

# #1 Solutions

### Algorithm findSmallerHelper(T, key, T.root(), seq)

```

If(T. isExternal()) return 0;                                n

```

```
If(key>=p.element())
```

Seq.insertLast(p)	n
-------------------	---

```
findSmallerHelper(T,key,T.leftChild(p),seq).  n
```

```
findSmallerHelper(T, key, T.rightChild(p), seq). n
```

### Algorithm findSmallerKeys(T, key)

```
Seq:=new Sequence() 1
```

```
findSmallerHelper(T, key, T.root())
```

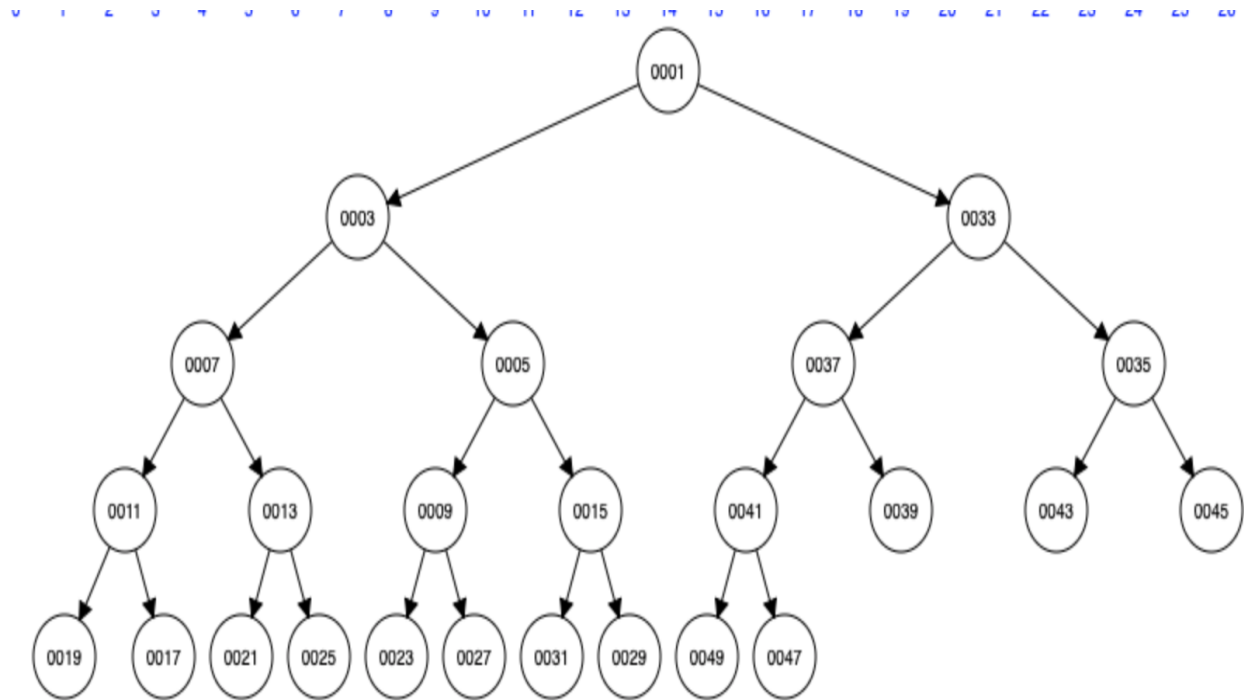
```
return seq
```

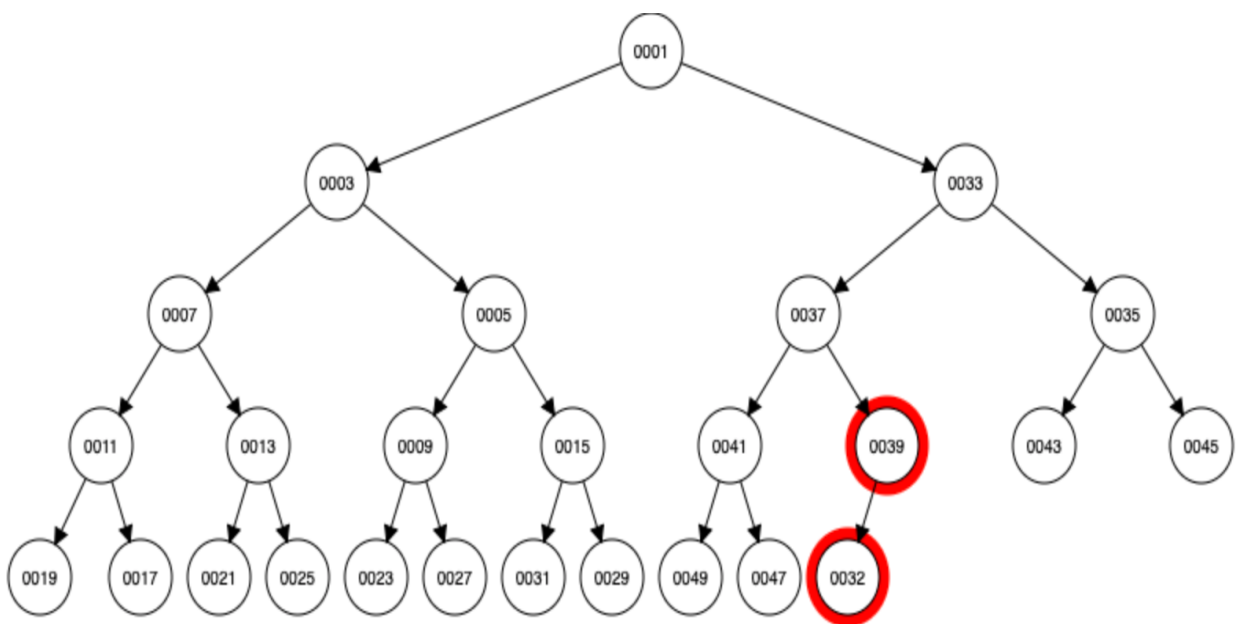
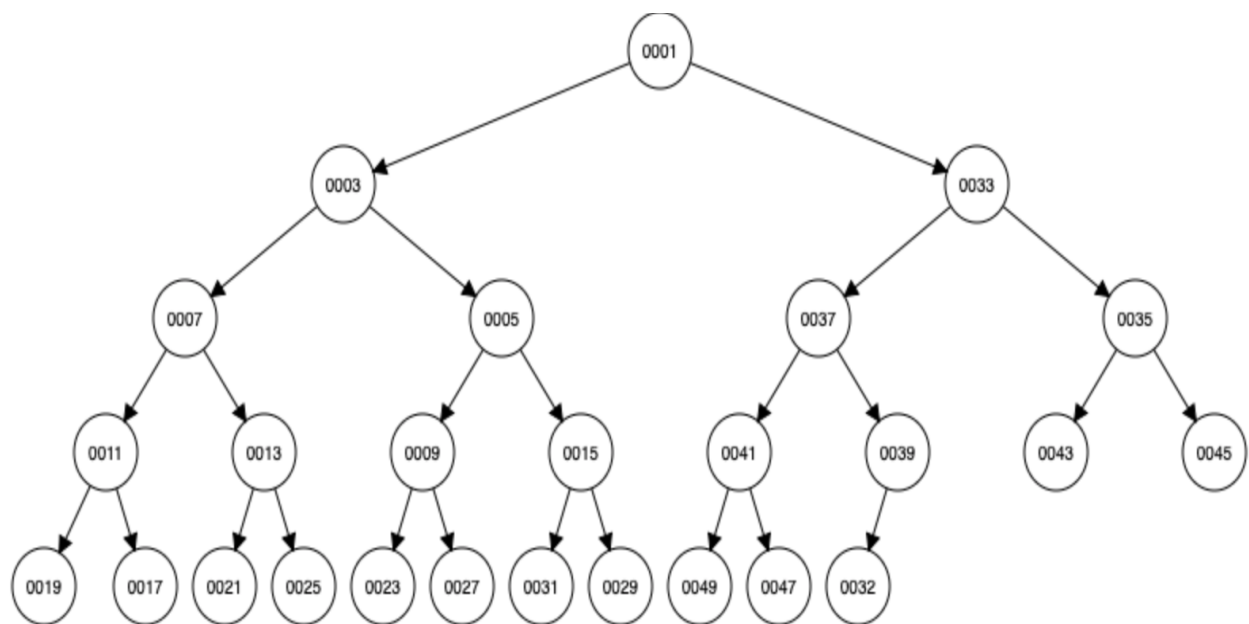
Time complexity is  $O(n)$

