

292. Nim Game

April 6, 2016 | 82.5K views

Previous Next
★★★★★
Average Rating: 4.65 (147 votes)

You are playing the following Nim Game with your friend: There is a heap of stones on the table, each time one of you take turns to remove 1 to 3 stones. The one who removes the last stone will be the winner. You will take the first turn to remove the stones.

Both of you are very clever and have optimal strategies for the game. Write a function to determine whether you can win the game given the number of stones in the heap.

Example:

Input: 4
Output: false
Explanation: If there are 4 stones in the heap, then you will never win the game; No matter 1, 2, or 3 stones you remove, the last stone will always be removed by your friend.

Solution

You can *always* win a Nim game if the number of stones n in the pile is not divisible by 4.

Reasoning

Let us think of the small cases. It is clear that if there are only one, two, or three stones in the pile, and it is your turn, you can win the game by taking all of them. Like the problem description says, if there are exactly four stones in the pile, you will lose. Because no matter how many you take, you will leave some stones behind for your opponent to take and win the game. So in order to win, you have to ensure that you never reach the situation where there are exactly four stones on the pile on your turn.

Similarly, if there are five, six, or seven stones you can win by taking just enough to leave four stones for your opponent so that they lose. But if there are eight stones on the pile, you will inevitably lose, because regardless whether you pick one, two or three stones from the pile, your opponent can pick three, two or one stone to ensure that, again, four stones will be left to you on your turn.

It is obvious that the same pattern repeats itself for $n = 4, 8, 12, 16, \dots$, basically all multiples of 4.

Java

```
public boolean canWinNim(int n) {  
    return (n % 4 != 0);  
}
```

Complexity Analysis

Time complexity is $O(1)$, since only one check is performed. No additional space is used, so space complexity is also $O(1)$.

References


[Lecture on Nim Games](#) from University of Maryland: MATH 199: Math, Game Theory and the Theory of Games, Summer 2006.

Analysis written by: @noran


Rate this article: ★★★★★

Previous Next


Comments: 25 Sort By ▾



Type comment here... (Markdown is supported)

 Preview

Post




nageshg29★19🕒 August 23, 2018 1:39 AM

Hi All,
say there are 8 stones. then
say I pick 3 (5 is left)
other person picks 2 (3 is left)
then i would pick three (0 is left) so i can win the game right.

Read More

19👍👎🔄 Share👤 Reply

SHOW 6 REPLIES




leetcode_deleted_user★275🕒 March 10, 2018 5:22 PM

@bdsh_14 In this question, both of you and your friend are very clever and have optimal strategies for the game. So if you pick 3, the opponent will pick 2 then you will lose.

16👍👎🔄 Share👤 Reply

SHOW 1 REPLY




sriramt★11🕒 April 24, 2019 11:37 PM

// DP Solution
public boolean canWinNim(int n) {
 List list = new LinkedList();
 for(int i=1; i <= n; i++){
 if (i <= 3) list.add(true);
 }
 // ...
}

Read More

8👍👎🔄 Share👤 Reply




isojay★38🕒 June 21, 2019 2:09 AM

I hope I get this kind of question in an interview. :)

5👍👎🔄 Share👤 Reply

SHOW 1 REPLY




tom_net★5🕒 May 12, 2020 9:30 PM

Python 3
Runtime: 28 ms, faster than 71.08% of Python3 online submissions for Nim Game.
Memory Usage: 13.9 MB, less than 14.29% of Python3 online submissions for Nim Game.

Place Solution

Read More

4👍👎🔄 Share👤 Reply



Nevsanev★1138🕒 April 14, 2019 10:05 PM

Wow. Just finished the contest yesterday. One of the question is so similar to this one:
<https://leetcode.com/problems/divisor-game/>
This kind of question can all be solved by finding the underlying pattern behind it. If you cannot figure out, just do normal DP.

2👍👎🔄 Share👤 Reply

SHOW 3 REPLIES



tony407★160🕒 September 9, 2017 5:50 AM


C++ Solution:

class Solution {
public:
 bool canWinNim(int n) {
 // ...
 }
};

Read More

3👍👎🔄 Share👤 Reply

SHOW 1 REPLY




user5681R★2🕒 December 12, 2019 1:55 PM

I think problem is funny.. Each can pick 3 stones max. Opponent is very clever. If total stone is 5, then how can I win?
If i pick 3 then opponent will pick rest 2. But if i use n%4 to check whether I loss then how this scenario simulate???????

2👍👎🔄 Share👤 Reply


SHOW 2 REPLIES



JackyD★35🕒 May 20, 2019 5:45 AM

Just uses the fact that n and n-4 is the same situation since whoever take the (n-4)-th stone would win the game

1👍👎🔄 Share👤 Reply



bdsh_14★2🕒 March 10, 2018 4:12 AM

If there are 8 stones,
I can pick 3
Opponent can pick 3
I can pick 2 stones .
I win. So how is this solution valid.

Read More

1👍👎🔄 Share👤 Reply

SHOW 14 REPLIES