LEC 13

CSE 123

Binary Trees

BEFORE WE START

Talk to your neighbors:

What's your favorite flower?

Instructors: Nathan Brunelle

TAs:

Arohan	Ashar	Neha	Rohini	Rushil
Ido	Zachary	Sebastian	Joshua	Sean
Hayden	Caleb	Justin	Heon	Rashad
Srihari	Benoit	Derek	Chris	Bhaumik
Kuhu	Kavya	Cynthia	Shreya	Ashley
Ziao	Kieran	Marcus	Crystal	Eeshani
Prakshi	Packard	Cora	Dixon	Nichole
Niyati	Trien	Lawrence	Evan	Cady

Questions during Class?

Raise hand or send here

sli.do #cse123A

Lecture Outline

- **Announcements**
- Binary Tree Review
- Traversals
- Practice!

Announcements

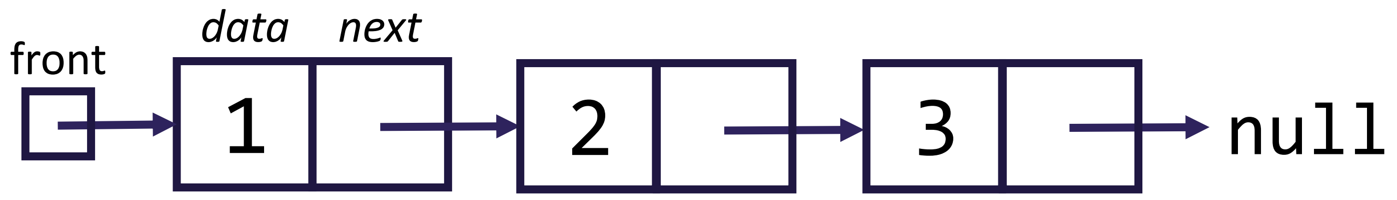
- Resubmission Cycle 4 is due tonight at 11:59pm
  - *C1*, P1 eligible
- Programming Assignment 2 is out, due Wednesday (May 21)

Lecture Outline

- Announcements
- **Binary Tree Review** ◀
- Traversals
- Practice!

