# [TAP:BYGMP] Selection Sort

- Which of the following is the worst algorithm?
  - A. Selection Sort (with linear search)
  - B. Selection Sort with binary search
  - C. Selection Sort with a heap
  - D. Heapsort
  - E. Whatever

# Removing From a PQ

min Heap

- Steps
  - Store the value of root
  - Delete the (right most node among the nodes with the largest depth) put its value in the root
  - while (value > value of (at least) one child )
    - Swap with a child with the smallest value
  - Return the value stored in step 1

"find" leaf

# Today’s Outline

- Binary Search Tree
  - Basics
  - Operations
  - Implementation

# Searching in sorted list vs unsorted list

- Search in ***unsorted*** list

  8          7, 3, 12, 6, 9, 1, 15

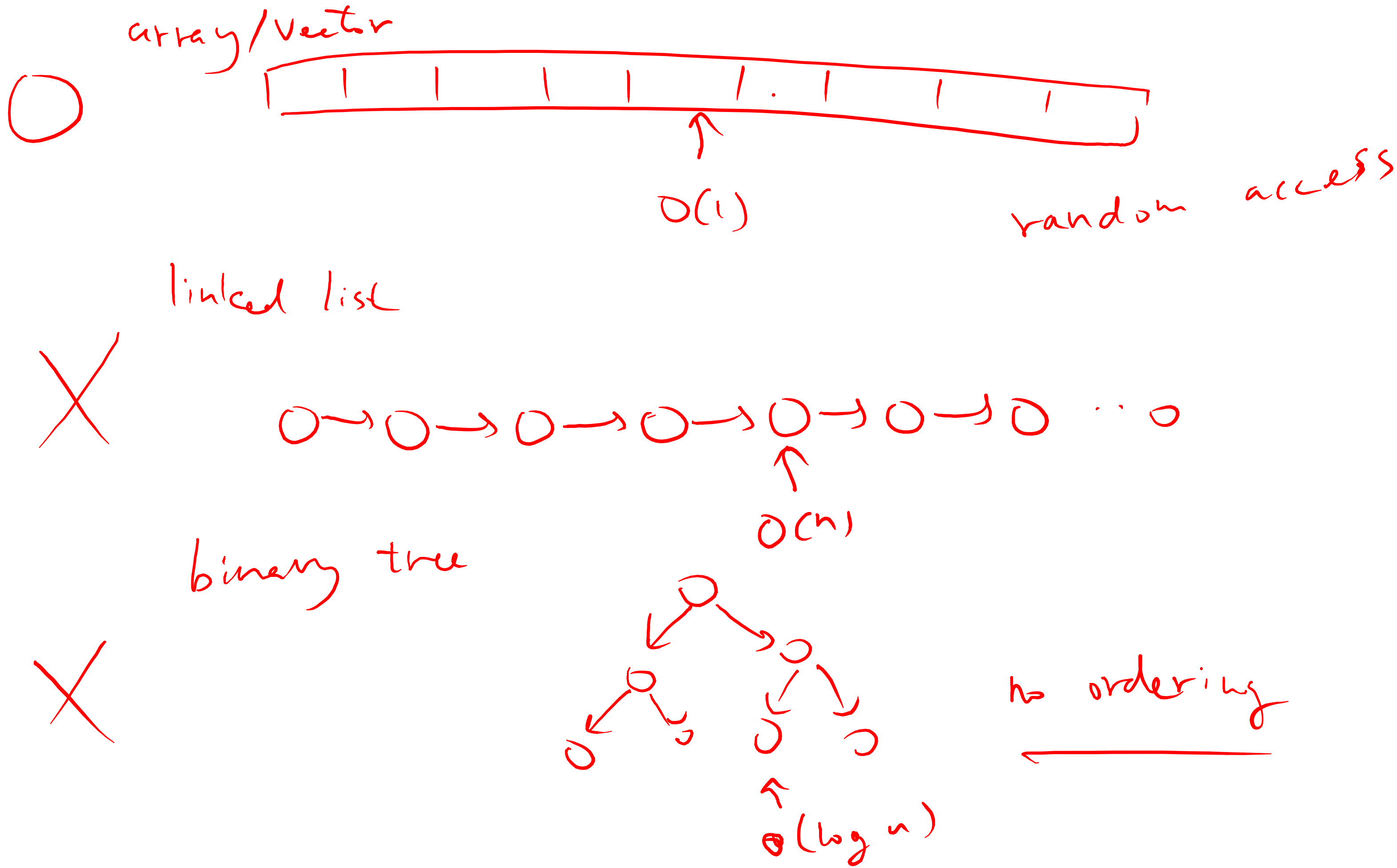
  - Linear Search: O( n )
- Search in ***sorted*** list

