TIP102 | Intermediate Technical Interview Prep

Intermediate Technical Interview Prep Summer 2025 (@ Section 1b | Tuesdays and Thursdays 3PM - 5PM PDT)
Personal Member ID#: 126663

Session 1: Binary Trees

Session Overview

One paragraph explanation of what students will learn in this lesson.

> You can find all resources from today including session slide decks, session recordings, and more on the resources tab

📈 Part 1 : Instructor Led Session

We'll spend the first portion of the synchronous class time in large groups, where the instructor will lead class instruction for 30-45 minutes.

👩‍💻 Part 2: Breakout Session

In breakout sessions, we will explore and collaboratively solve problem sets in small groups. Here, the **collaboration, conversation, and approach** are just as important as “solving the problem” - please engage warmly, clearly, and plentifully in the process!

In breakout rooms you will:

- Screen-share the problem/s, and verbally review them together
- Screen-share an interactive coding environment, and talk through the steps of a solution approach
    - ProTip: - An Integrated Development Environment (IDE) is a fancy name for a tool you could use for shared writing of code - like Replit.com, Collabed.it, CodePen.io, or other - your staff team will specify which tool to use for this class!
- Screen-share an implementation of your proposed solution
- Independently follow-along, or create an implementation, in your own IDE.

Your program leader/s will indicate which code sharing tool/s to use as a group, and will help break down provide specific scaffolding with the main concepts above.

▼ **Note on Expectations**

Please Note: **It is not required or expected** that you complete all of the practice problems! In some sessions you may only complete 1 problem and that's okay.

Strengthening your **approach** to problems, and your **ability to speak and engage through the process** are key skills most often underdeveloped for engineers at this stage - focus on those in our small groups for your long term success!

You can always return to problems independently, after class time, to embrace the technical concepts and gain additional practice.

Close Section

🔎 Problem Solving Approach

We will approach problems using the six steps in the UMPIRE approach.

UMPIRE: Understand, Match, Plan, Implement, Review, Evaluate.

We'll apply these six steps to the problems we'll see in the first half of the course.

We will learn to:

- **Understand** the problem
- **Match** identifies common approaches you've seen/used before
- **Plan** a solution step-by-step, and
- **Implement** the solution
- **Review** your solution
- **Evaluate** your solution's time and space complexity and think critically about the advantages and disadvantages of your chosen approach.

ℹ️ Note: Testing your Binary Tree (Printing)

To keep the amount of starter code manageable, we have chosen not to include a function to print a binary tree as part of each relevant problem statement. You may instead copy the function in the drop-down below `print_tree()` and use it as needed while you complete the problem sets.

▼ Print Binary Tree Function

Accepts the root of a binary tree and prints out the values of each node level by level from left to right. Values of `None` are used to indicate a null child node between non-null children on the same level. Prints `"Empty"` for an empty tree.

```
from collections import deque

# Tree Node class
class TreeNode:
    def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def print_tree(root):
    if not root:
        return "Empty"
    result = []
    queue = deque([root])
    while queue:
        node = queue.popleft()
        if node:
            result.append(node.val)
            queue.append(node.left)
            queue.append(node.right)
        else:
            result.append(None)
    while result and result[-1] is None:
        result.pop()
    print(result)
```

Example Usage:

```
"""
          1
        /   \
       2     3
      /     / \
     4     5   6
"""

root = Node(1, Node(2, Node(4)), Node(3, Node(5), Node(6)))

print_tree(root)
print_tree(None)
```

Example Output:

```
[1, 2, 3, 4, None, 5, 6]
'Empty'
```

ℹ️ Note: Testing your Binary Tree (Generating a Tree)

Now that you have practice manually building trees for testing in previous sessions, we are providing a function that builds binary trees based off of a list of values to speed up the testing process. We have chosen not to include this function in the starter code for each problem to keep the length of problems manageable. You may instead copy the function in the drop-down below `build_tree()` and use it as needed while you complete the problem sets.

▼ Build Binary Tree Function

Takes in a list `values` where each element in the list corresponds to a node in the binary tree you would like to build. The values should be in level order (from top to bottom, left to right). Use `None` to indicate a null child between non-null children on the same level.

Some problems may ask you to build a tree where nodes have both keys and values. This function may be used to build trees with just values *and* trees with both keys and values:

- If building a tree with only values, `values` should be given in the form: `[value1, value2, value3, ...]`.
- If building a tree with both keys and values `values` should be given in the form `[(key1, value1), (key2, value2), (key3, value3), ...]`.

Returns the `root` of the binary tree made from `values`.

```
from collections import deque

# Tree Node class
class TreeNode:
  def __init__(self, value, key=None, left=None, right=None):
      self.key = key
      self.val = value
      self.left = left
      self.right = right

def build_tree(values):
  if not values:
      return None

  def get_key_value(item):
      if isinstance(item, tuple):
          return item[0], item[1]
      else:
          return None, item

  key, value = get_key_value(values[0])
  root = TreeNode(value, key)
  queue = deque([root])
  index = 1

  while queue:
      node = queue.popleft()
      if index < len(values) and values[index] is not None:
          left_key, left_value = get_key_value(values[index])
          node.left = TreeNode(left_value, left_key)
          queue.append(node.left)
      index += 1
      if index < len(values) and values[index] is not None:
          right_key, right_value = get_key_value(values[index])
          node.right = TreeNode(right_value, right_key)
          queue.append(node.right)
      index += 1

  return root
```

Example Usage:

```
"""
          1
        /   \
       2     3
      /     / \
     4     5   6
"""

tree_with_just_values = [1, 2, 3, 4, None, 5, 6]
val_tree = build_tree(tree_with_just_values)

"""
          (1, 'A')
          /       \
       (2, 'B')   (3, 'C')
      /           /      \
  (4, 'D')    (5, 'E')   (6, 'F')
"""

tree_with_keys_and_values = [(1, 'A'), (2, 'B'), (3, 'C'), (4, 'D'), None, (5, 'E'), (6,
key_val_tree = build_tree(tree_with_keys_and_values)

# Using print_tree() function included above
print_tree(val_tree)
print_tree(key_val_tree) # Only values will be printed
```

Example Output:

```
[1, 2, 3, 4, None, 5, 6]
['A', 'B', 'C', 'D', None, 'E', 'F']
```

Breakout Problems Session 1

▾ Standard Problem Set Version 1

Problem 1: Merging Cookie Orders

You run a local bakery and are given the roots of two binary trees `order1` and `order2` where each node in the binary tree represents the number of a certain cookie type the customer has ordered. To maximize efficiency, you want to bake enough of each type of cookie for both orders together.

