Segment Trees

http://bit.ly/VTProgSegmentTrees

What are segment trees?

Segment trees are a data structure used to support range queries over a set of data. They support O(log(n)) querying and updating.

Range Queries

Range queries check a set of data over a specific range, for example two of the most common range queries are the range minimum query (RMQ) and the range sum query.

[4 3 5 1 8 3 6 9]

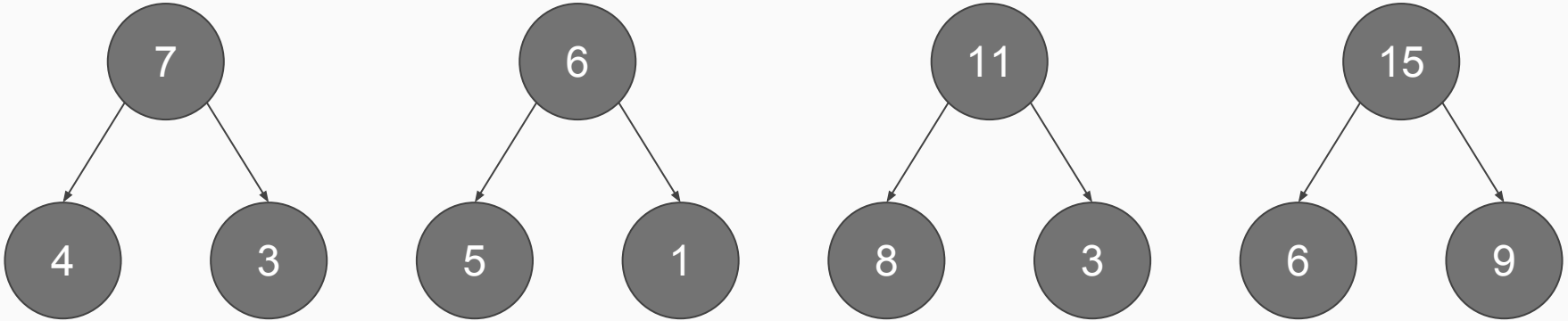
Range Sum Queries

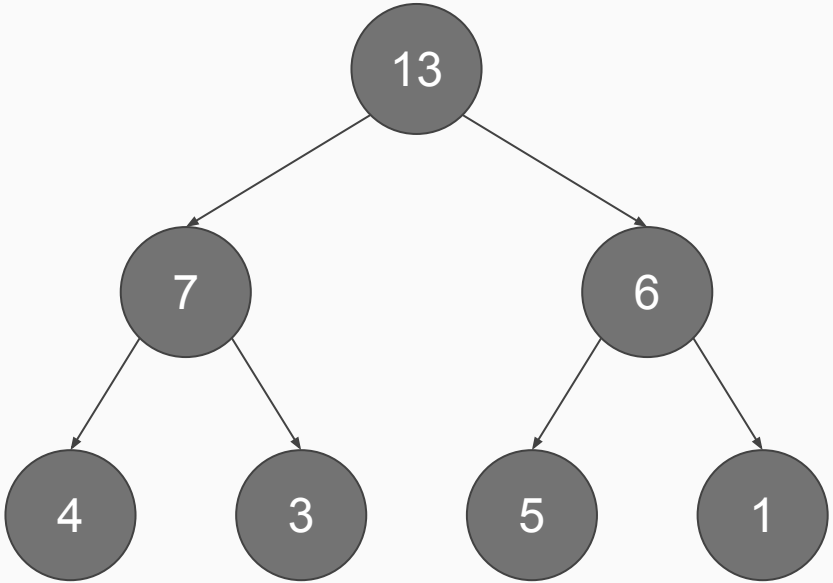
- (0, 3) = 13
- (3, 4) = 9
- (0, 7) = 39
- (5, 7) = 18