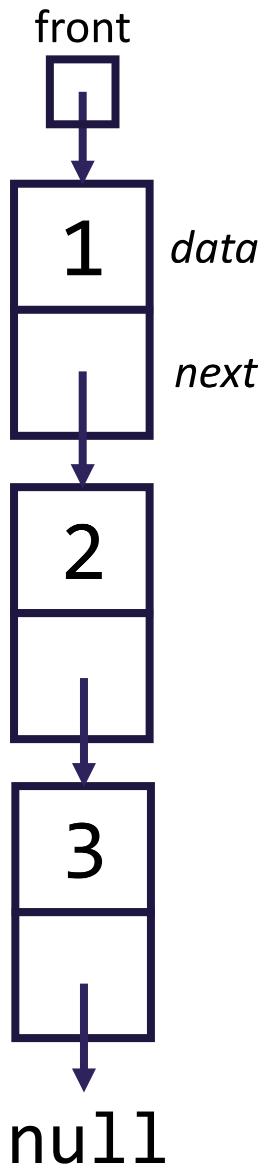
Binary Trees

- Last data structure of the quarter!
  - Very similar to `LinkedLists`…



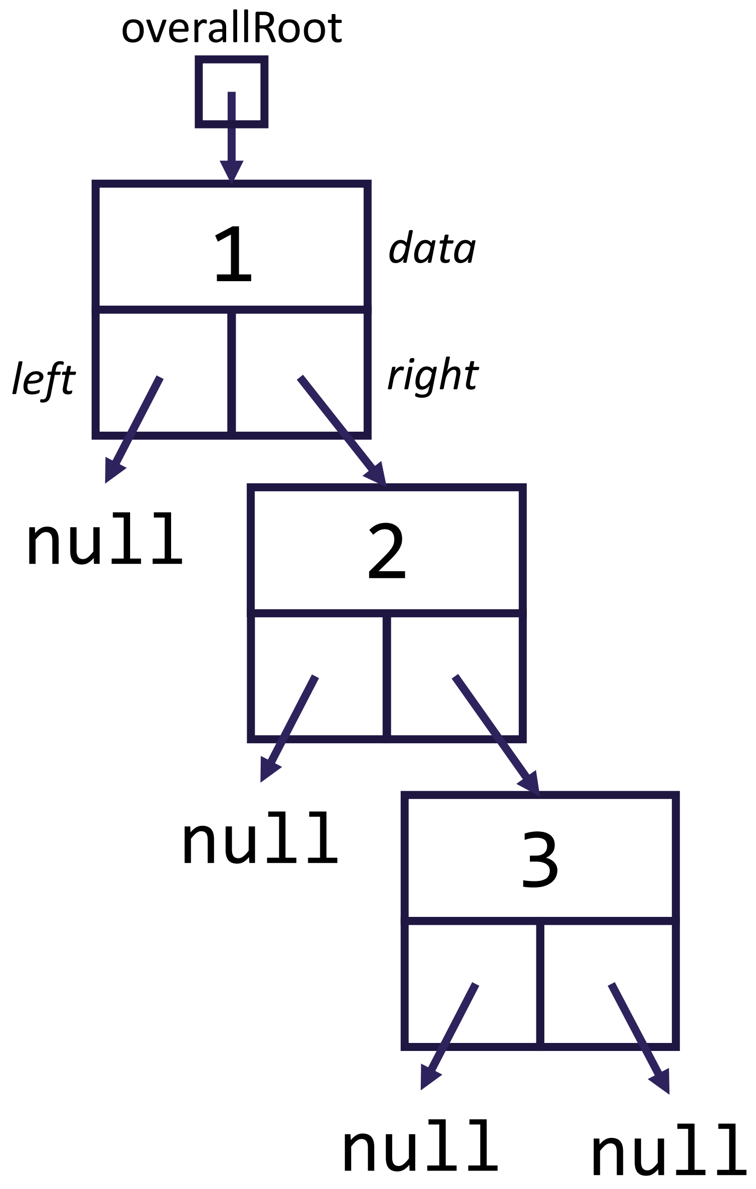
Binary Trees

- Last data structure of the quarter!
  - Very similar to `LinkedLists`…



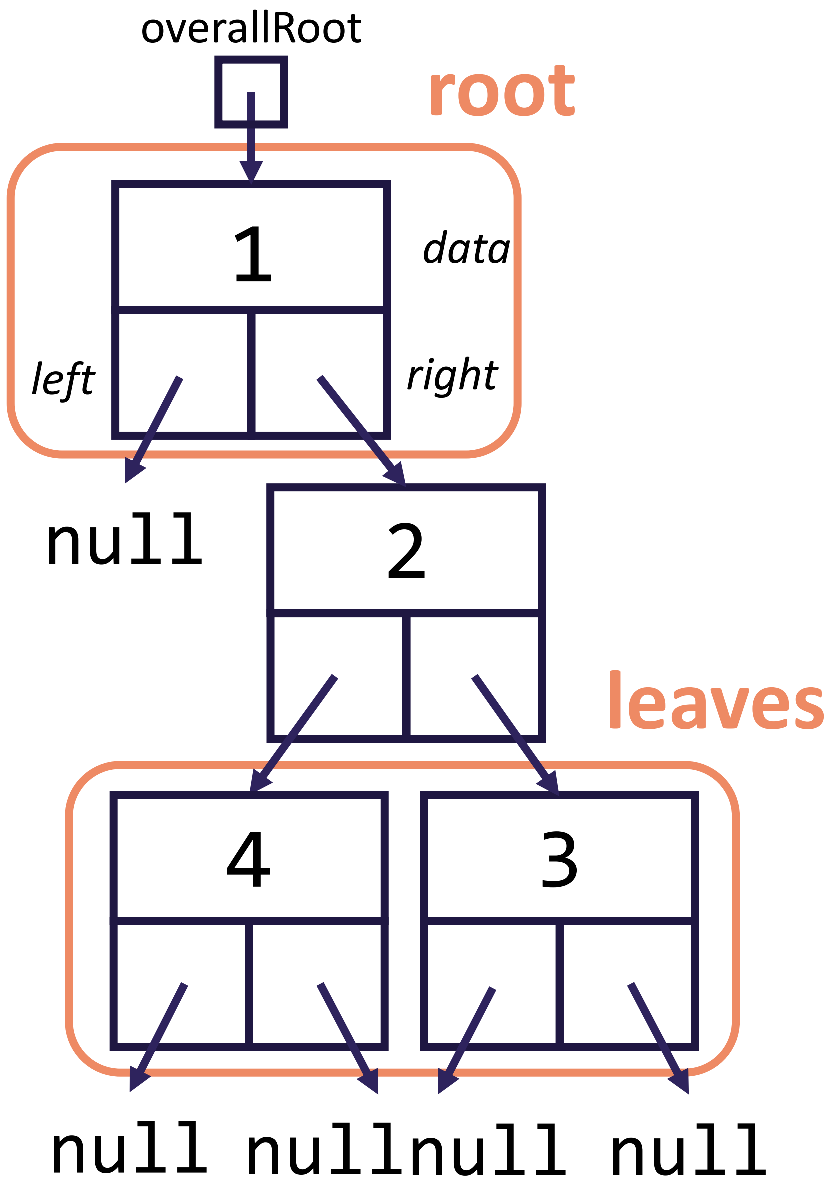
Binary Trees

- Last data structure of the quarter!
  - Very similar to `LinkedLists`…
- Linked `TreeNodes` w/ 3 fields:
  - int data, `TreeNode` left, `TreeNode` right
  - Doubly complicated!

