

2443. Sum of Number and Its Reverse

MediumMathEnumeration

Leetcode Link

Problem Description

In the context of this LeetCode problem, one is tasked with determining whether a non-negative integer `num` can be represented as a sum of any non-negative integer and its reverse. The reverse of an integer is the number obtained by reversing the order of its digits. For instance, the reverse of `123` is `321`. The problem requires the function to return `true` if such a representation is possible for the given `num`, or `false` otherwise.

Intuition

The straightforward approach to solve this problem relies on the simple brute force method. We consider all non-negative integers from `0` up to `num` inclusive, because the sum of a number and its reverse cannot be greater than `num` itself. For each of these integers, named `k`, we calculate its reverse by converting `k` to a string, reversing the string, and converting it back to an integer. Then, we check whether the original number `k` plus its reverse equals `num`. If we find any such `k` that satisfies this condition, the function returns `true`. If the loop completes without finding any valid `k`, the function returns `false`. This approach ensures that all possibilities are checked.

This process is efficiently executed in the solution code using a generator expression within the `any` function, which iteratively checks each number until a match is found, and returns `true` as soon as a satisfying number is encountered.

Solution Approach

For this problem, the implementation is fairly straightforward and does not involve complex data structures or advanced algorithms. It's a direct translation of the brute force approach into Python code.

The solution defines a method `sumOfNumberAndReverse` within the `Solution` class. This method takes one parameter, `num`, which is the non-negative integer that we want to examine.

The core of the implementation is the expression:

```
1 any(k + int(str(k)[::-1]) == num for k in range(num + 1))
```

Here's a step-by-step walk-through of what's happening:

- `range(num + 1)`: We create an iterable sequence of numbers starting from `0` up to and including `num`. This is because the largest number that, when added to its reverse, could potentially equal `num` is `num` itself.
- `str(k)[::-1]`: For each number `k` in the range, we convert `k` into a string using `str(k)` then reverse the string by applying the slicing operation `[::-1]`. This slice notation is a Python idiom for reversing sequences.
- `int(...)`: The reversed string is converted back to an int because we need to perform arithmetic with it.
- `k + int(str(k)[::-1]) == num`: We add the integer `k` to its reverse and check if the sum is equal to `num`.
- `any(...)`: This is a built-in Python function that takes an iterable and returns `True` if at least one element in the iterable is `True`. In this case, it iterates over the generator expression, which yields `True` or `False` for each `k` in the sequence based on whether `k` plus its reverse equals `num`.
- `return ...`: Finally, the method returns the result of the `any` function. If any value of `k` found satisfies the condition, `True` is returned; otherwise, `False` is returned.

This solution is elegant and concise thanks to Python's high-level abstractions but comes with an $O(n)$ time complexity, as it might need to check all integers from `0` to `num`. The space complexity, on the other hand, is $O(1)$ since there are no additional data structures consuming memory based on the input size; the integers are generated one by one.

Example Walkthrough

Let's consider a small example using the number `num = 121` to illustrate the solution approach. We want to determine if there exists a non-negative integer `k` such that when `k` is added to its reverse, the sum equals `121`.

- First, we generate a sequence of numbers from `0` to `121` inclusive, because these are all the potential candidates for `k` that, when combined with their reverse, could equal `num`.
- We then iterate through these numbers one by one. For each iteration, let's denote our current number as `k`.
- We reverse the digits of `k`. If `k` was `12`, the reversed version would be `21` which is obtained by converting `k` to a string ("`12`"), reversing the string ("`21`"), and converting it back to an integer (`21`).
- We add the original `k` to its reversed version. For `k = 12`, this would be `12 + 21` which equals `33`.
- We check if this sum equals `num` (`121` in this case). Since `33` is not equal to `121`, we continue this process with the next number in the sequence.
- If at any point the sum of `k` and its reverse equals `121`, we will return `True`. For example, if `k` were `112`, its reverse would be `211`, and adding those together yields `112 + 211 = 323` which is not `121`. So we move on.
- If we have gone through all numbers up to `121` and have not found a sum that equals `121`, we will return `False`.
- Luckily, when `k = 29`, we find that its reverse is `92`, and adding them together yields `29 + 92 = 121`. Since this satisfies our condition, the `any` function will immediately return `True`, indicating that `num = 121` can indeed be expressed as the sum of a number and its reverse.

