LEC 11

CSE 123

Binary Trees

BEFORE WE START

Talk to your neighbors:

Recap Quiz 2 - how did it go? What will you do differently in preparing for Quiz 3?

Music: [123 24su Lecture Tunes ☼]

Instructor: Joe Spaniac

TAs: Andras Daniel Eric Nicole Sahej Trien Zach

Questions during Class?

Raise hand or send here

sli.do #cse123

Lecture Outline

- **Announcements** ◀
- Binary Trees
  - Terminology
  - Recursive Definition
  - Tree Traversal
- Programming Binary Trees

Announcements

- Quiz 2 grades out!
  - Please check your grades before the next quiz, practice **metacognition**
- Quiz 3 in section on Tuesday, 7/30
  - Topics: Runtime; Recursion
  - Same policies as last time: One sheet of 8.5” x 11” notes (double-sided, printed or handwritten), 50mins, etc.
- Creative project 3 released last night, due 7/31 at 11:59pm
  - Last creative project of the quarter!
- Resubmission Period 4 closes tonight, 7/26 at 11:59pm
- Resubmission Period 5 opens tonight, due next Friday 7/19 at 11:59pm

Lecture Outline

- Announcements
- **Binary Trees** ◀
  - Terminology
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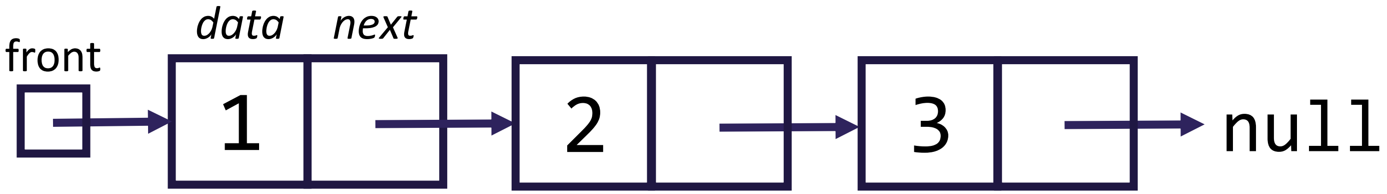
- Programming Binary Trees

Binary Trees

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



Binary Trees

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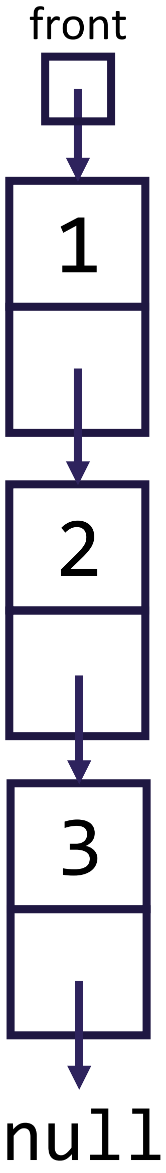
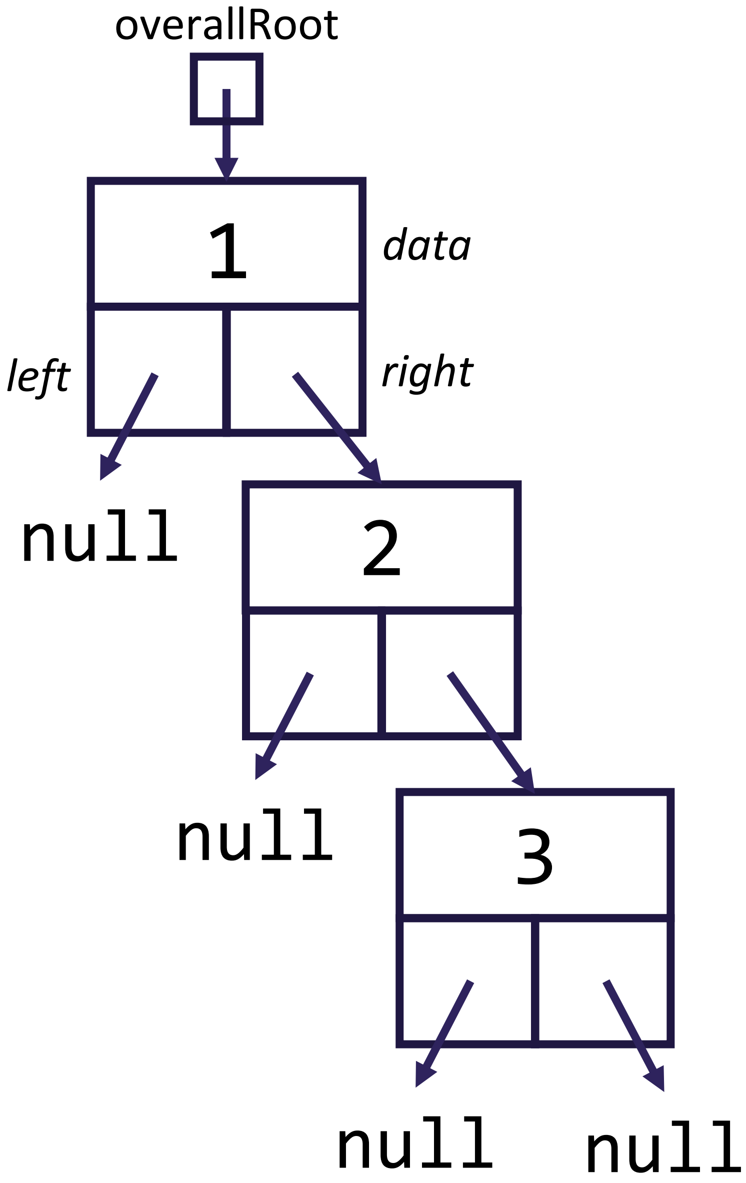