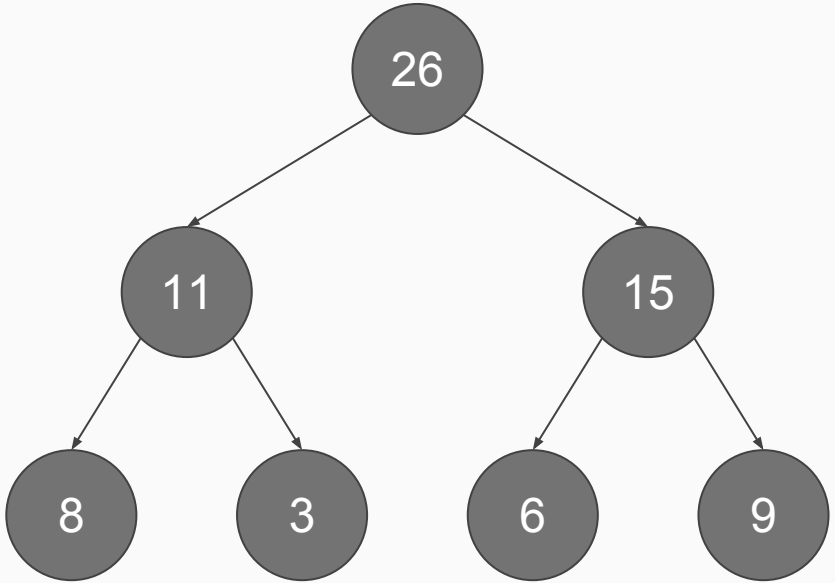
Range Minimum Queries

- (0, 3) = 1
- (3, 4) = 1
- (0, 7) = 1
- (5, 7) = 3

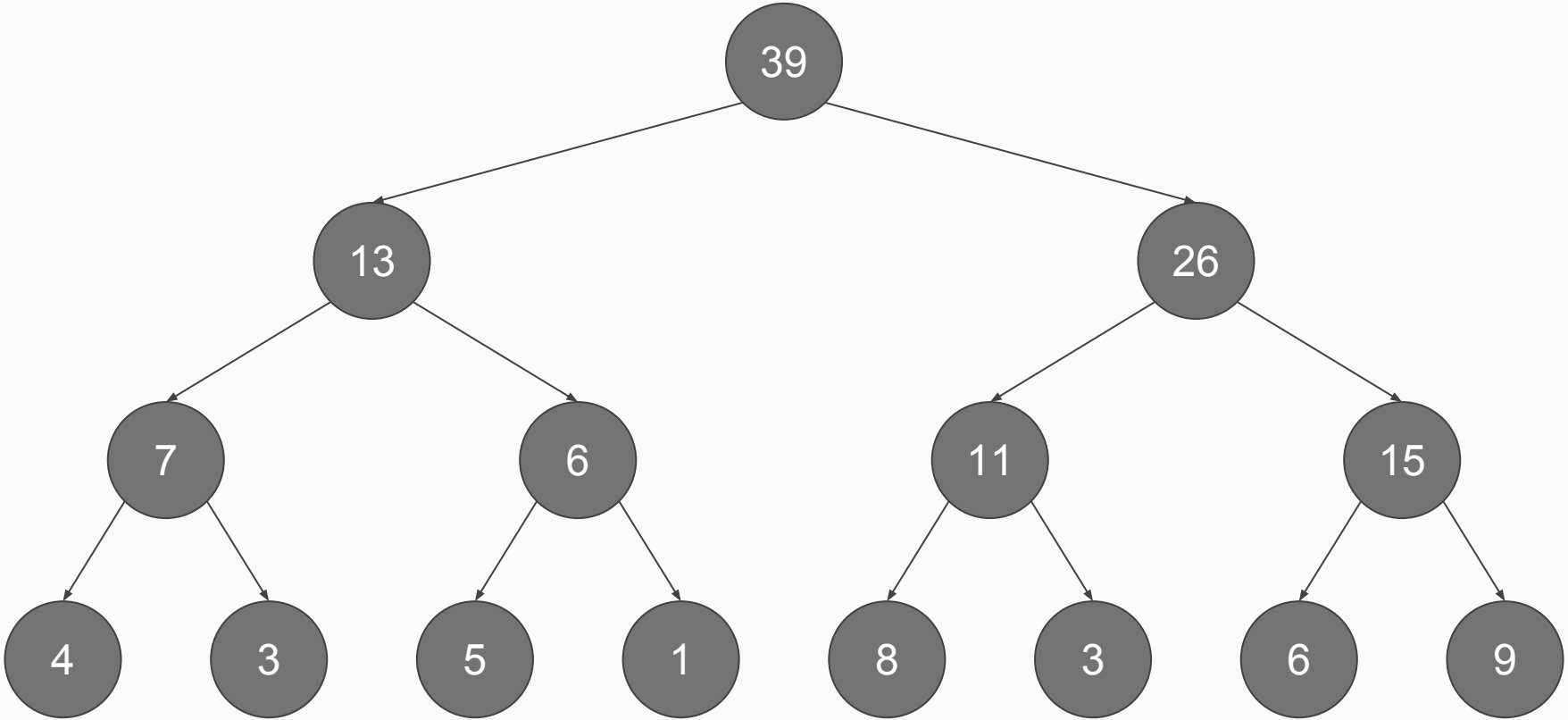
Segment Tree for range sum


7
4
3
6
5
1
11
8
3
15
6
9

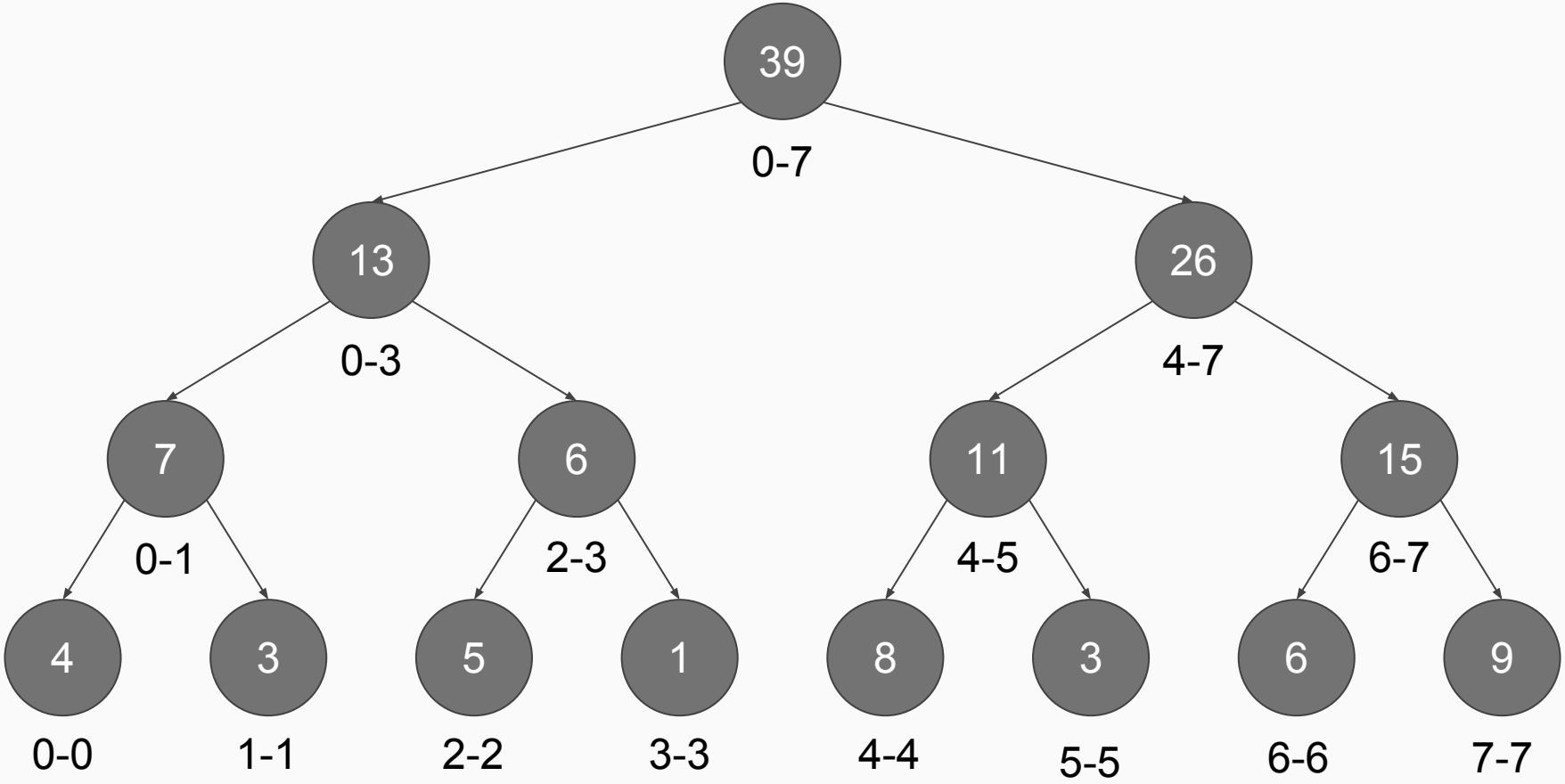




Segment Tree for range sum



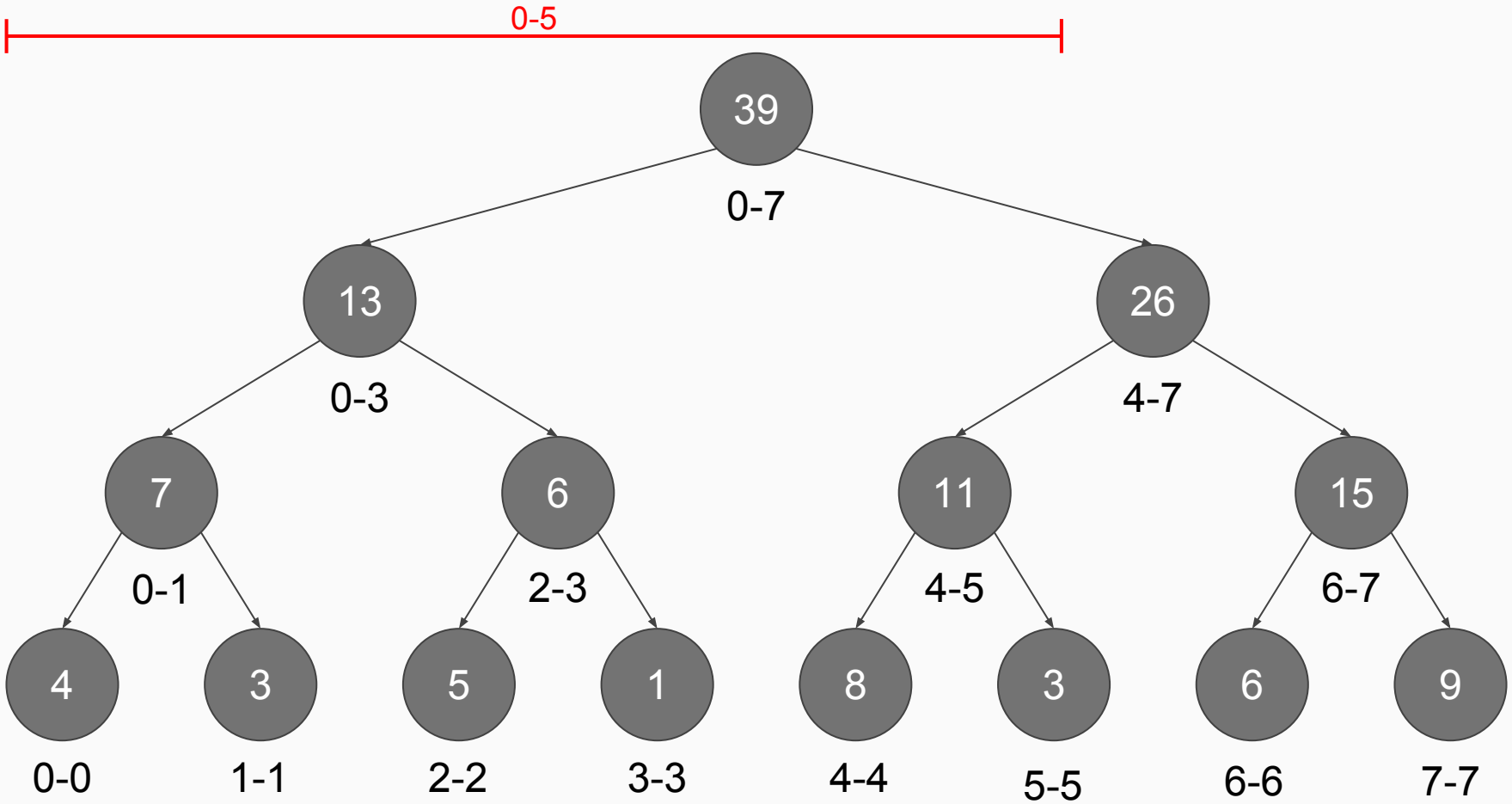
Segment Tree for range sum



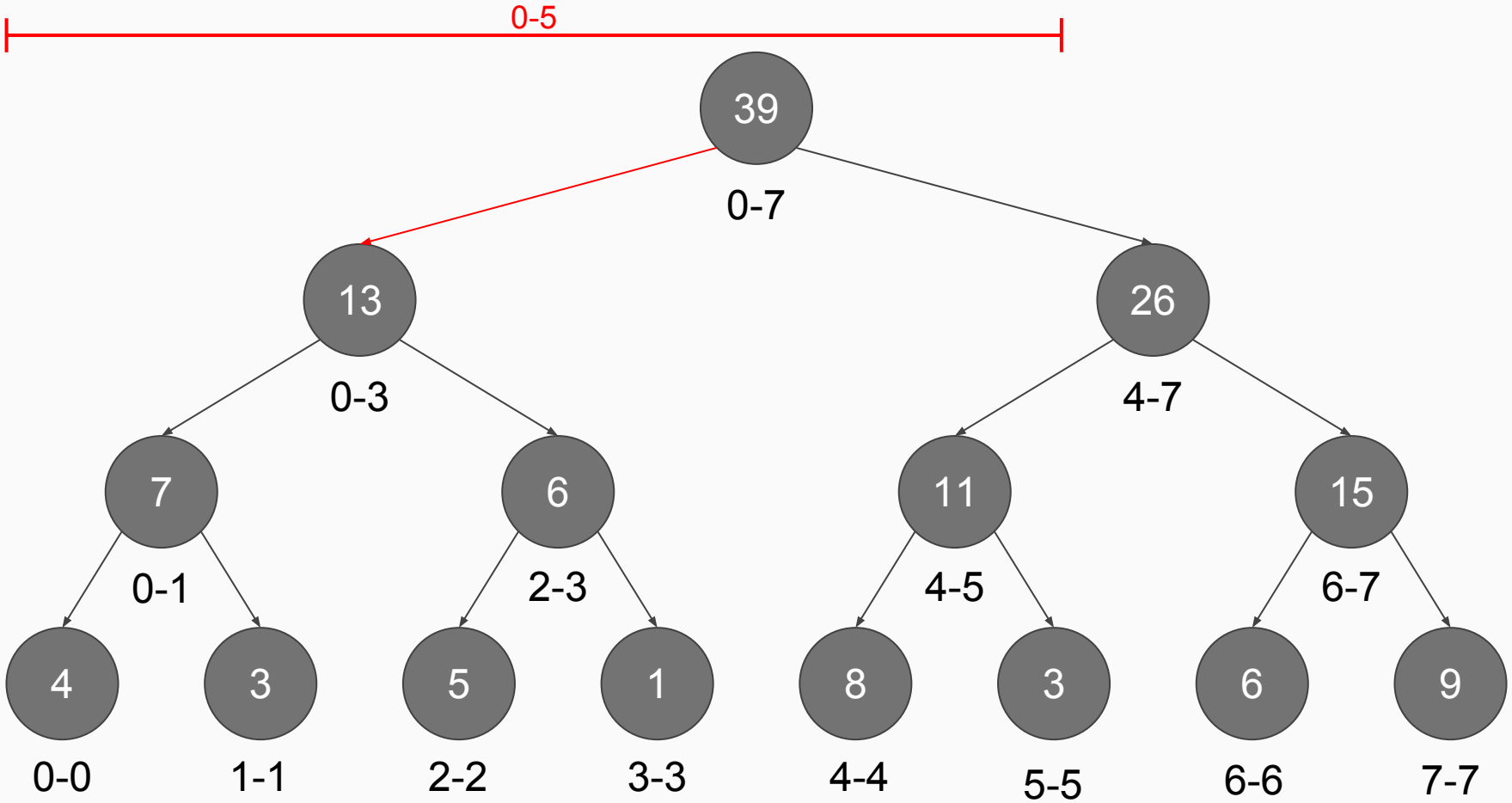
