Problem 545: Boundary of Binary Tree

Problem Information

Difficulty: Medium
Acceptance Rate: 0.00%
Paid Only: No

Problem Description

The

boundary

of a binary tree is the concatenation of the

root

, the

left boundary

, the

leaves

ordered from left-to-right, and the

reverse order

of the

right boundary

.

The

left boundary

is the set of nodes defined by the following:

The root node's left child is in the left boundary. If the root does not have a left child, then the left boundary is

empty

.

If a node is in the left boundary and has a left child, then the left child is in the left boundary.

If a node is in the left boundary, has

no

left child, but has a right child, then the right child is in the left boundary.

The leftmost leaf is

not

in the left boundary.

The

right boundary

is similar to the

left boundary

, except it is the right side of the root's right subtree. Again, the leaf is

not

part of the

right boundary

, and the

right boundary

is empty if the root does not have a right child.

The

leaves

are nodes that do not have any children. For this problem, the root is

not

a leaf.

Given the

root

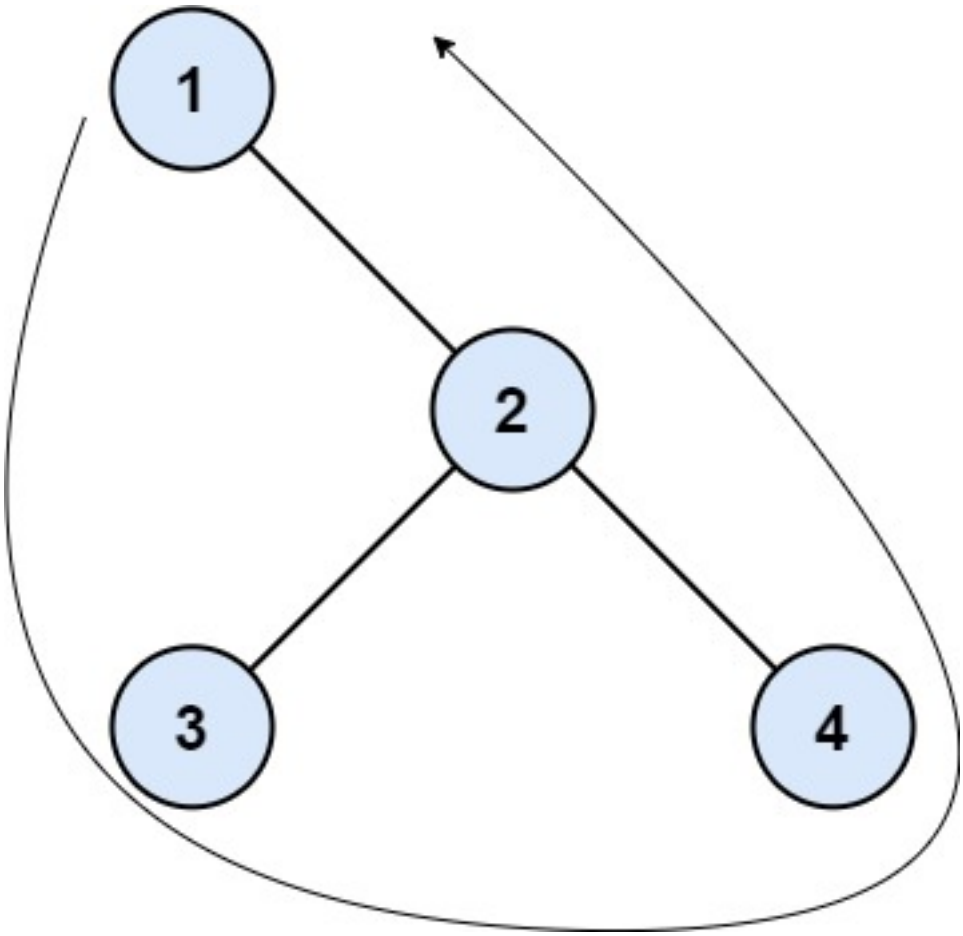
of a binary tree, return

the values of its

boundary

.

