Data structures and algorithms

Tutorial 12

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Outline

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What is a heap?

- A Heap is used to implement a priority queue
- A heap stores data in left-justified balanced binary tree

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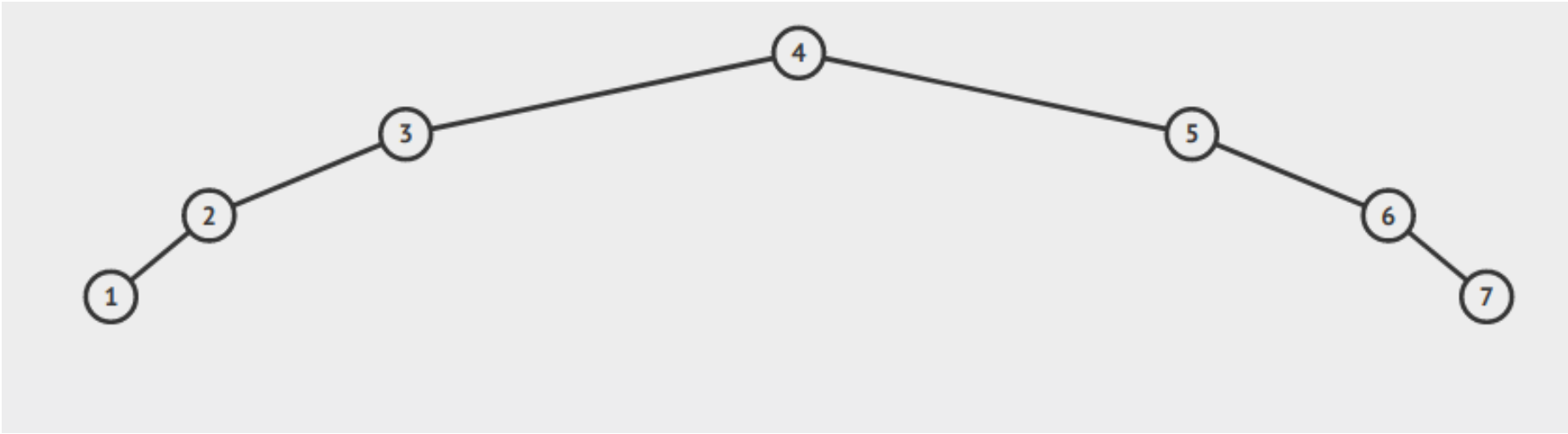
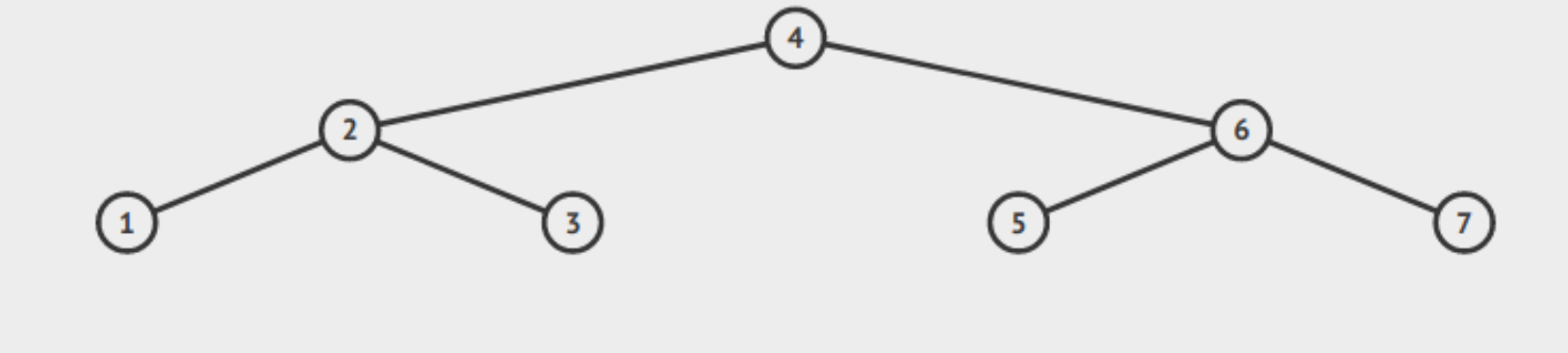
A binary tree is balanced if:

- Both sub-trees are balanced and the height of the two sub-trees differ by at most one.
  (Equivalently)
- All the nodes at depths 0 through n-2 have two children.