Segment Tree for range sum

Range Query Algorithm

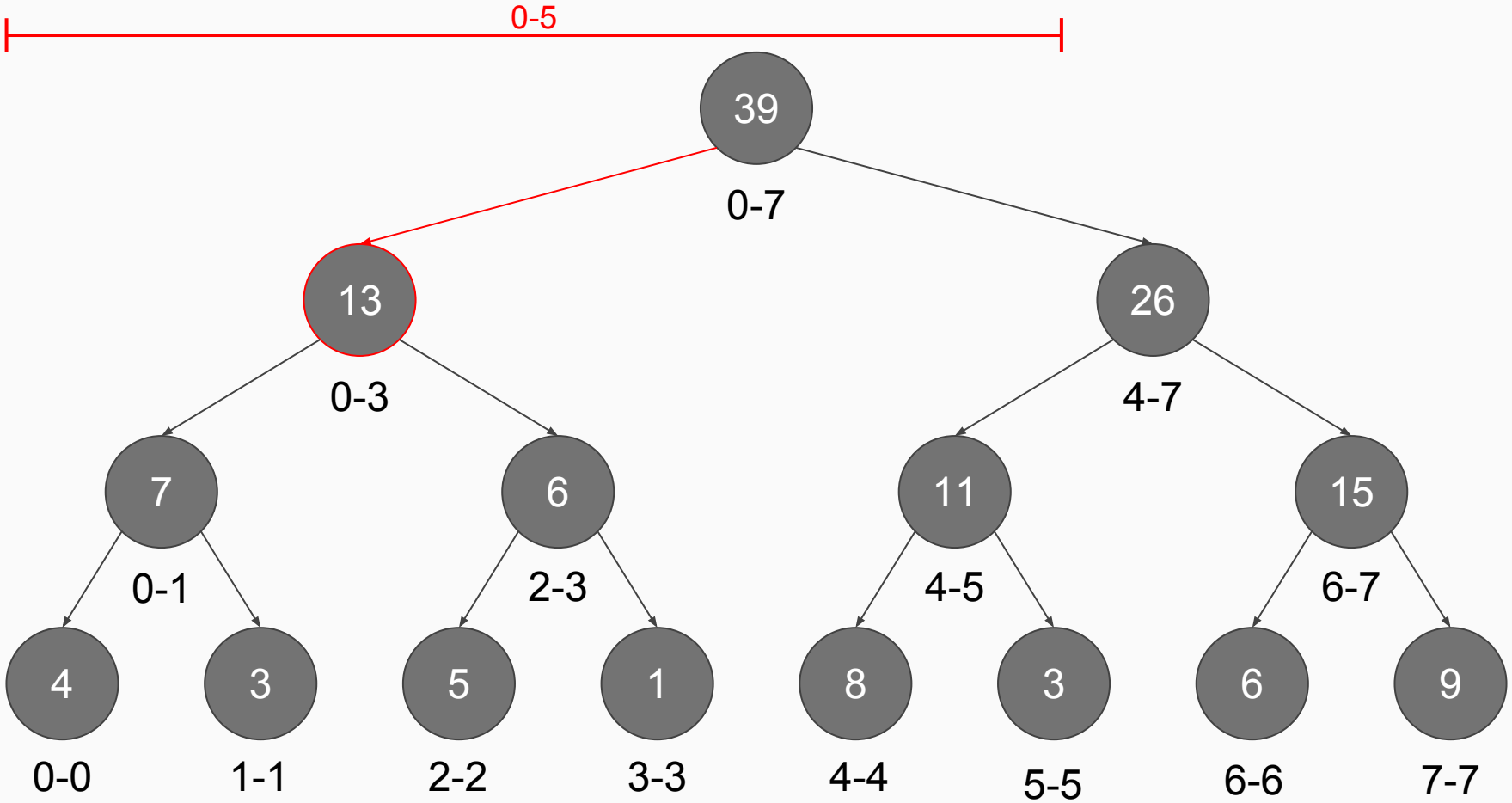
- If the range completely overlaps this node
  - Return the value at this node
- Otherwise check if the range overlaps
  - If so recursively call the the method on both children and combine their results
- Else return the identity of the operation (0, Integer.MAX, etc)



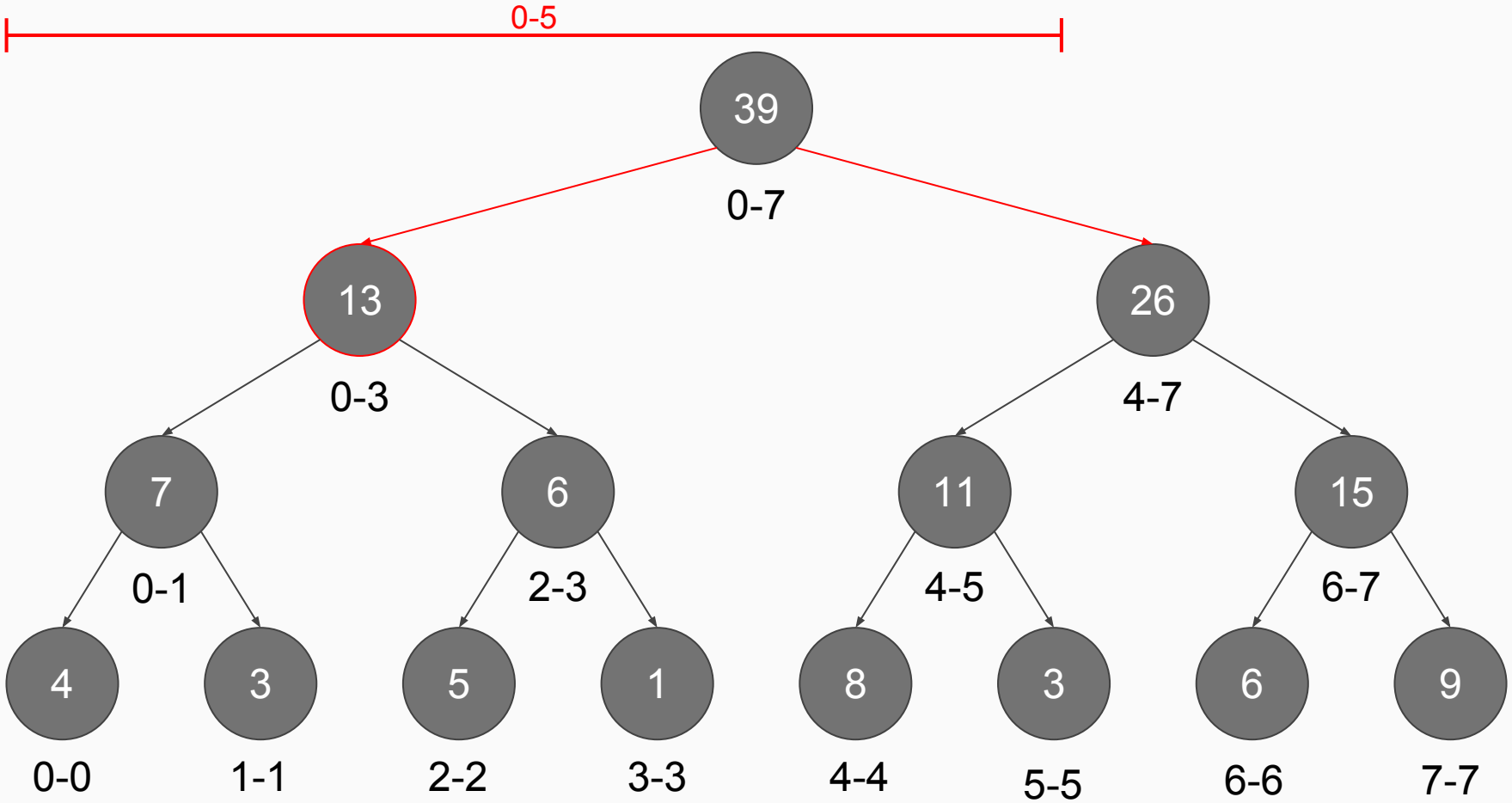
Range Query - (0-5)