Example 1:



Input:

root = [1,null,2,3,4]

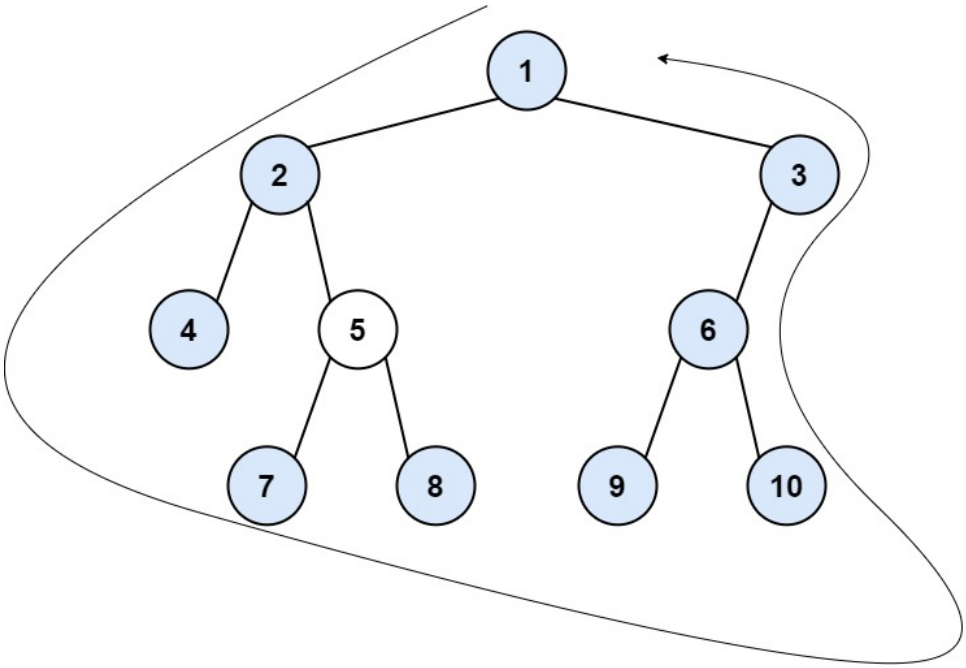
Output:

[1,3,4,2]

Explanation:

- The left boundary is empty because the root does not have a left child. - The right boundary follows the path starting from the root's right child 2 -> 4. 4 is a leaf, so the right boundary is [2]. - The leaves from left to right are [3,4]. Concatenating everything results in [1] + [] + [3,4] + [2] = [1,3,4,2].

Example 2:



Input:

root = [1,2,3,4,5,6,null,null,null,7,8,9,10]

Output:

[1,2,4,7,8,9,10,6,3]

Explanation:

- The left boundary follows the path starting from the root's left child 2 -> 4. 4 is a leaf, so the left boundary is [2]. - The right boundary follows the path starting from the root's right child 3 -> 6 -> 10. 10 is a leaf, so the right boundary is [3,6], and in reverse order is [6,3]. - The leaves from left to right are [4,7,8,9,10]. Concatenating everything results in [1] + [2] + [4,7,8,9,10] + [6,3] = [1,2,4,7,8,9,10,6,3].

Constraints:

The number of nodes in the tree is in the range

[1, 10

]

.

-1000 <= Node.val <= 1000

Code Snippets

C++:

```
/**
* Definition for a binary tree node.
* struct TreeNode {
* int val;
* TreeNode *left;
* TreeNode *right;
* TreeNode() : val(0), left(nullptr), right(nullptr) {}
* TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
* TreeNode(int x, TreeNode *left, TreeNode *right) : val(x), left(left),
right(right) {}
* };
*/
class Solution {
public:
vector<int> boundaryOfBinaryTree(TreeNode* root) {

}
};
```

Java:

```
/**
* Definition for a binary tree node.
* public class TreeNode {
* int val;
* TreeNode left;
* TreeNode right;
* TreeNode() {}
* TreeNode(int val) { this.val = val; }
* TreeNode(int val, TreeNode left, TreeNode right) {
* this.val = val;
```

```
* this.left = left;
* this.right = right;
* }
* }
*/
class Solution {
public List<Integer> boundaryOfBinaryTree(TreeNode root) {

}
}
```

Python3:

```
# Definition for a binary tree node.
# class TreeNode:
# def __init__(self, val=0, left=None, right=None):
# self.val = val
# self.left = left
# self.right = right
class Solution:
def boundaryOfBinaryTree(self, root: Optional[TreeNode]) -> List[int]:
```

