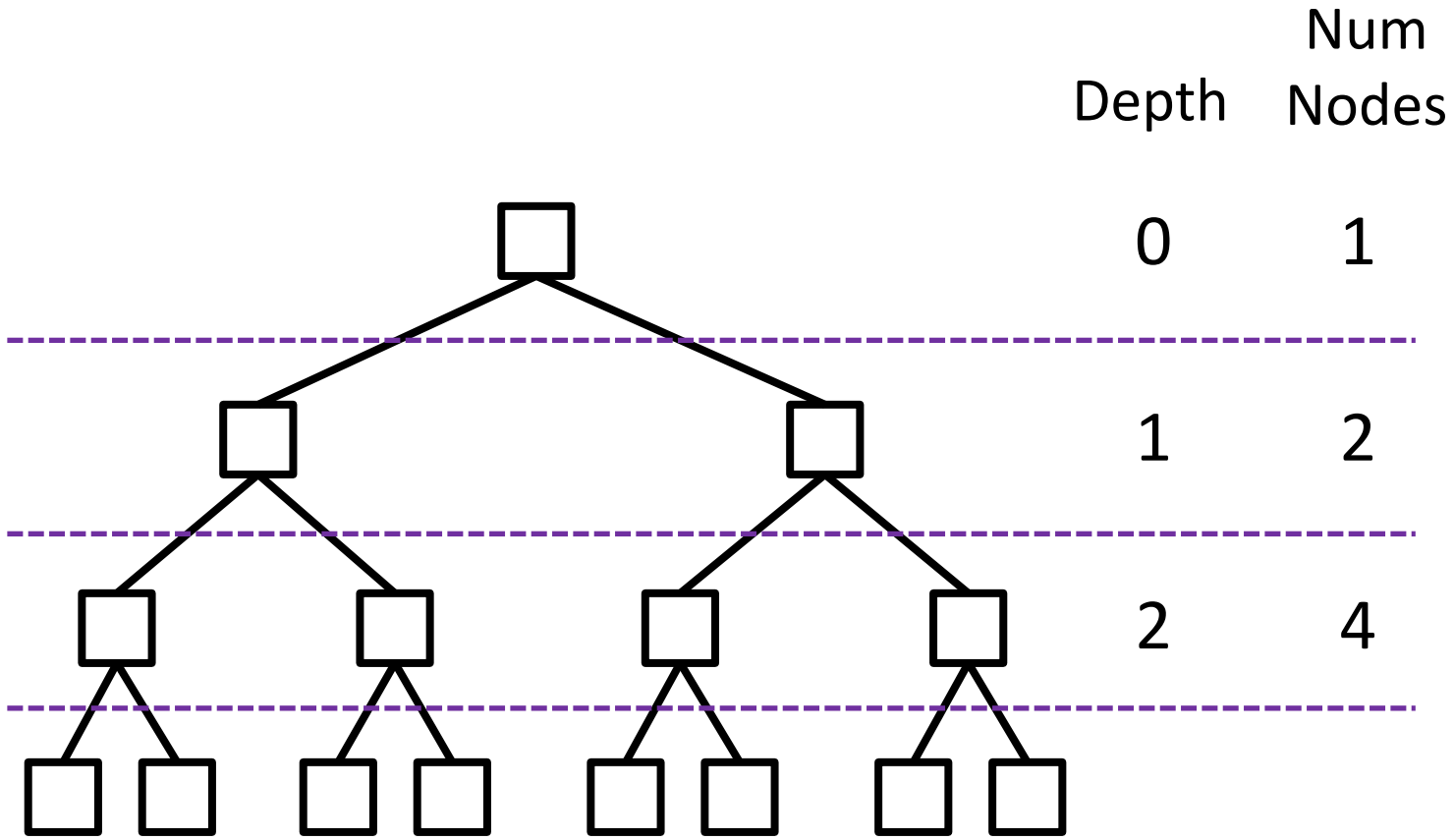

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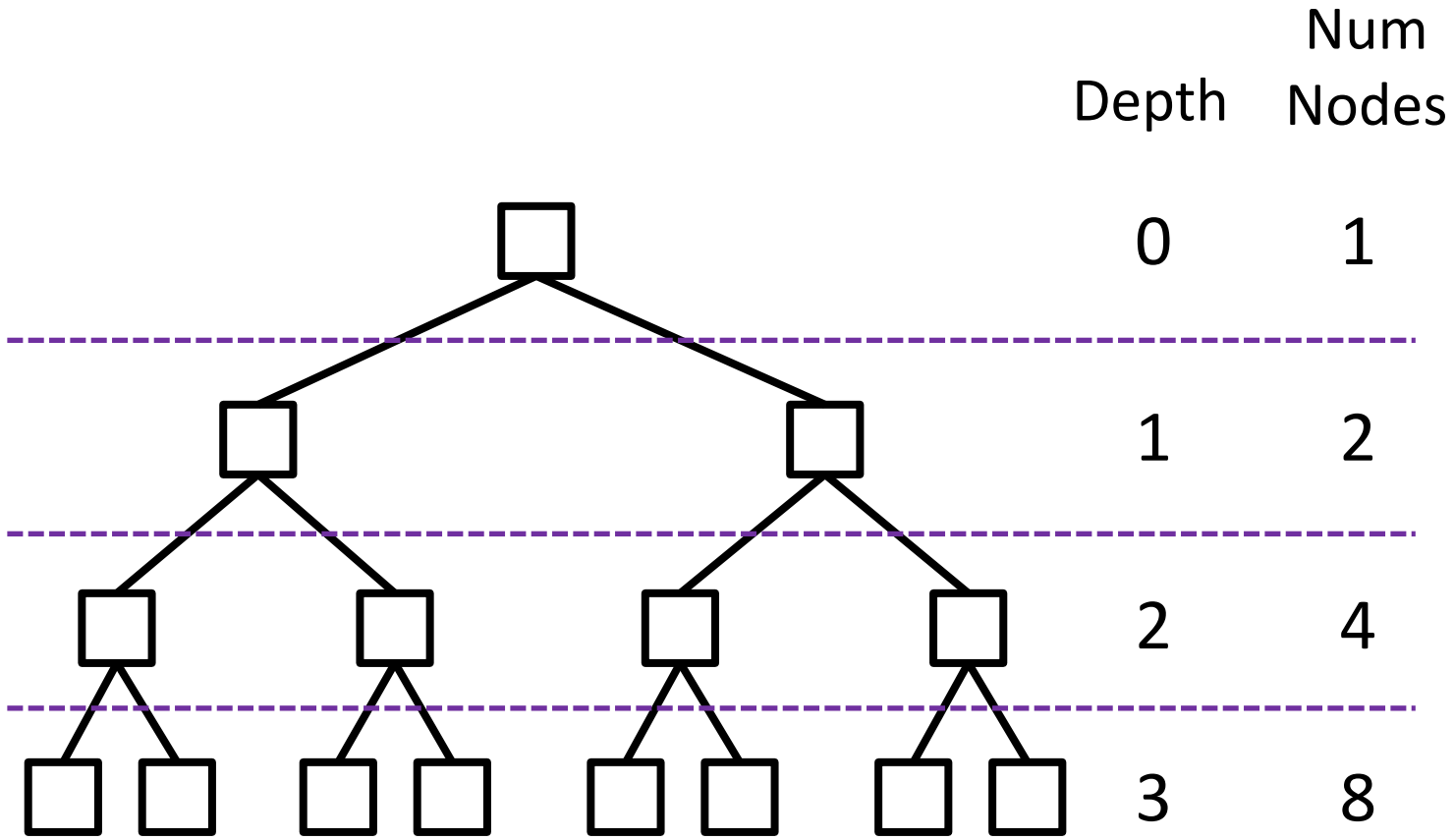

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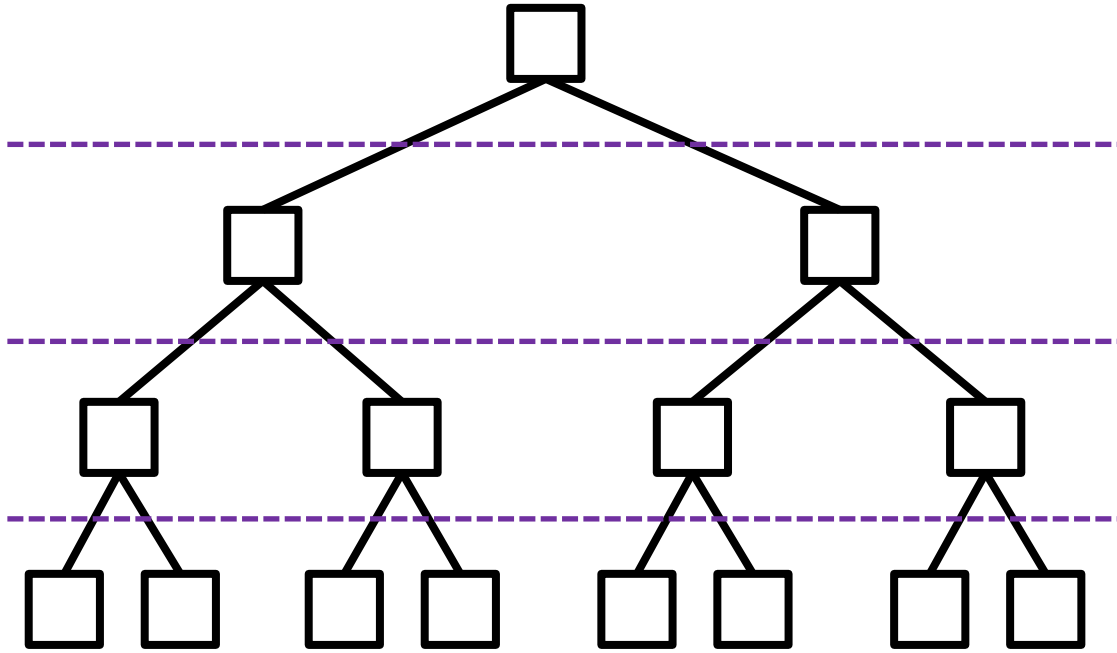
In general, at depth d, there are at most $??$ nodes.



Depth	Num Nodes
0	1
1	2
2	4
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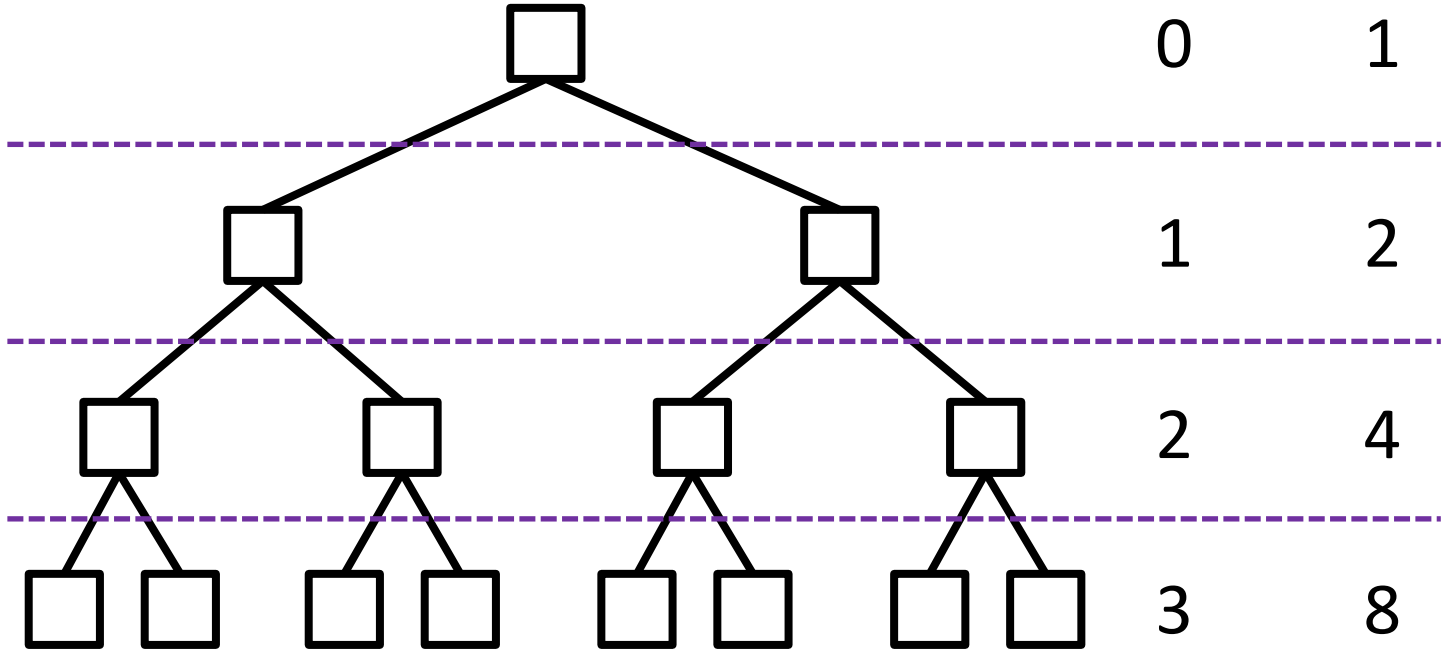
What is the point? Why use a BST?

In general, at depth d, there are at most 2^d nodes.



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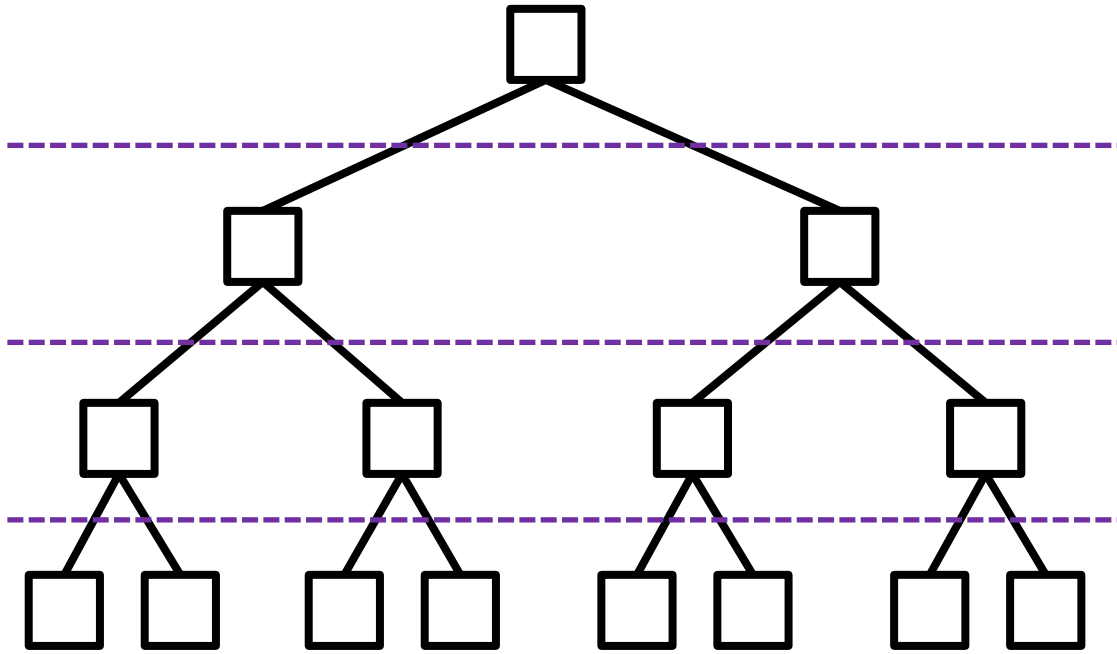

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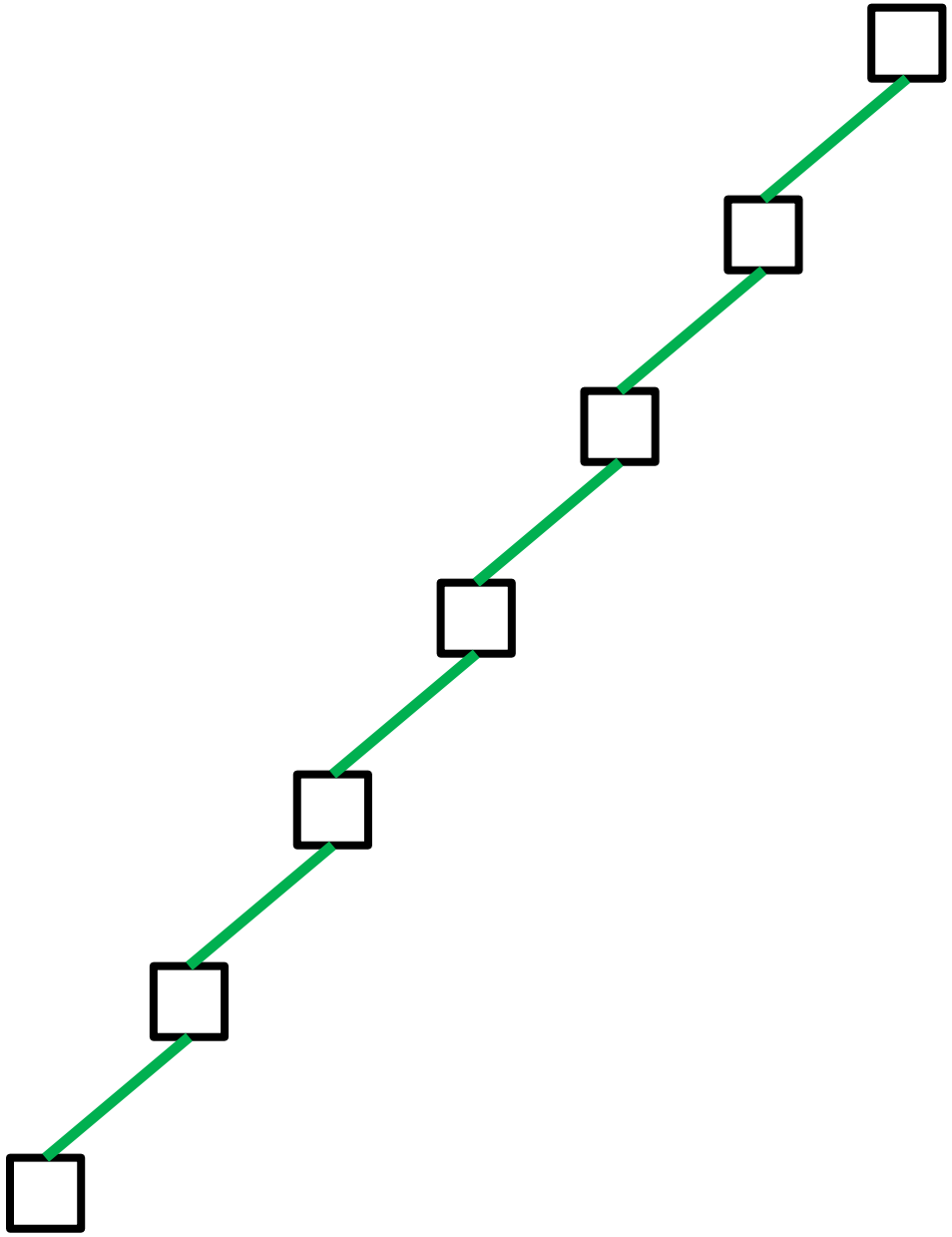

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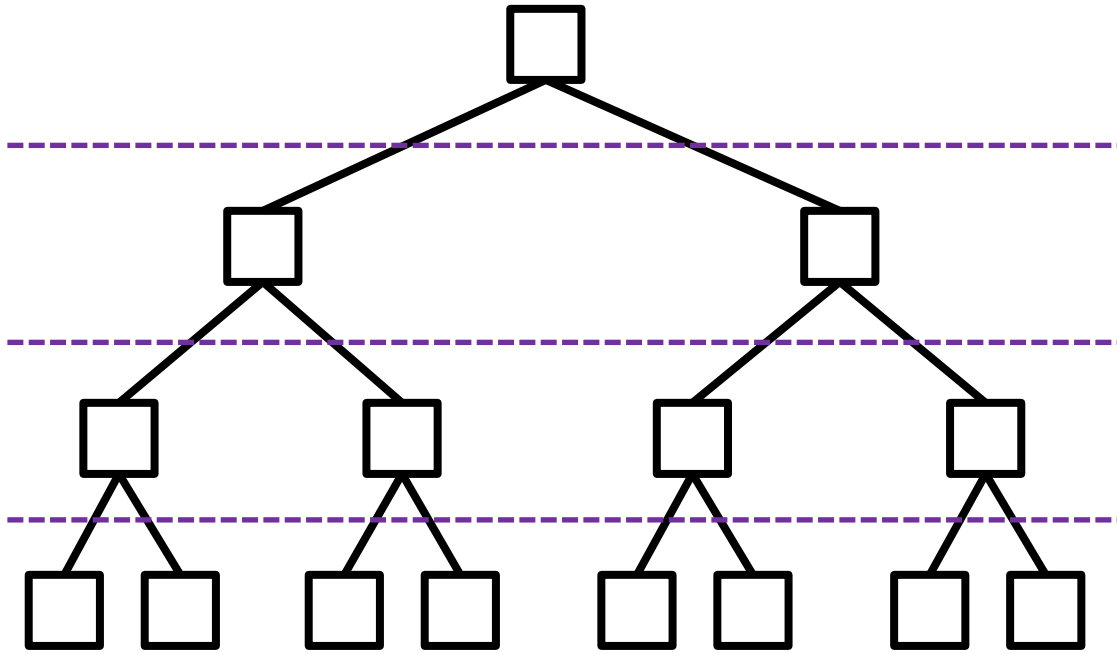