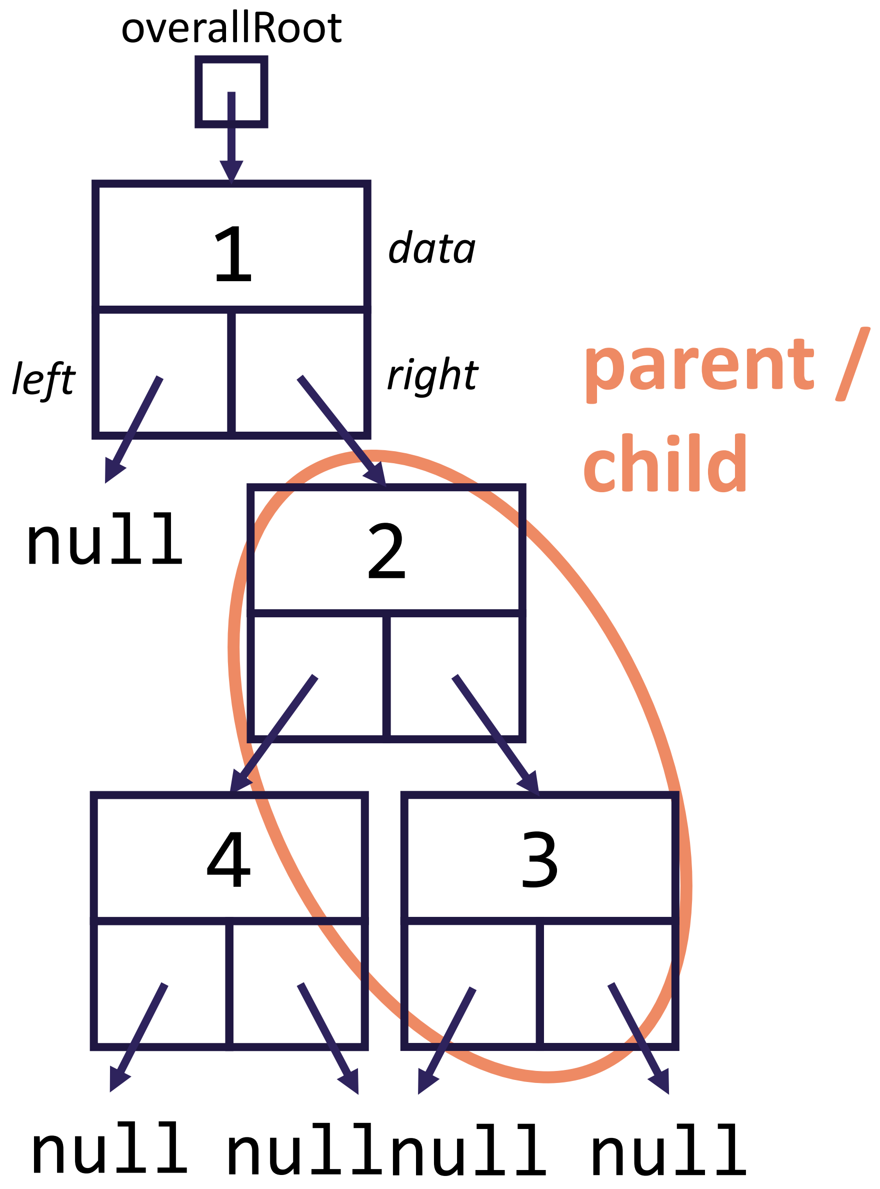


Binary Trees

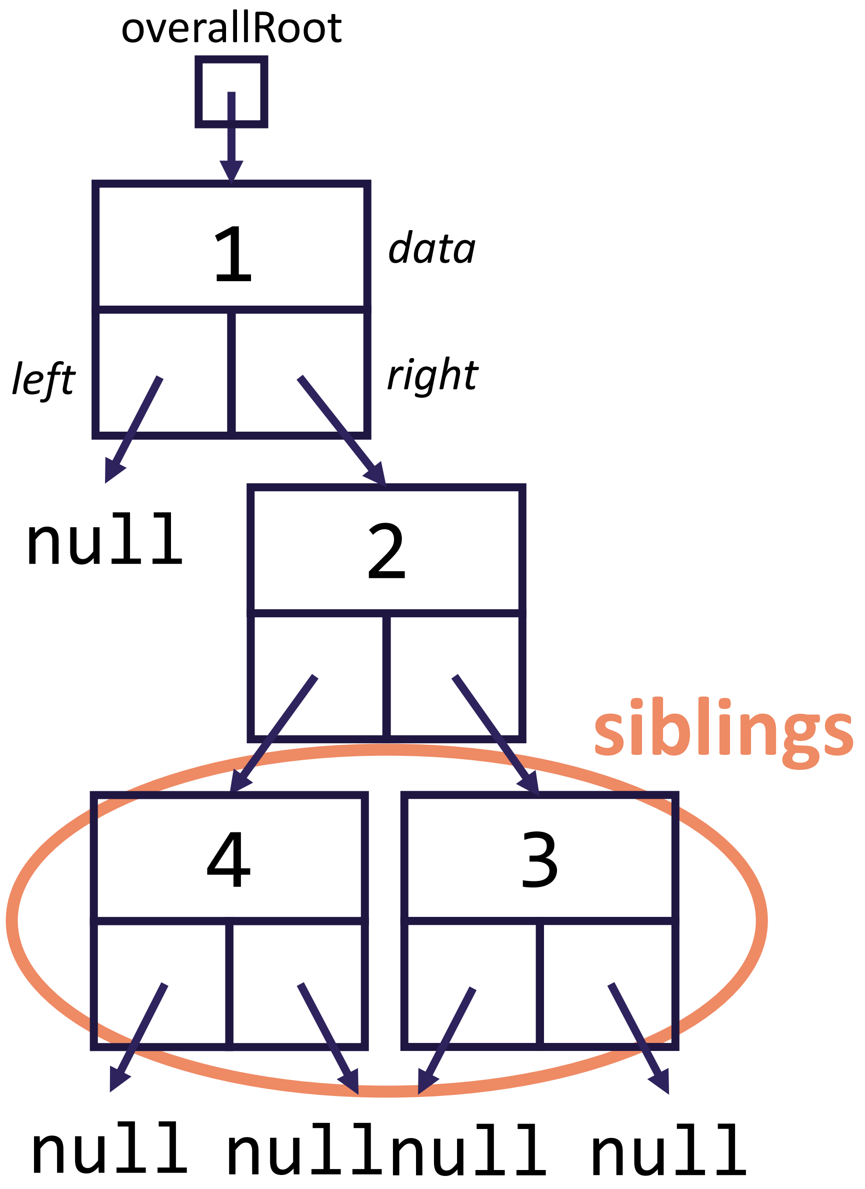
- Last data structure of the quarter!
  - Very similar to `LinkedLists`…
- Linked `TreeNodes` w/ 3 fields:
  - int data, `TreeNode` left, `TreeNode` right
  - Doubly complicated!
- Similar to trees?
  - Close enough!
  - Terminology: root / leaves
- Other terminology as well