Given `order1` and `order2`, merge the order together into one tree and return the root of the merged tree. To merge the orders, imagine that when place one tree on top of the other, some nodes of the two trees are overlapped while others are not. If two nodes overlap, then sum node values up

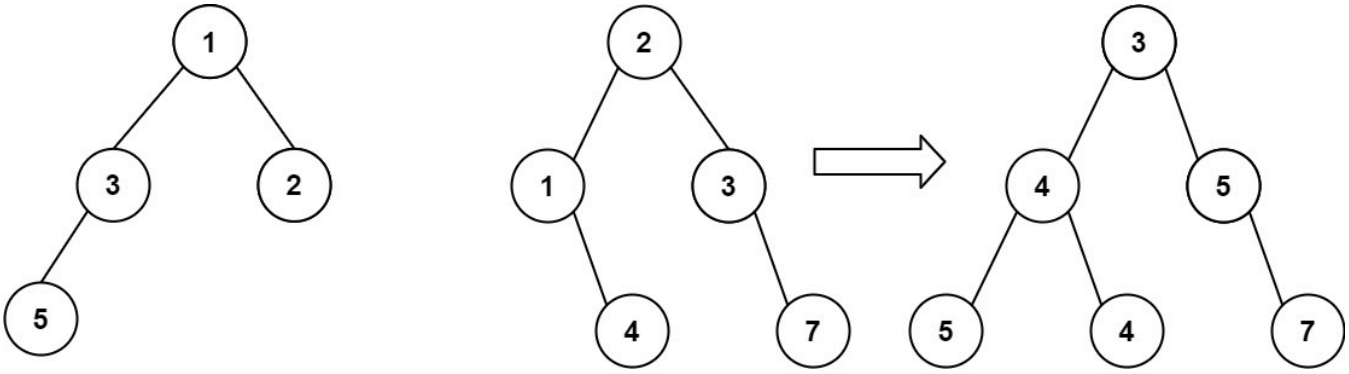
as the new value of the merged node. Otherwise, the **not** `None` node will be used as the node of the new tree.

Start the merging process from the root of both orders.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
     def __init__(self, quantity, left=None, right=None):
        self.val = quantity
        self.left = left
        self.right = right

def merge_orders(order1, order2):
    pass
```

Example Usage:




```
"""
     1             2
    /  \          /   \
   3    2        1     3
 /                \      \
5                  4      7
"""
# Using build_tree() function included at top of page
cookies1 = [1, 3, 2, 5]
cookies2 = [2, 1, 3, None, 4, None, 7]
order1 = build_tree(cookies1)
order2 = build_tree(cookies2)

# Using print_tree() function included at top of page
print_tree(merge_orders(order1, order2))
```

Example Usage:

```
[3, 4, 5, 5, 4, None, 7]
Explanation:
Merged Tree:
     3
    /  \
  4     5
 / \      \
5   4      7
```

Problem 2: Croquembouche

You are designing a delicious croquembouche (a French dessert composed of a cone-shaped tower of cream puffs 😋), for a couple's wedding. They want the cream puffs to have a variety of flavors. You've finished your design and want to send it to the couple for review.

Given a root of a binary tree `design` where each node in the tree represents a cream puff in the croquembouche, that **prints** a list of the flavors (`val` s) of each cream puff in level order (i.e., from left to right, level by level).

Note: The `build_tree()` and `print_tree()` functions both use variations of a level order traversal. To get the most out of this problem, we recommend that you reference these functions as little as possible while implementing your solution.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class Puff():
     def __init__(self, flavor, left=None, right=None):
        self.val = flavor
        self.left = left
        self.right = right

def print_design(design):
    pass
```

Example Usage:

```
"""
            Vanilla
           /       \
      Chocolate   Strawberry
      /     \
  Vanilla   Matcha
"""
croquembouche = Puff("Vanilla",
                     Puff("Chocolate", Puff("Vanilla"), Puff("Matcha")),
                     Puff("Strawberry"))
print_design(croquembouche)
```

Example Output:

```
['Vanilla', 'Chocolate', 'Strawberry', 'Vanilla', 'Matcha']
```

▼ ✨ AI Hint: Breadth First Search Traversal

Key Skill: Use AI to explain code concepts

To solve this problem, it may be helpful to understand both the **queue** data structure and **breadth first search** algorithm. To learn more about these concepts, visit the Queues and Breadth First Search sections of the Unit 9 Cheatsheet

If you still have questions, try explaining what you're doing, and ask an AI tool like ChatGPT or GitHub Copilot to help you understand what's confusing you. For example, you might ask:

"I'm trying to understand how to use a queue to implement breadth first search, but I'm confused about why I wouldn't just use a list. Can you explain the difference?"

Problem 3: Maximum Tiers in Cake

You have entered your bakery into a cake baking competition and for your entry have decided build a complicated pyramid shape cake, where different sections have different numbers of tiers. Given the root of a binary tree `cake` where each node represents a different section of your cake, return the maximum number of tiers in your cake.

The maximum number of tiers is the number of nodes along the longest path from the root node down to the farthest leaf node.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
     def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def max_tiers(cake):
    pass
```

Example Usage:

```
"""
        Chocolate
        /        \
    Vanilla    Strawberry
                /     \
         Chocolate    Coffee
"""
# Using build_tree() function included at top of page
cake_sections = ["Chocolate", "Vanilla", "Strawberry", None, None, "Chocolate", "Coffee"]
cake = build_tree(cake_sections)

print(max_tiers(cake))
```

Example Output:

```
3
```

Problem 4: Maximum Tiers in Cake II

If you solved `max_tiers()` in the previous problem using a depth first search approach, reimplement your solution using a breadth first search approach. If you implemented it using a breadth first search approach, use a depth first search approach.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
     def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def max_tiers(cake):
    pass
```

Example Usage:

```
"""
        Chocolate
        /        \
    Vanilla    Strawberry
                /     \
         Chocolate    Coffee
"""
# Using build_tree() function included at top of page
cake_sections = ["Chocolate", "Vanilla", "Strawberry", None, None, "Chocolate", "Coffee"]
cake = build_tree(cake_sections)

print(max_tiers(cake))
```