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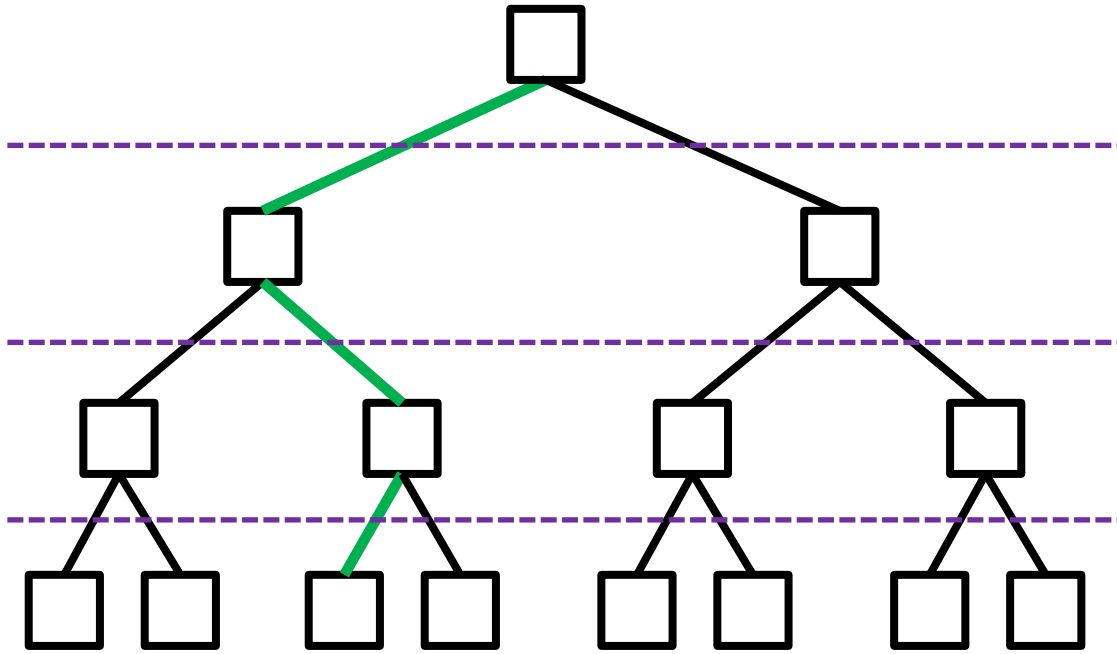

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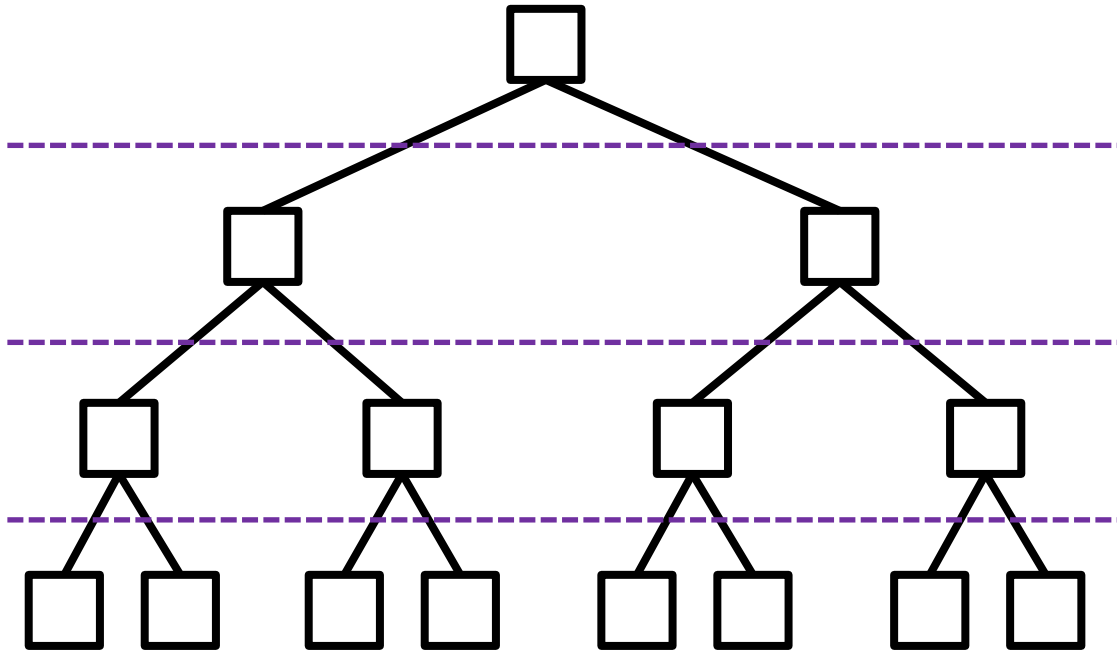

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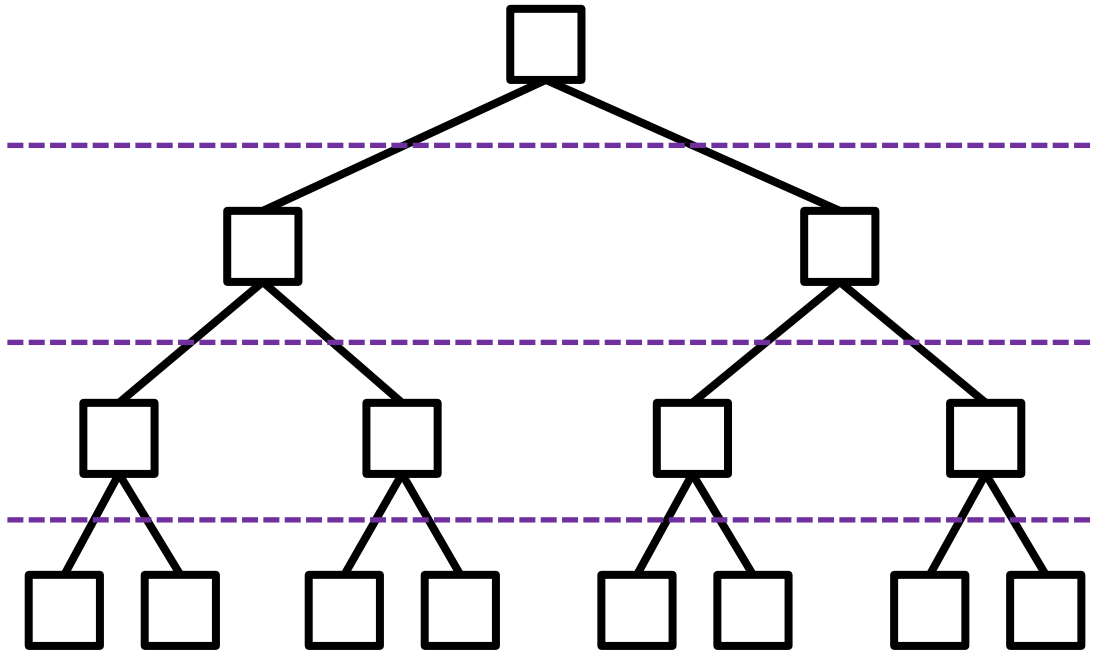

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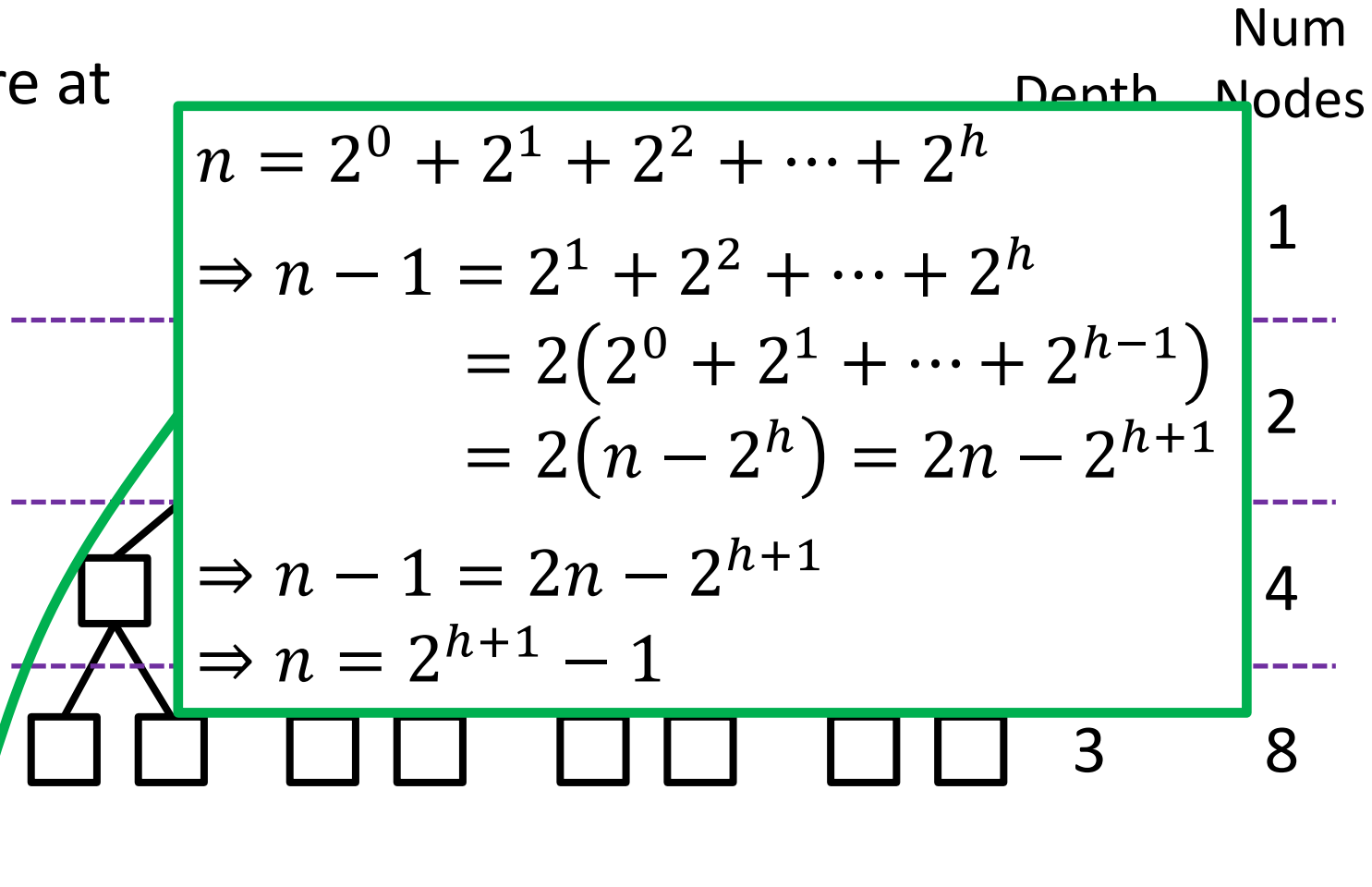

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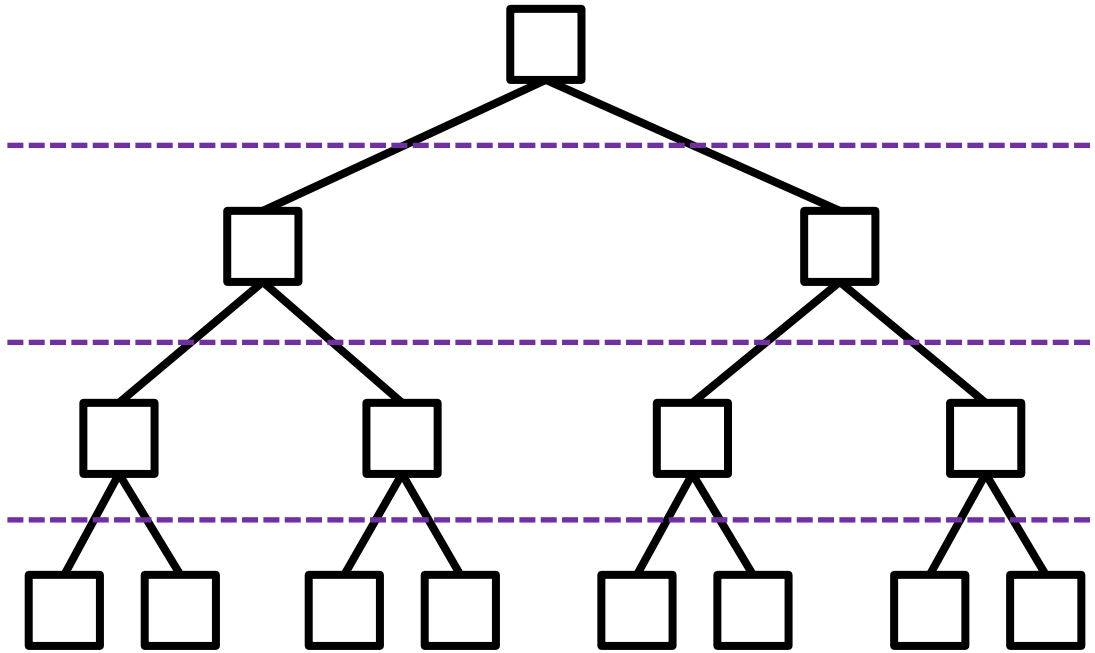

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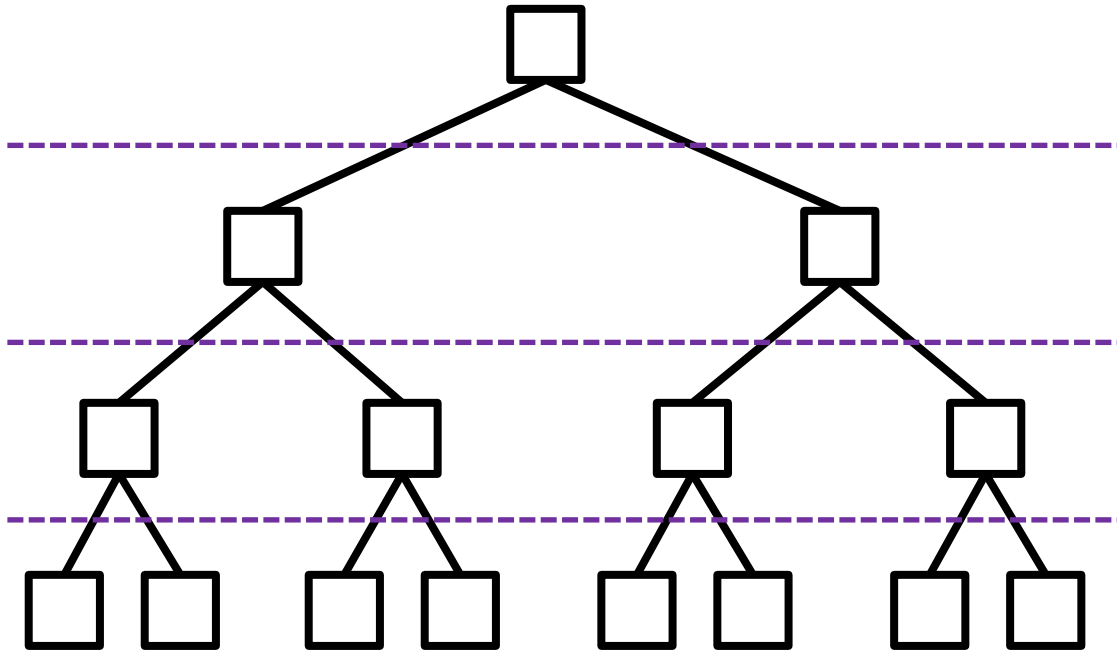

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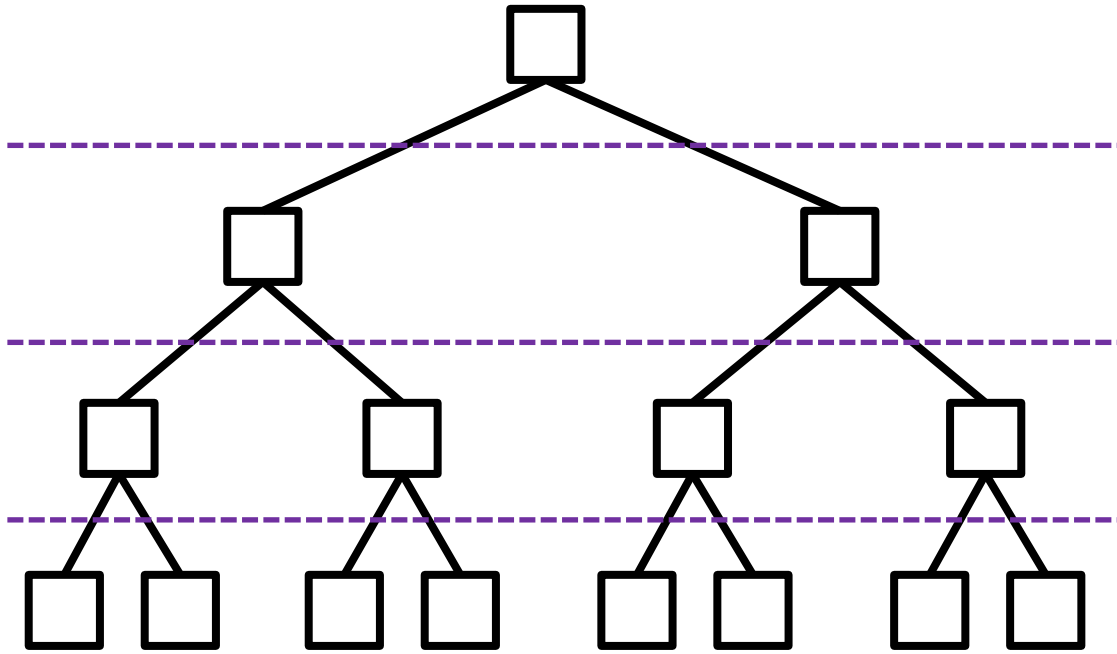

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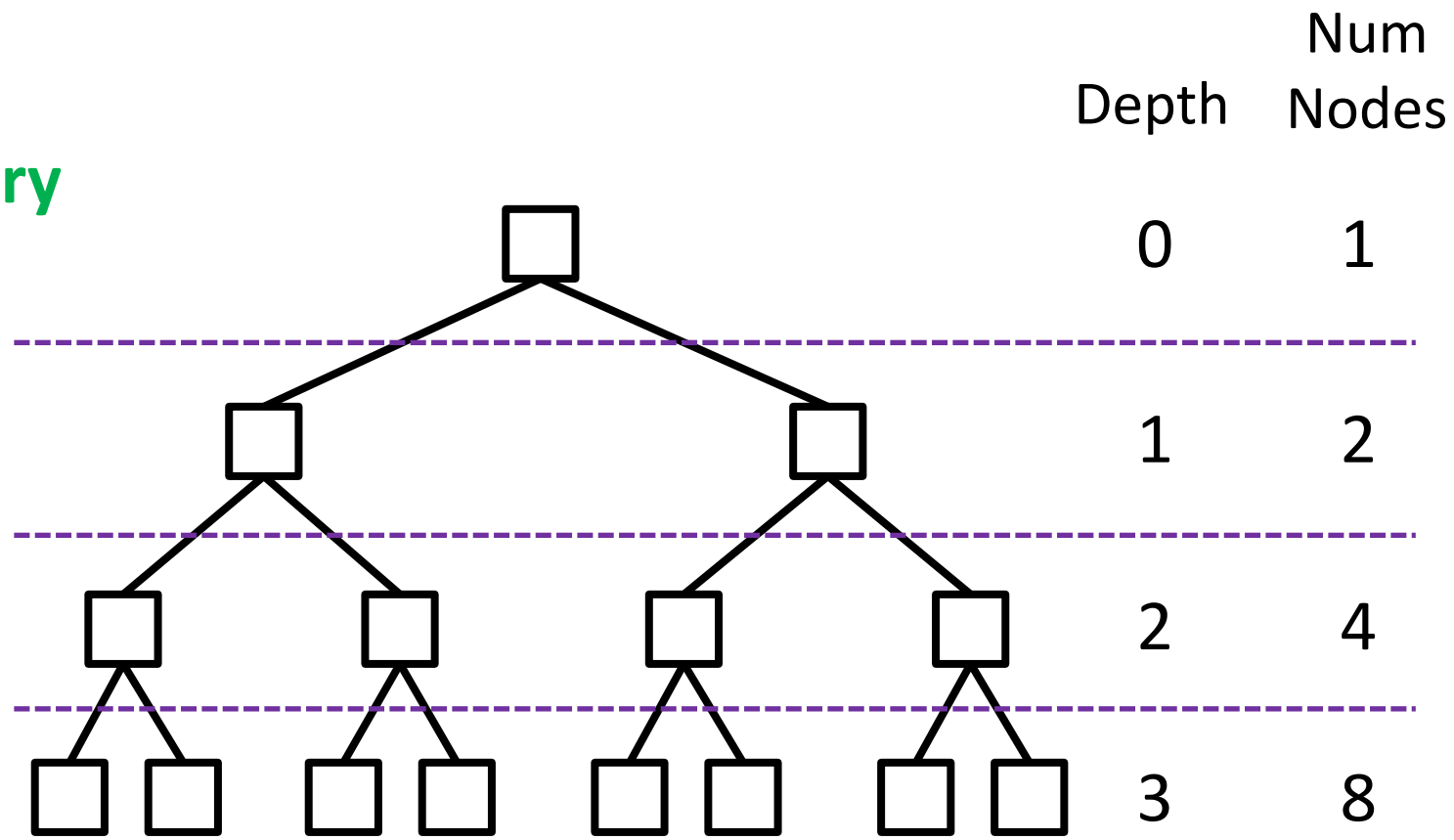
This means we can access any node in a specific type of binary tree in $\log n$ time.



