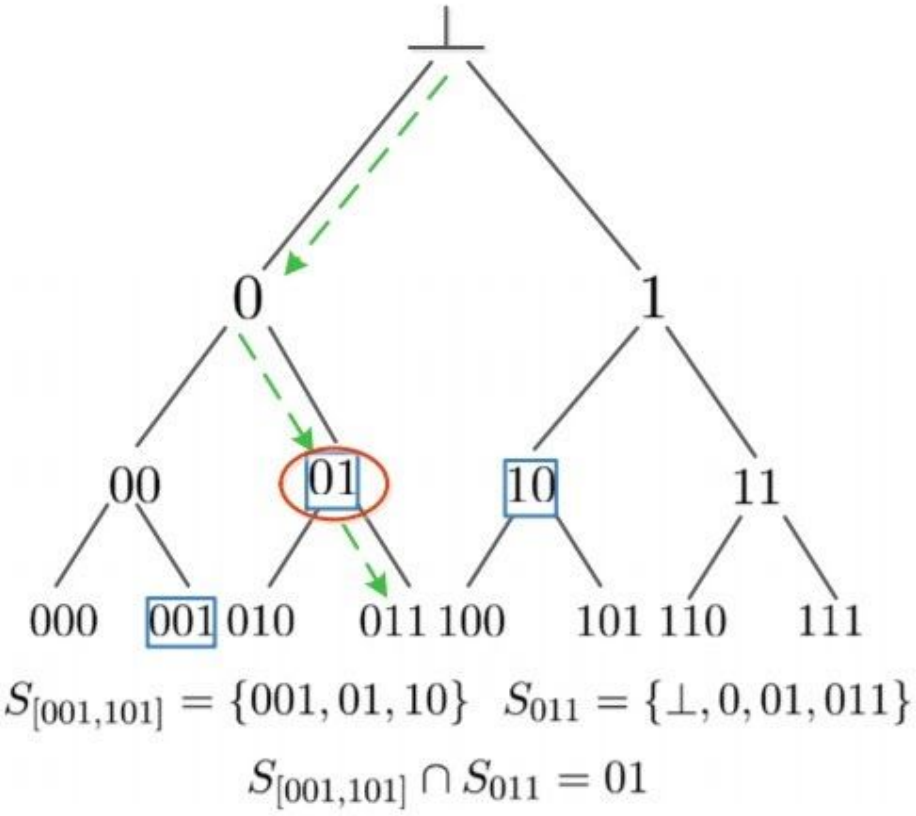
A program written in cpp implementing a one-dimensional range query tree.

The root node is given the value “root” and all the other nodes are represented in binary. For example, one father node is labeled as w, and its left child node is w0 and right child node is w1.

To denote an interval, all elements in this interval are selected and then the minimum sub-tree nodes that can cover these leaf nodes is taken.

To denote a value, we pick up the set which contains all nodes in the path from root node to the corresponding leaf node.

Representation of a 3-bit range query tree



In the program,
The program first asks the value of “n” (i.e the number of bits) for the n-bit tree to be generated.

If you want to see the range of an interval, enter the lower bound and the upper bound of the interval.
For eg. suppose we have a 4-bit range tree, then the min value of the lower-bound will be 0 (0000) and the max value of the upper-bound will be 15 (1111).

To see the path of a value, enter the value, say 3. Then it will show the path from the “root” to the binary value of 3 i.e 011 (for a 3-bit range tree).

To see if a value lies in an interval, we perform the range query and it returns true if the value lies in the interval, else false.

Screenshots:

1.Find path of a value/number

```
Enter how many bits do you want: 3
Enter 1 to find the path of a number.
Enter 2 to find the range of an interval.
Enter 3 to perform a range query on an interval
1
Enter the number for which you want to find the path:6
The path is: root -> 1 -> 11 -> 110 ->
```

2. Find range of an interval

```
Enter how many bits do you want: 3
Enter 1 to find the path of a number.
Enter 2 to find the range of an interval.
Enter 3 to perform a range query on an interval
2
Enter the interval for the range [low, high]
low: 1
high: 5
The Range is [ 01, 001, 10, ]
```

3. Range query

```
Enter how many bits do you want: 3
Enter 1 to find the path of a number.
Enter 2 to find the range of an interval.
Enter 3 to perform a range query on an interval
3
Enter the interval for the range [low, high]
low: 1
high: 5
Enter the number which you want to query: 3
The number is in the range.
```

```
Enter how many bits do you want: 3
Enter 1 to find the path of a number.
Enter 2 to find the range of an interval.
Enter 3 to perform a range query on an interval
3
Enter the interval for the range [low, high]
low: 1
high: 5
Enter the number which you want to query: 6
The number is NOT in the range.
```

Time complexity:
To build the tree : O(nlogn)
To find path : O(logn)
To perform range query : O(logn)

Where n is the total number of binary numbers that can be formed from k bits. (2^k)
Say k = 3, then n = 8.
000, 001, 010, 011, 100, 101, 110, 111.