Python:

```
# Definition for a binary tree node.
# class TreeNode(object):
# def __init__(self, val=0, left=None, right=None):
# self.val = val
# self.left = left
# self.right = right
class Solution(object):
def boundaryOfBinaryTree(self, root):
"""
:type root: Optional[TreeNode]
:rtype: List[int]
"""
```

JavaScript:

```
/**
* Definition for a binary tree node.
* function TreeNode(val, left, right) {
```

```
* this.val = (val===undefined ? 0 : val)
* this.left = (left===undefined ? null : left)
* this.right = (right===undefined ? null : right)
* }
*/
/**
* @param {TreeNode} root
* @return {number[]}
*/
var boundaryOfBinaryTree = function(root) {

};
```

TypeScript:

```
/**
* Definition for a binary tree node.
* class TreeNode {
* val: number
* left: TreeNode | null
* right: TreeNode | null
* constructor(val?: number, left?: TreeNode | null, right?: TreeNode | null)
{
* this.val = (val===undefined ? 0 : val)
* this.left = (left===undefined ? null : left)
* this.right = (right===undefined ? null : right)
* }
* }
*/

function boundaryOfBinaryTree(root: TreeNode | null): number[] {

};
```

C#:

```
/**
* Definition for a binary tree node.
* public class TreeNode {
* public int val;
* public TreeNode left;
* public TreeNode right;
```

```
* public TreeNode(int val=0, TreeNode left=null, TreeNode right=null) {
* this.val = val;
* this.left = left;
* this.right = right;
* }
* }
*/
public class Solution {
public IList<int> BoundaryOfBinaryTree(TreeNode root) {

}
}
```

C:

```
/**
* Definition for a binary tree node.
* struct TreeNode {
* int val;
* struct TreeNode *left;
* struct TreeNode *right;
* };
*/
/**
* Note: The returned array must be malloced, assume caller calls free().
*/
int* boundaryOfBinaryTree(struct TreeNode* root, int* returnSize) {

}
```

Go:

```
/**
* Definition for a binary tree node.
* type TreeNode struct {
* Val int
* Left *TreeNode
* Right *TreeNode
* }
*/
func boundaryOfBinaryTree(root *TreeNode) []int {
```

```
}
```

Kotlin:

```
/**
* Example:
* var ti = TreeNode(5)
* var v = ti.`val`
* Definition for a binary tree node.
* class TreeNode(var `val`: Int) {
* var left: TreeNode? = null
* var right: TreeNode? = null
* }
*/
class Solution {
fun boundaryOfBinaryTree(root: TreeNode?): List<Int> {

}
}
```

Swift:

```
/**
* Definition for a binary tree node.
* public class TreeNode {
* public var val: Int
* public var left: TreeNode?
* public var right: TreeNode?
* public init() { self.val = 0; self.left = nil; self.right = nil; }
* public init(_ val: Int) { self.val = val; self.left = nil; self.right =
nil; }
* public init(_ val: Int, _ left: TreeNode?, _ right: TreeNode?) {
* self.val = val
* self.left = left
* self.right = right
* }
* }
*/
class Solution {
func boundaryOfBinaryTree(_ root: TreeNode?) -> [Int] {

}
```

```
}
```

Rust:

```
// Definition for a binary tree node.
// #[derive(Debug, PartialEq, Eq)]
// pub struct TreeNode {
// pub val: i32,
// pub left: Option<Rc<RefCell<TreeNode>>>,
// pub right: Option<Rc<RefCell<TreeNode>>>,
// }
//
// impl TreeNode {
// #[inline]
// pub fn new(val: i32) -> Self {
// TreeNode {
// val,
// left: None,
// right: None
// }
// }
// }
use std::rc::Rc;
use std::cell::RefCell;
impl Solution {
pub fn boundary_of_binary_tree(root: Option<Rc<RefCell<TreeNode>>>) ->
Vec<i32> {

}
}
```

Ruby:

```
# Definition for a binary tree node.
# class TreeNode
# attr_accessor :val, :left, :right
# def initialize(val = 0, left = nil, right = nil)
# @val = val
# @left = left
# @right = right
# end
# end
```

```
# @param {TreeNode} root
# @return {Integer[]}
def boundary_of_binary_tree(root)

end
```