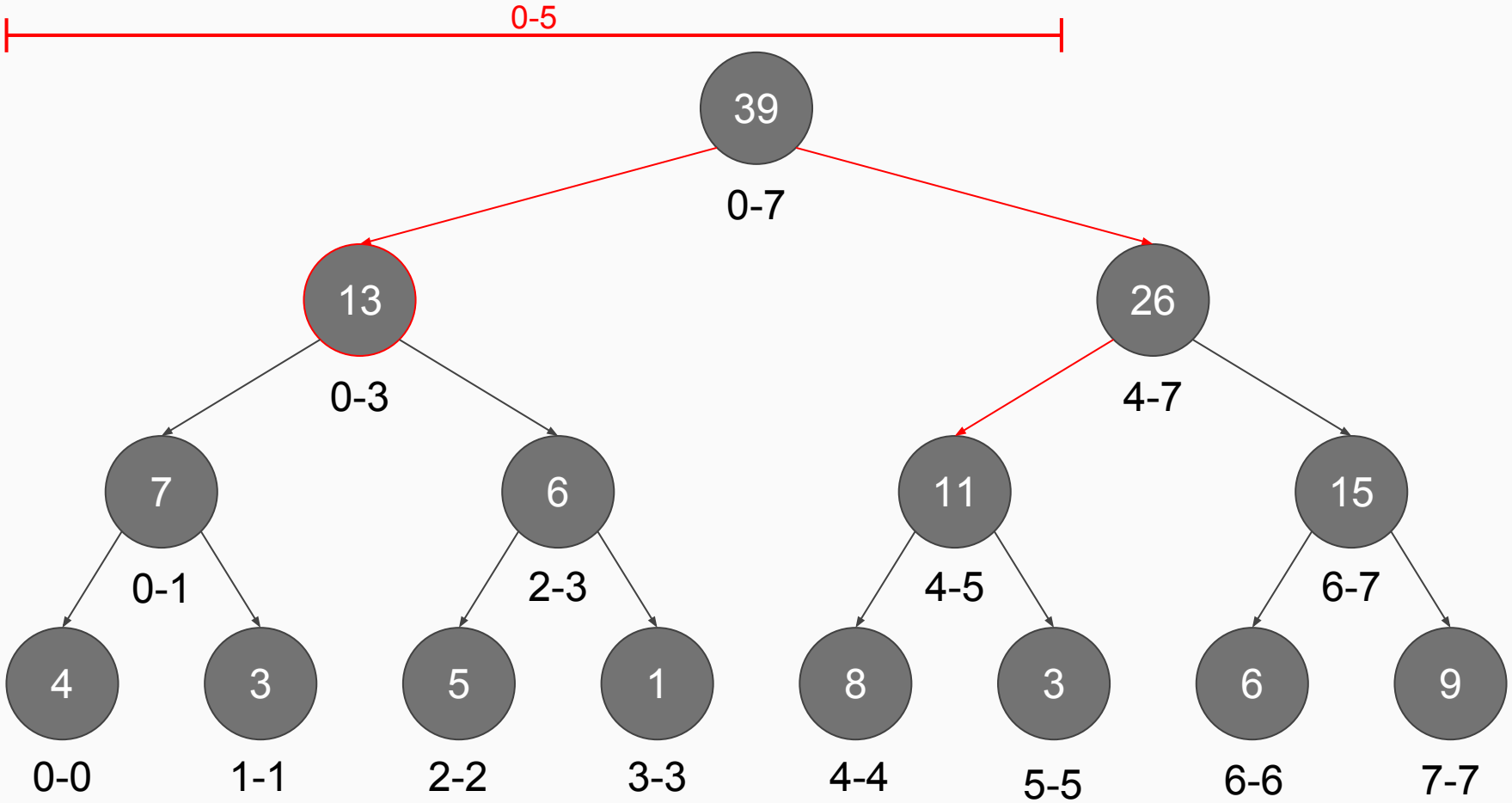
Range Query - (0-5)



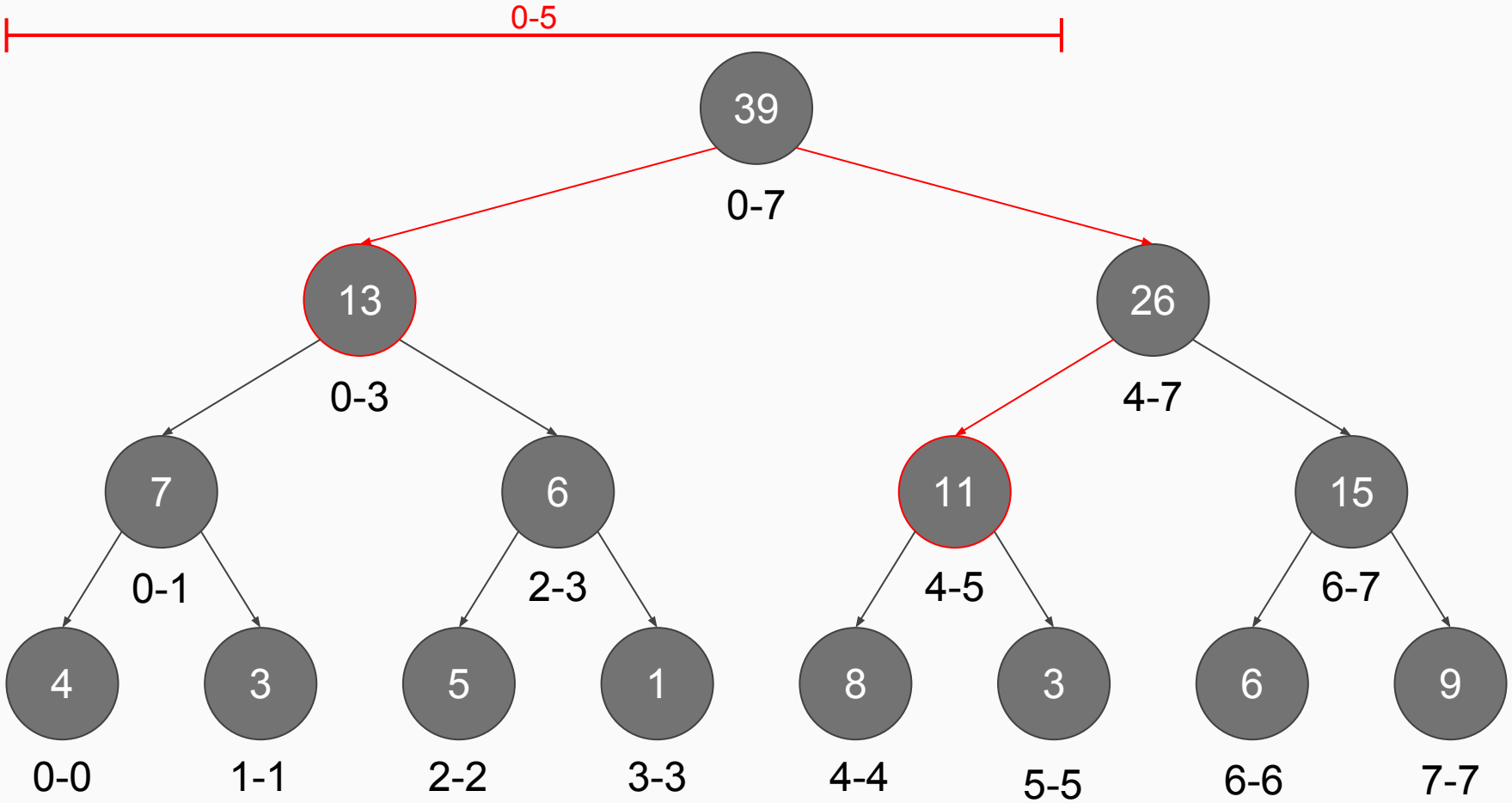
Range Query - (0-5)