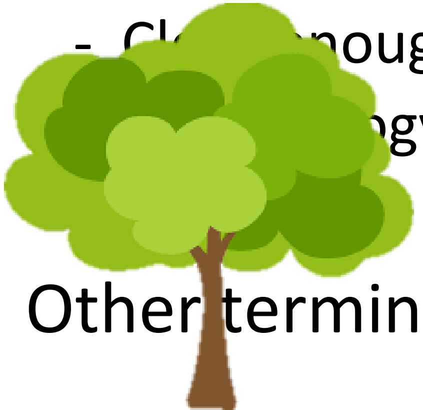
Binary Trees

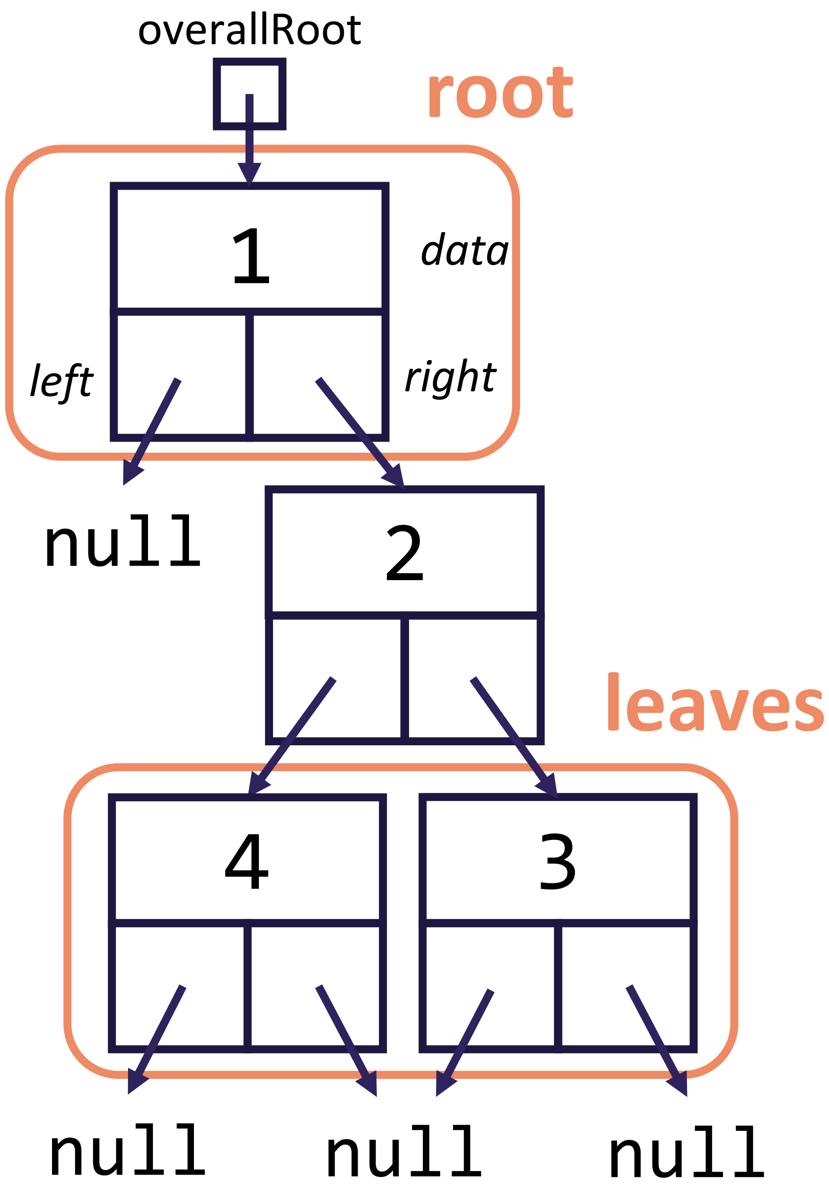
- Last data structure of the quarter!
  - Very similar to `LinkedLists`…
- Linked `TreeNodes` w/ 3 fields:
  - int data, `TreeNode` left, `TreeNode` right
  - Doubly complicated!