Python Solution

```
1 class Solution:
2     def sum_of_number_and_reverse(self, num: int) -> bool:
3         # Iterate over all numbers from 0 to num, inclusive
4         for integer in range(num + 1):
5             # Calculate the reverse of the current number by converting it to a string,
6             # reversing it, and then casting it back to an integer
7             reverse_integer = int(str(integer)[::-1])
8
9             # Check if the sum of the current number and its reverse equals the input number
10            if integer + reverse_integer == num:
11                # If a match is found, return True
12                return True
13
14            # If no match is found in the iteration, return False
15            return False
16
```

Java Solution

```
1 class Solution {
2     /**
3      * Checks whether a given number can be expressed as
4      * the sum of a number and its reverse.
5      *
6      * @param num The number to check.
7      * @return true if the number can be expressed as the sum
8      *         of a number and its reverse, otherwise false.
9      */
10    public boolean sumOfNumberAndReverse(int num) {
11        // Loop from 0 to the given number (inclusive)
12        for (int originalNumber = 0; originalNumber <= num; ++originalNumber) {
13            int reversedNumber = 0;
14            int temp = originalNumber;
15
16            // Reverse the current number
17            while (temp > 0) {
18                int lastDigit = temp % 10;
19                reversedNumber = reversedNumber * 10 + lastDigit;
20                temp /= 10;
21            }
22
23            // Check if the sum of the original and reversed number is equal to the input number
24            if (originalNumber + reversedNumber == num) {
25                return true; // Found a pair that satisfies the condition
26            }
27        }
28
29        // If no such pair is found in the loop, return false
30        return false;
31    }
32 }
33
```

C++ Solution

```
1 class Solution {
2 public:
3     // Checks if a number can be expressed as the sum of a number and its reverse
4     bool sumOfNumberAndReverse(int num) {
5         // Loop through all numbers starting from 0 up to the given number
6         for (int original_number = 0; original_number <= num; ++original_number) {
7             int remaining = original_number;
8             int reversed_number = 0;
9             // Reverse the original number
10            while (remaining > 0) {
11                reversed_number = reversed_number * 10 + remaining % 10; // Append the last digit of remaining to reversed_number
12                remaining /= 10; // Remove the last digit from remaining
13            }
14            // Check if the sum of the original number and its reverse equals the given number
15            if (original_number + reversed_number == num) {
16                return true; // If the condition is met, return true
17            }
18        }
19        return false; // If no such pair is found, return false
20    }
21 };
22
```

Typescript Solution

```
1 // Checks if a given number is equal to the sum of another number and its reverse.
2 // num: Number to check for this property.
3 // Returns a boolean value indicating whether such a pair exists.
4
5 function sumOfNumberAndReverse(num: number): boolean {
6     // Iterate over all numbers from 0 to the input number
7     for (let i = 0; i <= num; i++) {
8         // Calculate the reverse of the current number 'i'
9         const reversedNumber = Number([...(i.toString())].reverse().join(''));
10
11        // Check if the current number plus its reverse equals the input number
12        if (i + reversedNumber === num) {
13            // Return true if the condition holds for the current number
14            return true;
15        }
16    }
17    // After checking all numbers, return false if no suitable pair was found
18    return false;
19 }
20
```

Time and Space Complexity

Time Complexity

The given function `sumOfNumberAndReverse` performs a linear search from `0` to `num` inclusive. For each value `k` in this range, the function calculates the reverse of the number by converting it to a string, reverse the string (this is done using `str(k)[::-1]`), and then converting it back to an integer. After this, it checks if the sum of the number `k` and its reverse equals the input number `num`.

Therefore, we can say the time complexity of the function is $O(n * m)$, where n is the value of `num` and m represents the time taken to reverse the number. Since the number of digits `d` in the number `k` can be represented as $O(\log(k))$, the reverse operation is $O(d)$ which simplifies to $O(\log(n))$ for the worst case when `k` is close to `num`. Thus, the overall time complexity is $O(n * \log(n))$.

Space Complexity

The space complexity of the function is $O(1)$. The reason for this constant space complexity is because aside from a few variables (`k` and the reversed number), the function does not use any additional space that scales with the input size `num`. The inputs and variables are of a fixed size, so it doesn't matter how large `num` is, the space used by the function remains constant.