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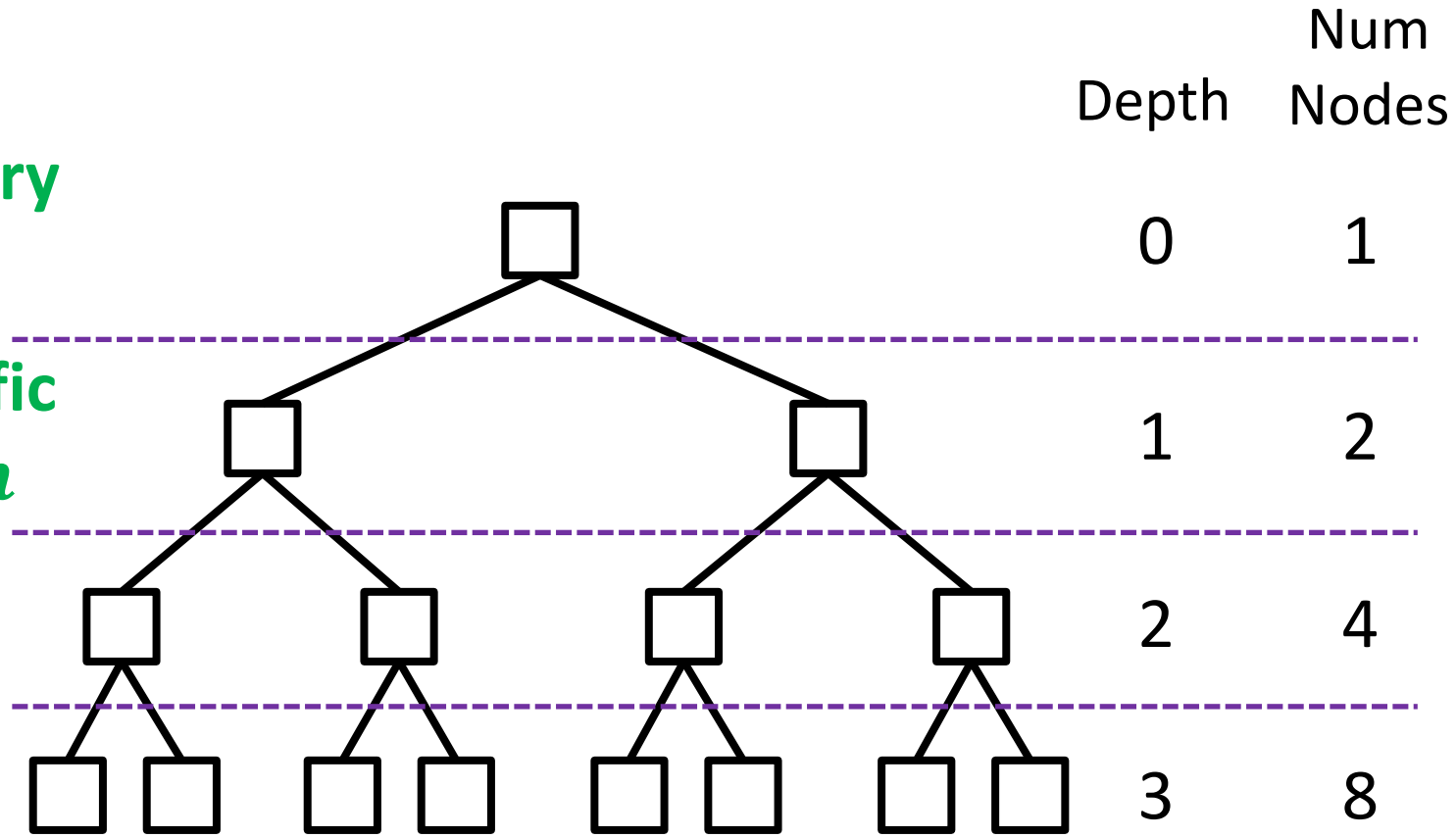

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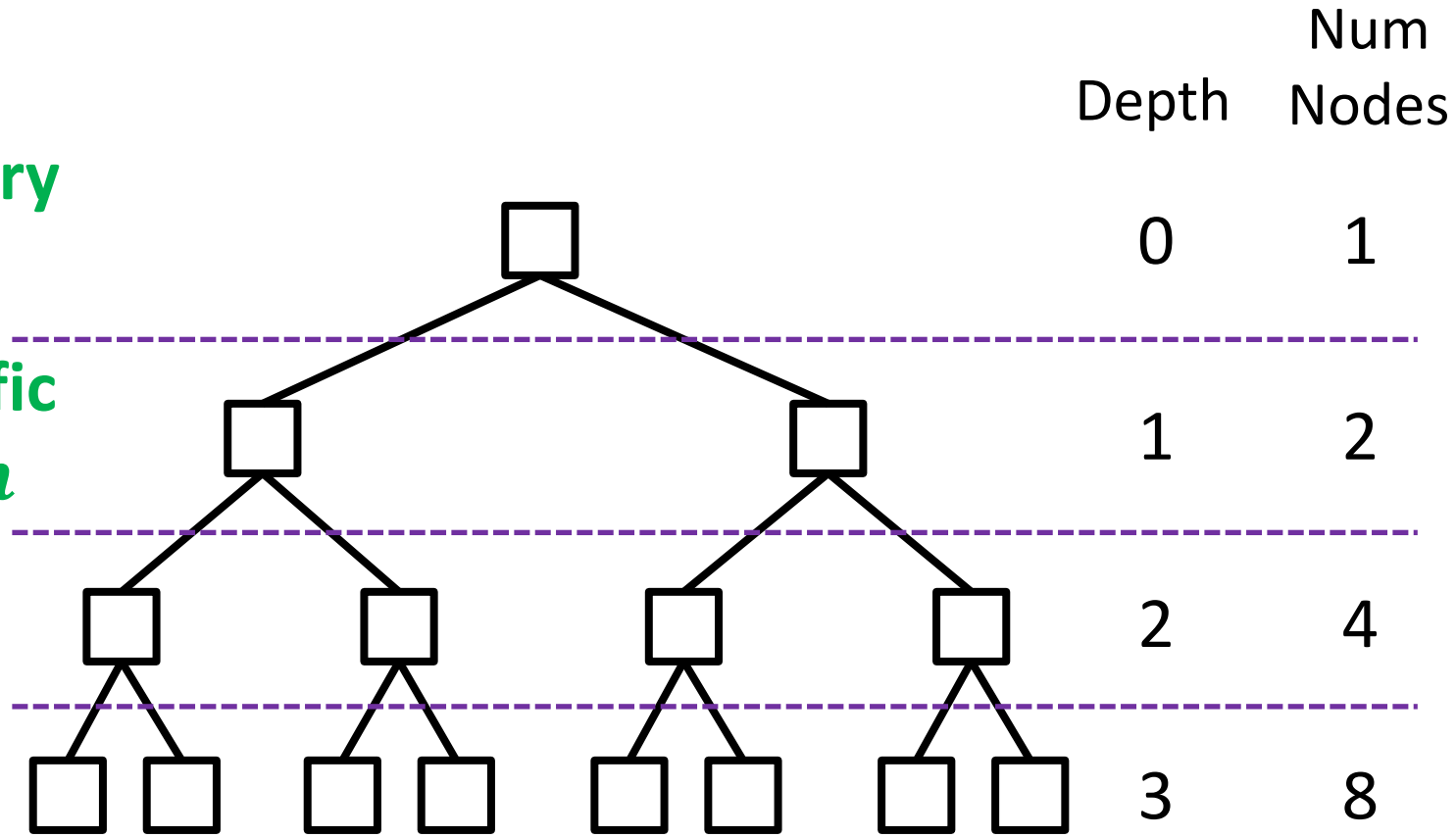

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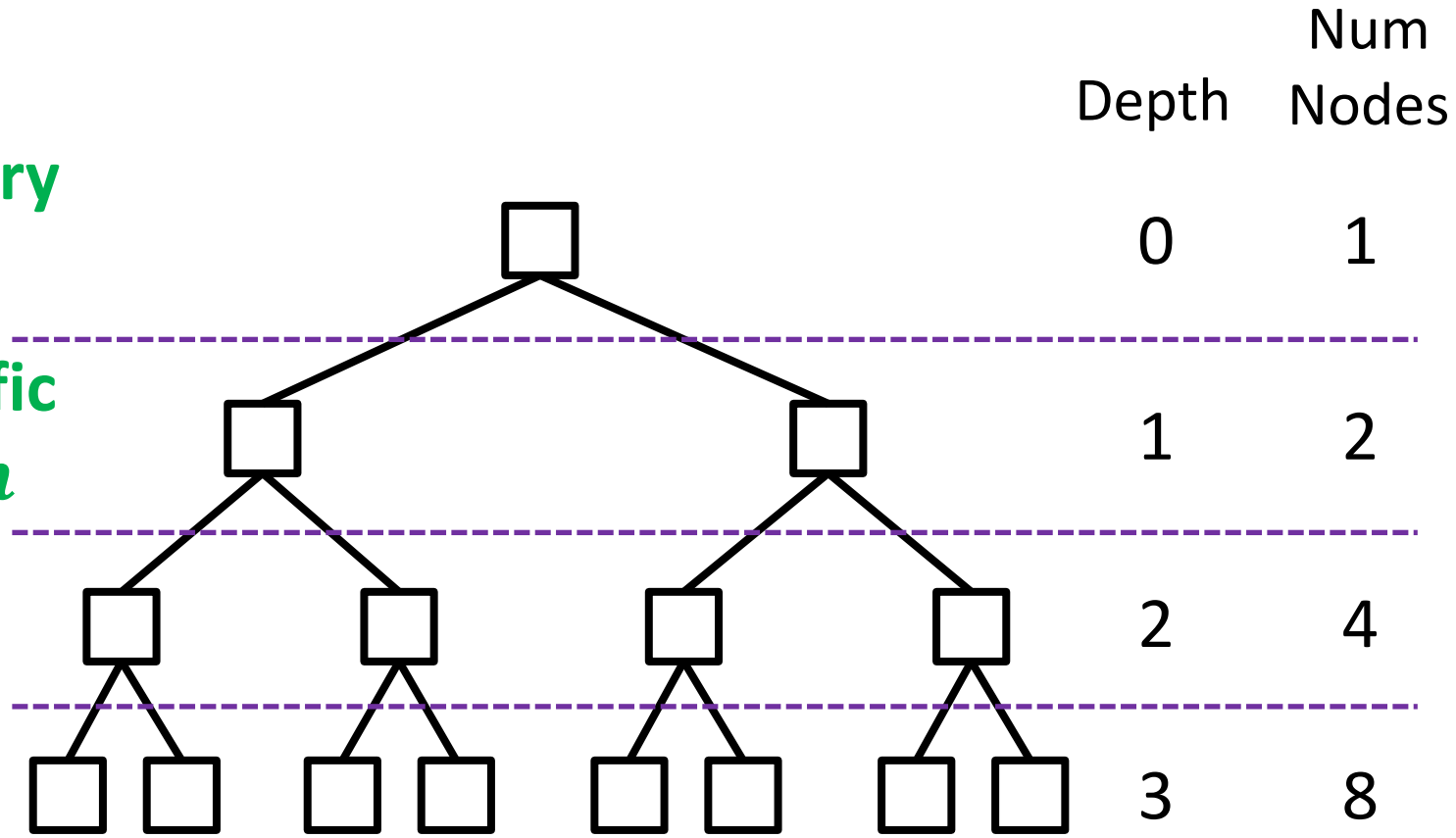


Perhaps managing a BST is more efficient than managing an array.

Binary Search Tree - Insertion

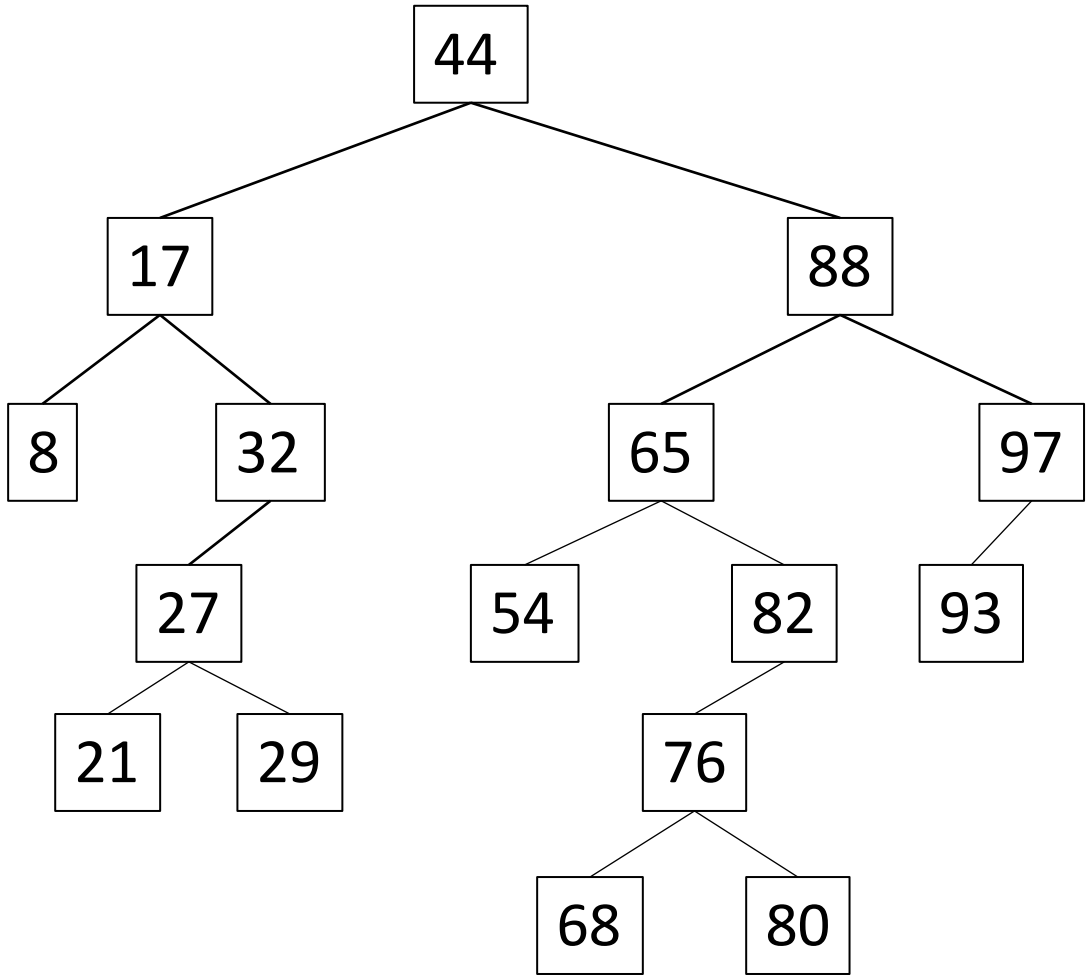
```
public class Node {

    private int value;
    private Node left;
    private Node right;
    private Node parent;

    public Node(int value) {
        this.value = value;
    }

    // getValue()
    // getLeft(), getRight()
    // getParent()

    // setLeft(), setRight()
    // setParent()
}
```



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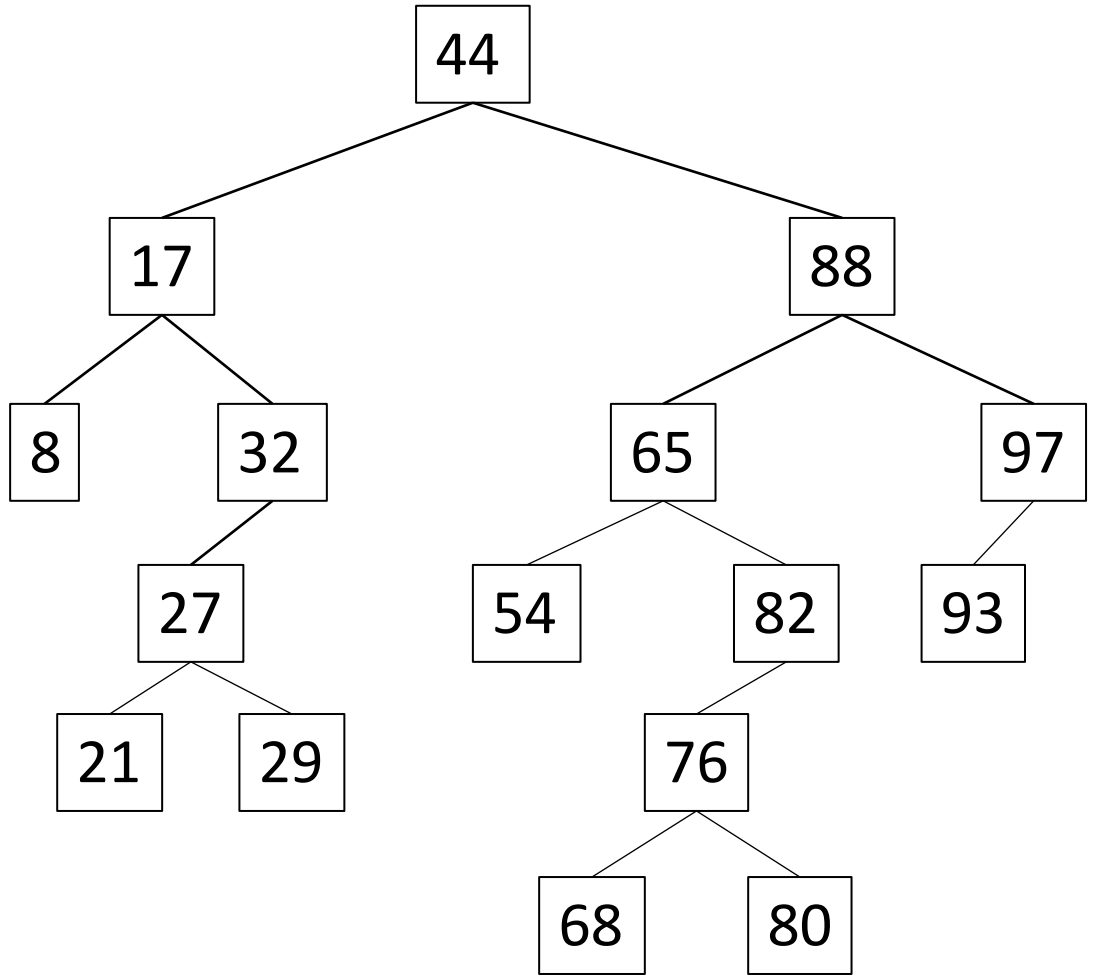

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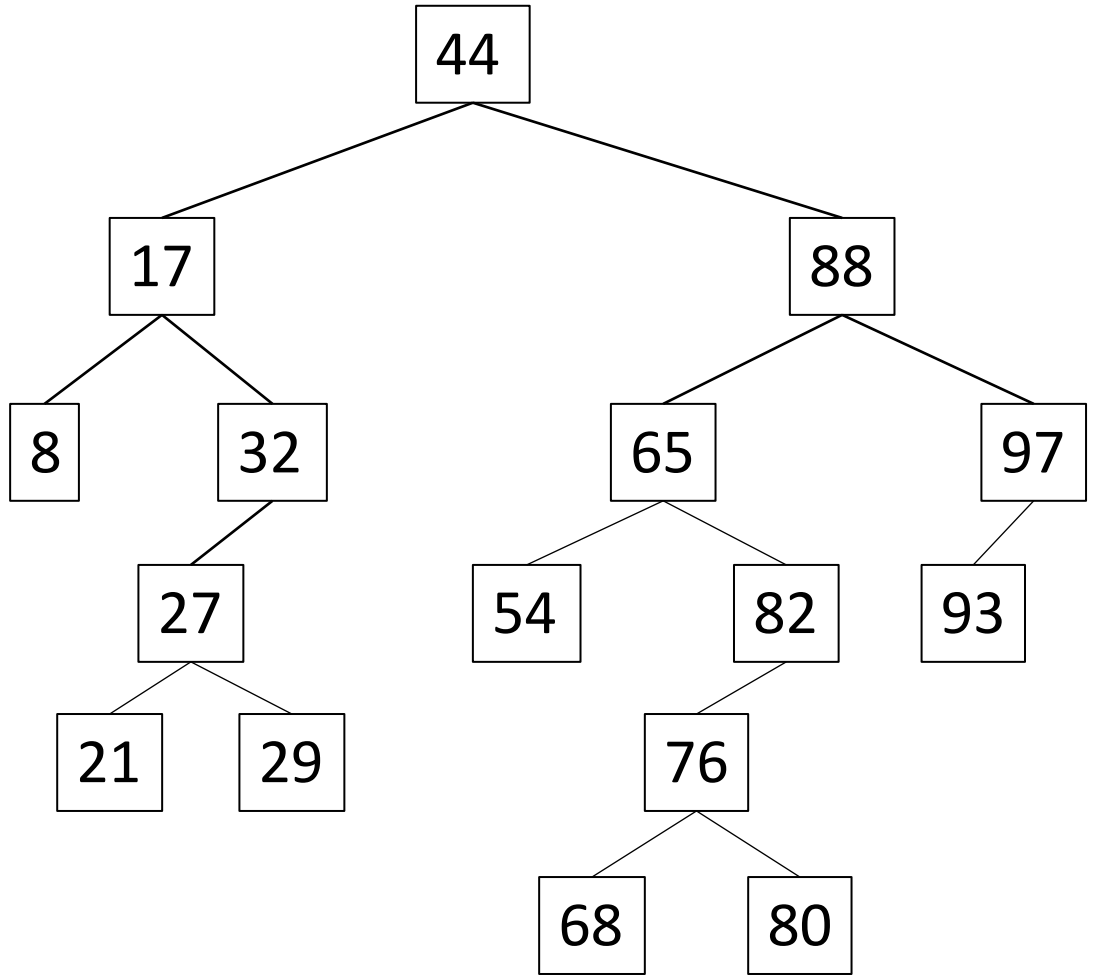
Step 2: Modify pointers.



