

Problem 230: Kth Smallest Element in a BST

Problem Information

Difficulty: Medium

Acceptance Rate: 0.00%

Paid Only: No

Problem Description

Given the

root

of a binary search tree, and an integer

k

, return

the

k

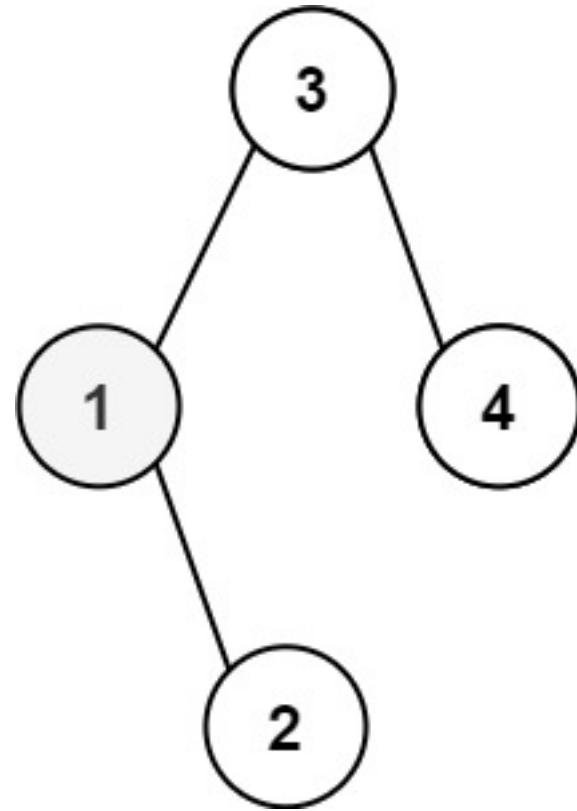
th

smallest value (

1-indexed

) of all the values of the nodes in the tree

Example 1:



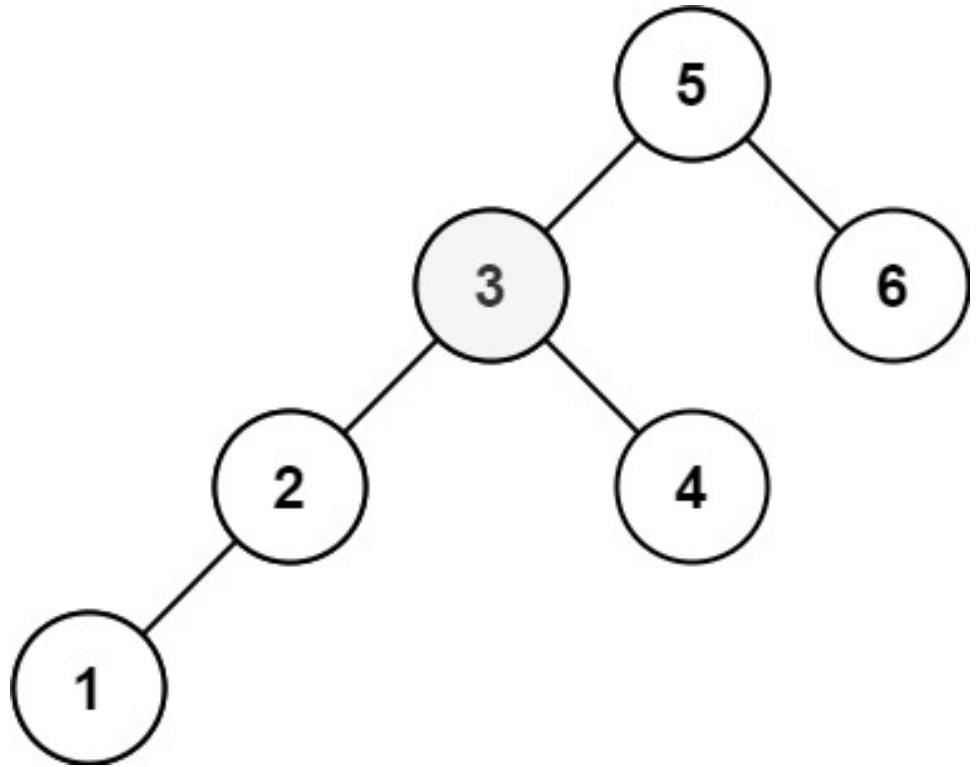
Input:

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

Output:

1

Example 2:



Input:

```
root = [5,3,6,2,4,null,null,1], k = 3
```

Output:

3

Constraints:

The number of nodes in the tree is

n

.

$1 \leq k \leq n \leq 10$

4

$0 \leq \text{Node.val} \leq 10$

Follow up:

If the BST is modified often (i.e., we can do insert and delete operations) and you need to find the kth smallest frequently, how would you optimize?