Example Output:

```
3
```

Problem 5: Can Fulfill Order

At your bakery, you organize your current stock of baked goods in a binary tree with root `inventory` where each node represents the quantity of a baked good in your bakery. A customer comes in wanting a random assortment of baked goods of quantity `order_size`. Given the root `inventory` and integer `order_size`, return `True` if you can fulfill the order and `False` otherwise. You can fulfill the order if the tree has a root-to-leaf path such that adding up all the values along the path equals `order_size`.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
     def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def can_fulfill_order(inventory, order_size):
    pass
```

Example Usage:

```
"""
             5
           /   \
          4     8
        /      /  \
       11     13   4
      /  \          \
     7   2           1
"""

# Using build_tree() function included at top of the page
quantities = [5,4,8,11,None,13,4,7,2,None,None,None,1]
baked_goods = build_tree(quantities)

print(can_fulfill_order(baked_goods, 22))
print(can_fulfill_order(baked_goods, 2))
```

Example Output:

```
True
Example 1 Explanation: 5 + 4 + 11 + 2 = 22

False
```

▼ 💡 **Hint: Choosing your Traversal Method**

This problem can be solved multiple ways, but may work best with a modified depth first search traversal. To learn more about how to choose a traversal algorithm visit the How to Pick a Traversal Algorithm section of the unit cheatsheet.

Problem 6: Icing Cupcakes in Zigzag Order

You have rows of cupcakes represented as a binary tree `cupcakes` where each node in the tree represents a cupcake. To ice them efficiently, you are icing cupcakes one row (level) at a time, in zig zag order (i.e., from left to right, then right to left for the next row and alternate between).

Return a list of the cupcake values in the order you iced them.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
     def __init__(self, flavor, left=None, right=None):
        self.val = flavor
        self.left = left
        self.right = right

def zigzag_icing_order(cupcakes):
    pass
```

Example Usage:

```
"""
            Chocolate
           /         \
        Vanilla       Lemon
       /              /    \
    Strawberry   Hazelnut   Red Velvet
"""

# Using build_tree() function included at top of page
flavors = ["Chocolate", "Vanilla", "Lemon", "Strawberry", None, "Hazelnut", "Red Velvet"]
cupcakes = build_tree(flavors)
print(zigzag_icing_order(cupcakes))
```

Example Output:

```
['Chocolate', 'Lemon', 'Vanilla', 'Strawberry', 'Hazelnut', 'Red Velvet']
```

▼ 💡 **Hint: Choosing your Traversal Method**

This problem can be solved multiple ways, but may work best with a modified breadth first search traversal. To learn more about how to choose a traversal algorithm visit the How to Pick a Traversal Algorithm section of the unit cheatsheet.

▼ 💡 **Hint: Available `deque()` methods**

Recall that the `deque` module has both `append()` and `appendleft()` methods as well as `popleft()` and `pop()` methods.

Close Section

▼ Standard Problem Set Version 2

Problem 1: Clone Detection

You have just started a new job working the night shift at a local hotel, but strange things have been happening and you're starting to think it might be haunted. Lately, you think you've been seeing double of some of the guests.

Given the roots of two binary trees `guest1` and `guest2` each representing a guest at the hotel, write a function that returns `True` if they are clones of each other and `False` otherwise.

Two binary trees are considered clones if they are structurally identical, and the nodes have the same values.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
    def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def is_clone(guest1, guest2):
    pass
```

Example Usage:

```
"""
     John Doe               John Doe
     /      \             /       \
  6 ft    Brown Eyes      6ft      Brown Eyes
"""
guest1 = TreeNode("John Doe", TreeNode("6 ft"), TreeNode("Brown Eyes"))
guest2 = TreeNode("John Doe", TreeNode("6 ft"), TreeNode("Brown Eyes"))

"""
     John Doe         John Doe
     /                       \
   6 ft                     6 ft
"""
guest3 = TreeNode("John Doe", TreeNode("6 ft"))
guest4 = TreeNode("John Doe", None, TreeNode("6 ft"))

print(is_clone(guest1, guest2))
print(is_clone(guest3, guest4))
```

Example Output:

```
True
False
```

Problem 2: Mapping a Haunted Hotel

Guests have been coming to check out of rooms that you're pretty sure don't exist in the hotel... or are you imagining things? To make sure, you want to explore the entire hotel and make your own map.

Given the root of a binary tree `hotel` where each node represents a room in the hotel, write a function `map_hotel()` that returns a list of each room value in the hotel. You should explore the hotel level by level from left to right.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

Note: The `build_tree()` and `print_tree()` functions both use variations of a level order traversal. To get the most out of this problem, we recommend that you reference these functions as little as possible while implementing your solution.

```
class TreeNode():
    def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def map_hotel(hotel):
    pass
```

Example Usage:

```
"""
          Lobby
        /     \
       /       \
      101      102
     /   \    /   \
   201  202  203  204
   /                \
 301                302
"""

hotel = Room("Lobby",
                Room(101, Room(201, Room(301)), Room(202)),
                Room(102, Room(203), Room(204, None, Room(302))))

print(map_hotel(hotel))
```

Example Output:

```
['Lobby', 101, 102, 201, 202, 203, 204, 301, 302]
```

▼ ✨ AI Hint: Breadth First Search Traversal

Key Skill: Use AI to explain code concepts

To solve this problem, it may be helpful to understand both the **queue** data structure and **breadth first search** algorithm. To learn more about these concepts, visit the Queues and Breadth First Search sections of the Unit 9 Cheatsheet

If you still have questions, try explaining what you're doing, and ask an AI tool like ChatGPT or GitHub Copilot to help you understand what's confusing you. For example, you might ask:

"I'm trying to understand how to use a queue to implement breadth first search, but I'm confused about why I wouldn't just use a list. Can you explain the difference?"

Problem 3: Minimum Depth of Secret Path

You've found a strange door in the hotel and aren't sure where it leads. Given the root of a binary tree `door` where each node represents a destination along a path behind the door, return the minimum depth of the tree.

The minimum depth is the number of nodes along the shortest path from from the root node down to the nearest leaf node.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
    def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def min_depth(door):
    pass
```