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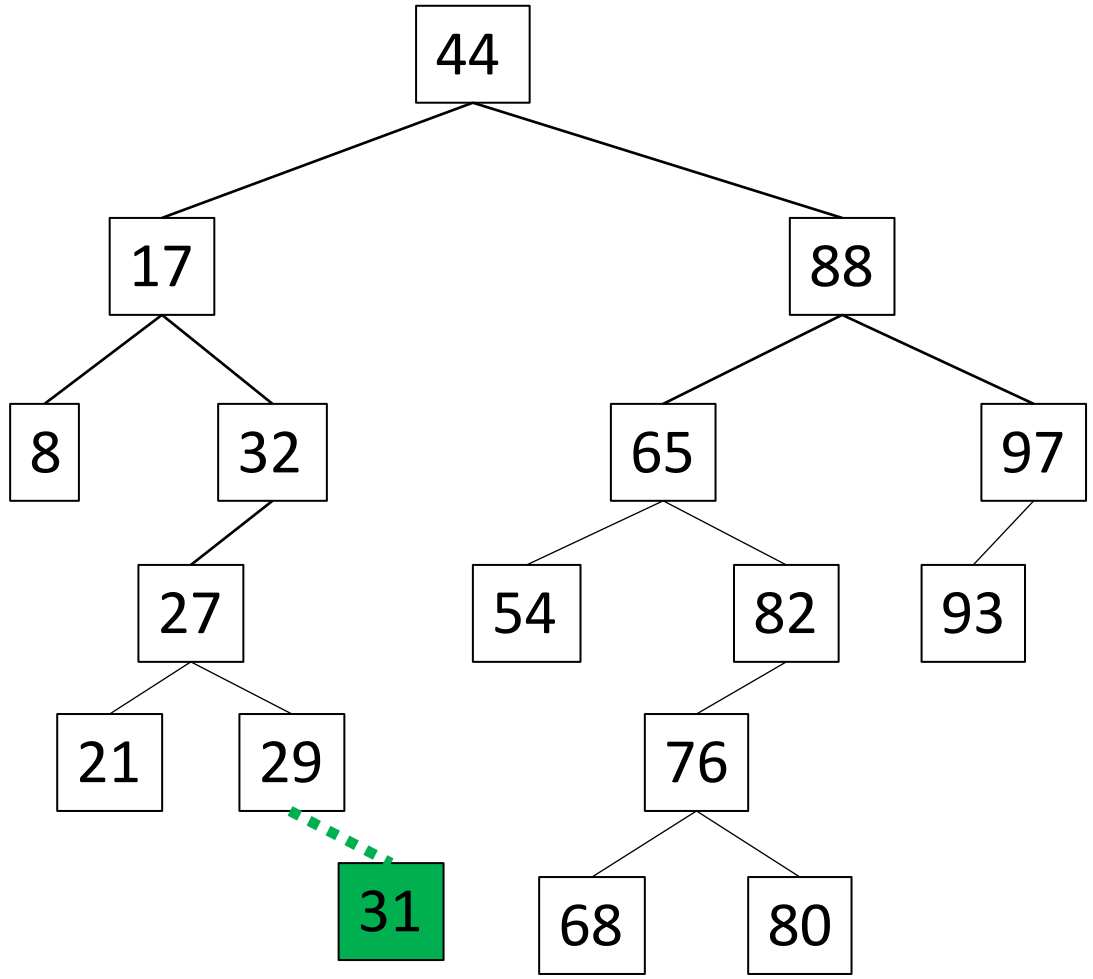
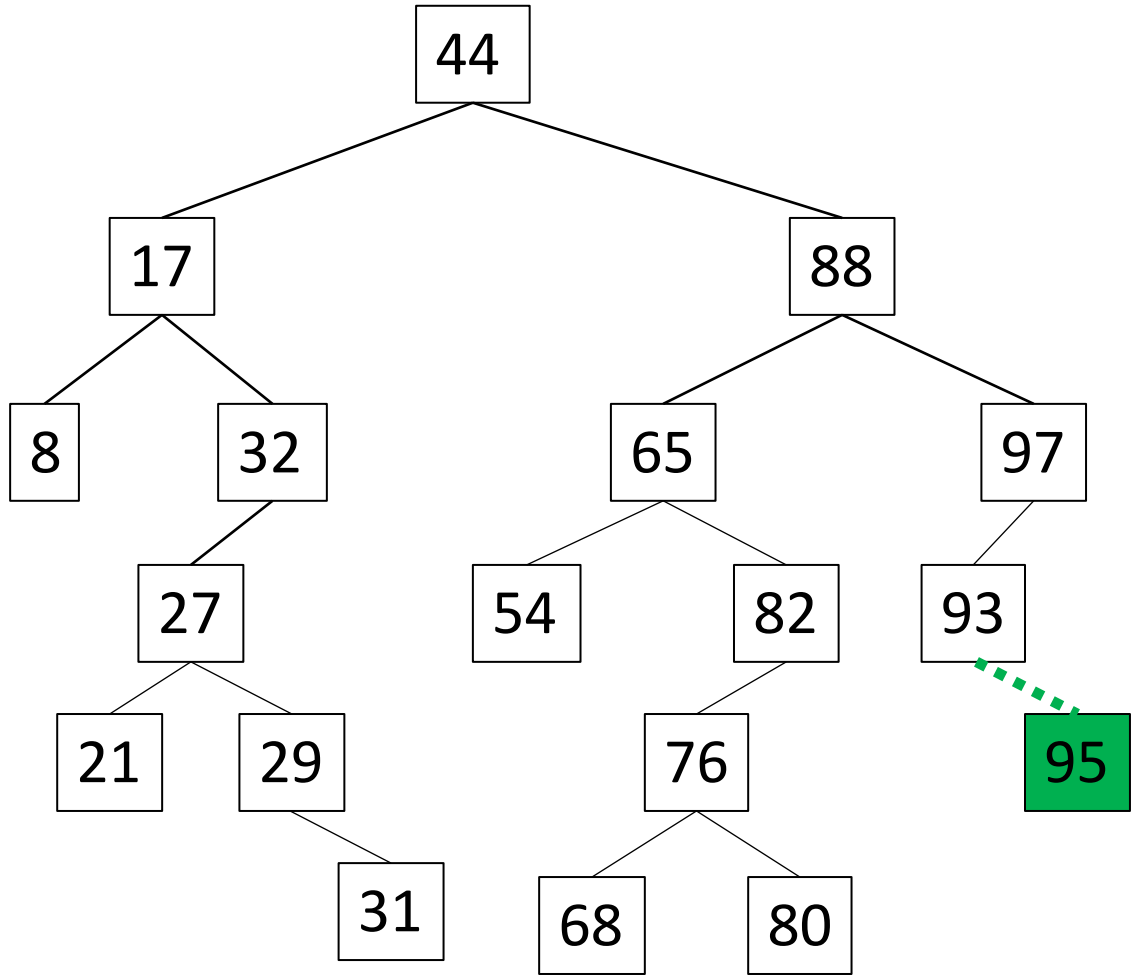


Binary Search Tree - Insertion

```
insert(95);
```

Step 1: Find where it should go.

Step 2: Modify pointers.



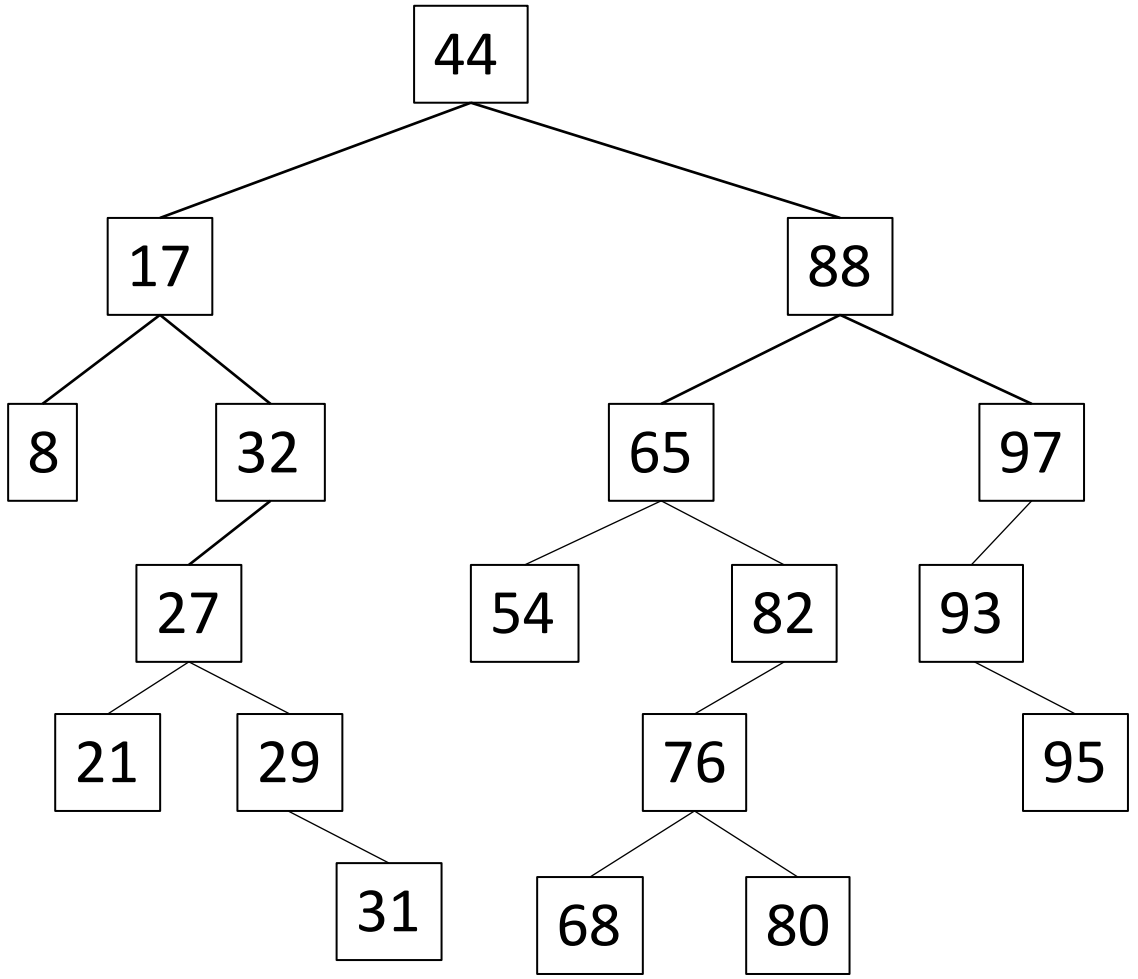
Binary Search Tree - Insertion

```
insert(95);
```

Step 1: Find where it should go.

Step 2: Modify pointers.

Any trends??



Binary Search Tree - Insertion

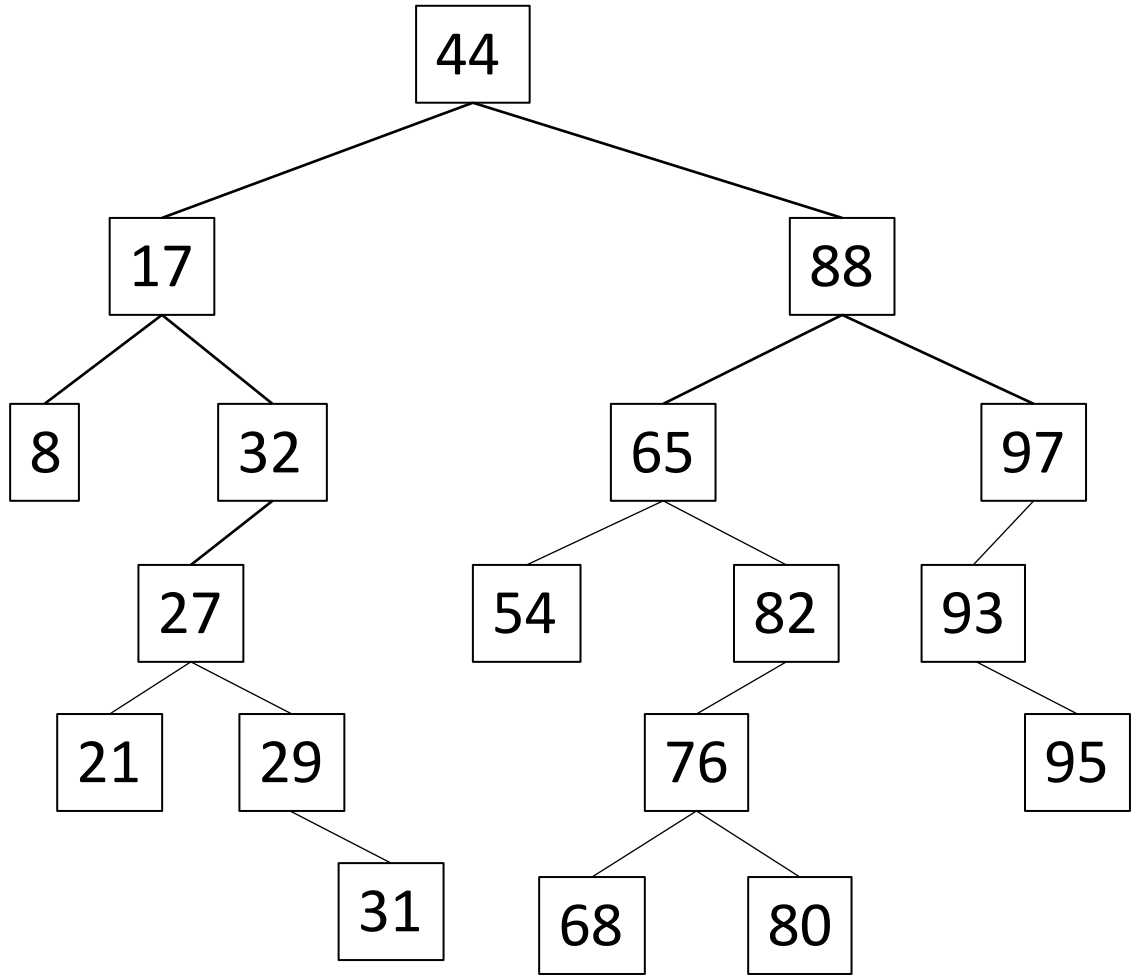
```
insert(95);
```

Step 1: Find where it should go.

Step 2: Modify pointers.

Any trends??

Always insert a new leaf!

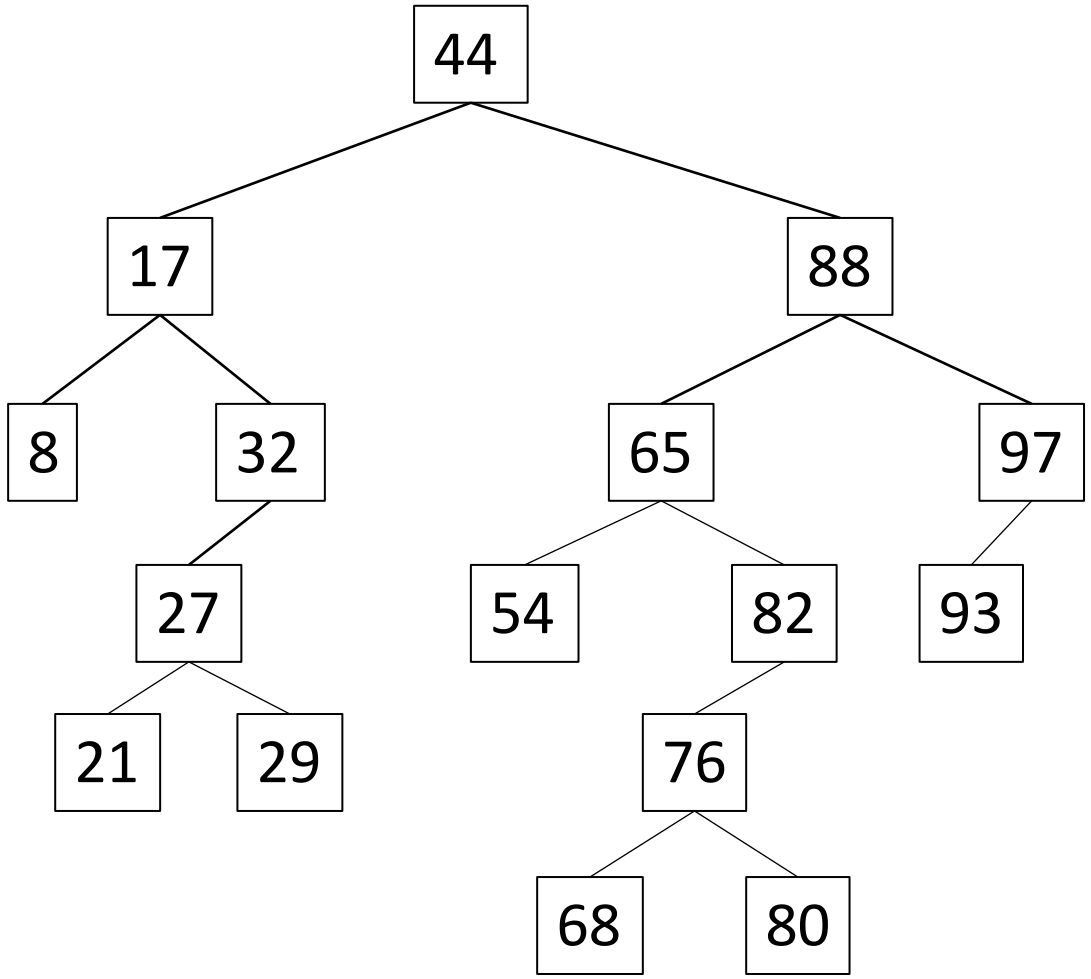


Binary Search Tree - Insertion

```
insert(28);
```

```
public void insert(int newValue) {

}
```



Binary Search Tree - Insertion

```
insert(28);
```

```
public void insert(int newValue) {
  if (root == null) {

  } else {

}
```

Binary Search Tree - Insertion

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insert(28);
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```
public void insert(int newValue) {
  if (root == null) {
    root = new Node(newValue);
  } else {




}
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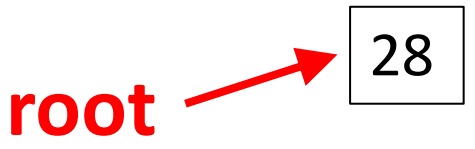

Binary Search Tree - Insertion

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public void insert(int newValue) {
  if (root == null) {
    root = new Node(newValue);
  } else {
    Node currentNode = root;
```

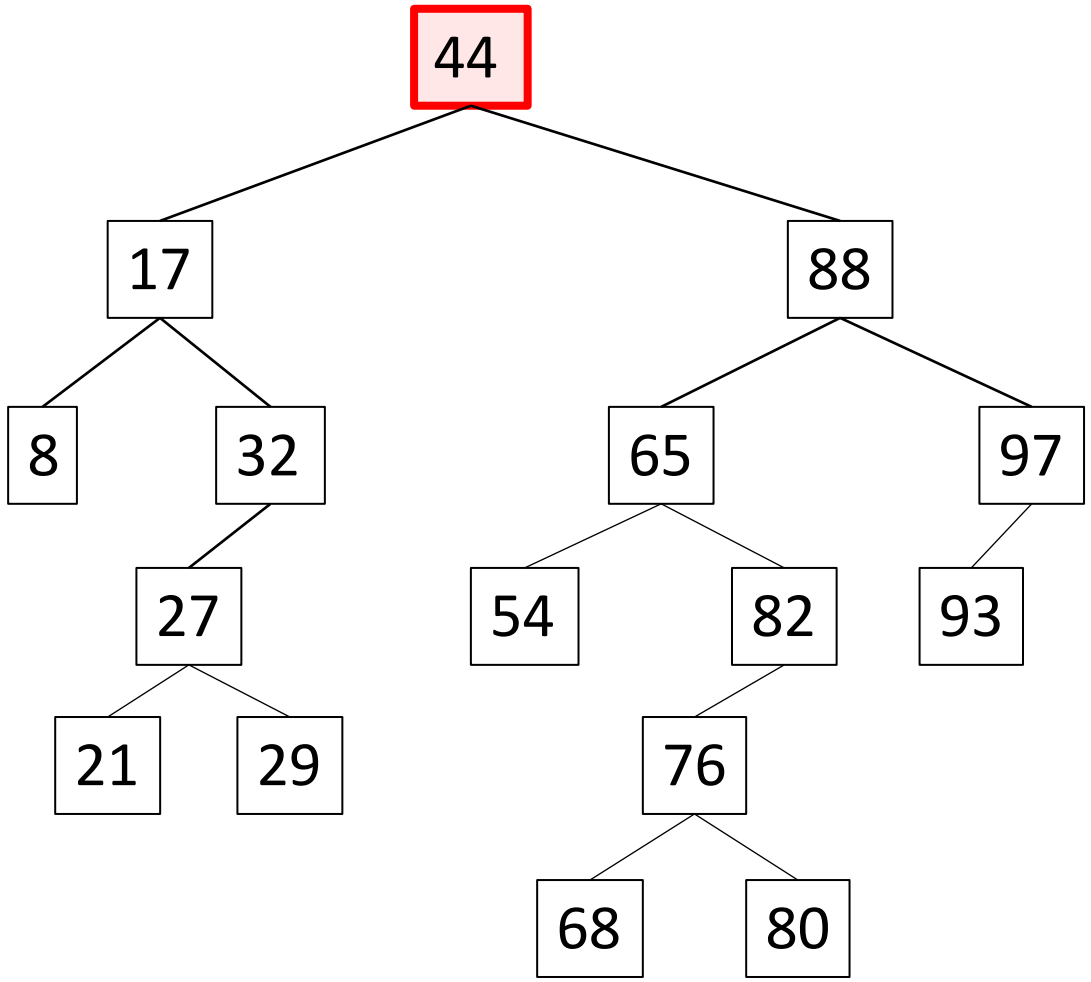


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}
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Binary Search Tree - Insertion

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```
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  if (root == null) {
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  } else {
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    boolean placed = false;




}
```