PHP:

```
/**
* Definition for a binary tree node.
* class TreeNode {
* public $val = null;
* public $left = null;
* public $right = null;
* function __construct($val = 0, $left = null, $right = null) {
* $this->val = $val;
* $this->left = $left;
* $this->right = $right;
* }
* }
*/
class Solution {

/**
* @param TreeNode $root
* @return Integer[]
*/
function boundaryOfBinaryTree($root) {

}
}
```

Dart:

```
/**
* Definition for a binary tree node.
* class TreeNode {
* int val;
* TreeNode? left;
* TreeNode? right;
* TreeNode([this.val = 0, this.left, this.right]);
* }
```

```
*/
class Solution {
List<int> boundaryOfBinaryTree(TreeNode? root) {

}
}
```

Scala:

```
/**
* Definition for a binary tree node.
* class TreeNode(_value: Int = 0, _left: TreeNode = null, _right: TreeNode =
null) {
* var value: Int = _value
* var left: TreeNode = _left
* var right: TreeNode = _right
* }
*/
object Solution {
def boundaryOfBinaryTree(root: TreeNode): List[Int] = {

}
}
```

Elixir:

```
# Definition for a binary tree node.
#
# defmodule TreeNode do
# @type t :: %__MODULE__{
# val: integer,
# left: TreeNode.t() | nil,
# right: TreeNode.t() | nil
# }
# defstruct val: 0, left: nil, right: nil
# end

defmodule Solution do
@spec boundary_of_binary_tree(root :: TreeNode.t | nil) :: [integer]
def boundary_of_binary_tree(root) do

end
```

```
end
```

Erlang:

```
%% Definition for a binary tree node.
%%
%% -record(tree_node, {val = 0 :: integer(),
%% left = null :: 'null' | #tree_node{},
%% right = null :: 'null' | #tree_node{}}).

-spec boundary_of_binary_tree(Root :: #tree_node{} | null) -> [integer()].
boundary_of_binary_tree(Root) ->
.
```

Racket:

```
; Definition for a binary tree node.
#|

; val : integer?
; left : (or/c tree-node? #f)
; right : (or/c tree-node? #f)
(struct tree-node
(val left right) #:mutable #:transparent)

; constructor
(define (make-tree-node [val 0])
(tree-node val #f #f))

|#

(define/contract (boundary-of-binary-tree root)
(-> (or/c tree-node? #f) (listof exact-integer?))
)
```

Solutions

C++ Solution:

```
/*
* Problem: Boundary of Binary Tree
* Difficulty: Medium
* Tags: tree, search
*
* Approach: DFS or BFS traversal
* Time Complexity: O(n) where n is number of nodes
* Space Complexity: O(h) for recursion stack where h is height
*/

/**
* Definition for a binary tree node.
* struct TreeNode {
* int val;
* TreeNode *left;
* TreeNode *right;
* TreeNode() : val(0), left(nullptr), right(nullptr) {}
* TreeNode(int x) : val(x), left(nullptr), right(nullptr) {}
* TreeNode(int x, TreeNode *left, TreeNode *right) : val(x), left(left),
right(right) {}
* };
*/
class Solution {
public:
vector<int> boundaryOfBinaryTree(TreeNode* root) {

}
};
```

Java Solution:

```
/**
* Problem: Boundary of Binary Tree
* Difficulty: Medium
* Tags: tree, search
*
* Approach: DFS or BFS traversal
* Time Complexity: O(n) where n is number of nodes
* Space Complexity: O(h) for recursion stack where h is height
*/

/**
```

```
* Definition for a binary tree node.
* public class TreeNode {
* int val;
* TreeNode left;
* TreeNode right;
* TreeNode() {}
* TreeNode(int val) { this.val = val; }
* TreeNode(int val, TreeNode left, TreeNode right) {
* this.val = val;
* this.left = left;
* this.right = right;
* }
* }
*/
class Solution {
public List<Integer> boundaryOfBinaryTree(TreeNode root) {

}
}
```

Python3 Solution:

```
"""
Problem: Boundary of Binary Tree
Difficulty: Medium
Tags: tree, search

Approach: DFS or BFS traversal
Time Complexity: O(n) where n is number of nodes
Space Complexity: O(h) for recursion stack where h is height
"""

# Definition for a binary tree node.
# class TreeNode:
# def __init__(self, val=0, left=None, right=None):
# self.val = val
# self.left = left
# self.right = right
class Solution:
def boundaryOfBinaryTree(self, root: Optional[TreeNode]) -> List[int]:
# TODO: Implement optimized solution
```

```
pass
```