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:
    int kthSmallest(TreeNode* root, int k) {

    }
};
```

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 int kthSmallest(TreeNode root, int k) {

}
}

```

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 kthSmallest(self, root: Optional[TreeNode], k: int) -> 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 kthSmallest(self, root, k):
        """
:type root: Optional[TreeNode]
:type k: int
:rtype: 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
 * @param {number} k
 * @return {number}
 */
var kthSmallest = function(root, k) {

};

```

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 kthSmallest(root: TreeNode | null, k: number): 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 int KthSmallest(TreeNode root, int k) {
        }
    }
}

```

C:

```

/**
 * Definition for a binary tree node.
 * struct TreeNode {
 *     int val;
 *     struct TreeNode *left;
 *     struct TreeNode *right;
 * };
 */
int kthSmallest(struct TreeNode* root, int k) {
    }
}

```

Go:

```

/**
 * Definition for a binary tree node.
 * type TreeNode struct {
 *     Val int
 *     Left *TreeNode
 *     Right *TreeNode
 * }
 */
func kthSmallest(root *TreeNode, k int) 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 kthSmallest(root: TreeNode?, k: Int): 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 kthSmallest(_ root: TreeNode?, _ k: Int) -> 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 kth_smallest(root: Option<Rc<RefCell<TreeNode>>, k: i32) -> 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
```

```

# @param {Integer} k
# @return {Integer}
def kth_smallest(root, k)

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
     * @param Integer $k
     * @return Integer
     */
    function kthSmallest($root, $k) {

    }
}

```

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 {
int kthSmallest(TreeNode? root, int k) {

}
}

```

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 kthSmallest(root: TreeNode, k: Int): 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 kth_smallest(TreeNode.t() | nil, integer) :: integer
def kth_smallest(root, k) 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 kth_smallest(Root :: #tree_node{} | null, K :: integer()) -> integer().  
kth_smallest(Root, K) ->  
.
```

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 (kth-smallest root k)  
(-> (or/c tree-node? #f) exact-integer? exact-integer?)  
)
```

Solutions

C++ Solution:

```

/*
 * Problem: Kth Smallest Element in a BST
 * 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) {
 *         // TODO: Implement optimized solution
 *         return 0;
 *     }
 *     TreeNode(int x) : val(x), left(nullptr), right(nullptr) {
 *         // TODO: Implement optimized solution
 *         return 0;
 *     }
 *     TreeNode(int x, TreeNode *left, TreeNode *right) : val(x), left(left),
 *     right(right) {
 *         // TODO: Implement optimized solution
 *         return 0;
 *     }
 * };
 */
class Solution {
public:
    int kthSmallest(TreeNode* root, int k) {
        }
    };
}

```

Java Solution:

```

/**
 * Problem: Kth Smallest Element in a BST

```

```

* 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() {
 *         // TODO: Implement optimized solution
 *         return 0;
 *     }
 *     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 int kthSmallest(TreeNode root, int k) {
}
}

```

Python3 Solution:

```

"""
Problem: Kth Smallest Element in a BST
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 kthSmallest(self, root: Optional[TreeNode], k: int) -> 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 kthSmallest(self, root, k):
        """
:type root: Optional[TreeNode]
:type k: int
:rtype: int
"""

```

JavaScript Solution:

```

/**
 * Problem: Kth Smallest Element in a BST
 * 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
 * @param {number} k
 * @return {number}
 */
var kthSmallest = function(root, k) {

};

```

TypeScript Solution:

```

    /**
 * Problem: Kth Smallest Element in a BST
 * 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 kthSmallest(root: TreeNode | null, k: number): number {
}

```

C# Solution:

```

/*
 * Problem: Kth Smallest Element in a BST
 * 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 int KthSmallest(TreeNode root, int k) {
 *
 *     }
 * }

```

C Solution:

```

/*
 * Problem: Kth Smallest Element in a BST
 * 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;
 * };
 */
int kthSmallest(struct TreeNode* root, int k) {

}

```

Go Solution:

```

// Problem: Kth Smallest Element in a BST
// 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 kthSmallest(root *TreeNode, k int) 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 kthSmallest(root: TreeNode?, k: Int): Int {  
        // Implementation  
    }  
}
```

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 kthSmallest(_ root: TreeNode?, _ k: Int) -> Int {  
        // Implementation  
    }  
}
```

```
}
```

```
}
```

Rust Solution:

```
// Problem: Kth Smallest Element in a BST
// 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 kth_smallest(root: Option<Rc<RefCell<TreeNode>>>, k: i32) -> 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
# @param {Integer} k
# @return {Integer}
def kth_smallest(root, k)

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
 * @param Integer $k
 * @return Integer
 */
function kthSmallest($root, $k) {

}
}

```

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 {  
int kthSmallest(TreeNode? root, int k) {  
  
}  
}
```

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 kthSmallest(root: TreeNode, k: Int): 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 kth_smallest(root :: TreeNode.t | nil, k :: integer) :: integer
def kth_smallest(root, k) 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 kth_smallest(Root :: #tree_node{} | null, K :: integer()) -> integer().
kth_smallest(Root, K) ->
.
.
```

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 (kth-smallest root k)
  (-> (or/c tree-node? #f) exact-integer? exact-integer?))
)
```