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





overallRoot

root

1

data

left

right

null

2

leaves

4

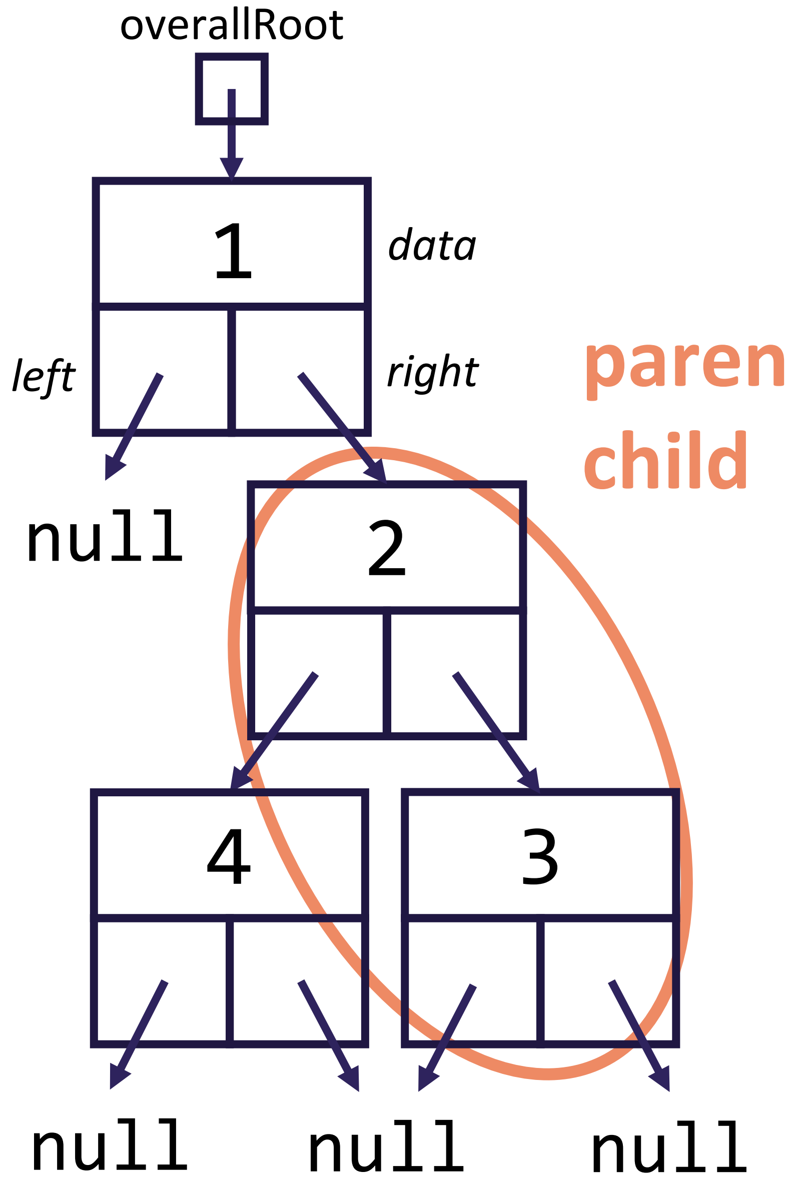
3

null

null

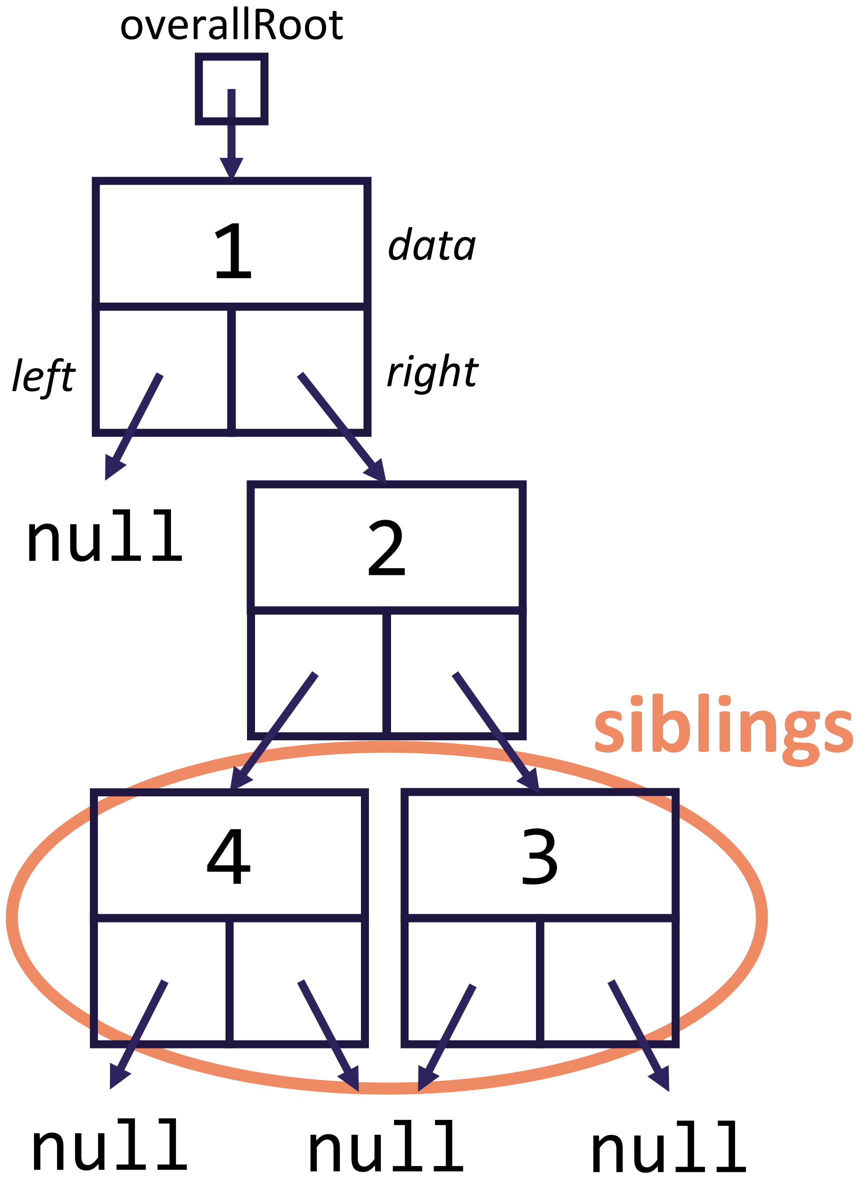
null

Tree Terminology



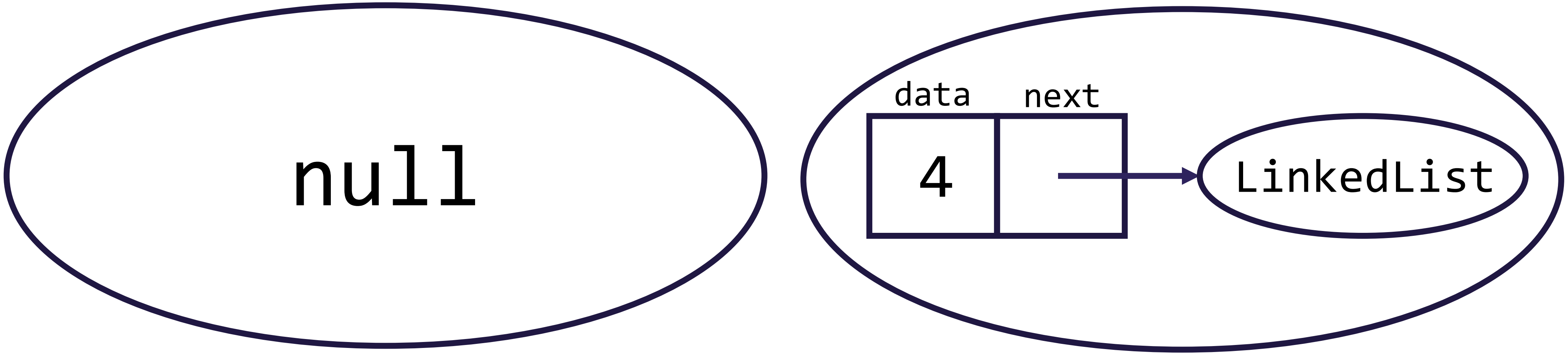