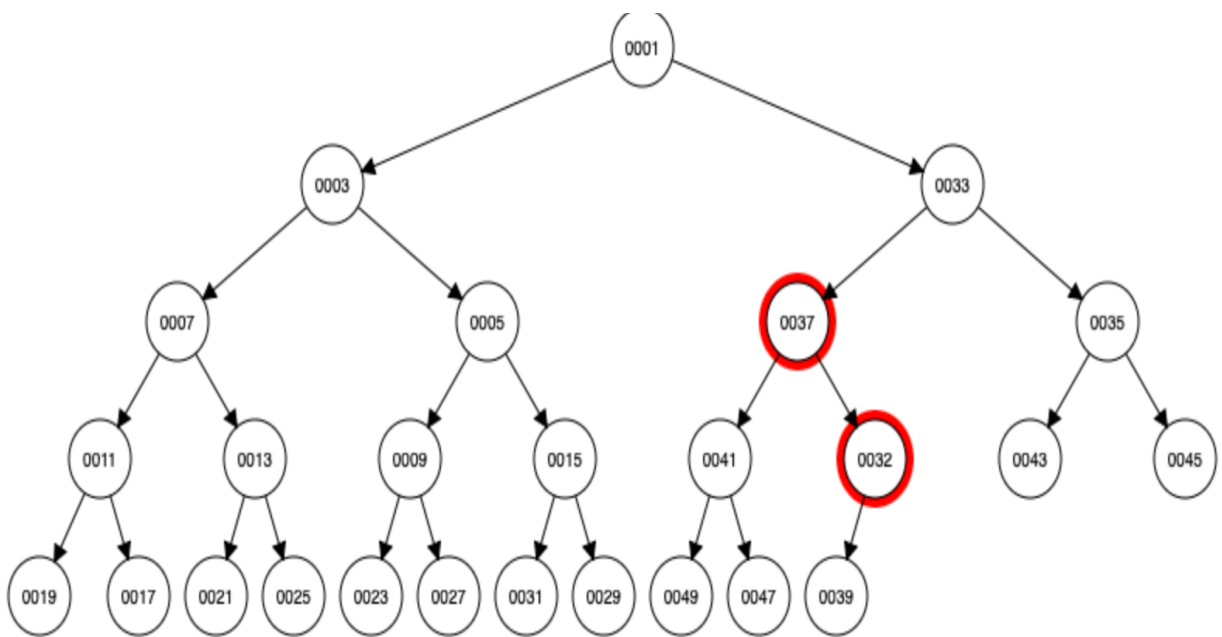
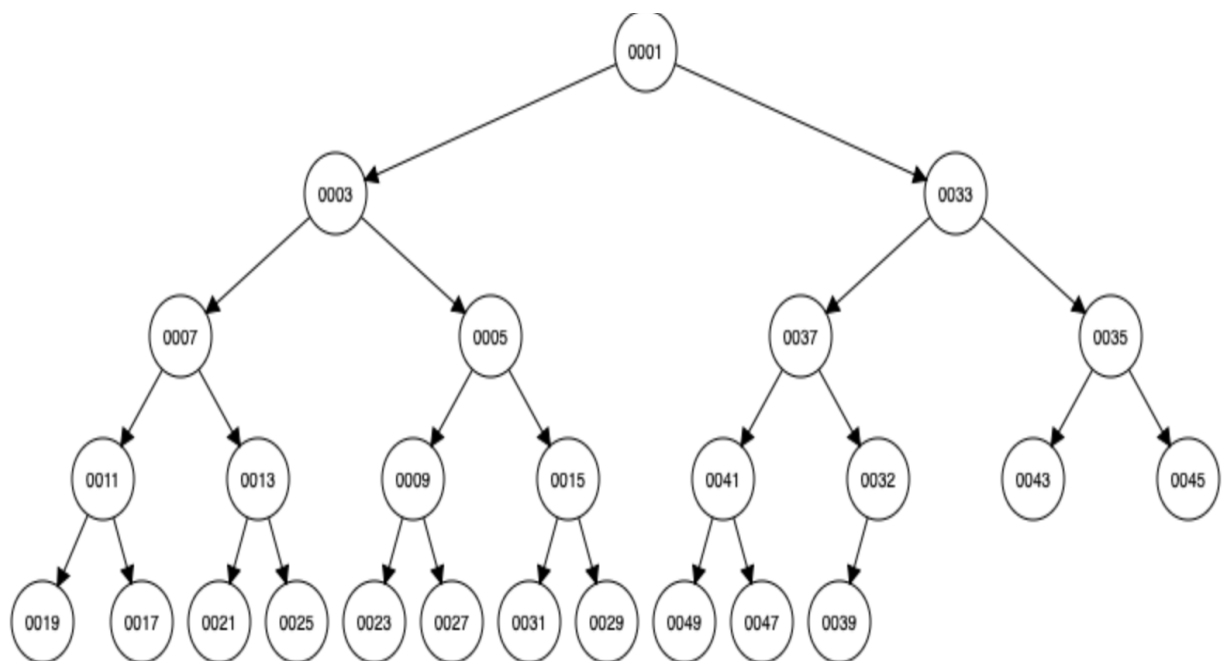
```
function findSmallerKeys(T, key) {
    let seq = new Seq.Sequence();
    findSmallerHelper(T, key, T.root(), seq);