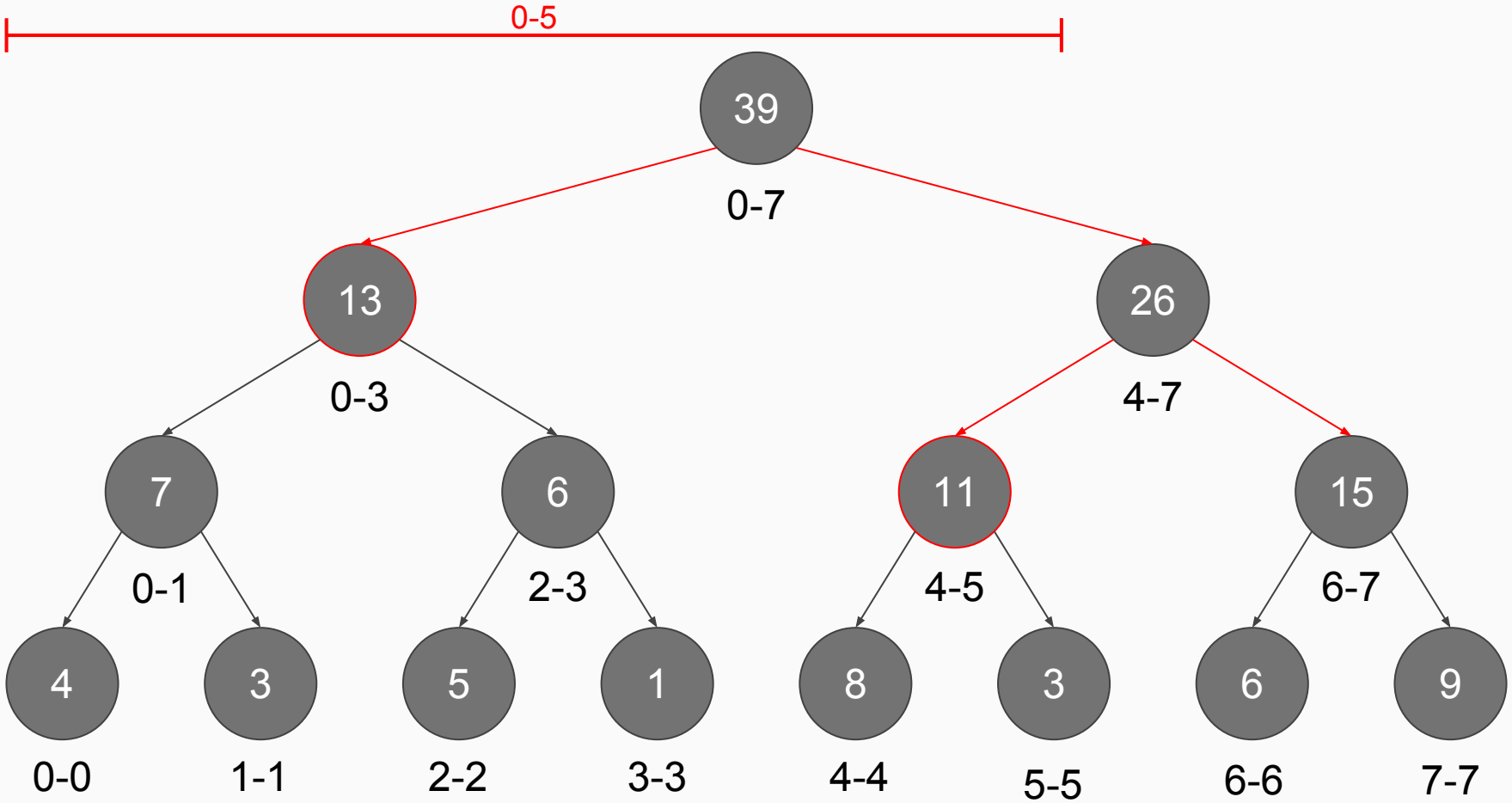
Range Query - (0-5)



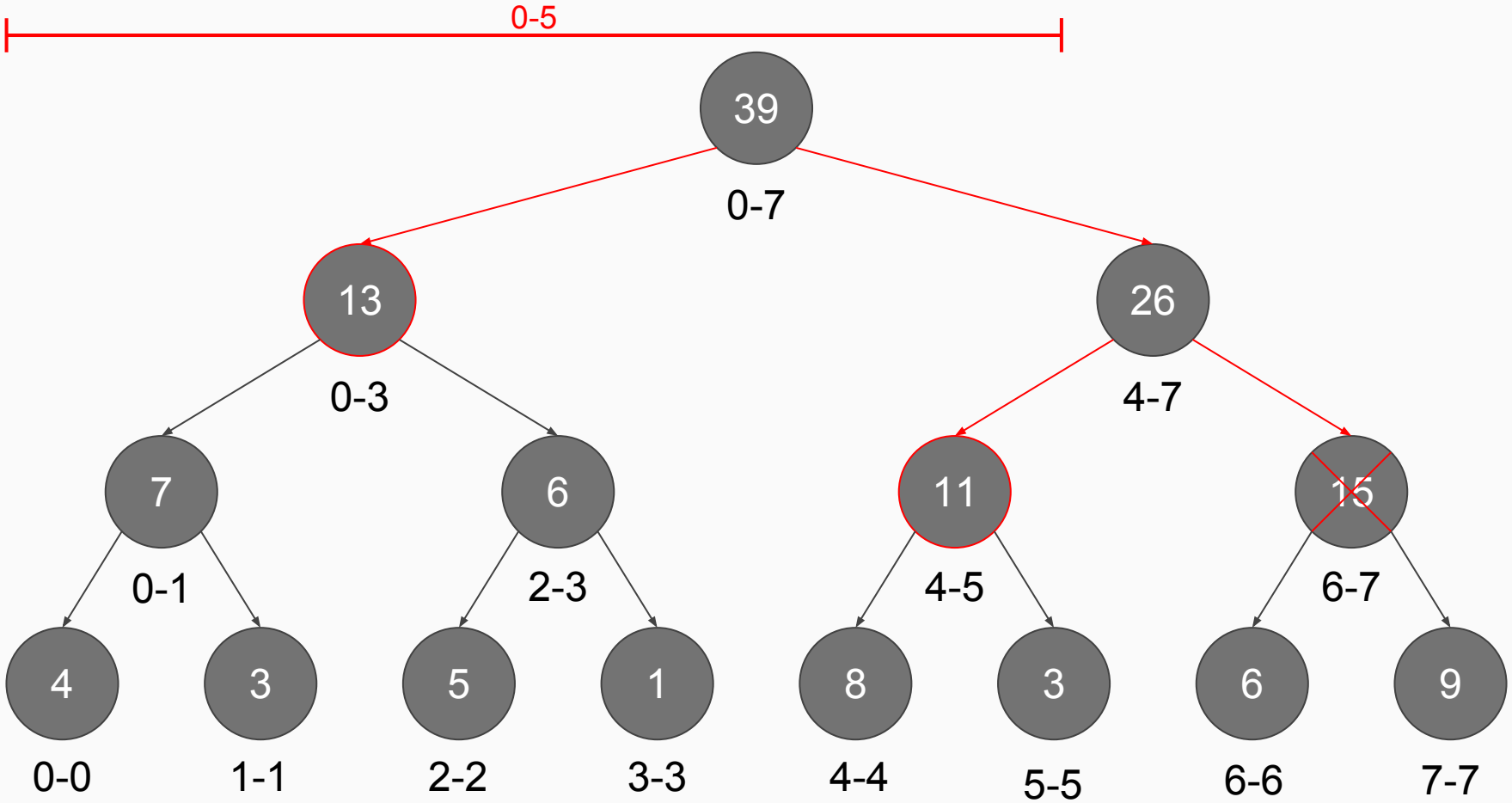
Range Query - (0-5)



Range Query - (0-5)



Range Query - (0-5)

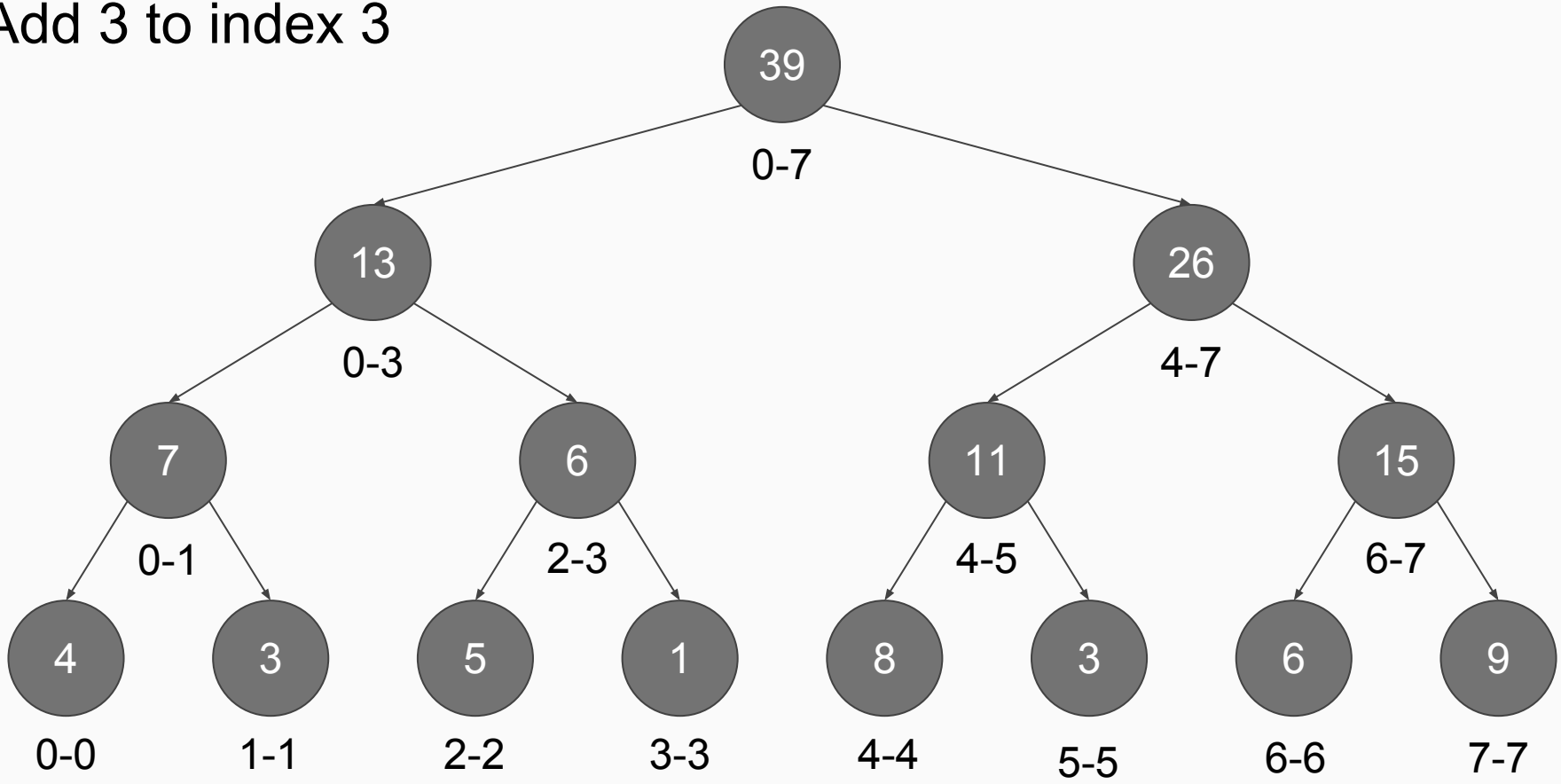


Range Query - (0-5)

