

## 2005. Subtree Removal Game with Fibonacci Tree Premium

Hard Topics Companies Hint

A **Fibonacci** tree is a binary tree created using the order function `order(n)`:

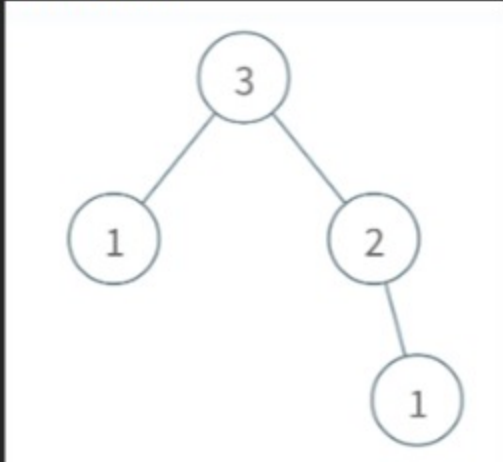
- `order(0)` is the empty tree.
- `order(1)` is a binary tree with only **one node**.
- `order(n)` is a binary tree that consists of a root node with the left subtree as `order(n - 2)` and the right subtree as `order(n - 1)`.

Alice and Bob are playing a game with a **Fibonacci** tree with Alice staring first. On each turn, a player selects a node and removes that node **and** its subtree. The player that is forced to delete `root` loses.

Given the integer `n`, return `true` if Alice wins the game or `false` if Bob wins, assuming both players play optimally.

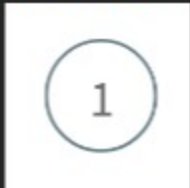
A subtree of a binary tree `tree` is a tree that consists of a node in `tree` and all of this node's descendants. The tree `tree` could also be considered as a subtree of itself.

### Example 1:



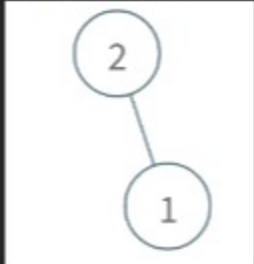
**Input:** `n = 3`  
**Output:** `true`  
**Explanation:**  
Alice takes the node 1 in the right subtree.  
Bob takes either the 1 in the left subtree or the 2 in the right subtree.  
Alice takes whichever node Bob doesn't take.  
Bob is forced to take the root node 3, so Bob will lose.  
Return `true` because Alice wins.

### Example 2:



**Input:** `n = 1`  
**Output:** `false`  
**Explanation:**  
Alice is forced to take the root node 1, so Alice will lose.  
Return `false` because Alice loses.

### Example 3:



**Input:** `n = 2`  
**Output:** `true`  
**Explanation:**  
Alice takes the node 1.  
Bob is forced to take the root node 2, so Bob will lose.  
Return `true` because Alice wins.

### Constraints:

- `1 <= n <= 100`

Seen this question in a real interview before? 1/5

Yes No

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### Hint 1

How can game theory help us solve this problem?

### Hint 2

Think about the Sprague–Grundy theorem and the Colon Principle

### Hint 3

The Grundy value of a node is the nim sum of the Grundy values of its children.

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