Tree Terminology

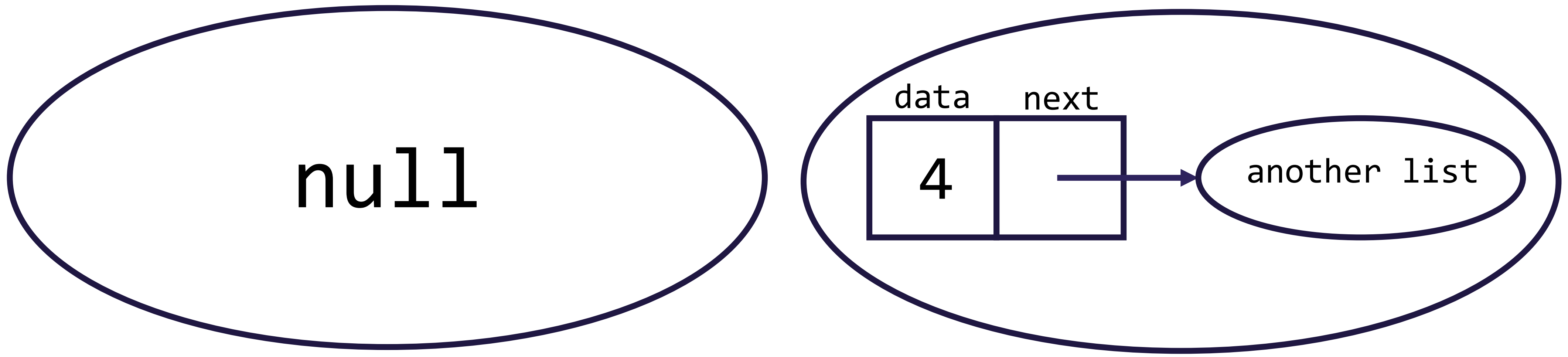


Tree Terminology



Linked Lists [Review]

- A linked list is either:



Empty list

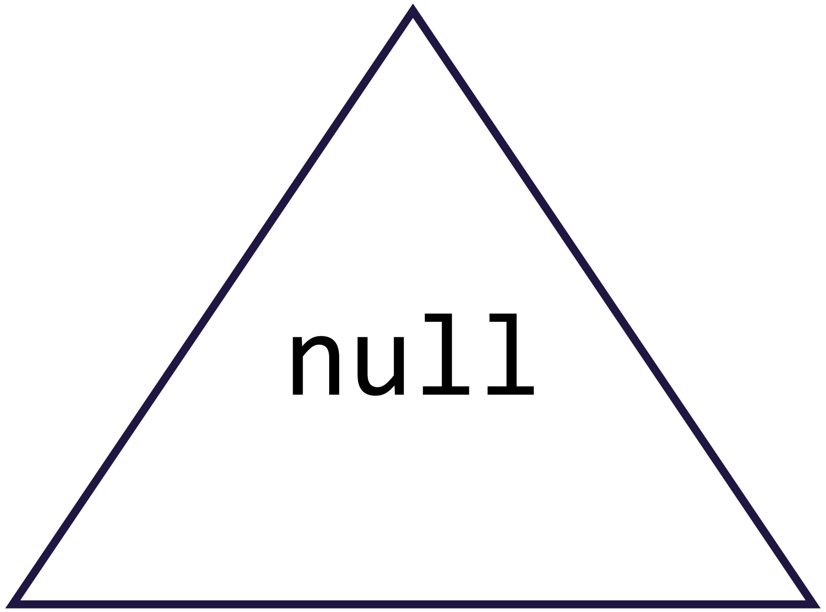
Node w/ another linked list

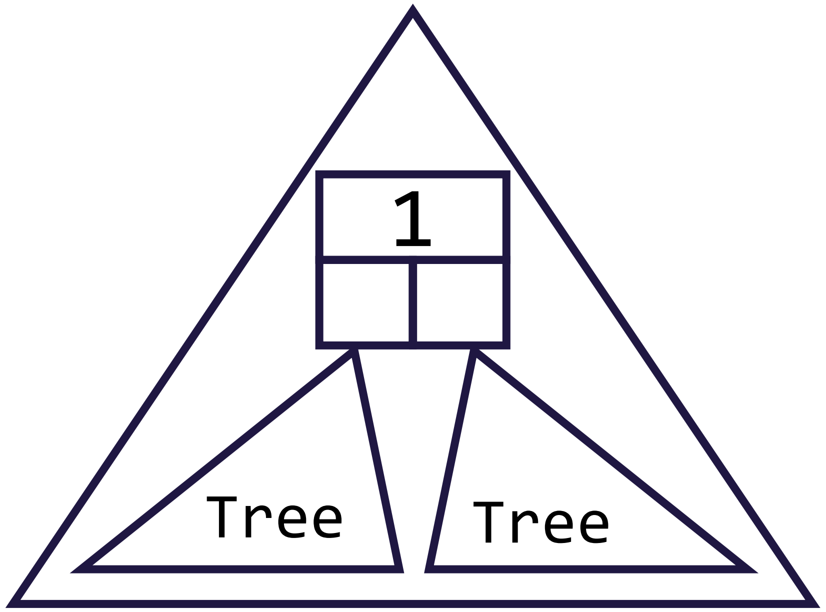
This is a recursive definition!

A list is either empty or a node with another list!

Binary Trees

- A Binary Tree is either:





Empty tree

Node w/ two subtrees

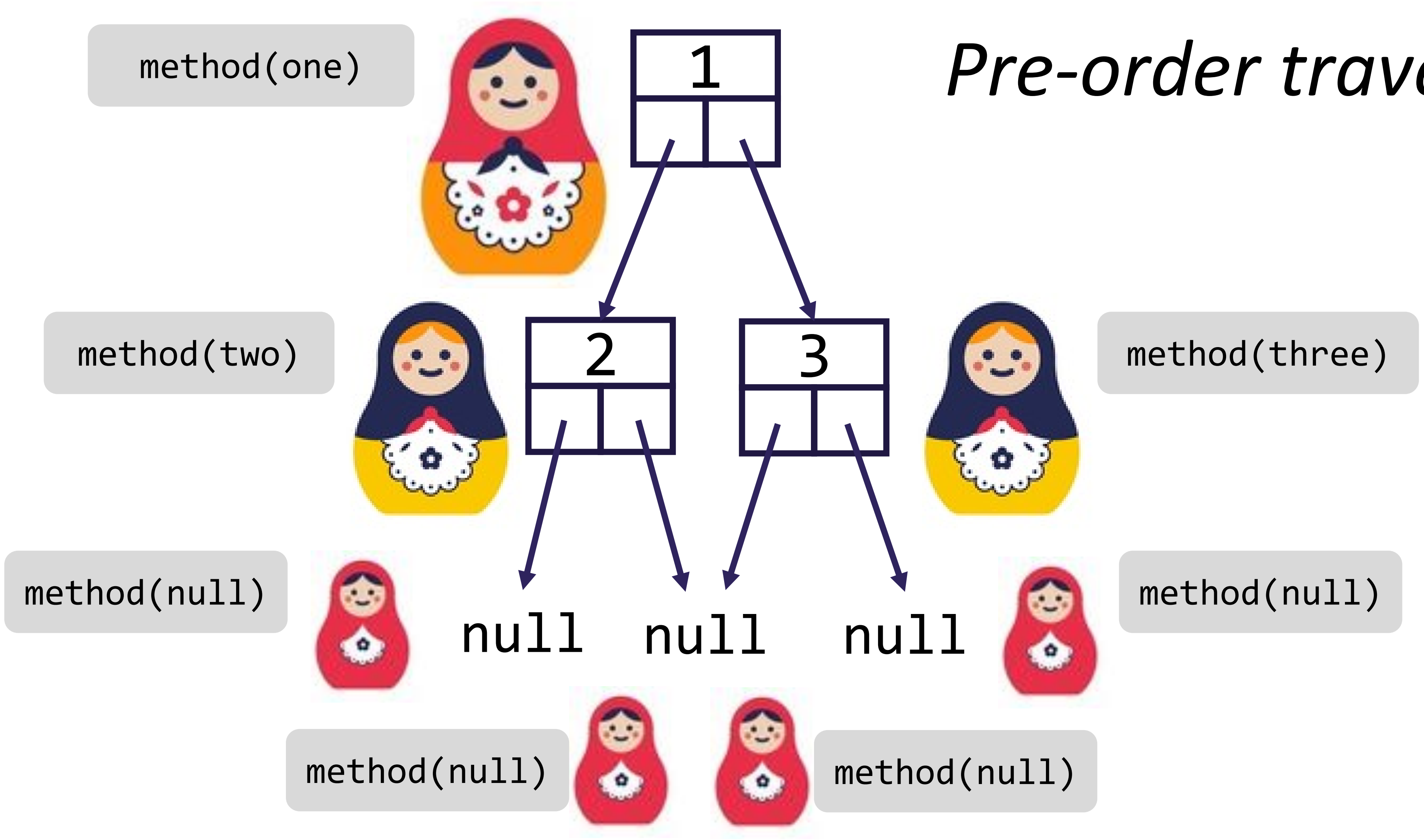
This is a recursive definition!
A tree is either empty or a node with two more trees!