Update Item Algorithm

- Base case: Update Node
- Recurse left or right depending on which side item is on
  - Combine results on the way back up

Add 3 to index 3



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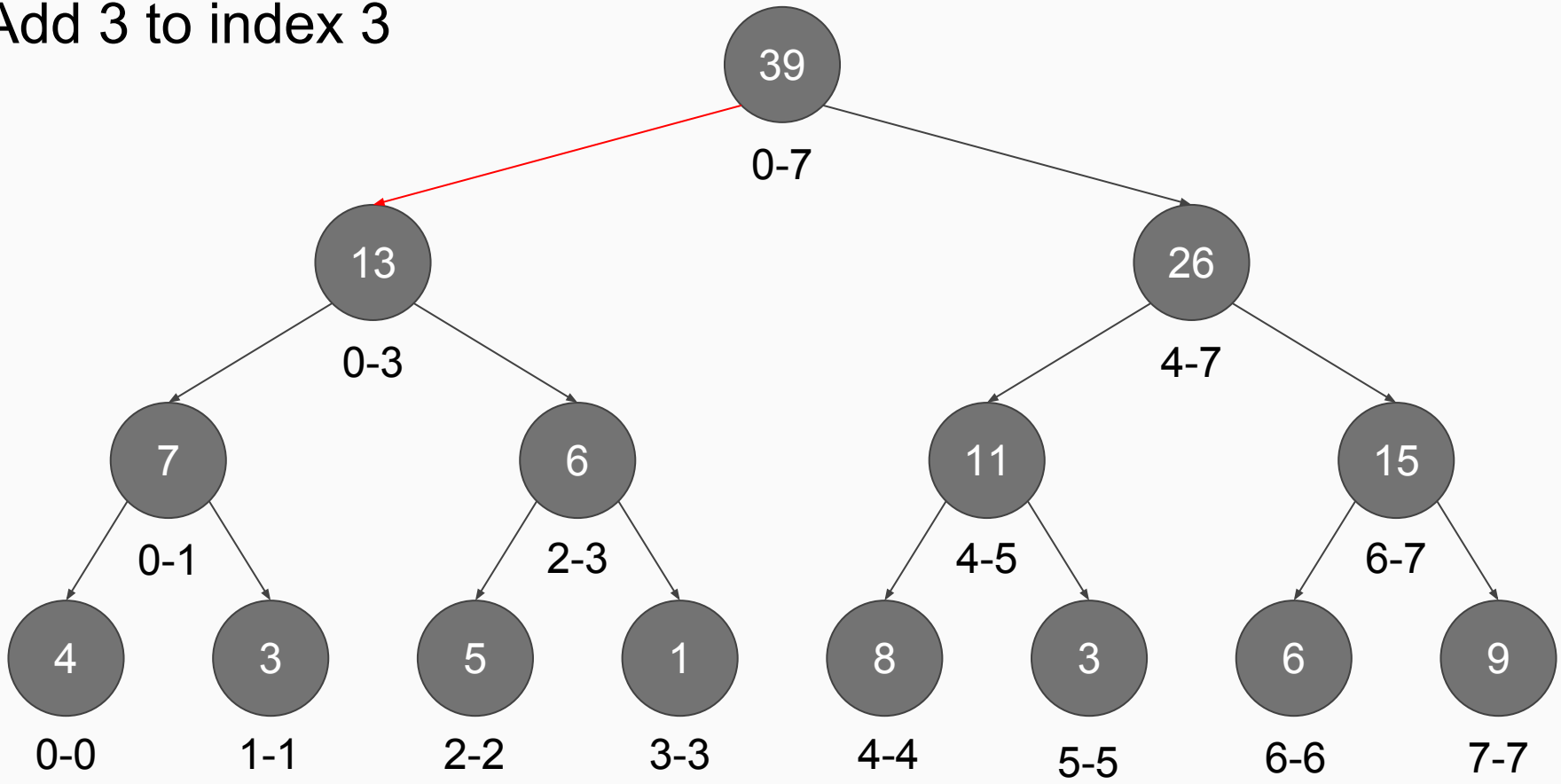

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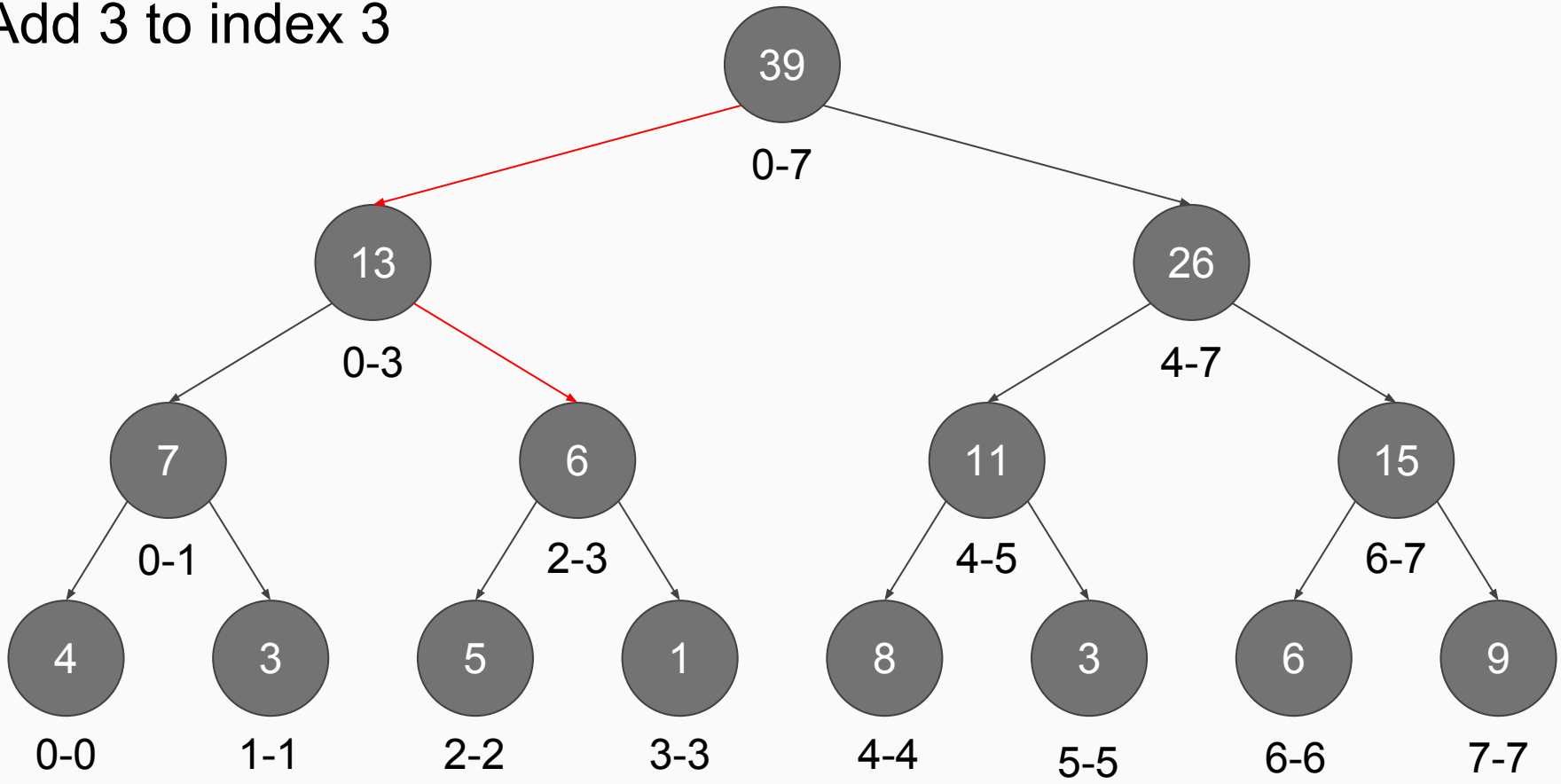