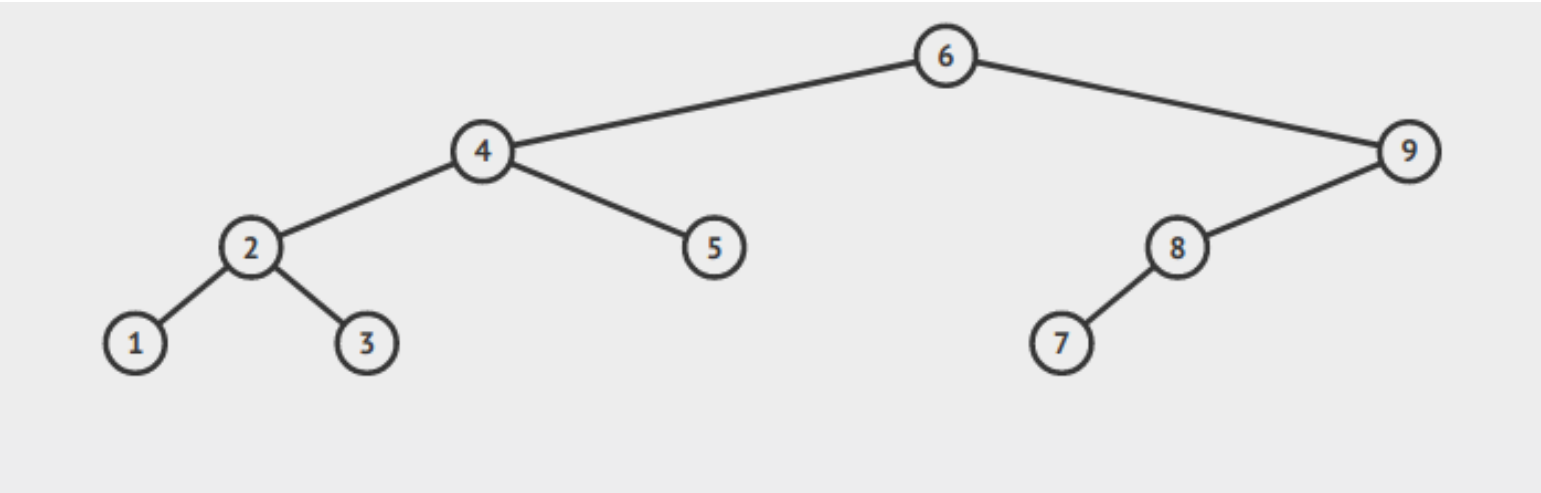
Is this a balanced tree?



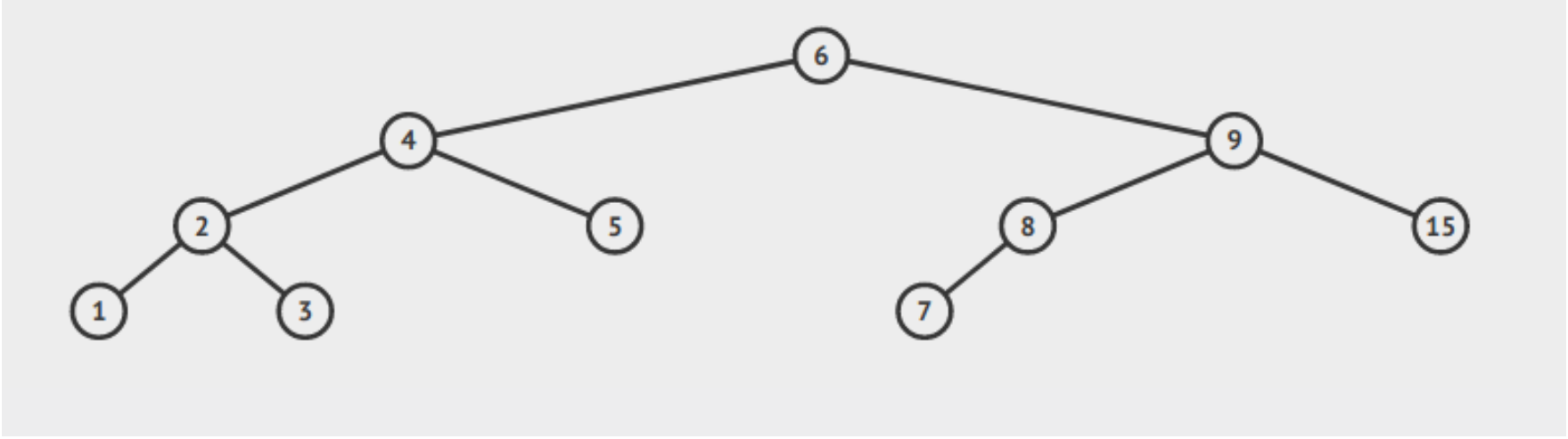
Is this a balanced tree?



Is this a balanced tree?