Example Usage:

```
"""
     Door
    /    \
 Attic    Cursed Room
         /       \
      Crypt     Haunted Cellar
"""

door = Room("Door", Room("Attic"), Room("Cursed Room", Room("Crypt"), Room("Haunted Cellar")

print(min_depth(attic))
```

Example Output:

```
2
```

Problem 4: Minimum Depth of Secret Path II

If you used a breadth first search approach to solve the previous problem, reimplement your solution using a depth first search approach. If you used a depth first search approach, try using a breadth first search approach.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
    def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def min_depth(door):
    pass
```

Example Usage:

```
"""
     Door
    /    \
 Attic    Cursed Room
         /       \
      Crypt     Haunted Cellar
"""

door = Room("Door", Room("Attic"), Room("Cursed Room", Room("Crypt"), Room("Haunted Cellar")

print(min_depth(attic))
```

Example Output:

```
2
```

Problem 5: Reverse Odd Levels of the Hotel

A poltergeist has been causing mischief and reversed the order of rooms on odd level floors. Given the root of a binary tree `hotel` where each node represents a room in the hotel and the root, restore order by reversing the node values at each odd level in the tree.

For example, suppose the rooms on level 3 have values `[308, 307, 306, 305, 304, 303, 302, 301]`. It should become `[301, 302, 303, 304, 305, 306, 307, 308]`.

Return the root of the altered tree.

A binary tree is perfect if all parent nodes have two children and all leaves are on the same level.

The level of a node is the number of edges along the path between it and the root node.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
     def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def reverse_odd_levels(hotel):
    pass
```

Example Usage:

```
"""
        Lobby
      /      \
     102     101
     / \     /  \
   201 202 203 204
"""
hotel = Room("Lobby",
            Room(102, Room(201), Room (202)),
                Room(101, Room(203), Room(204)))

# Using print_tree() function included at the top
print_tree(reverse_odd_levels(hotel))
```

Example Output:

```
['Lobby', 101, 102, 201, 202, 203, 204]

Explanation:
Updated Tree Structure:
        Lobby
      /      \
     101     102
     / \     /  \
   201 202 203 204
```

▼ 💡 **Hint: Choosing your Traversal Method**

> This problem can be solved multiple ways, but may work best with a modified breadth first search traversal. To learn more about how to choose a traversal algorithm visit the How to Pick a Traversal Algorithm section of the unit cheatsheet.

Problem 6: Kth Spookiest Room in the Hotel

Over time, your hotel has gained a reputation for being haunted, and you now have customers coming specifically for a spooky experience. You are given the `root` of a binary search tree (BST) with `n` nodes where each node represents a room in the hotel and each node has an integer `key` representing the spookiness of the room (`1` being most spooky and `n` being least spooky) and `val` representing the room number. The tree is organized according to its keys.

Given the `root` of a BST and an integer `k` write a function `kth_spookiest()` that returns the **value** of the `kth` spookiest room (smallest `key`, 1-indexed) of all the rooms in the hotel.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
     def __init__(self, key, value, left=None, right=None):
        self.key = key
        self.val = value
        self.left = left
        self.right = right

def kth_spookiest(root, k):
    pass
```

Example Usage:

```
"""
    (3, Lobby)
   /         \
(1, 101)   (4, 102)
     \
     (2, 201)
"""

# Using build_tree() function at the top of the page
rooms = [(3, "Lobby"), (1, 101), (4, 102), None, (2, 201)]
hotel1 = build_tree(rooms)


"""
            (5, Lobby)
            /         \
        (3, 101)   (6, 102)
        /      \
    (2, 201)  (4, 202)
    /
(1, 301)
"""
rooms = [(5, 'Lobby'), (3, 101), (6, 102), (2, 201), (4, 202), None, None, (1, 301)]
hotel2 = build_tree(rooms)

print(kth_spookiest(hotel1, 1))
print(kth_spookiest(hotel2, 3))
```

Example Markdown:

```
101
101
```

▼ 💡 **Hint: Choosing your Traversal Method**

This problem can be solved multiple ways, but may work best with a modified depth first search traversal. To learn more about how to choose a traversal algorithm visit the How to Pick a Traversal Algorithm section of the unit cheatsheet.

Close Section

▼ Advanced Problem Set Version 1

Problem 1: Croquembouche II

You are designing a delicious croquembouche (a French dessert composed of a cone-shaped tower of cream puffs 😋), for a couple's wedding. They want the cream puffs to have a variety of flavors. You've finished your design and want to send it to the couple for review.

Given a root of a binary tree `design` where each node in the tree represents a cream puff in the croquembouche, traverse the croquembouche in tier order (i.e., level by level, left to right).

You should return a list of lists where each inner list represents a tier (level) of the croquembouche and the elements of each inner list contain the flavors of each cream puff on that tier (node `val`s from left to right).

Note: The `build_tree()` and `print_tree()` functions both use variations of a level order traversal. To get the most out of this problem, we recommend that you reference these functions as little as possible while implementing your solution.

Evaluate the time and space complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time and space complexity. Assume the input tree is balanced when calculating time complexity.

Hint: Level order traversal, BST

```
class Puff():
     def __init__(self, flavor, left=None, right=None):
        self.val = flavor
        self.left = left
        self.right = right

def listify_design(design):
    pass
```

Example Usage:

```
"""
            Vanilla
           /       \
      Chocolate   Strawberry
      /     \
  Vanilla   Matcha
"""
croquembouche = Puff("Vanilla",
                     Puff("Chocolate", Puff("Vanilla"), Puff("Matcha")),
                     Puff("Strawberry"))
print(listify_design(croquembouche))
```

Example Output:

```
[['Vanilla'], ['Chocolate', 'Strawberry'], ['Vanilla', 'Matcha']]
```

▼ ✨ AI Hint: Breadth First Search Traversal

Key Skill: Use AI to explain code concepts

To solve this problem, it may be helpful to understand both the **queue** data structure and **breadth first search** algorithm. To learn more about these concepts, visit the Queues and Breadth First Search sections of the Unit 9 Cheatsheet

If you still have questions, try explaining what you're doing, and ask an AI tool like ChatGPT or GitHub Copilot to help you understand what's confusing you. For example, you might ask:

"I'm trying to understand how to use a queue to implement breadth first search, but I'm confused about why I wouldn't just use a list. Can you explain the difference?"

Problem 2: Icing Cupcakes in Zigzag Order

You have rows of cupcakes represented as a binary tree `cupcakes` where each node in the tree represents a cupcake. To ice them efficiently, you are icing cupcakes one row (level) at a time, in zig zag order (i.e., from left to right, then right to left for the next row and alternate between).

Return a list of the cupcake values in the order you iced them.

Evaluate the time and space complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time and space complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
     def __init__(self, flavor, left=None, right=None):
        self.val = flavor
        self.left = left
        self.right = right

def zigzag_icing_order(cupcakes):
    pass
```