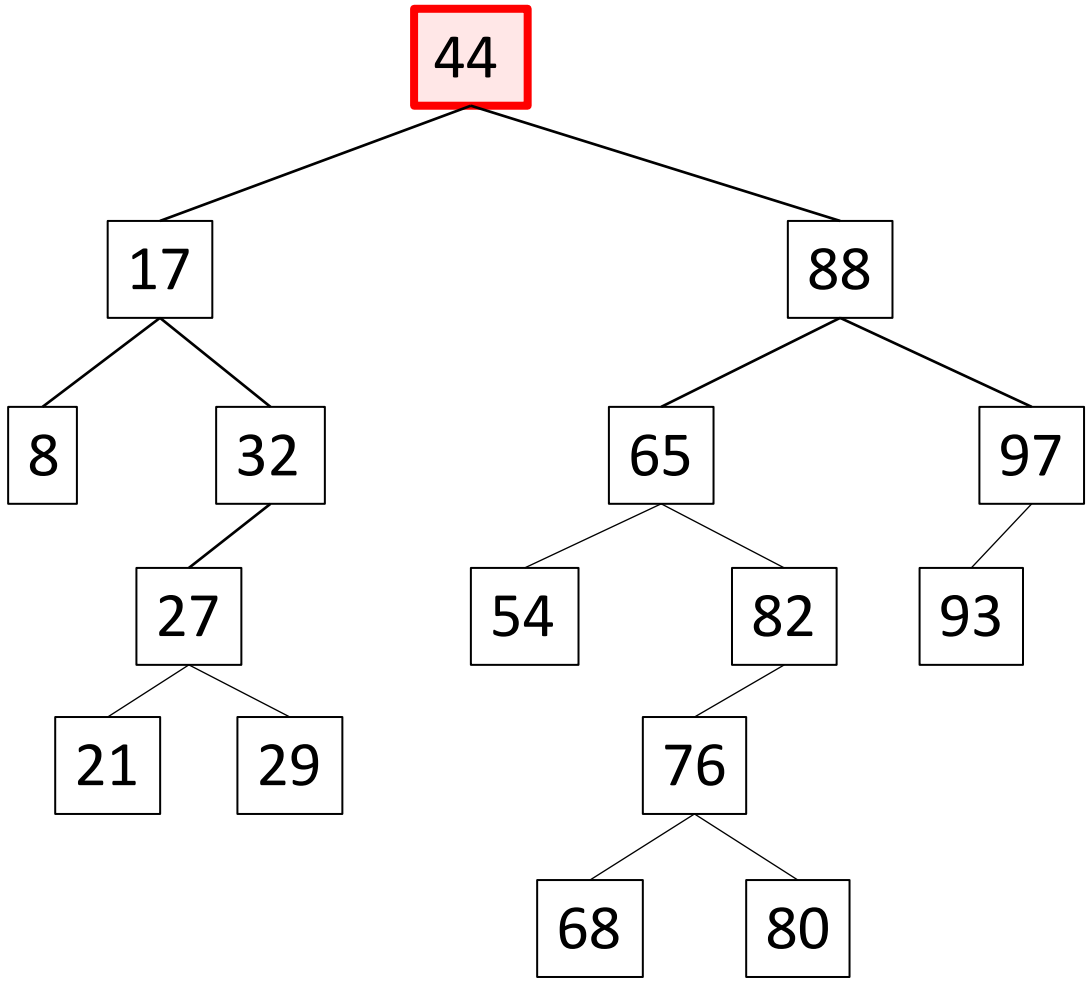

Binary Search Tree - Insertion

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```
public void insert(int newValue) {
  if (root == null) {
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  } else {
    Node currentNode = root;
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    while (!placed) {




}
```

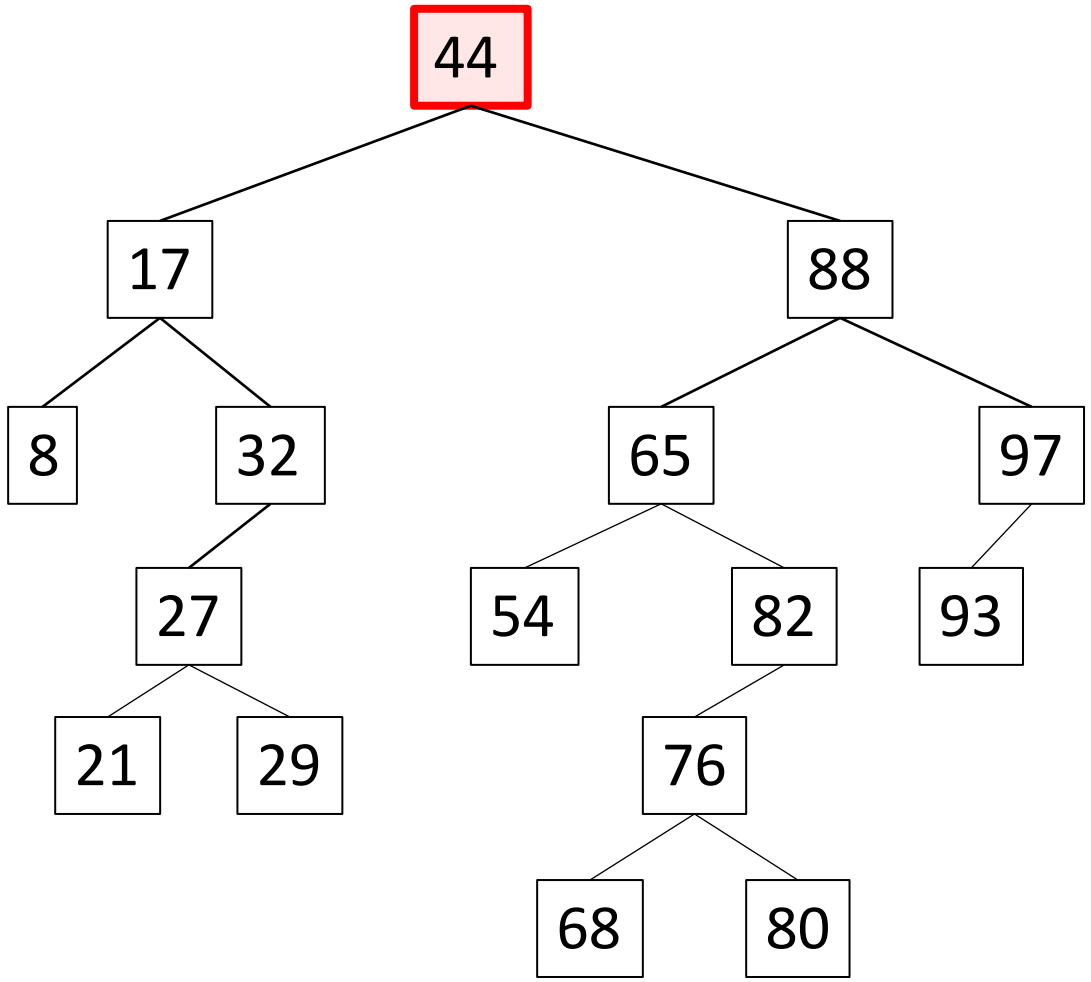

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  if (root == null) {
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    Node currentNode = root;
    boolean placed = false;
    while (!placed) {
      if (newValue < currentNode.getValue()) {









      } else {

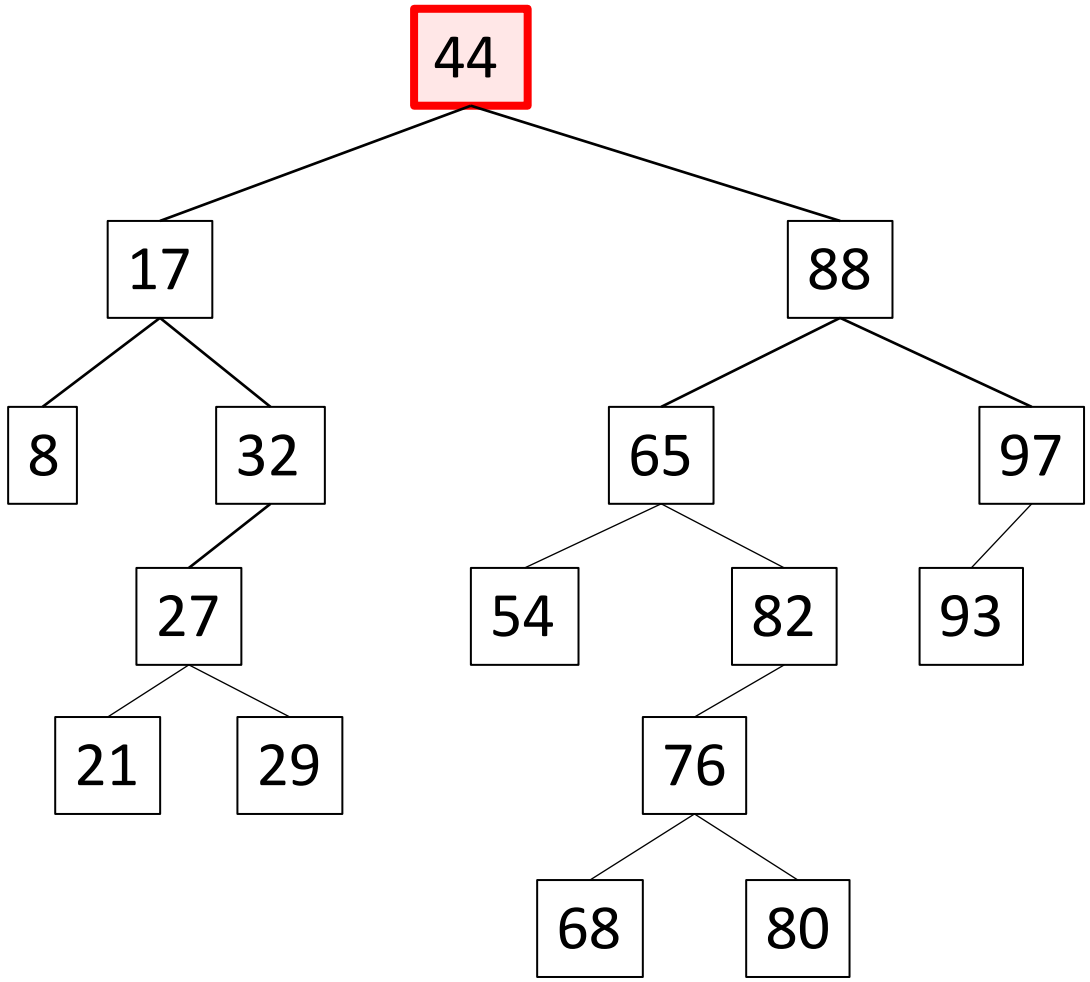








}
```



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        } else {




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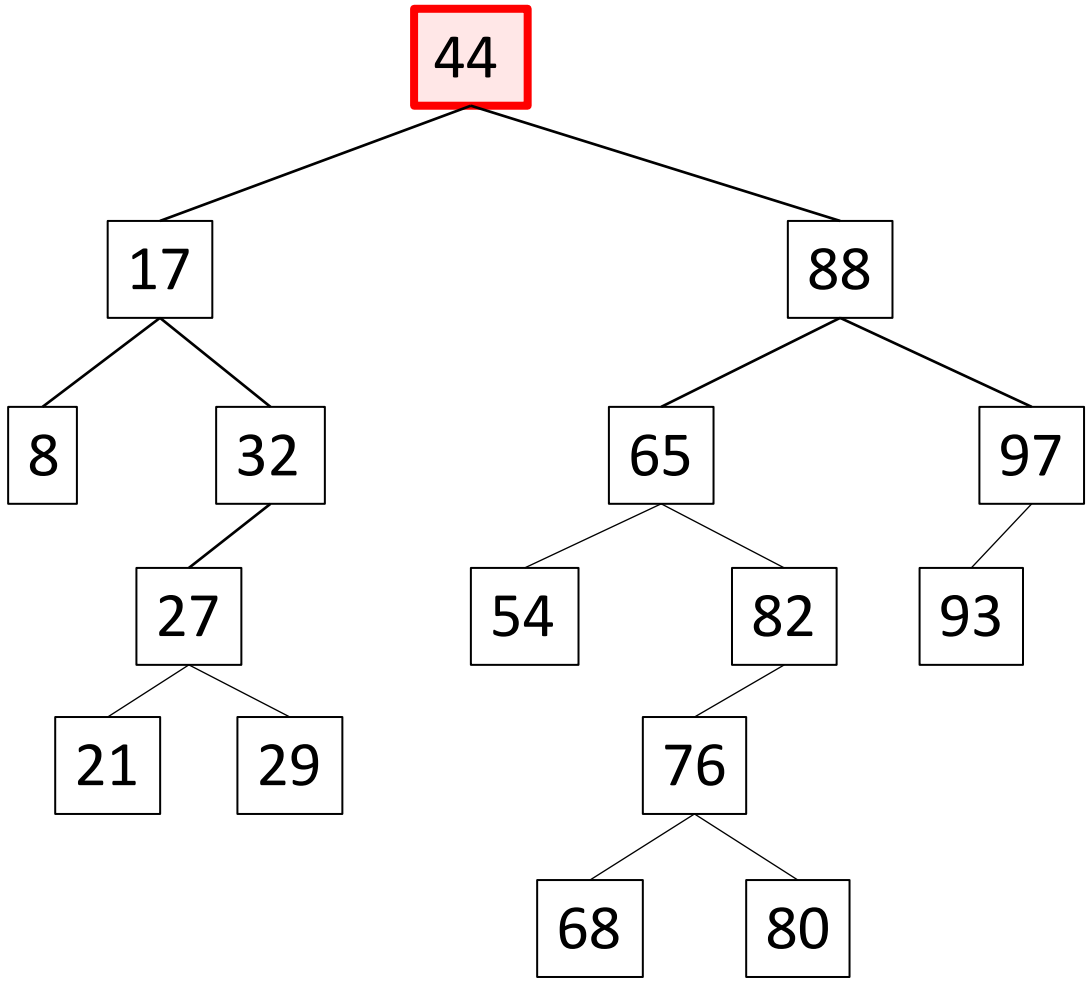

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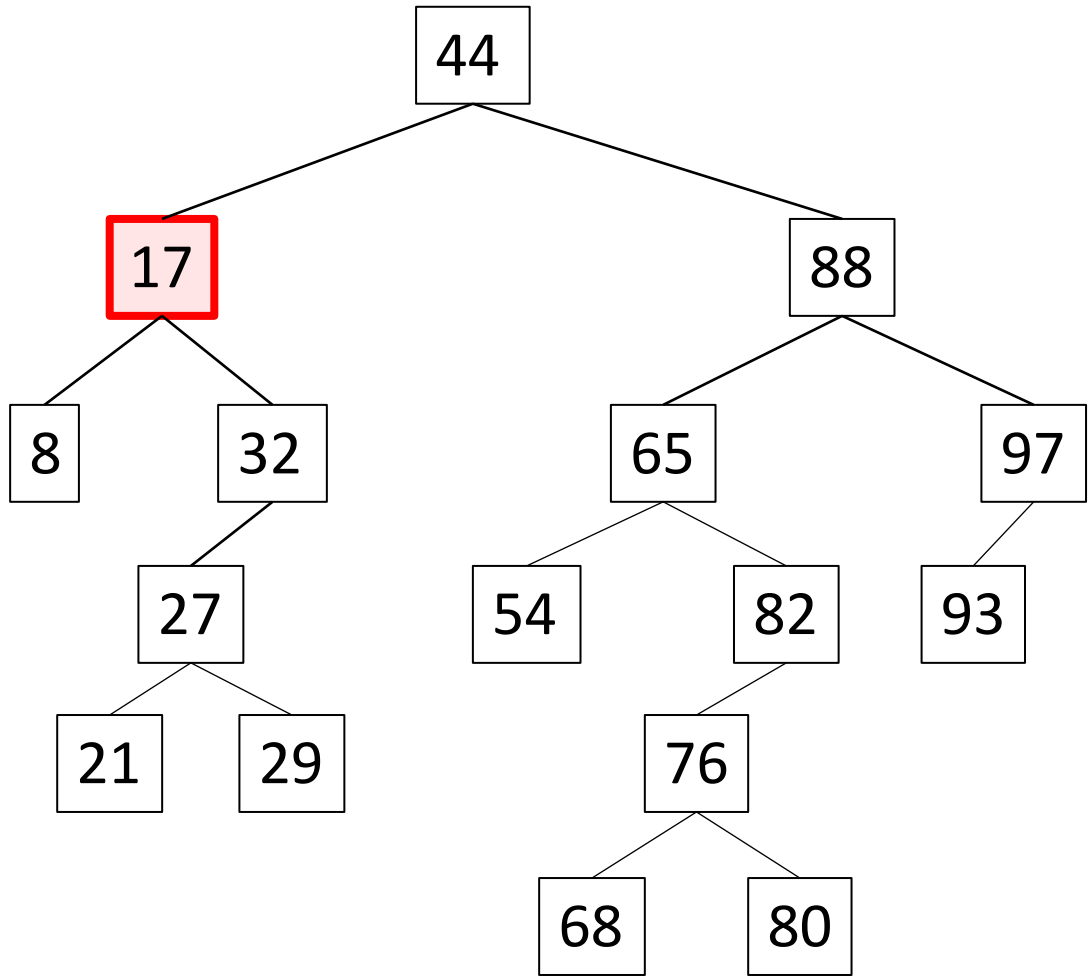

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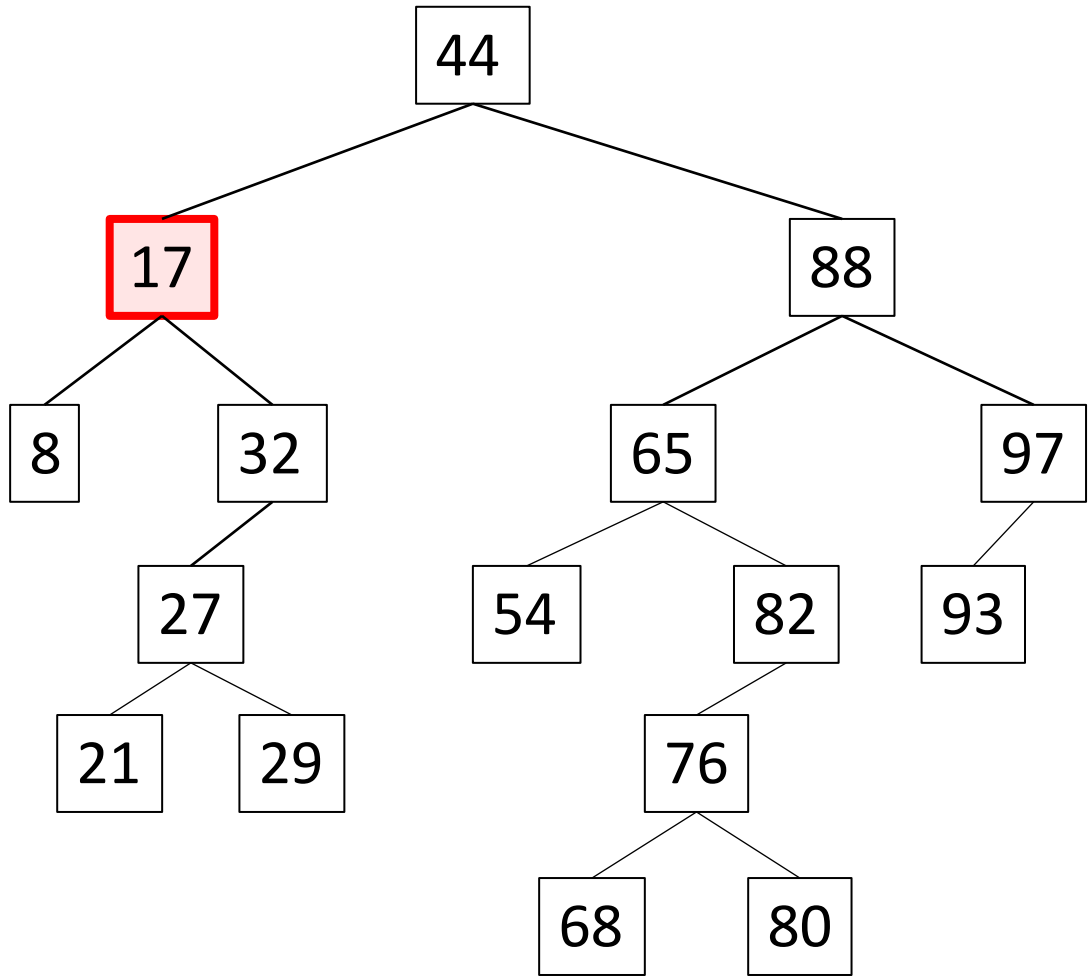

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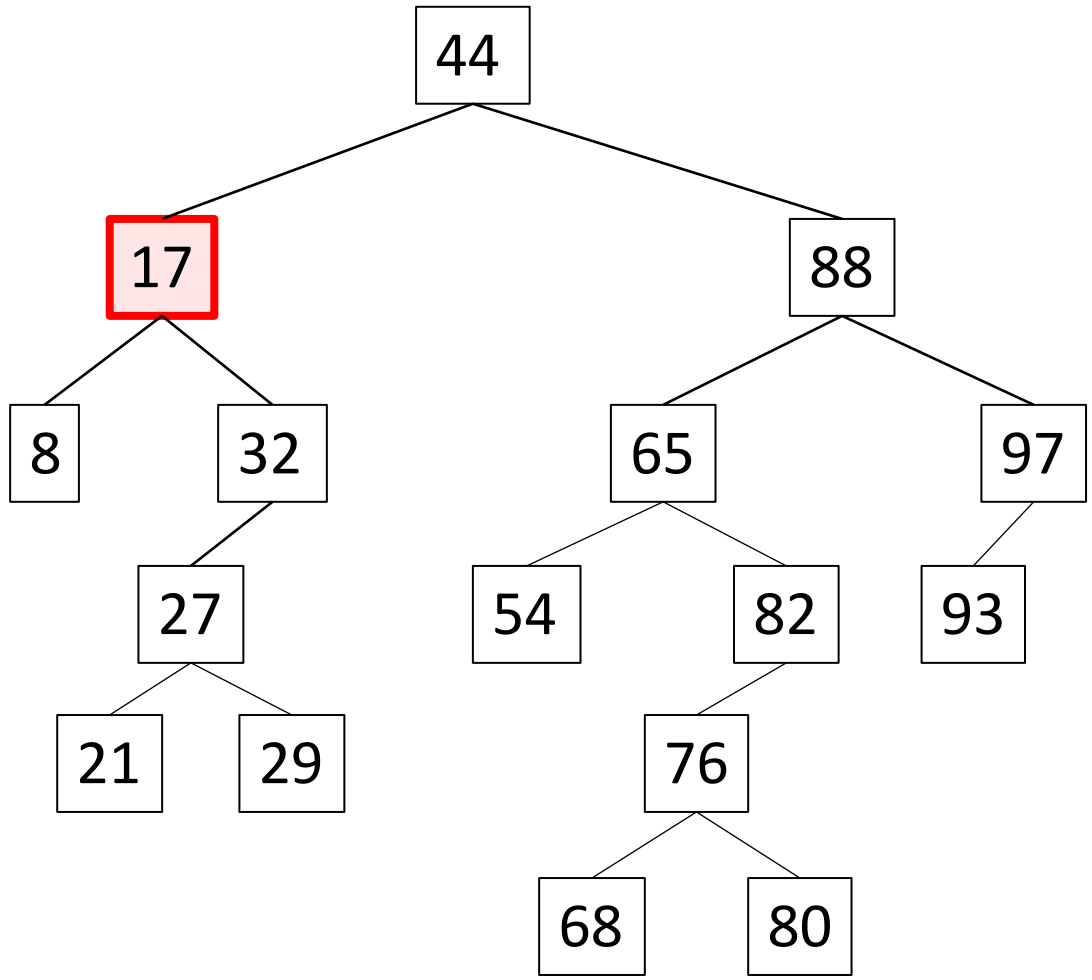