Binary Tree Programming

- Programs look very similar to Recursive LinkedList!
- Guaranteed base case: empty tree
  - Simplest possible input, should immediately know the return
- Guaranteed public / private pair
  - Need to know which subtree you're currently processing
- If modifying, we use `x = change(x)`
  - Don't stop early, return updated subtree (`IntTreeNode`)
- Let's trace through an example together…

Tracing Through Binary Tree Programming

Pre-order traversal



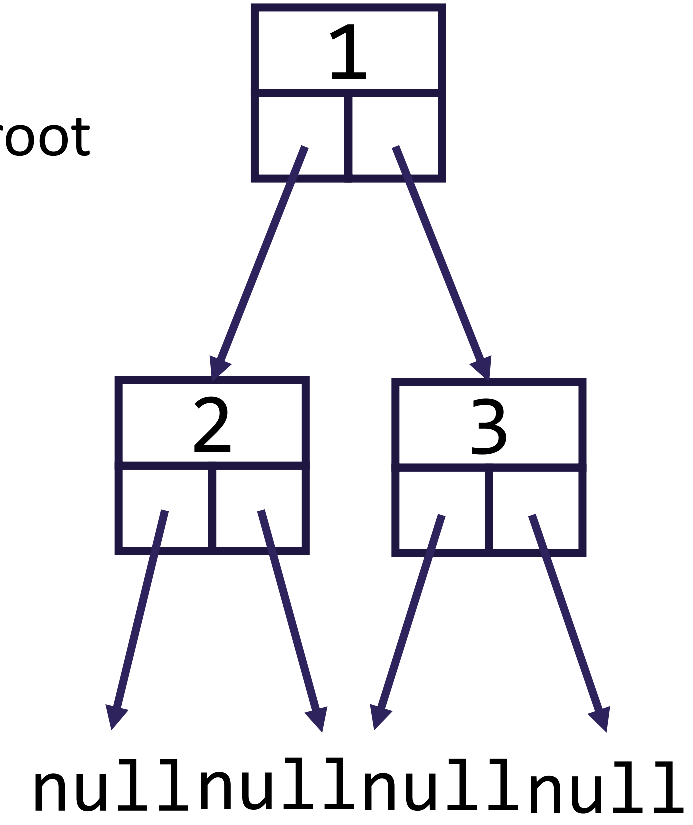
Lecture Outline

- Announcements
- Binary Tree Review
- **Traversals**
- Practice!

Binary Tree Traversals

- 3 different primary traversals
  - All concerned with when you process your current root

- Pre-order traversal:
  - Process **root**, left subtree, right subtree
- In-order traversal:
  - Process left subtree, **root**, right subtree
- Post-order traversal:
  - Process left subtree, right subtree, **root**