Example Usage:

```
"""
            Chocolate
           /         \
        Vanilla       Lemon
       /              /    \
    Strawberry   Hazelnut   Red Velvet
"""

# Using build_tree() function included at top of page
flavors = ["Chocolate", "Vanilla", "Lemon", "Strawberry", None, "Hazelnut", "Red Velvet"]
cupcakes = build_tree(flavors)
```

Example Output:

```
['Chocolate', 'Lemon', 'Vanilla', 'Strawberry', 'Hazelnut', 'Red Velvet']
```

▼ 💡 **Hint: Choosing your Traversal Method**

This problem can be solved multiple ways, but may work best with a modified breadth first search traversal. To learn more about how to choose a traversal algorithm visit the How to Pick a Traversal Algorithm section of the unit cheatsheet.

Problem 3: Larger Order Tree

You have the root of a binary search tree `orders`, where each node in the tree represents an order and each node's value represents the number of cupcakes the customer ordered. Convert the tree to a 'larger order tree' such that the value of each node in tree is equal to its original value plus the sum of all node values greater than it.

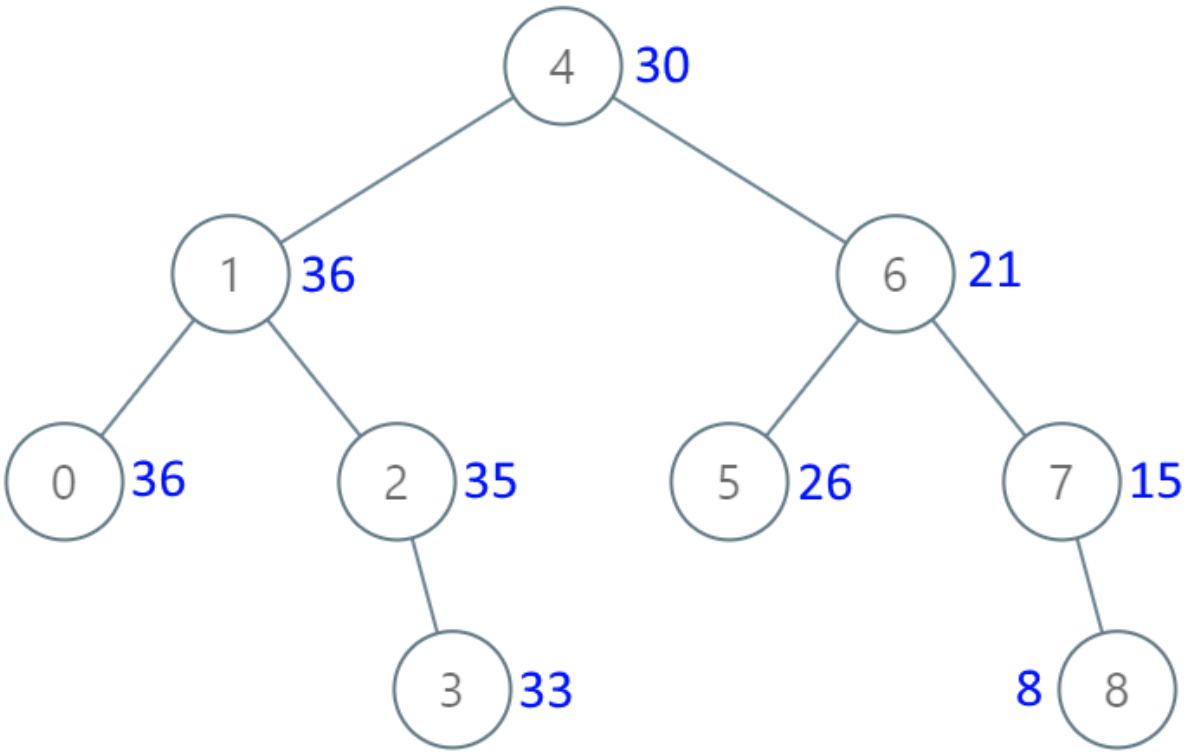
As a reminder a BST satisfies the following constraints:

- The left subtree of a node contains only nodes with keys less than the node's key.
- The right subtree of a node contains only nodes with keys greater than the node's key.
- Both the left and right subtrees must also be binary search trees.

Evaluate the time and space complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time and space complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
     def __init__(self, order_size, left=None, right=None):
        self.val = order_size
        self.left = left
        self.right = right

def larger_order_tree(orders):
    pass
```

Examples Usage:




```
"""
         4
       /   \
      /     \
     1       6
    / \     / \
   0   2   5   7
        \       \
         3       8
"""
# using build_tree() function included at top of page
order_sizes = [4,1,6,0,2,5,7,None,None,None,3,None,None,None,8]
orders = build_tree(order_sizes)

# using print_tree() function included at top of page
print_tree(larger_order_tree(orders))
```

Example Output:

```
[30,36,21,36,35,26,15,None,None,None,33,None,None,None,8]
Explanation:
Larger Order Tree:
        30
       /   \
      /     \
     36     21
    / \     / \
   36  35  26  15
         \       \
         33       8
```

▶ 💡 **Hint: Choosing your Traversal Method**

Problem 4: Find Next Order to Fulfill Today

You store each customer order at your bakery in a binary tree where each node represents a different order. Each level of the tree represents a different day's orders. Given the root of a binary tree `order_tree` and an `Treenode` object `order` representing the order you are currently fulfilling, return the next order to fulfill that day. The next order to fulfill is the nearest node on the same level. Return `None` if `order` is the last order of the day (rightmost node of the level).

Note: Because we must pass in a reference to a node in the tree, you cannot use the `build_tree()` function for testing. You must manually create the tree.