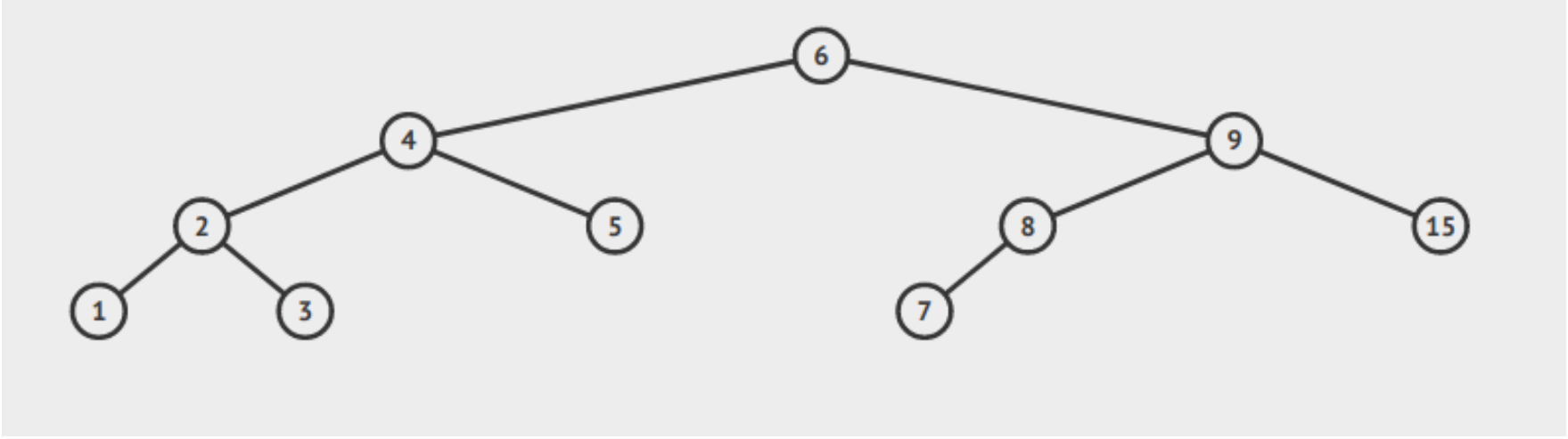
Is this a balanced tree?



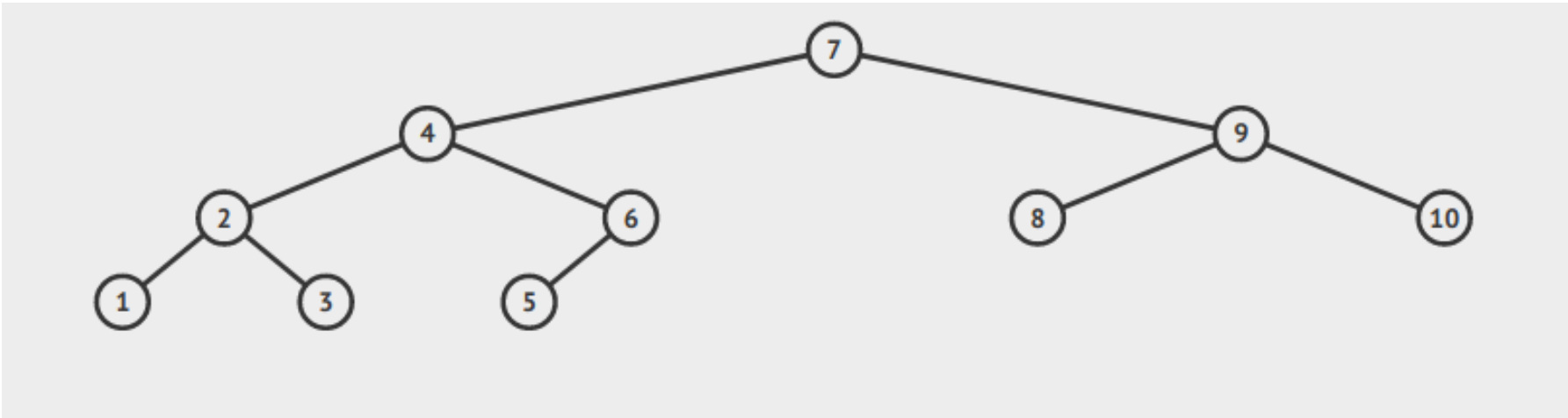
A binary tree is balanced and left-justified if:

- The tree is balanced.
- Leaves are filled in a left to right fashion.

Is this a left-justified balanced binary tree?