    console.log("findSmallerKeys key=" + key + " " +
seq.toString());
    return seq;
}

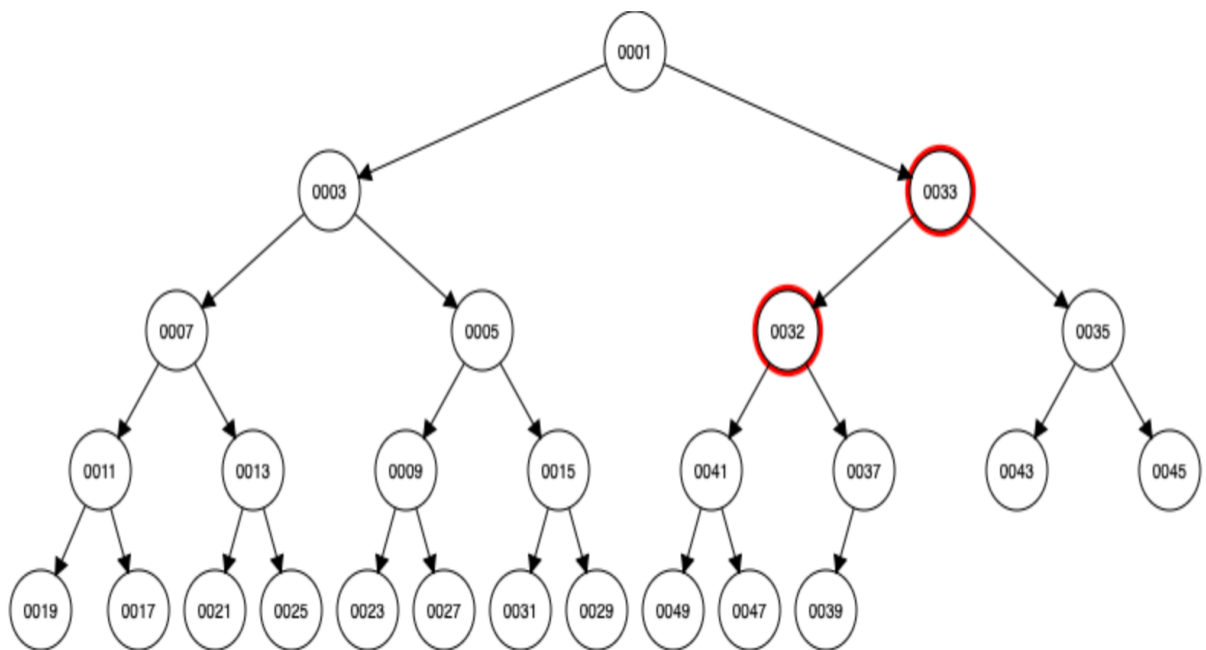
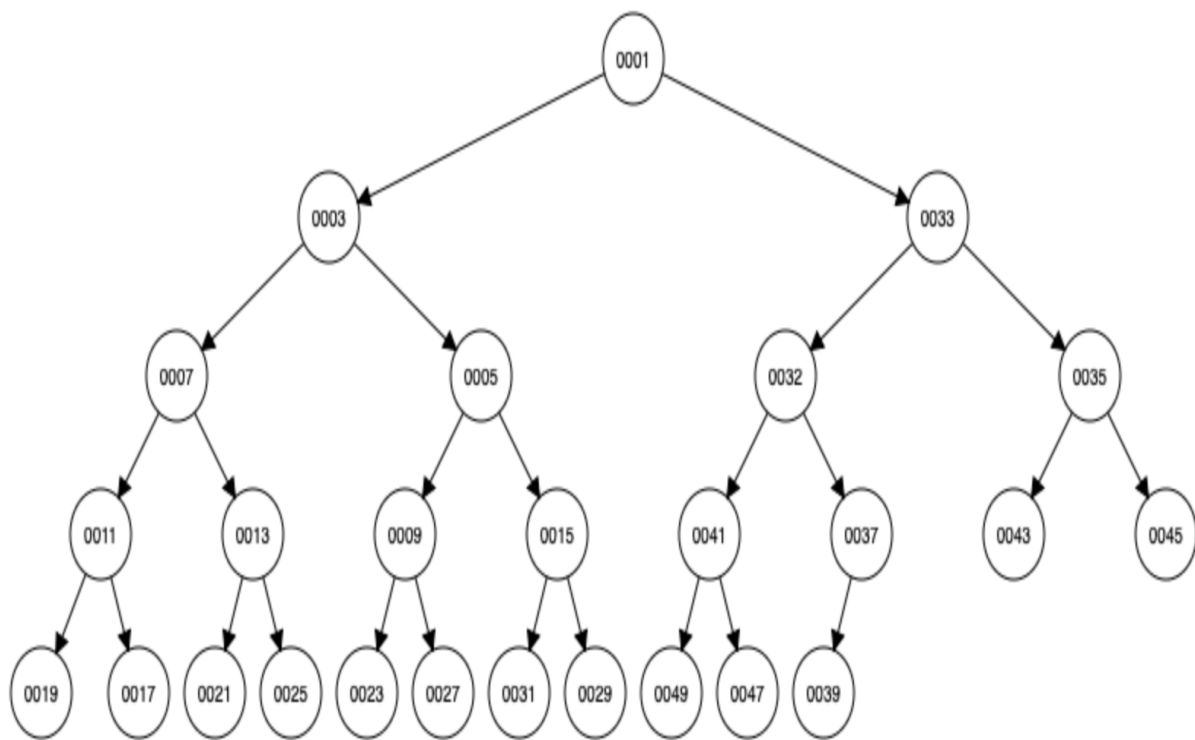
function findSmallerHelper(T, key, p, seq) {
    if(T.isExternal(p))
        return 0;
    if(key >= p.element())
        seq.insertLast(p)
    findSmallerHelper(T, key, T.leftChild(p), seq)
    findSmallerHelper(T, key, T.rightChild(p), seq)
}
```