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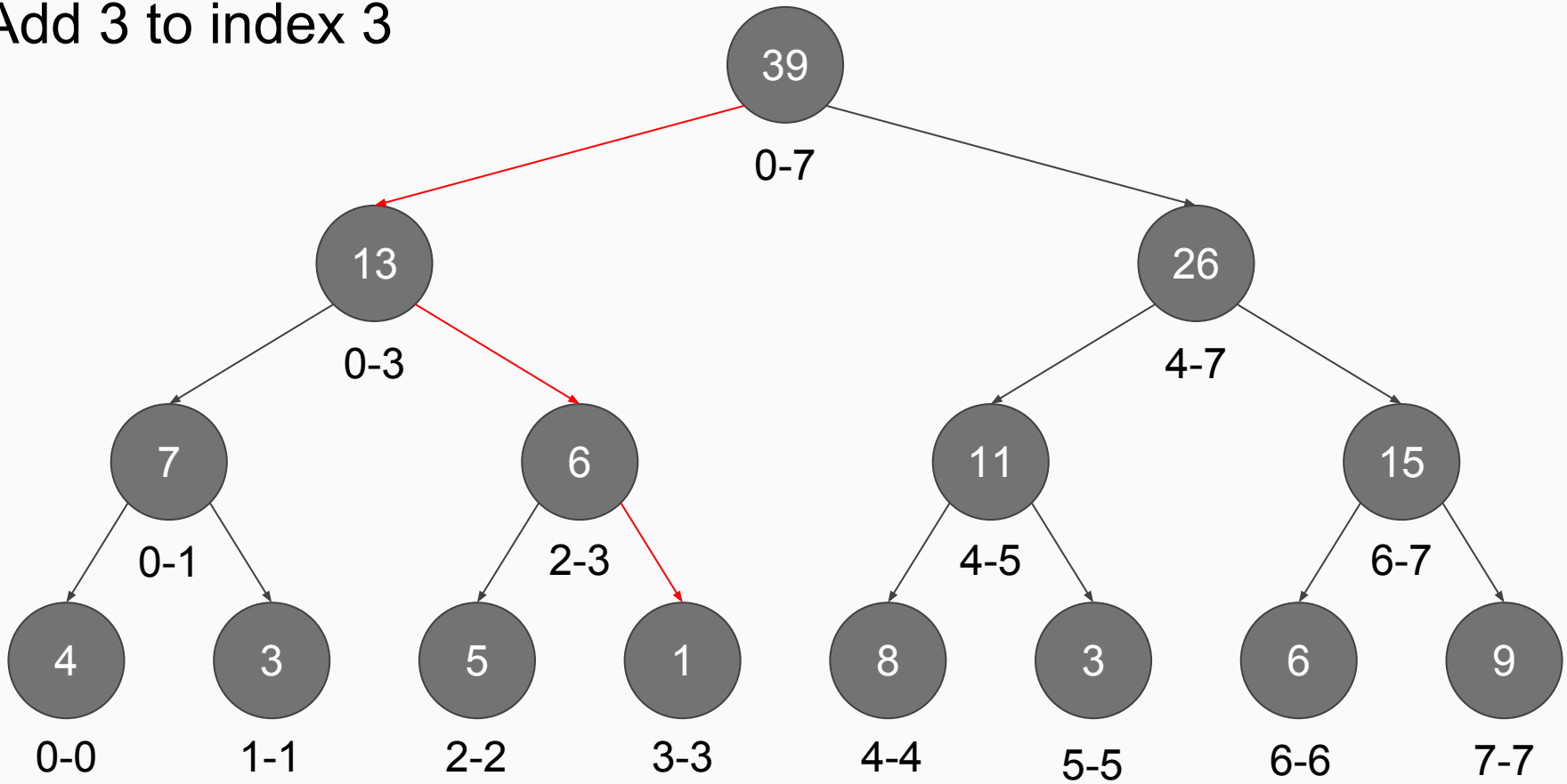

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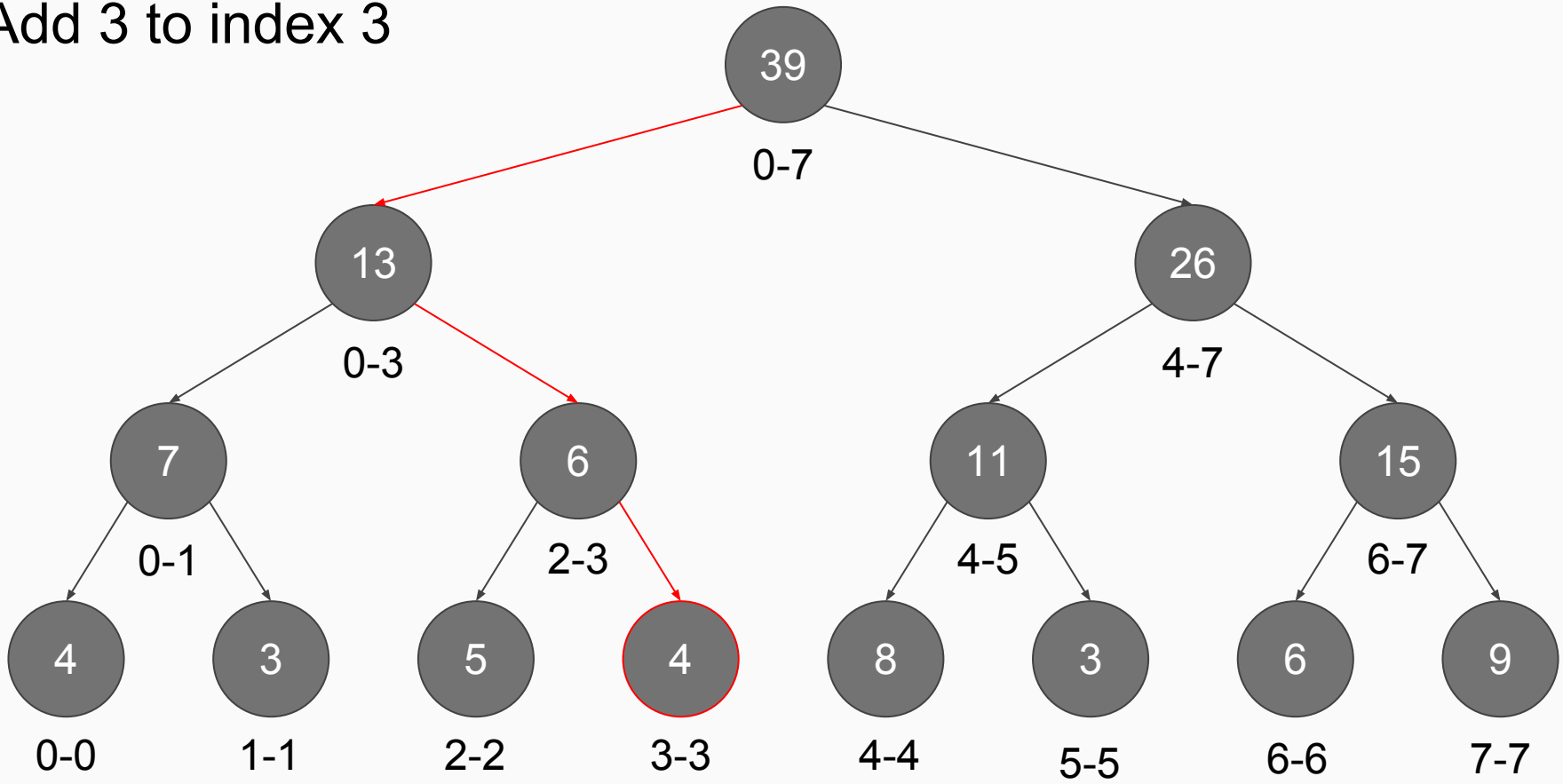

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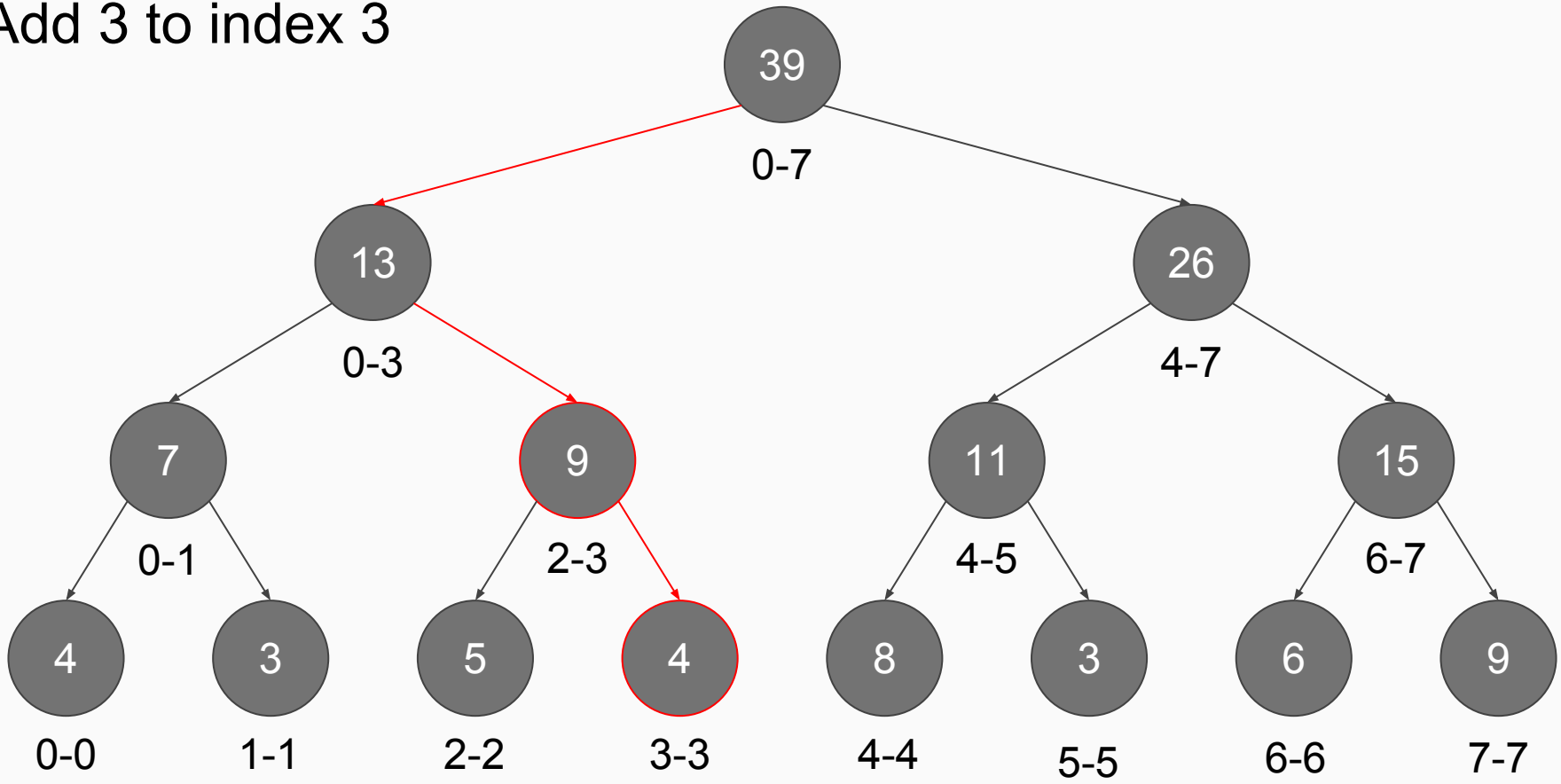