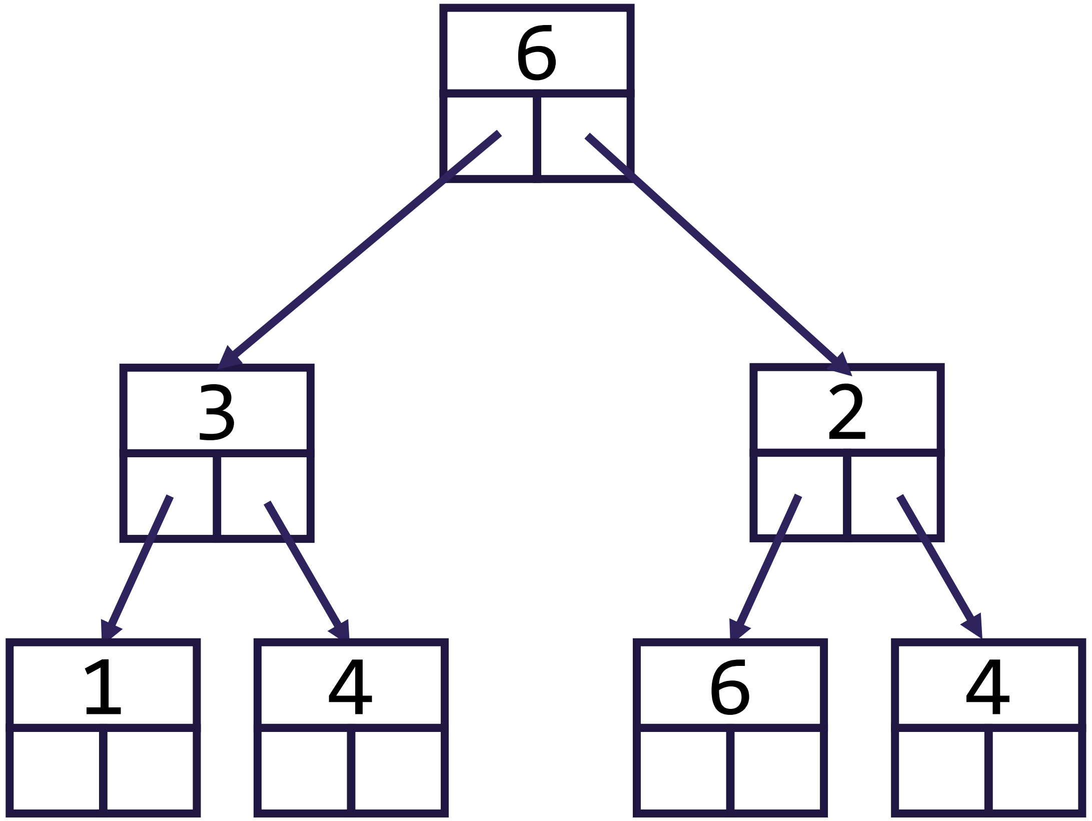


Sometimes different traversals yield different results

Practice : Think

sli.do #cse123A

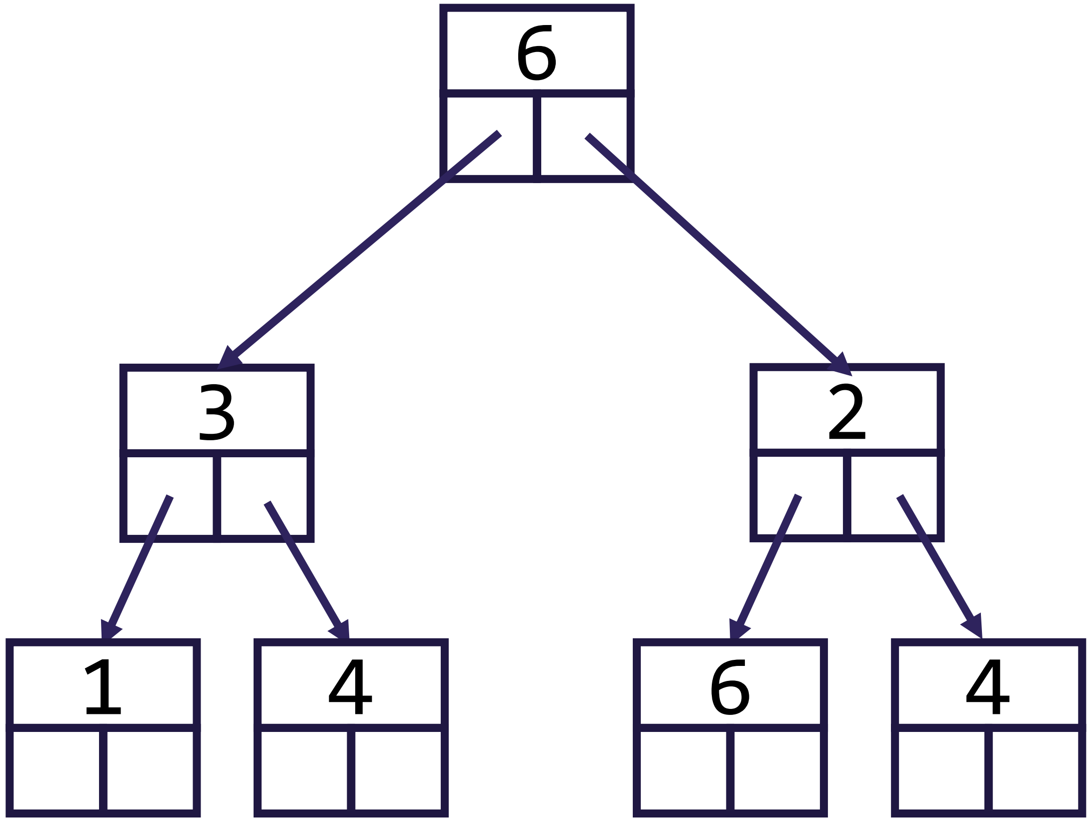
Enter the order in which the nodes of this tree would be visited in a <u>pre-order</u> traversal.