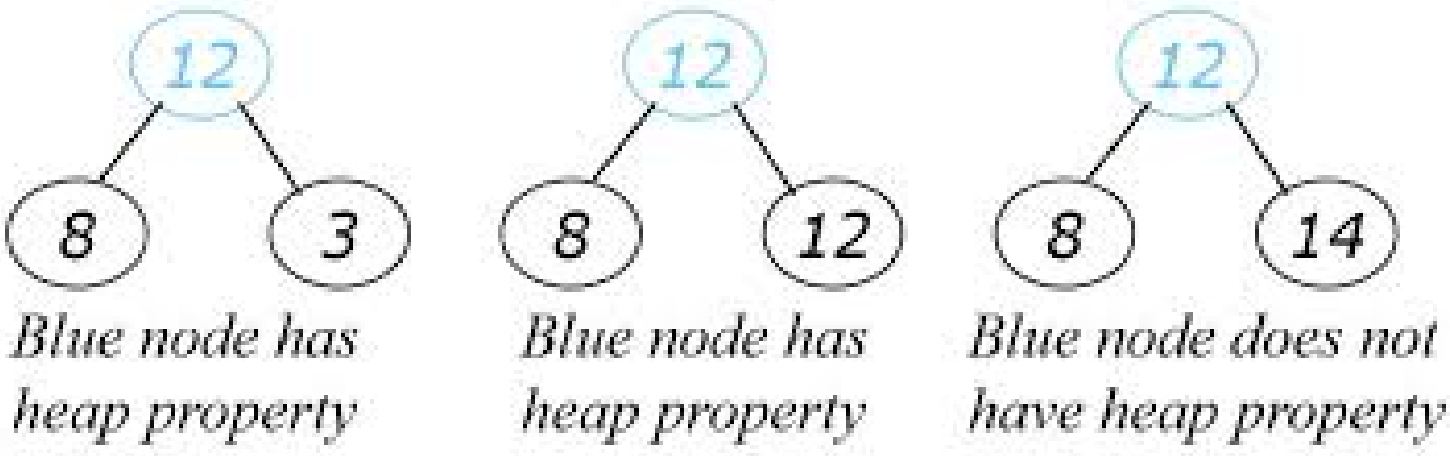


Is this a left-justified balanced binary tree?



Outline

Each and every node in the heap should satisfy the heap property: The value in the node is as large as or larger than the values in its children.



Important note: The tree satisfying the heap property isn't a Binary Search Tree!

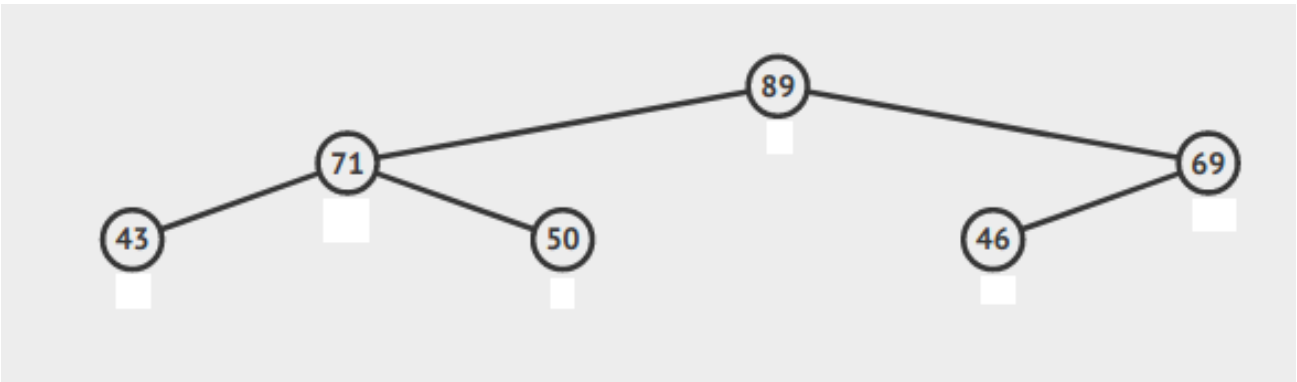
Outline

Operations that a heap should support are:

- Insert a new element to the heap.
- Get the maximum value.
- Delete the maximum value.

How to do the following operations:

- Insert a new value 100
- Insert a new value 75



How to do the insertion?

- Add the new value as the last leaf.
- Compare it to its parent.
  - If the new value is larger than the parent, swap them and compare it to the new parent (Perform sift-up recursively).
  - else, DONE.

How to delete the top of the tree (the root/ the maximum value)?

Outline

- Insert a new element to the heap: O(log(n))
- Get the maximum value: O(1)
- Delete the maximum value: O(log(n))

Outline

- Heap visualization: `https://visualgo.net/en/heap`
- How to do heap sorting?

Feedback form: `https://forms.gle/BZ76rh8hfth3Pxfu5`