Step 1 Add all the values of odd 1 up to 49 and finally add 32 the tree will be the following

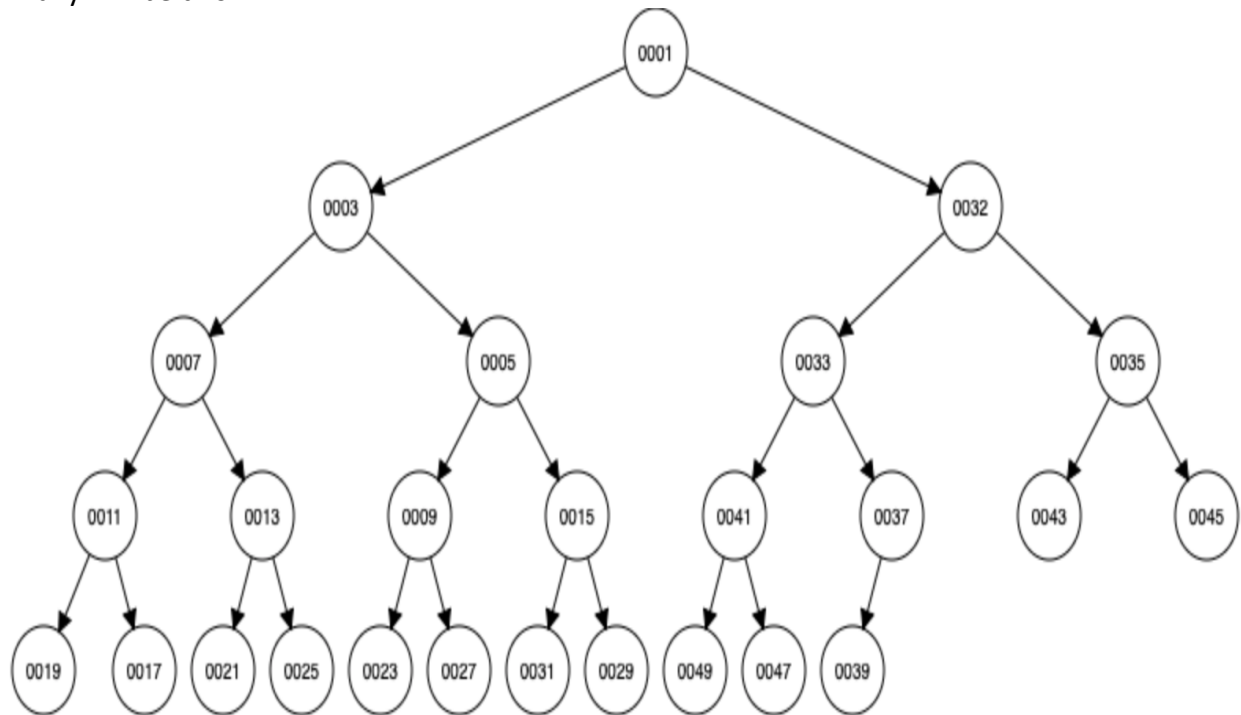








Finally will be this



## Level 2 Solution

Algorithm findSmallerHelper(T, key, p, seq)

```
    If(T.isExternal(p) || key < p.element()) return;    k  
    Seq.insertLast(p.element());                      k
```

```
findSmallerHelper(T, key, T.leftChild(p), seq)    k
```

```
findSmallerHelper(T, key, T.rightChild(p), seq).    k
```

Algorithm findSmallerKeys(T, key)

```
    Seq := new Sequence()                            1  
    findSmallerHelper(T, key, T.root())               k  
    return seq                                         1
```

Time complexity is  $O(k)$

```
function findSmallerKeys(T, key) {  
    let seq = new Seq.Sequence();  
    findSmallerHelper(T, key, T.root(), seq);  
    console.log("findSmallerKeys key=" + key + " " +  
seq.toString());  
    return seq;  
}  
  
function findSmallerHelper(T, key, p, seq) {  
    if(T.isExternal(p) || key < p.element())  
        return  
    seq.insertLast(p.element())  
    findSmallerHelper(T, key, T.leftChild(p), seq)  
    findSmallerHelper(T, key, T.rightChild(p), seq)  
}
```