Practice : Pair

sli.do #cse123A

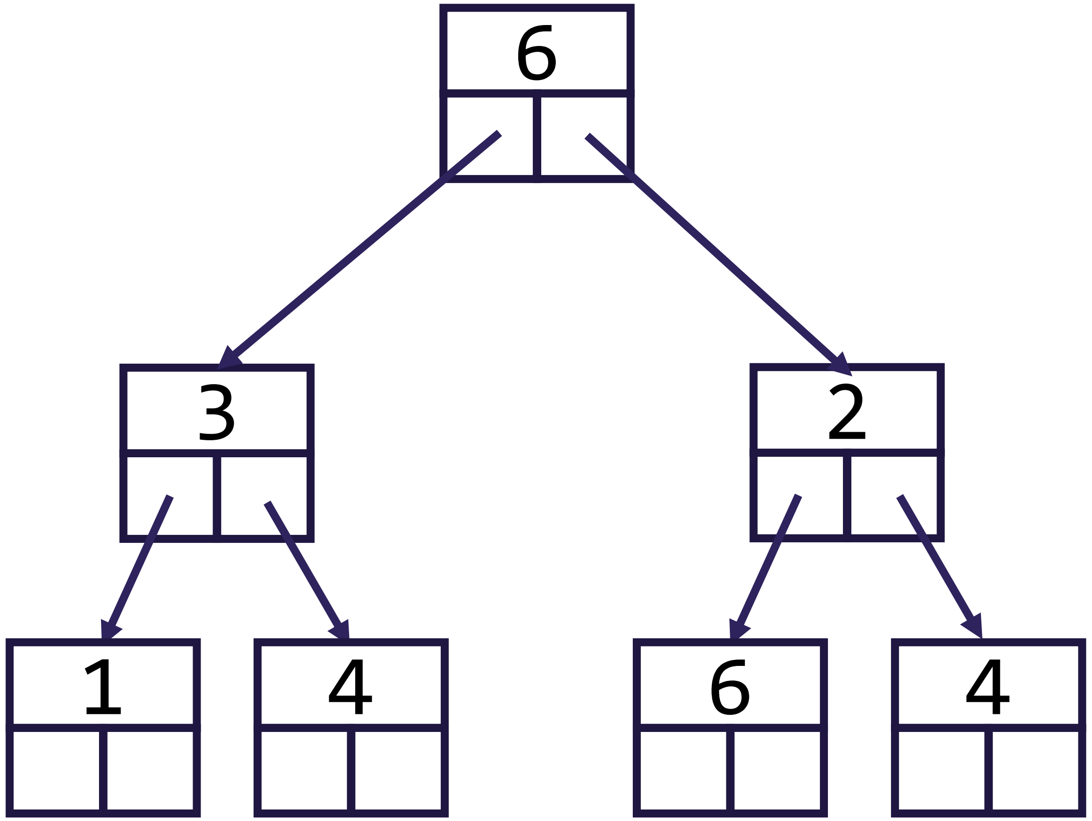
Enter the order in which the nodes of this tree would be visited in a pre-order traversal.



Practice : Pair

sli.do #cse123A

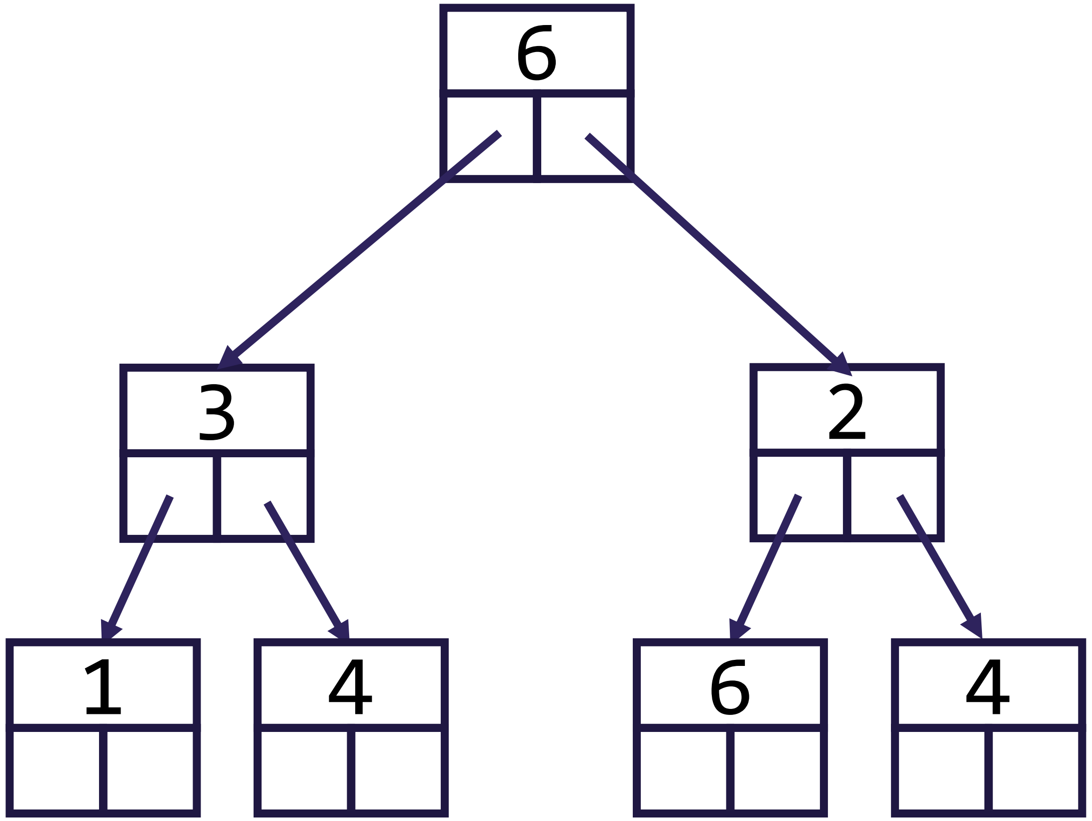
Enter the order in which the nodes of this tree would be visited in an in-order traversal.



Practice : Pair

sli.do #cse123A

Enter the order in which the nodes of this tree would be visited in a post-order traversal.



Lecture Outline

- Announcements
- Binary Tree Review
- Traversals
- **Practice!**

Tracing through size

```
public int size() {
    return size(overallRoot);
}

private int size(IntTreeNode currentRoot) {
    if (currentRoot == null) {
        return 0;
    } else {
        return 1 +
                  size(currentRoot.left) +
                  size(currentRoot.right);
    }
}
```