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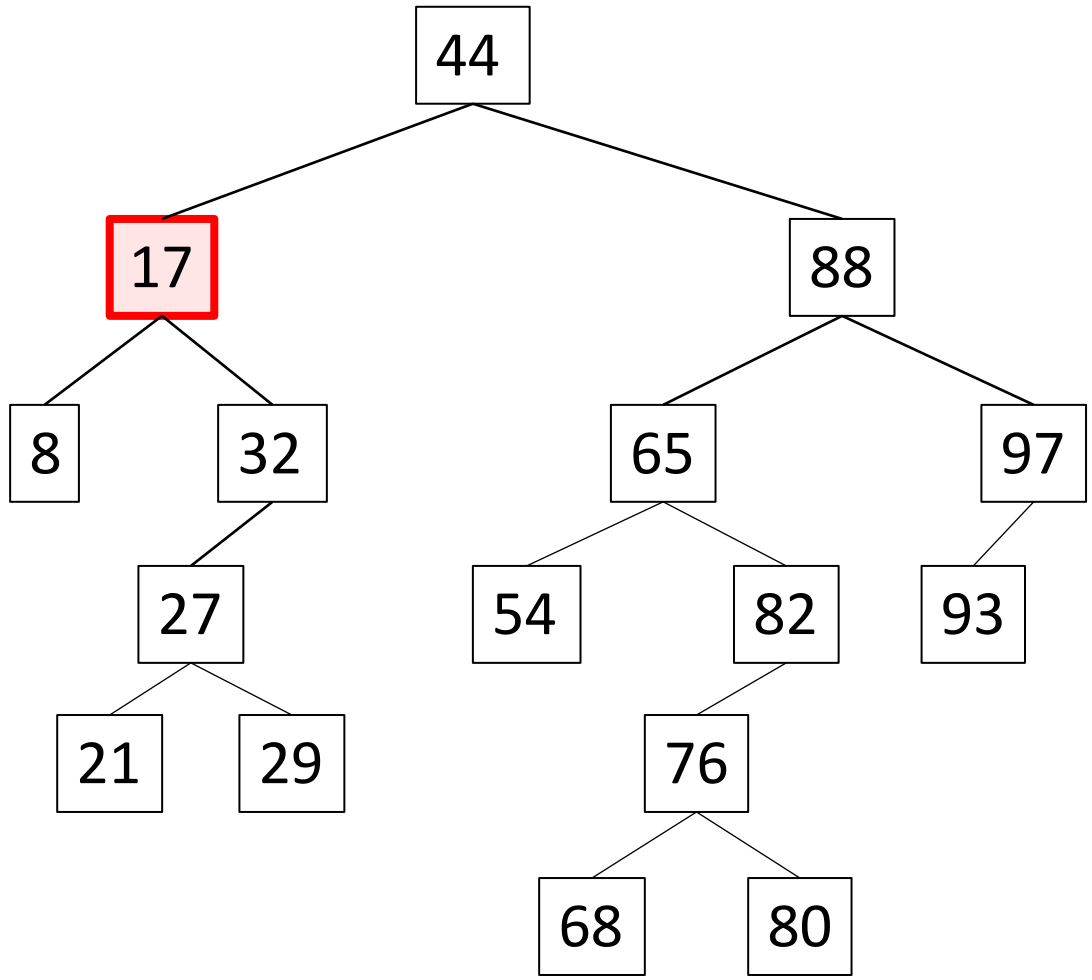