  8          1, 3, 6, 7, 9, 12, 15

  - Linear Search: O( n )
  - Binary Search: O( log n )

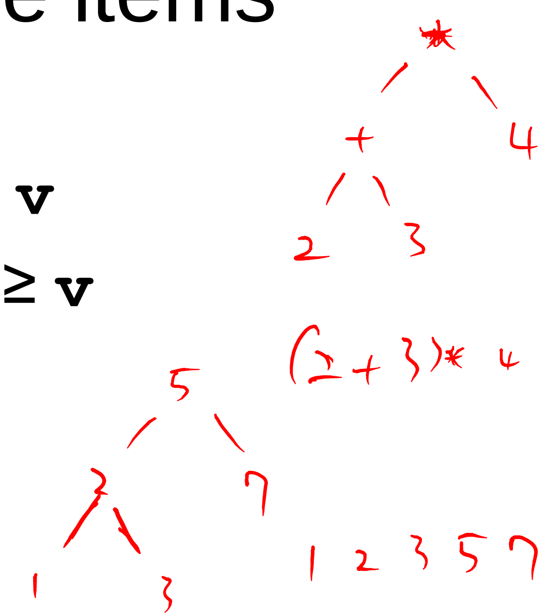
# Data structures compatible with binary search?

- Data structures to store a list:



# Binary Trees and Orders

- Binary trees impose multiple orderings on their elements (pre-/in-/post-/level-orders)
- In particular, in-order traversal suggests a natural way to hold comparable items
  - For each node **v** in tree
    - All values in left subtree of **v** are ≤ **v**
    - All values in right subtree of **v** are ≥ **v**
- This leads us to...



# Binary Search Tree (BST)

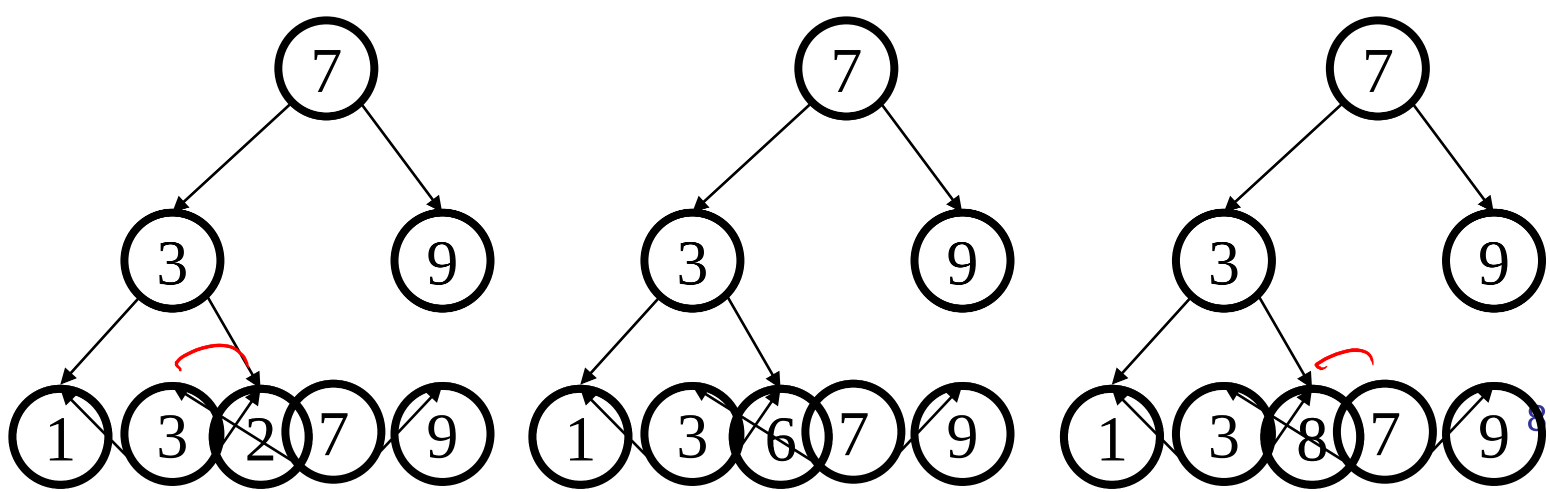
- **Definition:**
  - A *binary tree* s.t. for every node *n* in the tree,