parent / child

Tree Terminology



LinkedLists [Review]

- We'll say that any LinkedList falls into one of the following categories:



Empty list

`front == null`

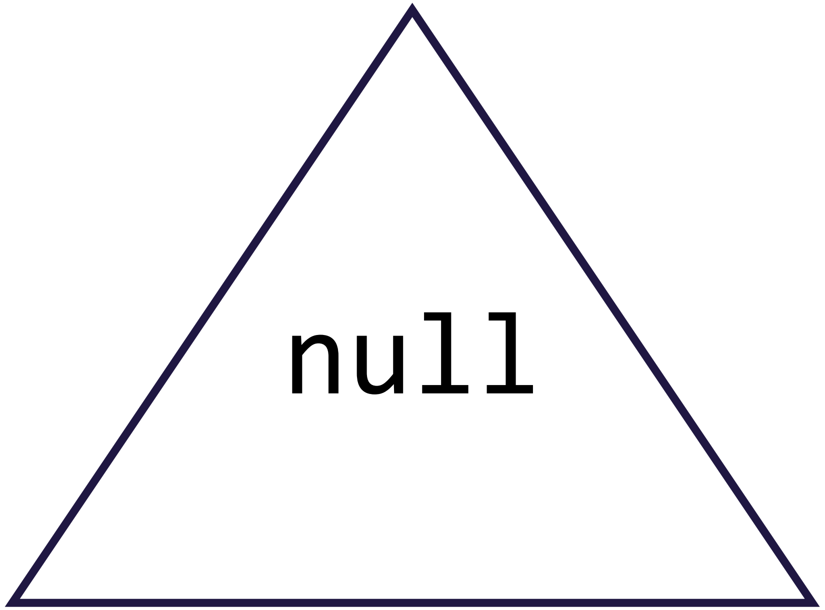
Node w/ another LinkedList

```