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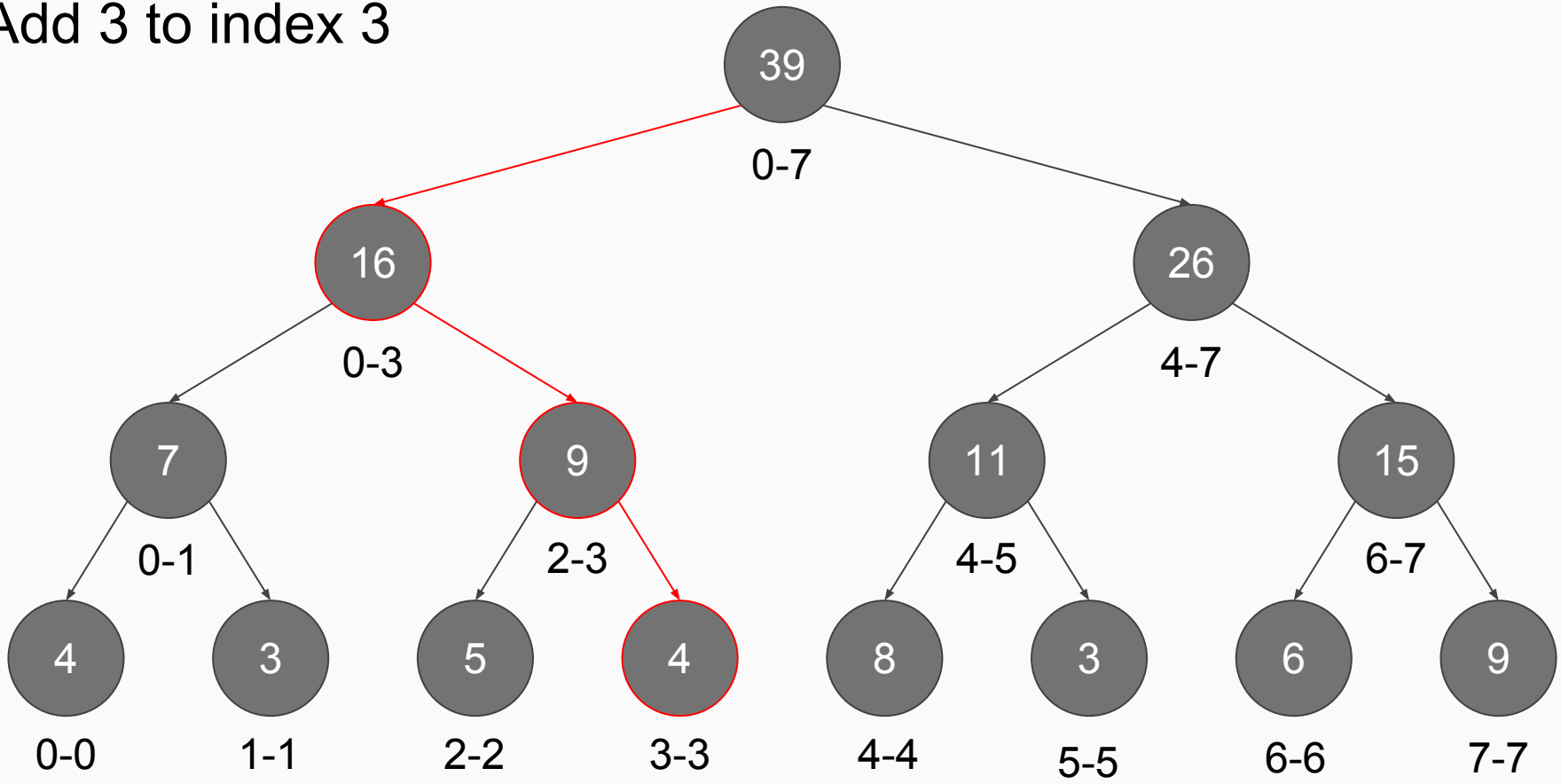

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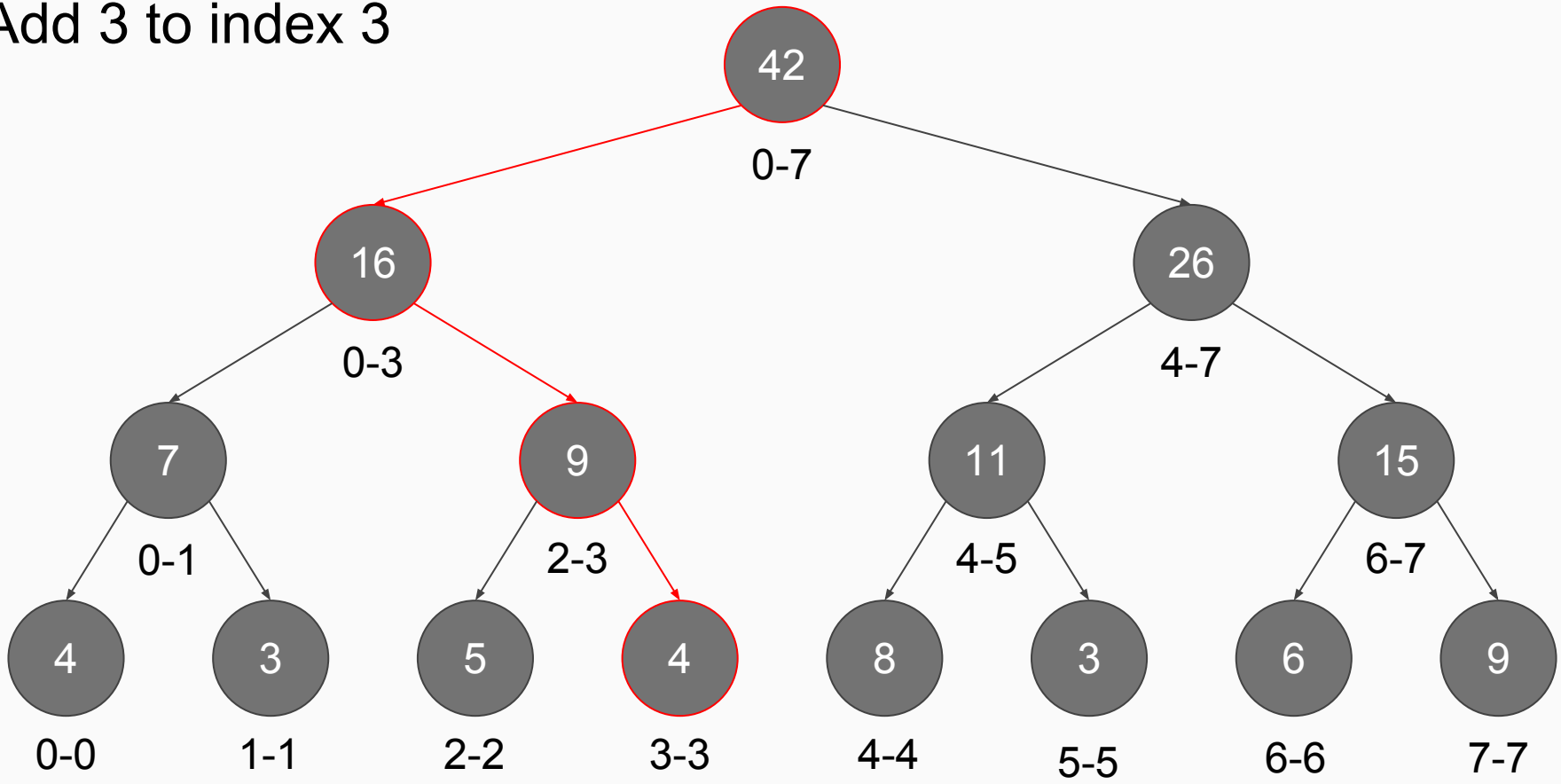

Problems

http://codeforces.com/contest/52/problem/C