# Introduction To Binary Trees

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#### Data structures

- Insert 5
- Insert 3
- Insert 7
- Contains 4? False
- Contains 5? True
- Insert 4
- Insert 6
- Contains 4? True
- Contains 5? True

### Solution #1 – Array

- Insert 5
- Insert 3
- Insert 7
- Contains 4? False
- Contains 5? True
- Insert 4
- Insert 6
- Contains 4? True
- Contains 5? True

- [5,\_,\_,\_,\_,\_,\_]
- [5,3,\_\_,\_,\_,\_,\_]
- [5,3,7,\_\_,\_,\_,\_]
- (Linear search)
- (Linear search)
- [5,3,7,4,\_\_,\_,\_,\_]
- [5,3,7,4,6,\_\_,\_,\_,\_]
- (Linear search)
- (Linear search)

Quick insertion, slow search

## Solution #2 – Ordered Array

- Insert 5
- Insert 3
- Insert 7
- Contains 4? False
- Contains 5? True
- Insert 4
- Insert 6
- Contains 4? True
- Contains 5? True

- [5,\_,\_,\_,\_,\_,\_]
- [3,5,\_,\_,\_,\_,\_,\_]
- [3,5,7,\_\_,\_,\_,\_]
- (Binary search)
- (Binary search)
- [3,4,5,7,<u>\_</u>,\_,\_,\_,\_]
- [3,4,5,6,7,\_\_,\_,\_,\_]
- (Binary search)
- (Binary search)

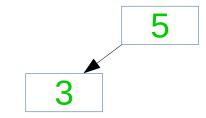
Quick search, slow insertion

Goal: Quick search, quick insertion. Idea:

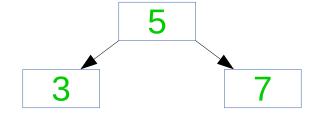
- No array;
- Each number is in its own "node";
- Smaller numbers go to left;
- Larger numbers go to right.

- Insert 5
- Insert 3

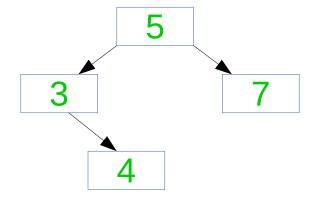
- Insert 5
- Insert 3
- Insert 7



- Insert 5
- Insert 3
- Insert 7
- Insert 4

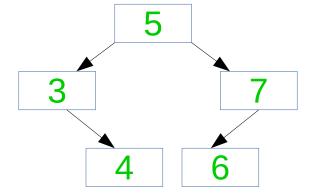


- Insert 5
- Insert 3
- Insert 7
- Insert 4
- Insert 6



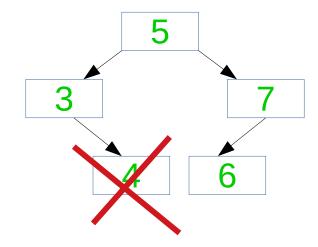
# **Binary Tree**

- Insert 5
- Insert 3
- Insert 7
- Insert 4
- Insert 6



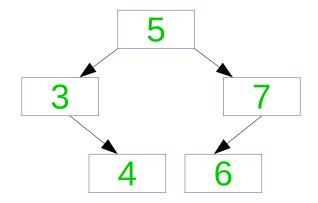
#### Binary Tree – remove node with **no children**:

- Insert 5
- Insert 3
- Insert 7
- Insert 4
- Insert 6
- Remove 4 just delete the node.



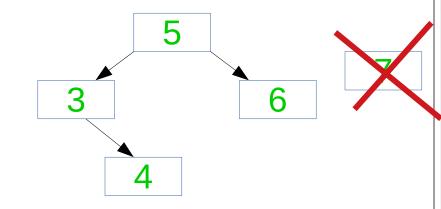
## Binary Tree – remove node with **one child**:

- Insert 5
- Insert 3
- Insert 7
- Insert 4
- Insert 6
- Remove 7



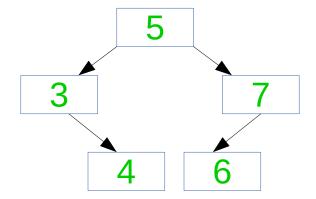
#### Binary Tree – remove node with **one child**:

- Insert 5
- Insert 3
- Insert 7
- Insert 4
- Insert 6
- Remove 7 take left sub-tree and move it instead of the deleted node.



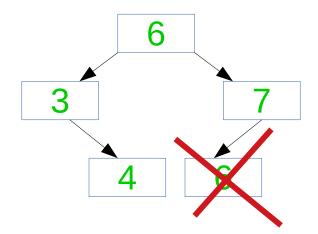
#### Binary Tree – remove node with two children:

- Insert 5
- Insert 3
- Insert 7
- Insert 4
- Insert 6
- Remove 5



#### Binary Tree – remove node with two children:

- Insert 5
- Insert 3
- Insert 7
- Insert 4
- Insert 6
- Remove 5 copy smallest number in right sub-tree to deleted node; delete smallest element recursively.



## Binary Tree – further information

 http://www.algolist.net/Data\_structures/Binary\_searc h\_tree/Removal