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        } else {



        }
      } else {
        if (currentNode.getRight() != null) {

        } else {



}
```

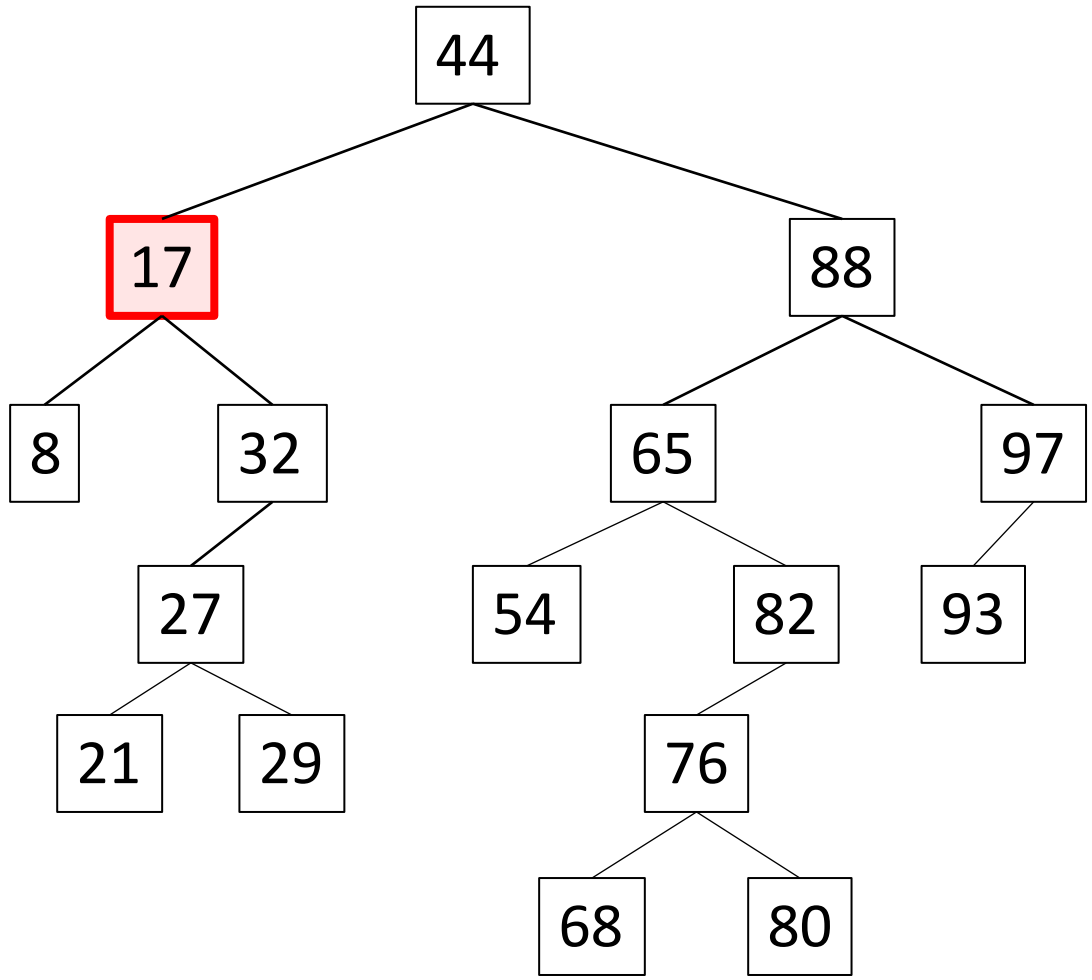

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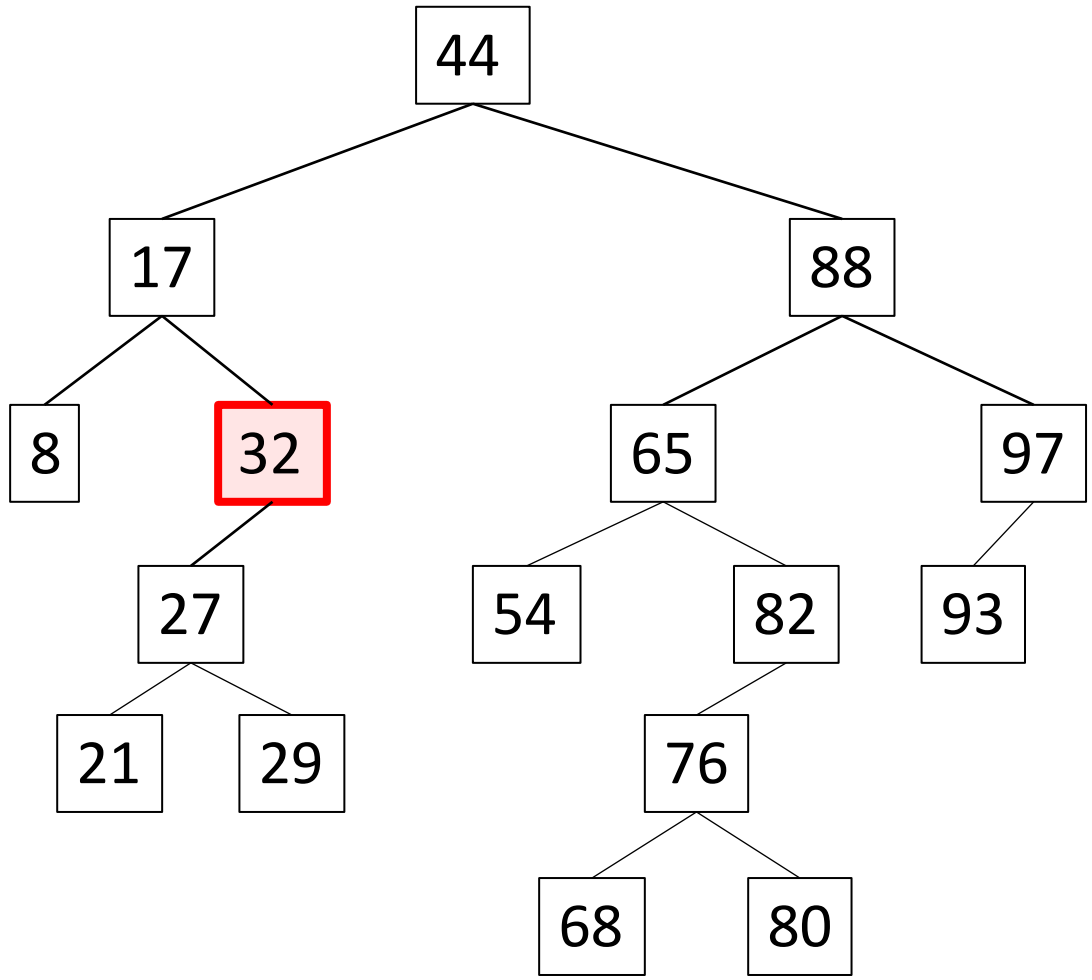

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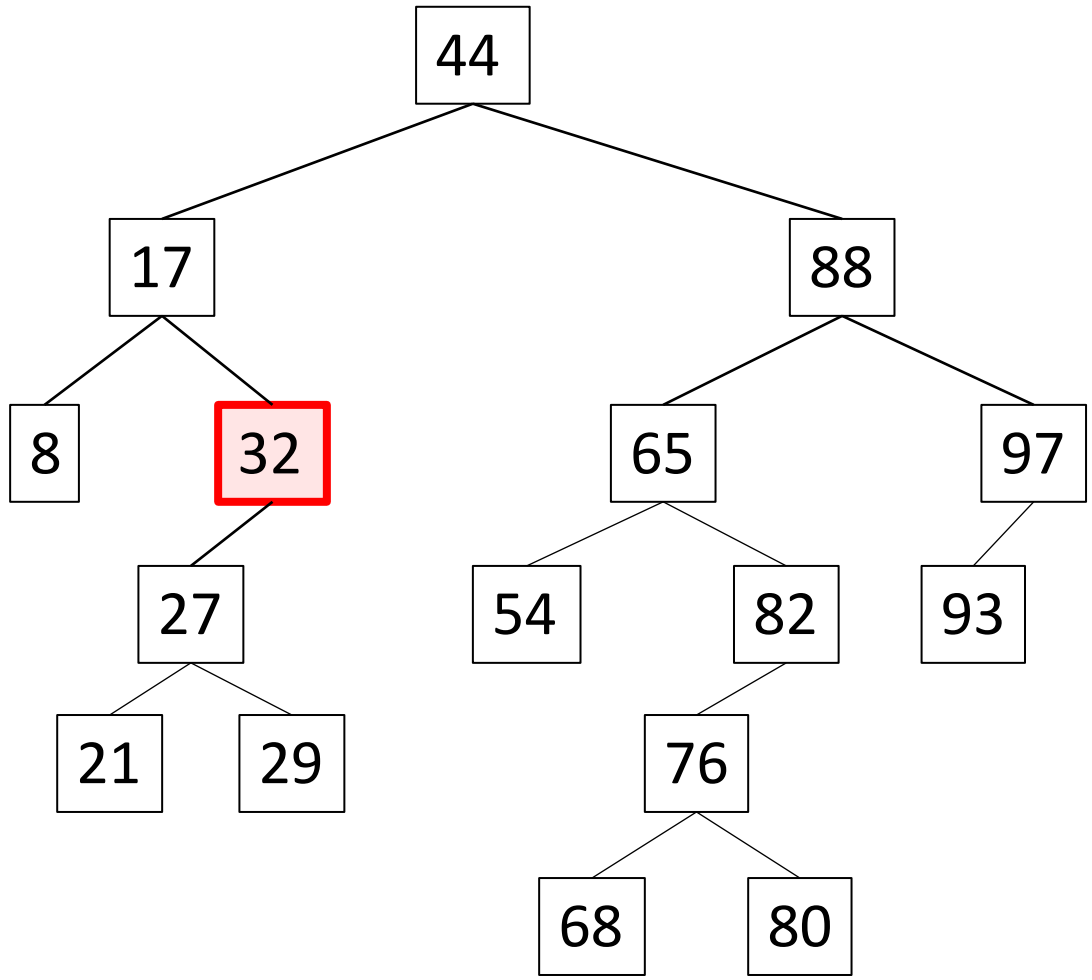

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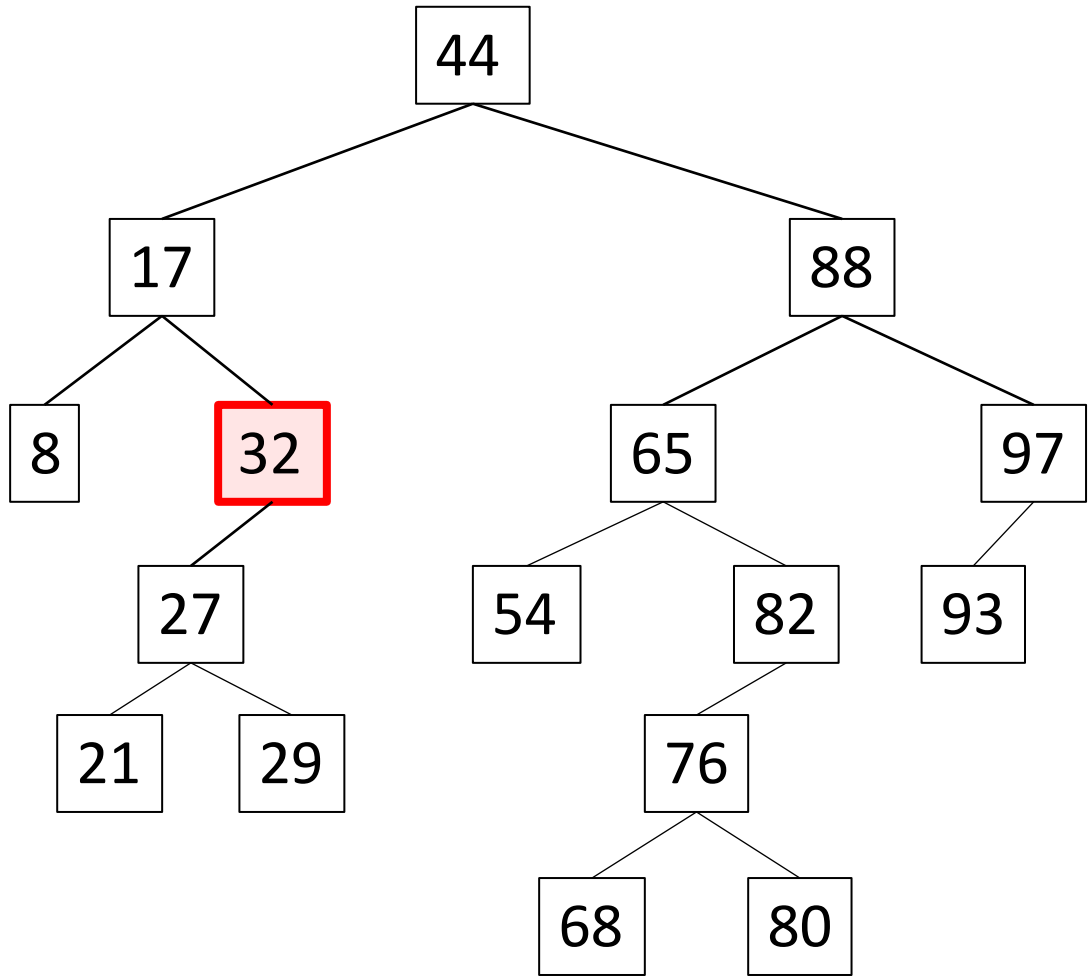

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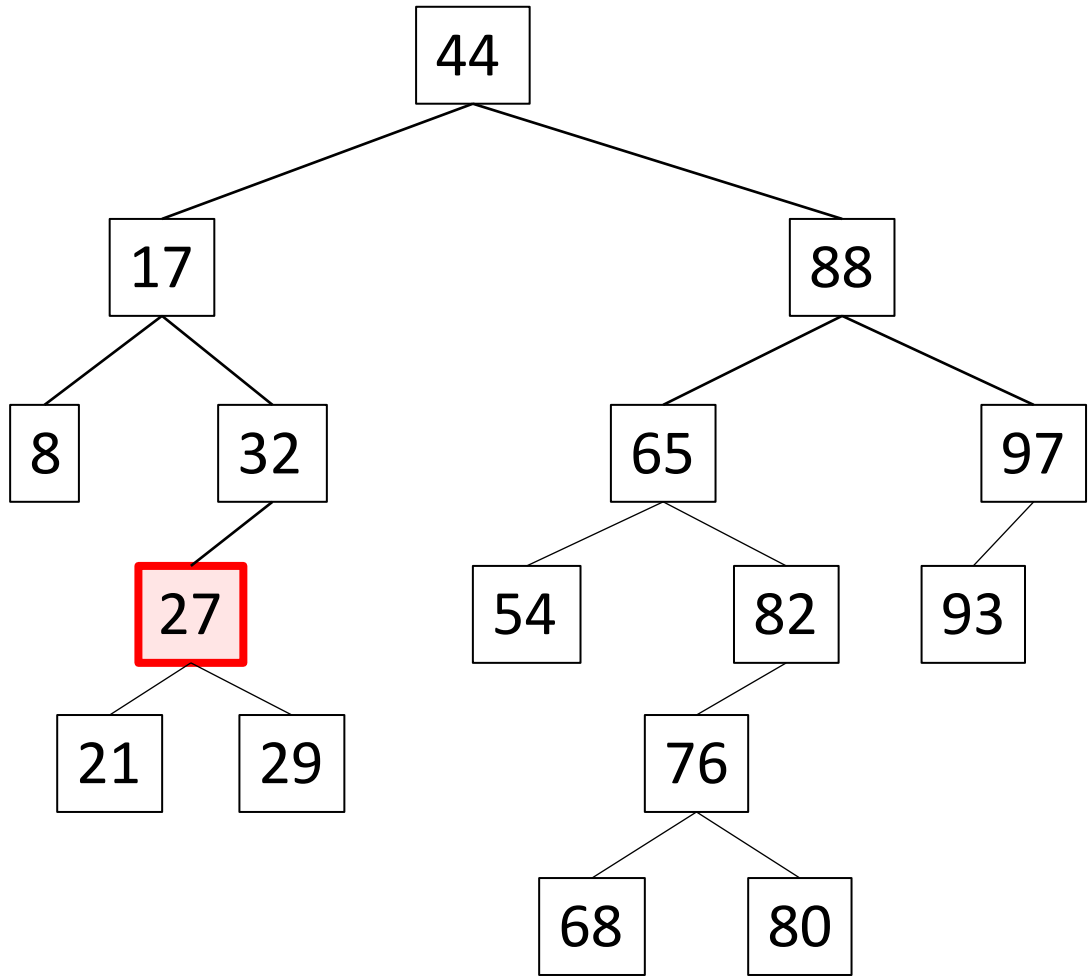

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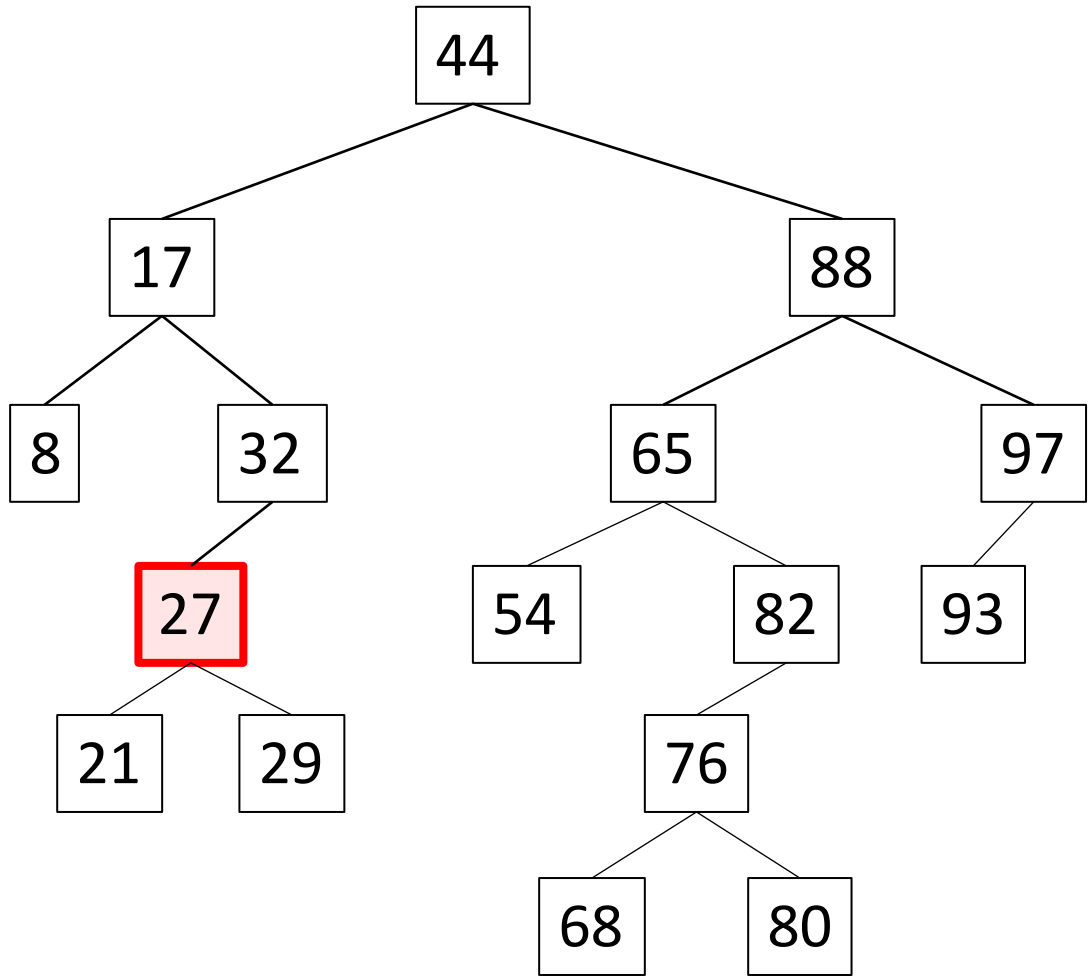

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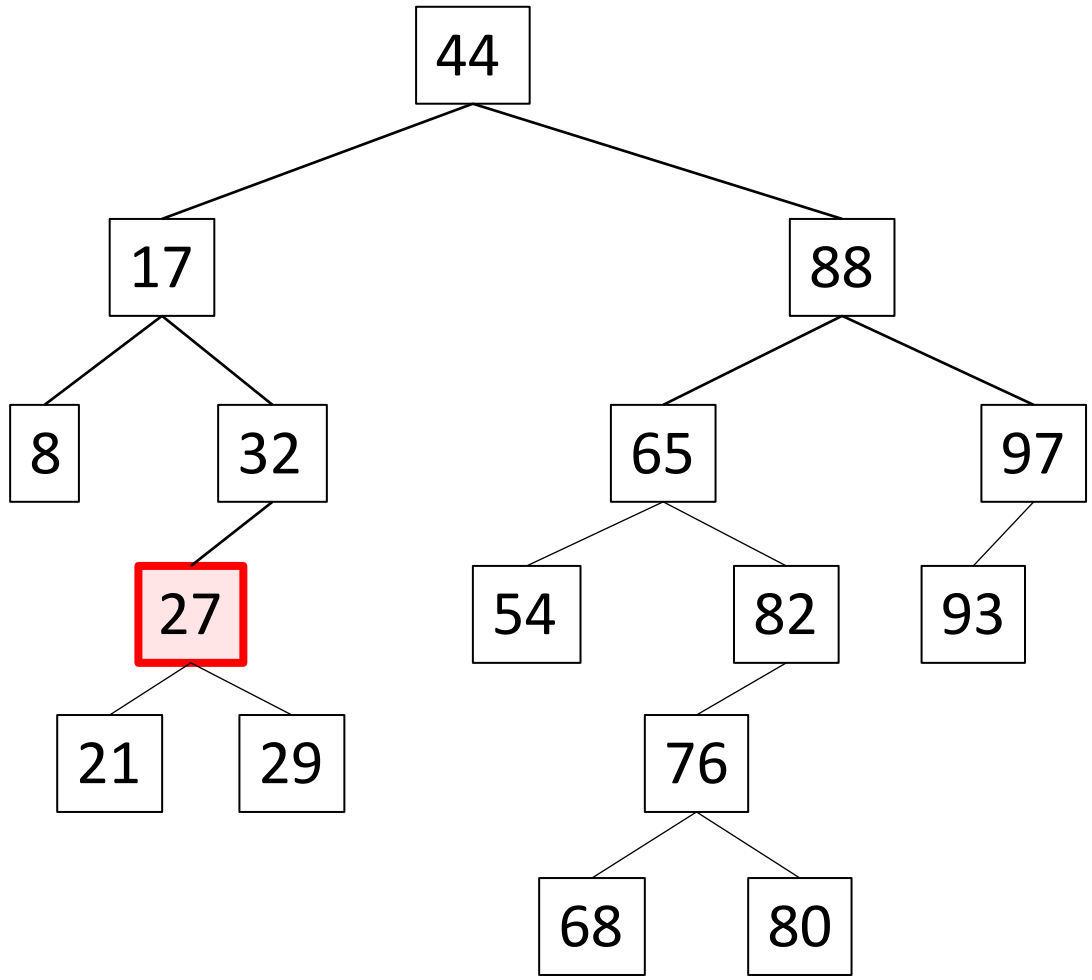

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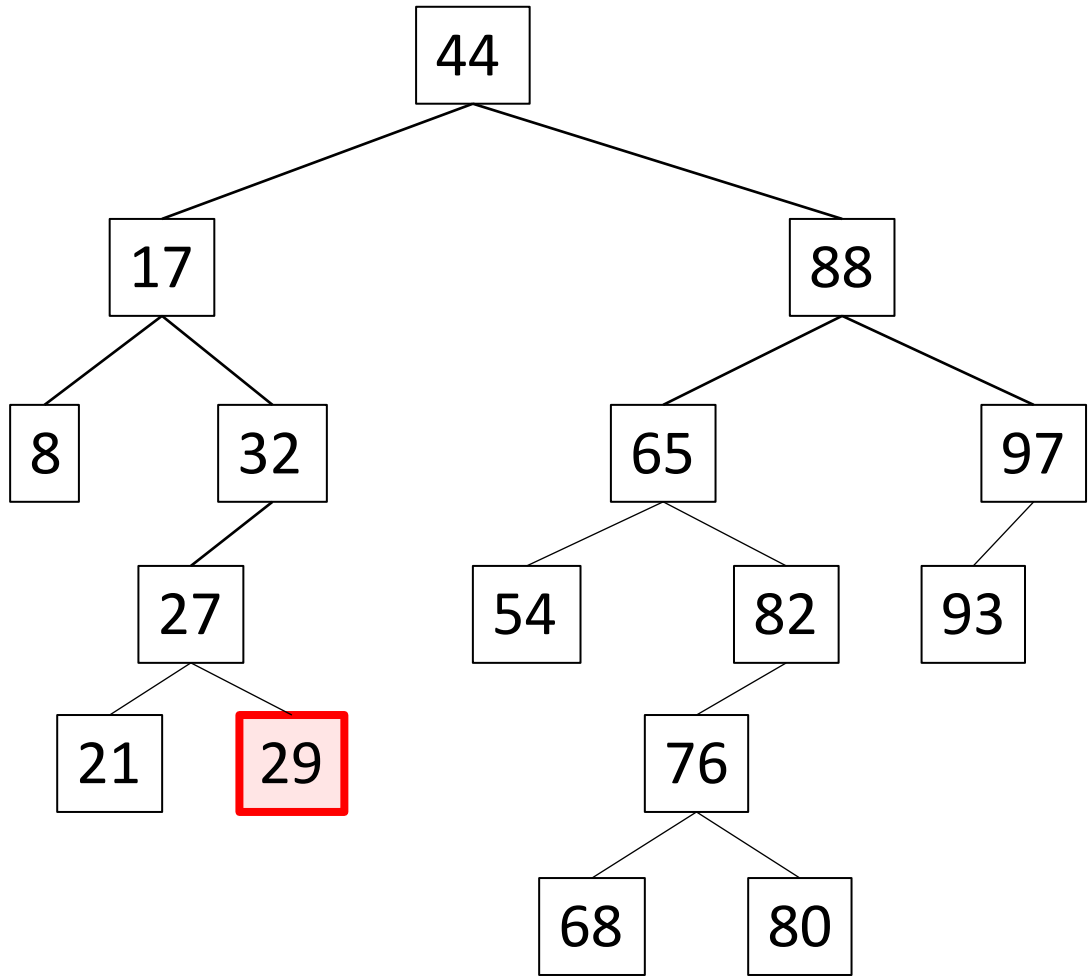

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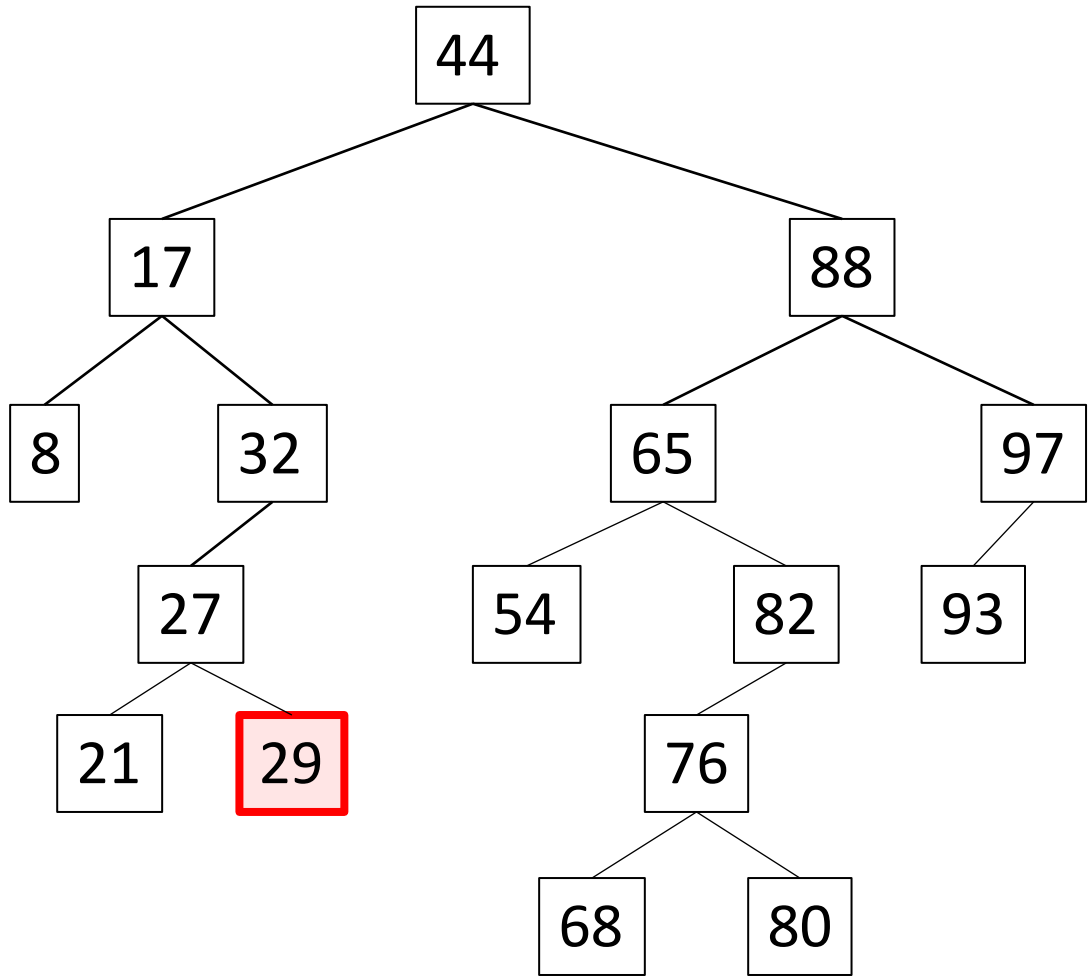

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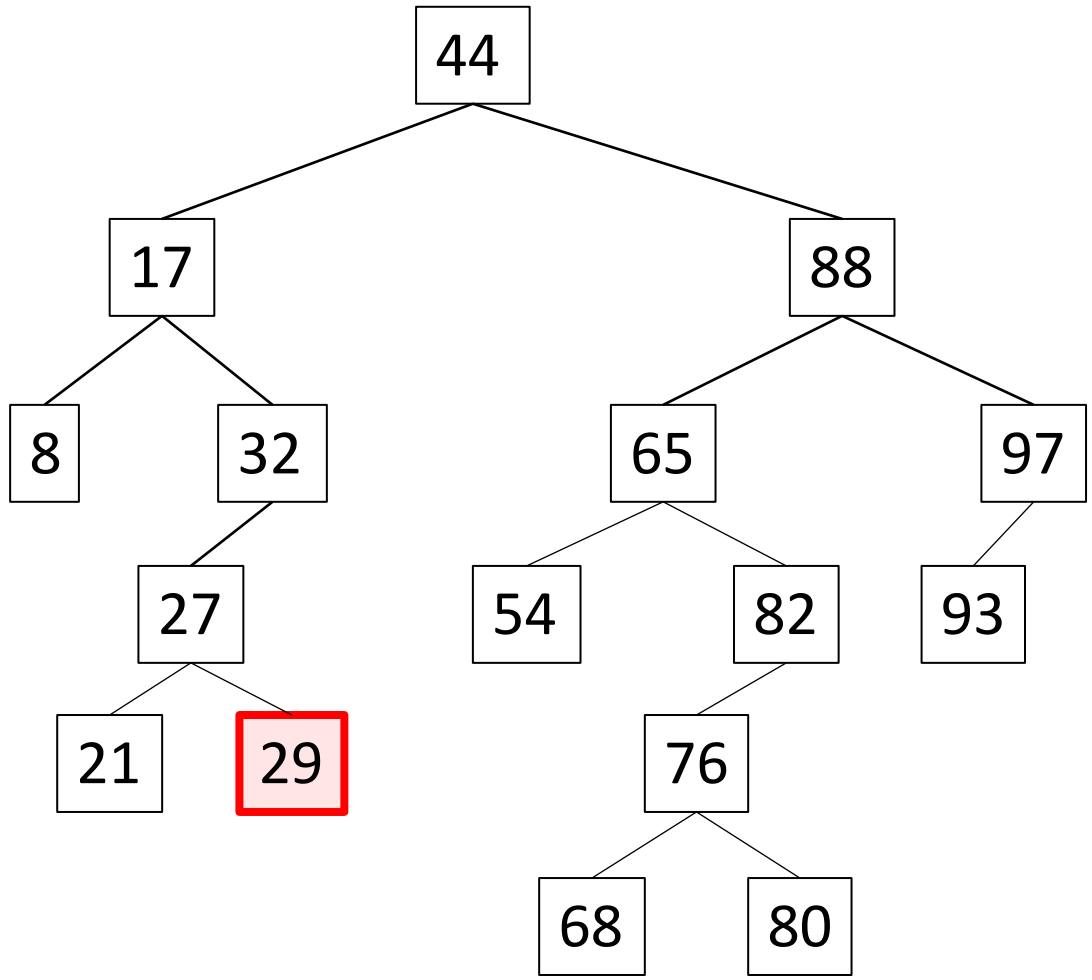

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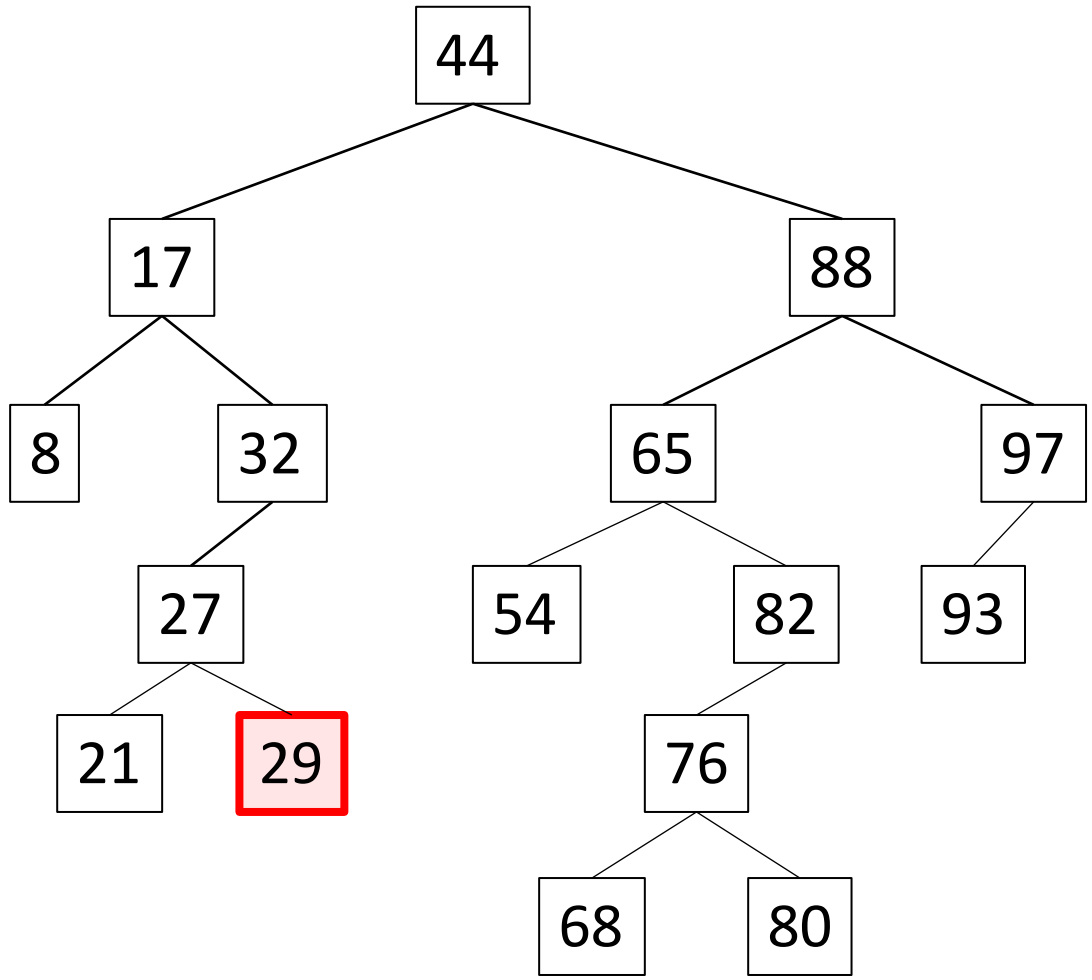

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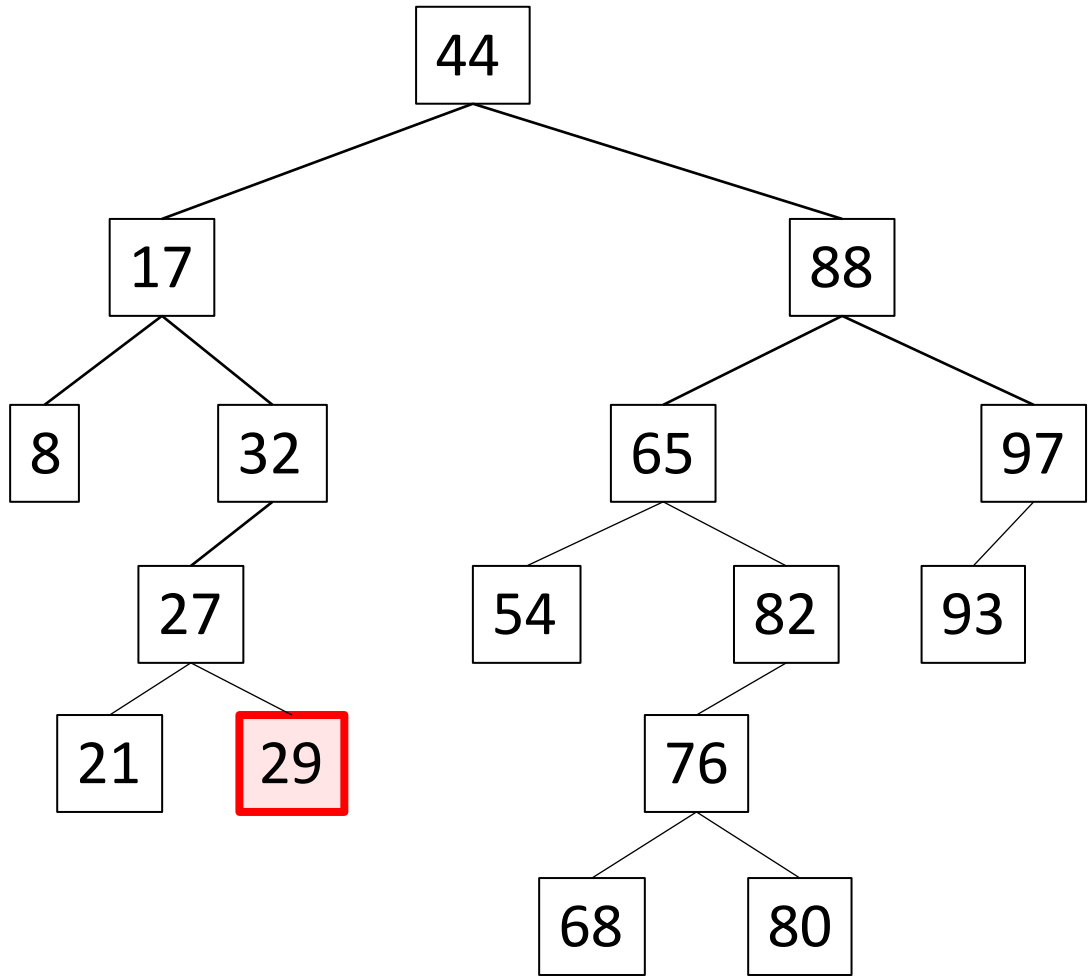

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        if (currentNode.getLeft() != null) {
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        } else {
          currentNode.setLeft(new Node(newValue));



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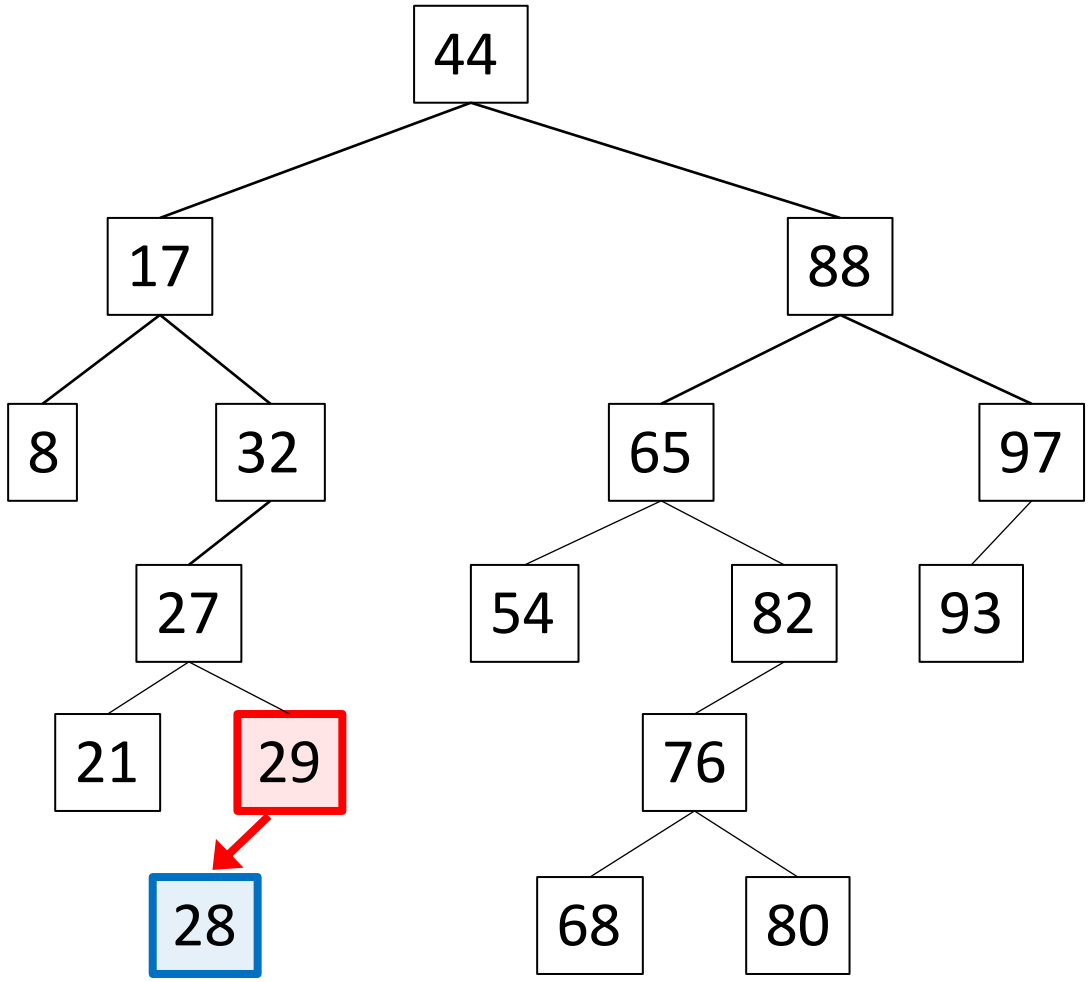

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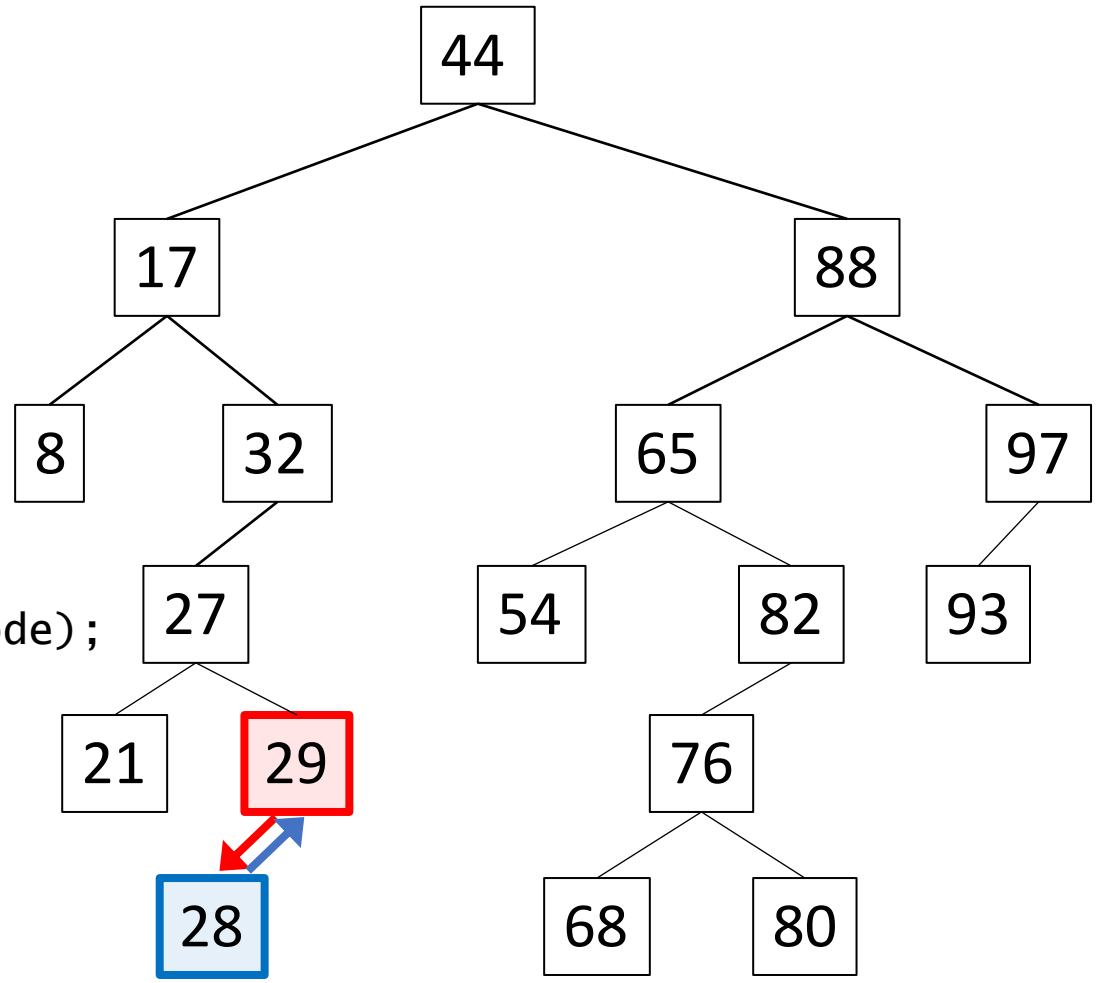

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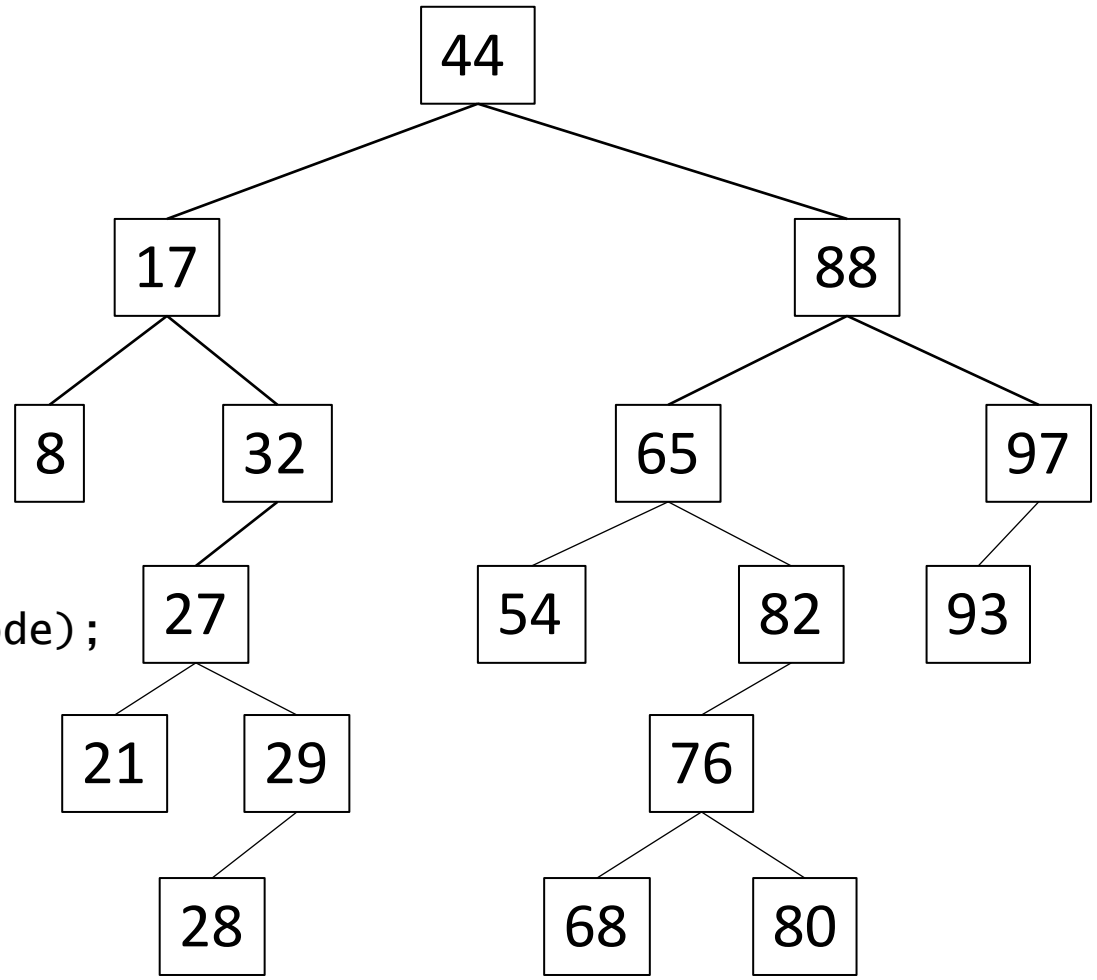

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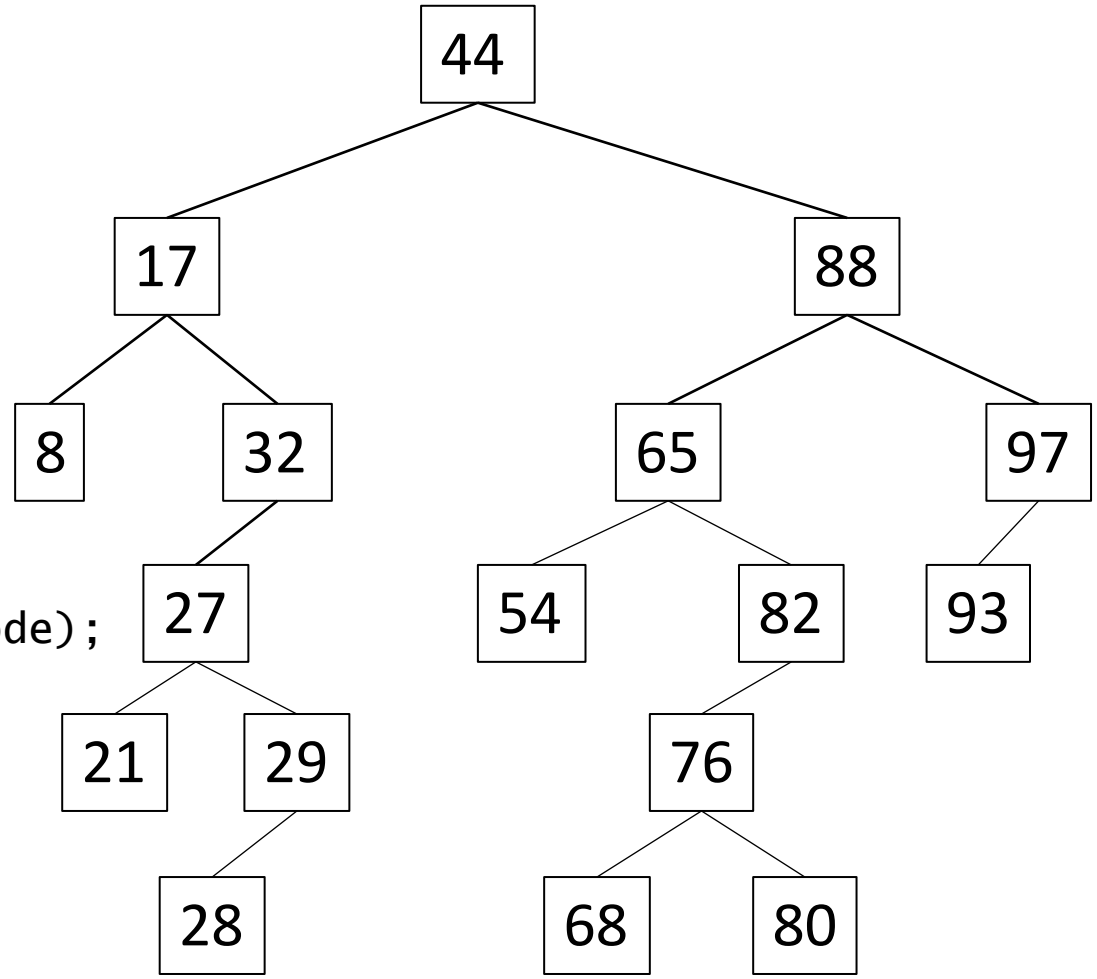
        if (currentNode.getLeft() != null) {
          currentNode = currentNode.getLeft();
        } else {
          currentNode.setLeft(new Node(newValue));
          currentNode.getLeft().setParent(currentNode);
          placed = true;
        }
      } else {
        if (currentNode.getRight() != null) {
          currentNode = currentNode.getRight();
        } else {

}
```

```
insert(28);
```