Python Solution:

```
# Definition for a binary tree node.
# class TreeNode(object):
# def __init__(self, val=0, left=None, right=None):
# self.val = val
# self.left = left
# self.right = right
class Solution(object):
def boundaryOfBinaryTree(self, root):
"""
:type root: Optional[TreeNode]
:rtype: List[int]
"""
```

JavaScript Solution:

```
/**
* Problem: Boundary of Binary Tree
* Difficulty: Medium
* Tags: tree, search
*
* Approach: DFS or BFS traversal
* Time Complexity: O(n) where n is number of nodes
* Space Complexity: O(h) for recursion stack where h is height
*/

/**
* Definition for a binary tree node.
* function TreeNode(val, left, right) {
* this.val = (val===undefined ? 0 : val)
* this.left = (left===undefined ? null : left)
* this.right = (right===undefined ? null : right)
* }
*/
/**
* @param {TreeNode} root
* @return {number[]}
*/
```

```
var boundaryOfBinaryTree = function(root) {

};
```

TypeScript Solution:

```
/**
* Problem: Boundary of Binary Tree
* Difficulty: Medium
* Tags: tree, search
*
* Approach: DFS or BFS traversal
* Time Complexity: O(n) where n is number of nodes
* Space Complexity: O(h) for recursion stack where h is height
*/

/**
* Definition for a binary tree node.
* class TreeNode {
* val: number
* left: TreeNode | null
* right: TreeNode | null
* constructor(val?: number, left?: TreeNode | null, right?: TreeNode | null)
{
* this.val = (val===undefined ? 0 : val)
* this.left = (left===undefined ? null : left)
* this.right = (right===undefined ? null : right)
* }
* }
*/

function boundaryOfBinaryTree(root: TreeNode | null): number[] {

};
```

C# Solution:

```
/*
* Problem: Boundary of Binary Tree
* Difficulty: Medium
* Tags: tree, search
```

```
*
* Approach: DFS or BFS traversal
* Time Complexity: O(n) where n is number of nodes
* Space Complexity: O(h) for recursion stack where h is height
*/

/**
* Definition for a binary tree node.
* public class TreeNode {
* public int val;
* public TreeNode left;
* public TreeNode right;
* public TreeNode(int val=0, TreeNode left=null, TreeNode right=null) {
* this.val = val;
* this.left = left;
* this.right = right;
* }
* }
*/
public class Solution {
public IList<int> BoundaryOfBinaryTree(TreeNode root) {

}
}
```

C Solution:

```
/*
* Problem: Boundary of Binary Tree
* Difficulty: Medium
* Tags: tree, search
*
* Approach: DFS or BFS traversal
* Time Complexity: O(n) where n is number of nodes
* Space Complexity: O(h) for recursion stack where h is height
*/

/**
* Definition for a binary tree node.
* struct TreeNode {
* int val;
```

```
* struct TreeNode *left;
* struct TreeNode *right;
* };
*/
/**
* Note: The returned array must be malloced, assume caller calls free().
*/
int* boundaryOfBinaryTree(struct TreeNode* root, int* returnSize) {

}
```

Go Solution:

```
// Problem: Boundary of Binary Tree
// Difficulty: Medium
// Tags: tree, search
//
// Approach: DFS or BFS traversal
// Time Complexity: O(n) where n is number of nodes
// Space Complexity: O(h) for recursion stack where h is height

/**
* Definition for a binary tree node.
* type TreeNode struct {
* Val int
* Left *TreeNode
* Right *TreeNode
* }
*/
func boundaryOfBinaryTree(root *TreeNode) []int {

}
```

Kotlin Solution:

```
/**
* Example:
* var ti = TreeNode(5)
* var v = ti.`val`
* Definition for a binary tree node.
* class TreeNode(var `val`: Int) {
```

```
* var left: TreeNode? = null
* var right: TreeNode? = null
* }
*/
class Solution {
fun boundaryOfBinaryTree(root: TreeNode?): List<Int> {

}
}
```