$$left \leq n \leq right$$

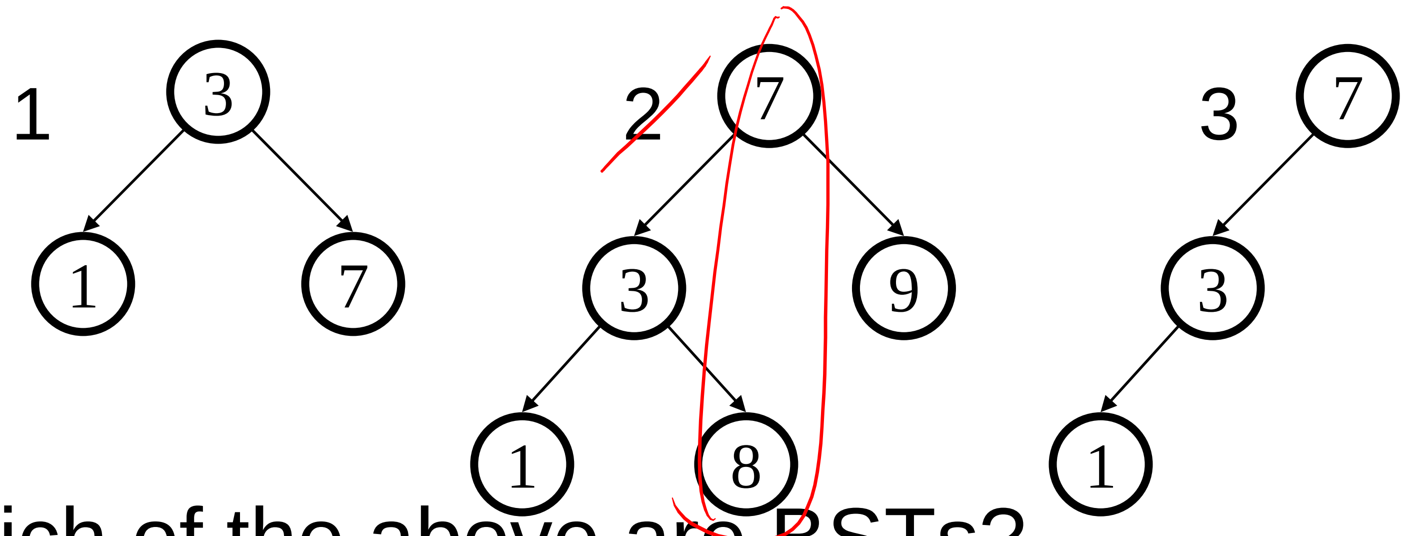
where *left* = any node in the left subtree

*right* = any node in the right subtree

1 2 3



# [TAP] Binary Search Tree




- Which of the above are BSTs?
  A. 1
  B. 1 and 2
  C. 1 and 3
  D. 1, 2, and 3
  E. Whatever

# Today's Outline

- Binary Search Tree
  - Basics
  - Operations
  - Implementation

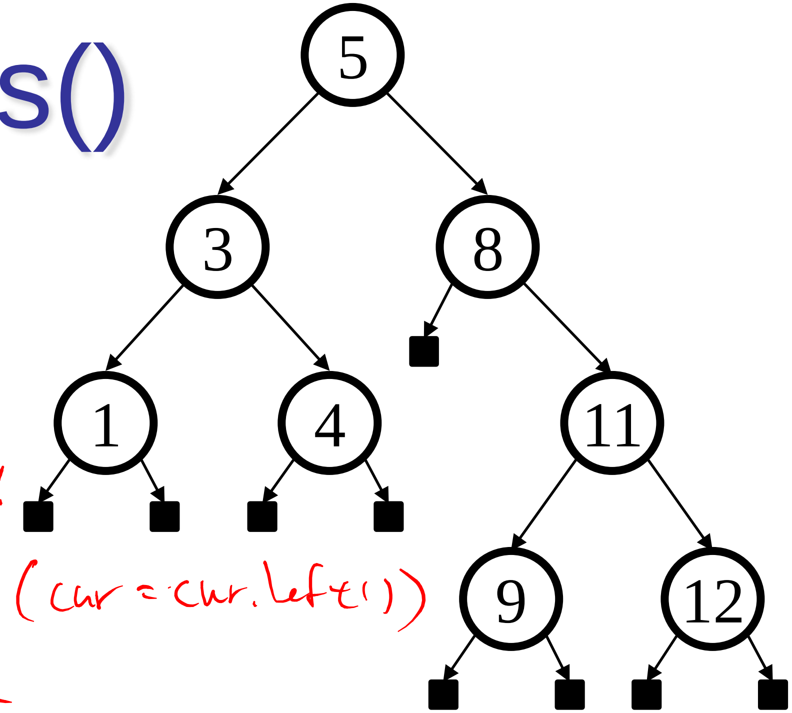
# BST Operations

- BSTs will implement the OrderedStructure Interface
  - `add(E item)`
  - `contains(E item)`
  - `get(E item)`
  - `remove(E item)`
  - `iterator()` ← in-order traversal