front != null
front.next = LinkedList
```

This is a recursive definition! A sublist is either empty or a node with another sublist!

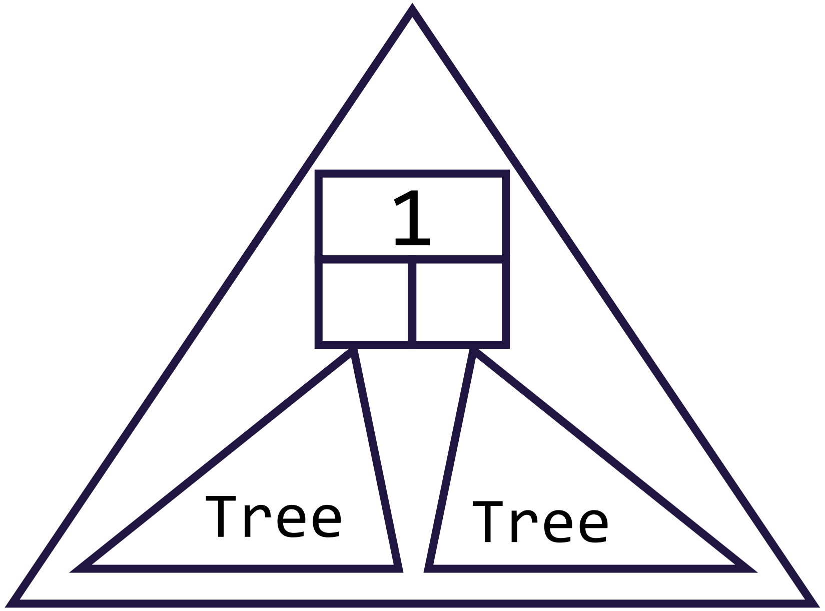
Binary Trees

- We'll say that any Binary Tree falls into one of the following categories:



Empty tree

`root == null`



Node w/ two subtrees

```
root != null
root.left / root.right = Tree
```

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

Binary Tree Programming

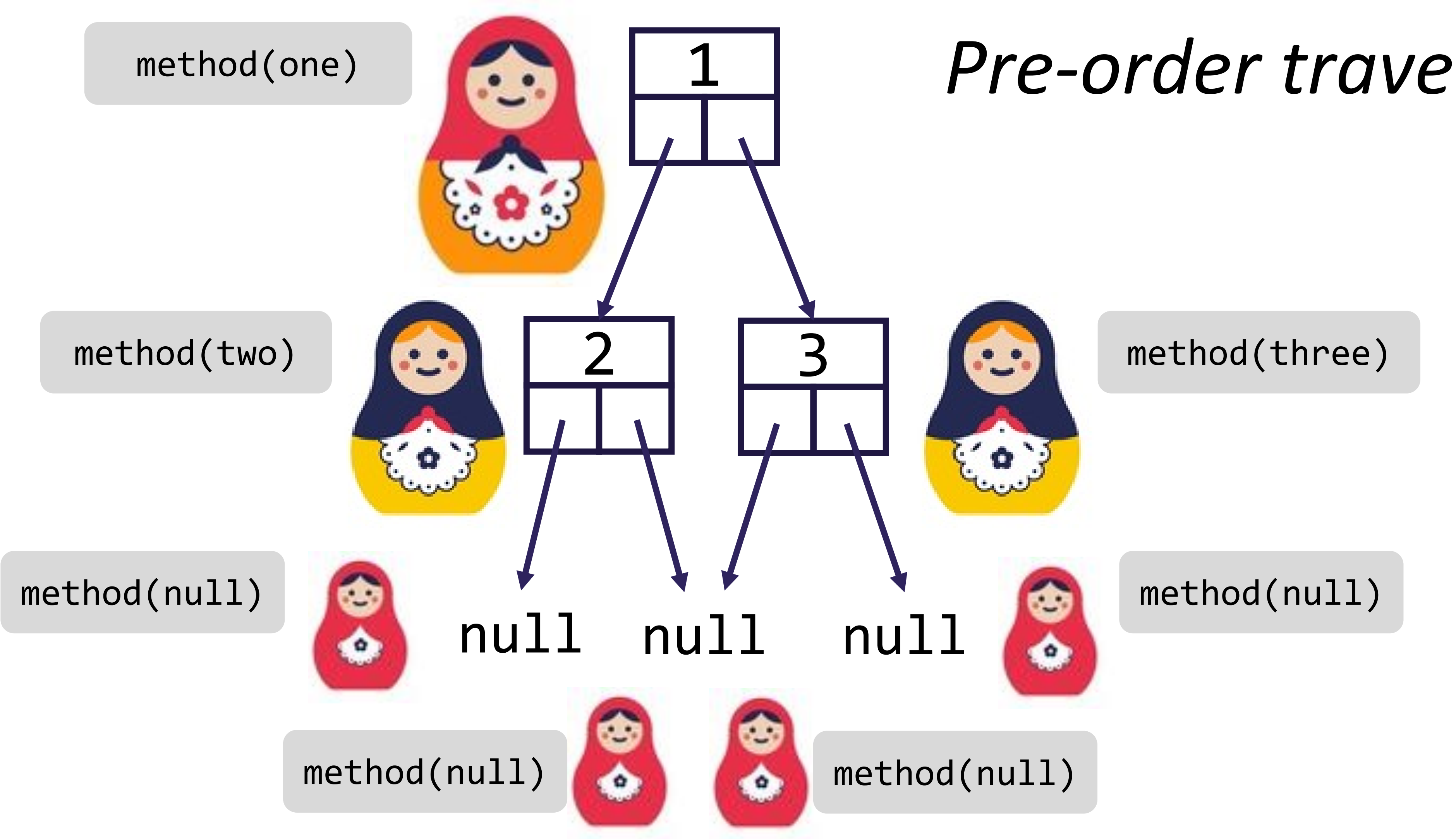
- Programs look very similar to Recursive LinkedList!

- 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 (i.e. `root`)
- If modifying, we use `x = change(x)`
  - Don't stop early, return updated subtree (`IntTreeNode`)

- Let's trace through an example together…

Binary Tree Programming

Pre-order traversal



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

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- **Programming Binary Trees**