Swift Solution:

```
/**
* Definition for a binary tree node.
* public class TreeNode {
* public var val: Int
* public var left: TreeNode?
* public var right: TreeNode?
* public init() { self.val = 0; self.left = nil; self.right = nil; }
* public init(_ val: Int) { self.val = val; self.left = nil; self.right =
nil; }
* public init(_ val: Int, _ left: TreeNode?, _ right: TreeNode?) {
* self.val = val
* self.left = left
* self.right = right
* }
* }
*/
class Solution {
func boundaryOfBinaryTree(_ root: TreeNode?) -> [Int] {

}
}
```

Rust Solution:

```
// Problem: Boundary of Binary Tree
// Difficulty: Medium
// Tags: tree, search
//
// Approach: DFS or BFS traversal
```

```
// Time Complexity: O(n) where n is number of nodes
// Space Complexity: O(h) for recursion stack where h is height

// Definition for a binary tree node.
// #[derive(Debug, PartialEq, Eq)]
// pub struct TreeNode {
// pub val: i32,
// pub left: Option<Rc<RefCell<TreeNode>>>,
// pub right: Option<Rc<RefCell<TreeNode>>>,
// }
//
// impl TreeNode {
// #[inline]
// pub fn new(val: i32) -> Self {
// TreeNode {
// val,
// left: None,
// right: None
// }
// }
// }
use std::rc::Rc;
use std::cell::RefCell;
impl Solution {
pub fn boundary_of_binary_tree(root: Option<Rc<RefCell<TreeNode>>>) ->
Vec<i32> {

}
}
```

Ruby Solution:

```
# Definition for a binary tree node.
# class TreeNode
# attr_accessor :val, :left, :right
# def initialize(val = 0, left = nil, right = nil)
# @val = val
# @left = left
# @right = right
# end
# end
```

```
# @param {TreeNode} root
# @return {Integer[]}
def boundary_of_binary_tree(root)

end
```

PHP Solution:

```
/**
* Definition for a binary tree node.
* class TreeNode {
* public $val = null;
* public $left = null;
* public $right = null;
* function __construct($val = 0, $left = null, $right = null) {
* $this->val = $val;
* $this->left = $left;
* $this->right = $right;
* }
* }
*/
class Solution {

/**
* @param TreeNode $root
* @return Integer[]
*/
function boundaryOfBinaryTree($root) {

}
}
```

Dart Solution:

```
/**
* Definition for a binary tree node.
* class TreeNode {
* int val;
* TreeNode? left;
* TreeNode? right;
* TreeNode([this.val = 0, this.left, this.right]);
```

```
* }
*/
class Solution {
List<int> boundaryOfBinaryTree(TreeNode? root) {

}
}
```

Scala Solution:

```
/**
* Definition for a binary tree node.
* class TreeNode(_value: Int = 0, _left: TreeNode = null, _right: TreeNode =
null) {
* var value: Int = _value
* var left: TreeNode = _left
* var right: TreeNode = _right
* }
*/
object Solution {
def boundaryOfBinaryTree(root: TreeNode): List[Int] = {

}
}
```

Elixir Solution:

```
# Definition for a binary tree node.
#
# defmodule TreeNode do
# @type t :: %__MODULE__{
# val: integer,
# left: TreeNode.t() | nil,
# right: TreeNode.t() | nil
# }
# defstruct val: 0, left: nil, right: nil
# end

defmodule Solution do
@spec boundary_of_binary_tree(root :: TreeNode.t | nil) :: [integer]
def boundary_of_binary_tree(root) do
```

```
end
end
```

Erlang Solution:

```
%% Definition for a binary tree node.
%%
%% -record(tree_node, {val = 0 :: integer(),
%% left = null :: 'null' | #tree_node{},
%% right = null :: 'null' | #tree_node{}}).

-spec boundary_of_binary_tree(Root :: #tree_node{} | null) -> [integer()].
boundary_of_binary_tree(Root) ->
.
```

Racket Solution:

```
; Definition for a binary tree node.
#|

; val : integer?
; left : (or/c tree-node? #f)
; right : (or/c tree-node? #f)
(struct tree-node
(val left right) #:mutable #:transparent)

; constructor
(define (make-tree-node [val 0])
(tree-node val #f #f))

|#

(define/contract (boundary-of-binary-tree root)
(-> (or/c tree-node? #f) (listof exact-integer?))
)
```