~~$O(\log n)$~~ $\log n \le h \le n$

$O(h)$ ← height of the tree

# contains()




- contains(key):

cur == root

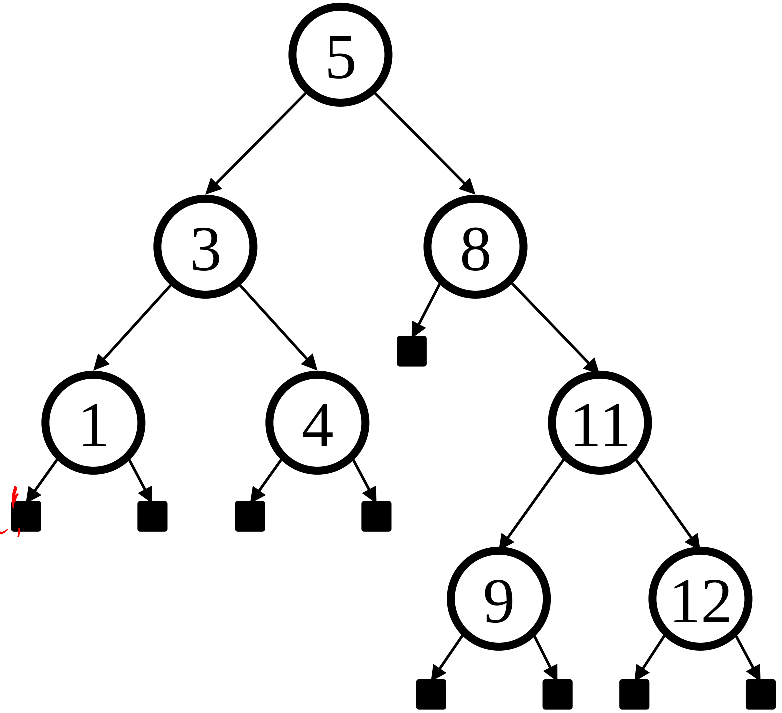
if cur.isEmpty() : not found!

if key < cur.key : go left (cur = cur.left())

if key > cur.key : go right

if key == cur.key : found it!

# get()




- get(key):

    cur = root

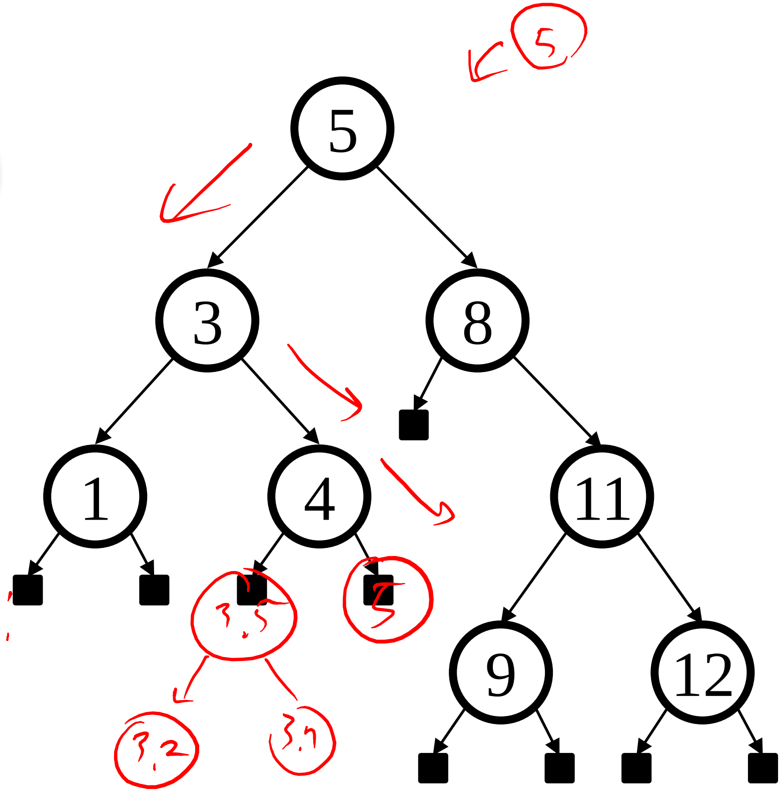
    if cur.isEmpty(): not found!

    if key < cur.key: go left

    if key > cur.key: go right

    if key == cur.key: found it!

# add()




- add(x):

    cur = root

    if cur.isEmpty(): add here!

    if key < cur.key: go left

    if key > cur.key: go right

    if key == cur.key: add x at predecessor(cur)