```
class TreeNode():
     def __init__(self, order, left=None, right=None):
        self.val = order
        self.left = left
        self.right = right

def larger_order_tree(order_tree, order):
    pass
```

Example Usage:

```
"""
        Cupcakes
       /       \
   Macaron     Cookies
        \      /      \
      Cake   Eclair   Croissant
"""
cupcakes = TreeNode("Cupcakes")
macaron = TreeNode("Macaron")
cookies = TreeNode("Cookies")
cake = TreeNode("Cake")
eclair = TreeNode("Eclair")
croissant = TreeNode("Croissant")

cupcakes.left, cupcakes.right = macaron, cookies
macaron.right = cake
cookies.left, cookies.right = eclair, croissant

next_order1 = larger_order_tree(cupcakes, cake)
next_order2 = larger_order_tree(cupcakes, cookies)
print(next_order1.val)
print(next_order2.val)
```

Example Output:

```
Eclair
None
```

Problem 5: Add Row of Cupcakes to Display

You have a cupcake display represented by a binary tree where each node represents a different cupcake in the display and each node value represents the flavor of the cupcake. Given the root of the binary tree `display` a string `flavor` and an integer `depth`, add a row of nodes with value `flavor` at the given depth `depth`.

Note that the root node has depth `1`.

The adding rule is:

- Given the integer `depth`, for each not `None` tree node `cur` at the depth `depth - 1`, create two cupcakes with value `flavor` as `cur`'s left subtree root and right subtree root.
- `cur`'s original left subtree should be the left subtree of the new left subtree root.
- `cur`'s original right subtree should be the right subtree of the new right subtree root.
- If `depth == 1` that means there is no depth `depth - 1` at all, then create a cupcake with value `flavor` as the new root of the whole original tree, and the original tree is the new root's left subtree.

Evaluate the time and space complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time and space complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
    def __init__(self, sweetness, left=None, right=None):
        self.val = sweetness
        self.left = left
        self.right = right

def add_row(display, flavor, depth):
    pass
```

```
"""
        Chocolate
        /        \
    Vanilla    Strawberry
                /     \
         Chocolate    Red Velvet
"""
# Using build_tree() function included at top of page
cupcake_flavors = ["Chocolate", "Vanilla", "Strawberry", None, None, "Chocolate", "Red Velve
display = build_tree(cupcake_flavors)

# Using print_tree() function included at top of page
print_tree(add_row(display, "Mocha", 3))
```

Example Output:

```
['Chocolate', 'Vanilla', 'Strawberry', 'Mocha', 'Mocha', 'Mocha', 'Mocha', None, None, None,
Explanation:
Tree with added row:
                  Chocolate
                  /        \
             Vanilla        Strawberry
             /    \         /       \
          Mocha   Mocha  Mocha     Mocha
                         /             \
                     Chocolate       Red Velvet
```

Problem 6: Maximum Icing Difference

In your bakery, you're planning a display of cupcakes where each cupcake is represented by a node in a binary tree. The sweetness level of the icing on each cupcake is stored in the node's value. You want to identify the maximum icing difference between any two cupcakes where one cupcake is an ancestor of the other in the display.

Given the `root` of a binary tree representing the cupcake display, find the maximum value `v` for which there exist different cupcakes `a` and `b` where `v = |a.val - b.val|` and `a` is an ancestor of `b`.

A cupcake `a` is an ancestor of `b` if either any child of `a` is equal to `b`, or any child of `a` is an ancestor of `b`.

Evaluate the time and space complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time and space complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
    def __init__(self, sweetness, left=None, right=None):
        self.val = sweetness
        self.left = left
        self.right = right

def max_icing_difference(root):
    pass
```

Example Usage:

```
"""
            8
           /  \
         3     10
        / \      \
       1   6     14
          /  \    /
         4    7  13
"""

# Using build_tree() function included at top of page
sweetness_levels = [8, 3, 10, 1, 6, None, 14, None, None, 4, 7, 13]
display = build_tree(sweetness_levels)

print(max_icing_difference(display))
```

Example Output:

```
13
Explanation: The maximum icing difference is between the root cupcake (8) and a descendant w
sweetness level 1, yielding a difference of |8 - 1| = 7.
```

Close Section

Advanced Problem Set Version 2

Problem 1: Mapping a Haunted Hotel II

You have been working the night shift at a haunted hotel and guests have been coming to check out of rooms that you're pretty sure don't exist in the hotel... or are you imagining things? To make sure, you want to explore the entire hotel and make your own map.

Given the root of a binary tree `hotel` where each node represents a room in the hotel, write a function `map_hotel()` that returns a dictionary mapping each level of the hotel to a list with the level's room values in the order they appear on that level from left to right.

Evaluate the time and space complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time and space complexity. Assume the input tree is balanced when calculating time complexity.

Note: The `build_tree()` and `print_tree()` functions both use variations of a level order traversal. To get the most out of this problem, we recommend that you reference these functions as little as possible while implementing your solution.

```
class TreeNode():
    def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def map_hotel(hotel):
    pass
```

Example Usage:

```
"""
         Lobby
        /     \
       /       \
      101      102
     /   \    /   \
   201  202  203  204
   /                \
 301                302
"""

hotel = Room("Lobby",
                Room(101, Room(201, Room(301)), Room(202)),
                Room(102, Room(203), Room(204, None, Room(302))))

print(map_hotel(hotel))
```

Example Output:

```
{
    0: ['Lobby'],
    1: [101, 102],
    2: [201, 202, 203, 204],
    3: [301, 302]
}
```

▼ ✨ AI Hint: Breadth First Search Traversal

Key Skill: Use AI to explain code concepts

To solve this problem, it may be helpful to understand both the **queue** data structure and **breadth first search** algorithm. To learn more about these concepts, visit the Queues and Breadth First Search sections of the Unit 9 Cheatsheet

If you still have questions, try explaining what you're doing, and ask an AI tool like ChatGPT or GitHub Copilot to help you understand what's confusing you. For example, you might ask:

"I'm trying to understand how to use a queue to implement breadth first search, but I'm confused about why I wouldn't just use a list. Can you explain the difference?"

Problem 2: Reverse Odd Levels of the Hotel

A poltergeist has been causing mischief and reversed the order of rooms on odd level floors. Given the root of a binary tree `hotel` where each node represents a room in the hotel and the root, restore order by reversing the node values at each odd level in the tree.

For example, suppose the rooms on level 3 have values `[308, 307, 306, 305, 304, 303, 302, 301]`. It should become `[301, 302, 303, 304, 305, 306, 307, 308]`.

Return the root of the altered tree.

A binary tree is perfect if all parent nodes have two children and all leaves are on the same level.

The level of a node is the number of edges along the path between it and the root node.

Evaluate the time complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time complexity. Assume the input tree is balanced when calculating time complexity.