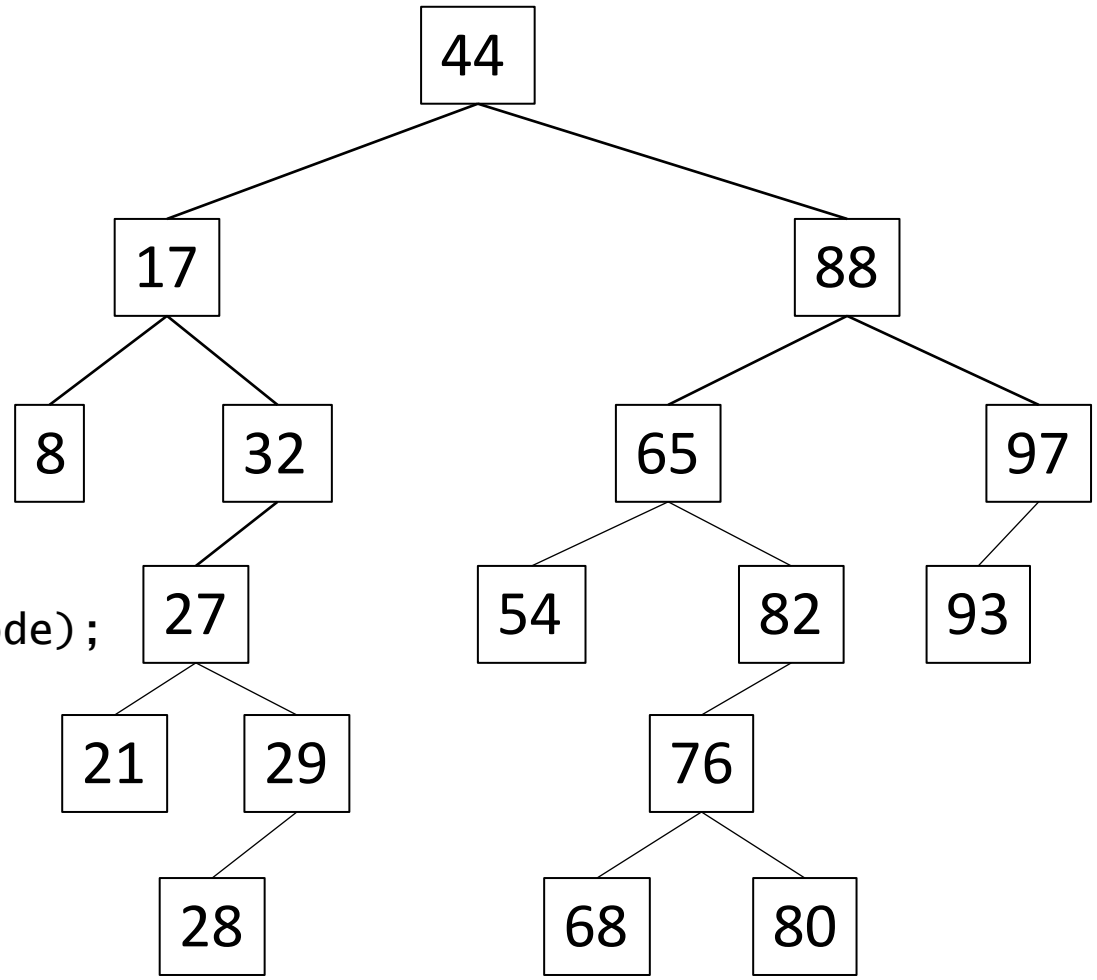


Binary Search Tree - Insertion

```
insert(28);
```

```
public void insert(int newValue) {
  if (root == null) {
    root = new Node(newValue);
  } else {
    Node currentNode = root;
    boolean placed = false;
    while (!placed) {
      if (newValue < currentNode.getValue()) {
        if (currentNode.getLeft() != null) {
          currentNode = currentNode.getLeft();
        } else {
          currentNode.setLeft(new Node(newValue));
          currentNode.getLeft().setParent(currentNode);
          placed = true;
        }
      } else {
        if (currentNode.getRight() != null) {
          currentNode = currentNode.getRight();
        } else {
          currentNode.setRight(new Node(newValue));


}
```



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        }
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          currentNode.setRight(new Node(newValue));
          currentNode.getRight().setParent(currentNode);

}
```

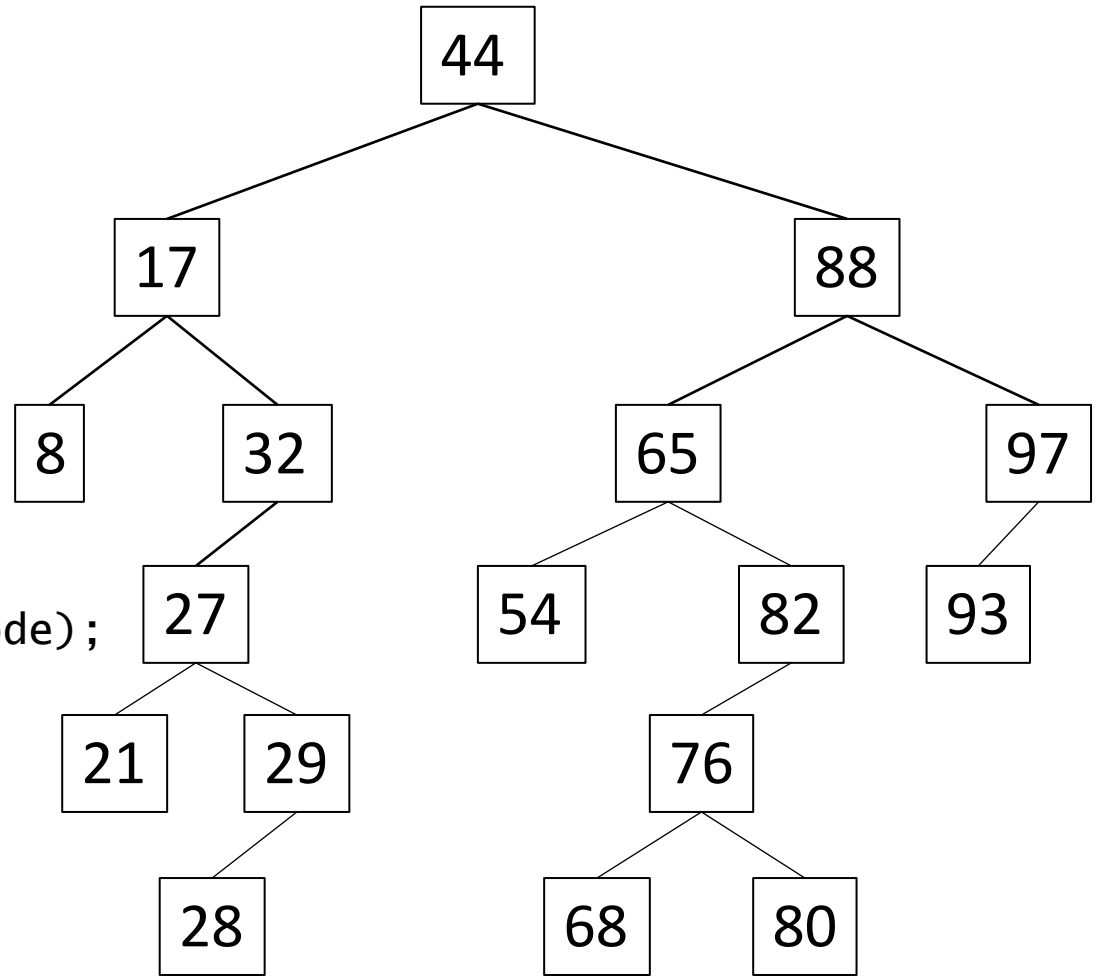

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