```
class TreeNode():
     def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def reverse_odd_levels(hotel):
    pass
```

Example Usage:

```
"""
        Lobby
      /      \
     102     101
     / \     /  \
   201 202 203 204
"""
hotel = Room("Lobby",
            Room(102, Room(201), Room (202)),
                Room(101, Room(203), Room(204)))

# Using print_tree() function included at the top
print_tree(reverse_odd_levels(hotel))
```

Example Output:

```
['Lobby', 101, 102, 201, 202, 203, 204]

Explanation:
Updated Tree Structure:
        Lobby
      /      \
     101     102
     / \     /  \
   201 202 203 204
```

▼ 💡 **Hint: Choosing your Traversal Method**

This problem can be solved multiple ways, but may work best with a modified breadth first search traversal. To learn more about how to choose a traversal algorithm visit the How to Pick a Traversal Algorithm section of the unit cheatsheet.

Problem 3: Purging Unwanted Guests

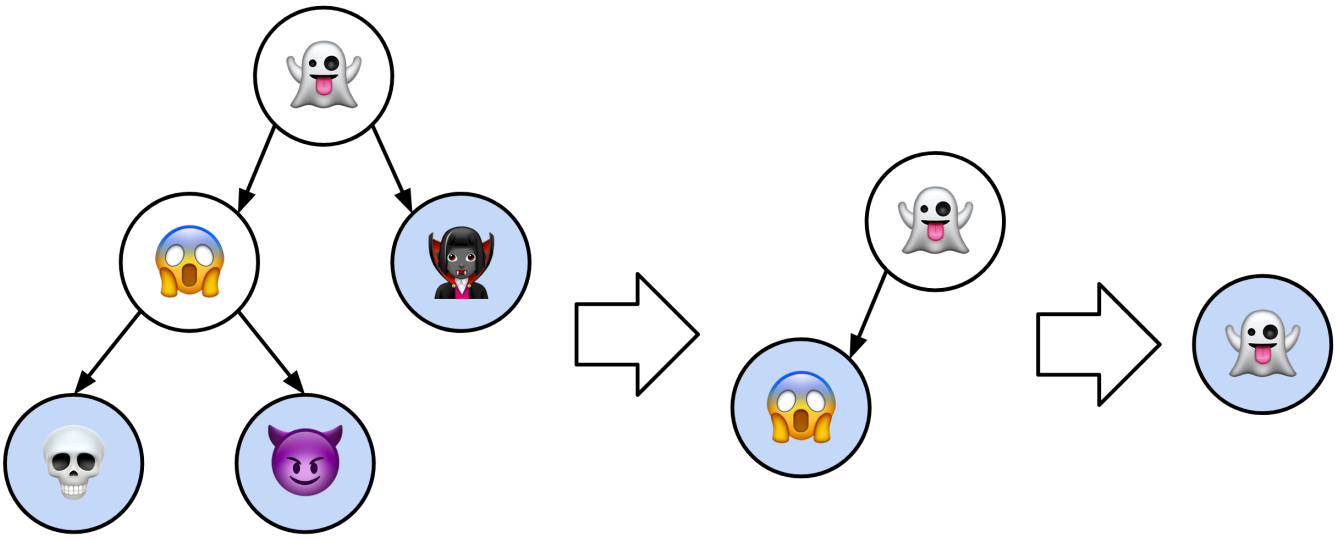
There are unwanted visitors lurking in the rooms of your haunteds hotel, and it's time for a clear out. Given the root of a binary tree `hotel` where each node represents a room in the hotel and each node value represents the guest staying in that room. You want to systematically remove visitors in the following order:

- Collect the guests (values) of all leaf nodes and store them in a list. The leaf nodes may be stored in any order.
- Remove all the leaf nodes.
- Repeat until the hotel (tree) is empty.

Return a list of lists, where each inner list represents a collection of leaf nodes.

```
class TreeNode():
     def __init__(self, value, left=None, right=None):
        self.val = value
        self.left = left
        self.right = right

def purge_hotel(hotel):
    pass
```

Example Usage:



```
"""
      👻
    /  \
   😱   🧛
  /  \
 💀   😈
"""

# Using build_tree() function included at the top of the page
guests = ["👻", "😱", "🧛", "💀", "😈"]
hotel = build_tree(guests)

# Using print_tree() function included at the top of the page
print_tree(hotel)
print(purge_hotel(hotel))
```

Example Output:

```
Empty
[['💀', '😈', '🧛'], ['😱'], ['👻']]
Explanation:
[['💀', '🧛', '😈'], ['😱'], ['👻']] and [['🧛', '😈', '💀'], ['😱'], ['👻']] are also
answers since it doesn't matter which order the leaves in a given level are returned.
The tree should always be empty once `purge_hotel()` has been executed.
```

▼ 💡 **Hint: Choosing your Traversal Method**

This problem can be solved multiple ways, but may work best with a modified depth first search traversal. To learn more about how to choose a traversal algorithm visit the How to Pick a Traversal Algorithm section of the unit cheatsheet.

Problem 4: Kth Spookiest Room in the Hotel

Over time, your hotel has gained a reputation for being haunted, and you now have customers coming specifically for a spooky experience. You are given the `root` of a binary search tree (BST) with `n` nodes where each node represents a room in the hotel and each node has an integer `key` representing the spookiness of the room (`1` being most spooky and `n` being least spooky) and `val` representing the room number. The tree is organized according to its keys.

Given the `root` of a BST and an integer `k` write a function `kth_spookiest()` that returns the **value** of the `kth` spookiest room (smallest `key`, 1-indexed) of all the rooms in the hotel.

Evaluate the time and space complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time and space complexity. Assume the input tree is balanced when calculating time and space complexity.

```
class TreeNode():
     def __init__(self, key, value, left=None, right=None):
        self.key = key
        self.val = value
        self.left = left
        self.right = right

def kth_spookiest(root, k):
    pass
```

Example Usage:

```
"""
    (3, Lobby)
   /         \
(1, 101)   (4, 102)
     \
     (2, 201)
"""

# Using build_tree() function at the top of the page
rooms = [(3, "Lobby"), (1, 101), (4, 102), None, (2, 201)]
hotel1 = build_tree(rooms)


"""
            (5, Lobby)
            /         \
        (3, 101)   (6, 102)
        /      \
    (2, 201)  (4, 202)
    /
(1, 301)
"""
rooms = [(5, 'Lobby'), (3, 101), (6, 102), (2, 201), (4, 202), None, None, (1, 301)]
hotel2 = build_tree(rooms)

print(kth_spookiest(hotel1, 1))
print(kth_spookiest(hotel2, 3))
```

Example Markdown:

```
101
101
```

Problem 5: Lowest Common Ancestor of Youngest Children

There's a tapestry hanging up on the wall with the family tree of the cursed family who owns the hotel. Given the `root` of the binary tree where each node represents a member in the family, return the value of the lowest common ancestor of the youngest children in the family. The youngest children in the family are the deepest leaves in the tree.

Recall that:

- The node of a binary tree is a leaf if and only if it has no children
- The depth of the root of the tree is `0`. If the depth of a node is `d`, the depth of each of its children is `d + 1`.
- The lowest common ancestor of a set `S` of nodes, is the node `A` with the largest depth such that every node in `S` is in the subtree with root `A`.

```
class TreeNode():
     def __init__(self, key, value, left=None, right=None):
        self.key = key
        self.val = value
        self.left = left
        self.right = right

def lca_youngest_children(root):
    pass
```

Example Usage:

```
"""
                Isadora the Hexed
                /               \
            Thorne               Raven
           /      \             /      \
      Dracula     Doom      Hecate    Wraith
                  /    \
              Gloom   Mortis
"""
# Using build_tree() function included at top of the page
members = ["Isadora the Hexed", "Thorne", "Raven", "Dracula", "Doom", "Hecate", "Wraith", No
family1 = build_tree(members)

"""
               Grandmama Addams
               /              \
        Gomez Addams        Uncle Fester
                \
            Wednesday Addams
"""
members = ["Grandmama Addams", "Gomez Addams", "Uncle Fester", None, "Wednesday Addams"]
family2 = build_tree(members)

print(lca_youngest_children(family1))
print(lca_youngest_children(family2))
```

Example Output:

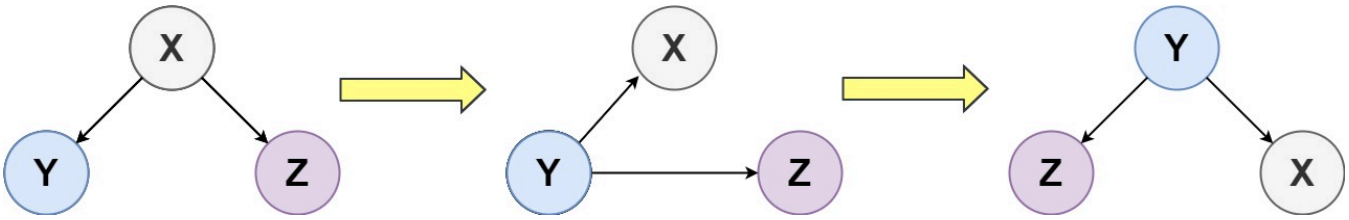
```
Doom
Example 1 Explanation: Gloom and Mortis are the youngest children (deepest leaves) in the tre
Doom in their lowest common ancestor.

Wednesday Addams
Example 2 Explanation: The youngest child in the tree is Wednesday Addams and the lowest comm
of one node is itself
```

Problem 6: Topsy Turvy

You're walking down the hotel hallway one night and something strange begins to happen - the entire hotel flips upside down. The room sand their connections were flipped in a peculiar way and now you need to restore order. Given the root of a binary tree `hotel` where each node represents a room in the hotel, write a function `upside_down_hotel()` that flips the hotel right side up according to the following rules:

1. The original left child becomes the new root
2. The original root becomes the new right child

3. The original right child becomes the new left child.



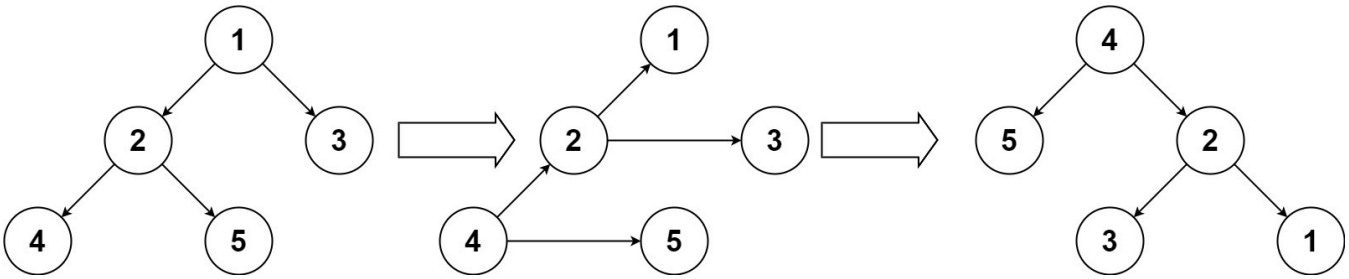
The above steps are done level by level. It is **guaranteed** each right node has a sibling (a left node with the same parent) and has no children.

Return the root of the flipped hotel.

Evaluate the time and space complexity of your function. Define your variables and provide a rationale for why you believe your solution has the stated time and space complexity. Assume the input tree is balanced when calculating time and space complexity.

```
class TreeNode():
     def __init__(self, key, value, left=None, right=None):
        self.key = key
        self.val = value
        self.left = left
        self.right = right

def flip_hotel(hotel):
    pass
```

Example Usage:




```
"""
      1
    /   \
   2     3
  / \
 4   5
"""

# Using build_tree() function included at top of page
rooms = [1, 2, 3, 4, 5]
hotel = build_tree(rooms)

# Using print_tree() function included at top of page
print_tree(flip_hotel(hotel))
```

Example Output:

```
[4, 5, 2, None, None, 3, 1]
Explanation:
Flipped hotel structure:
      4
    /   \
   5     2
        / \
       3   1
```

Close Section