Sunday, January 9, 2022 8:32 PM

2. Add Two Numbers

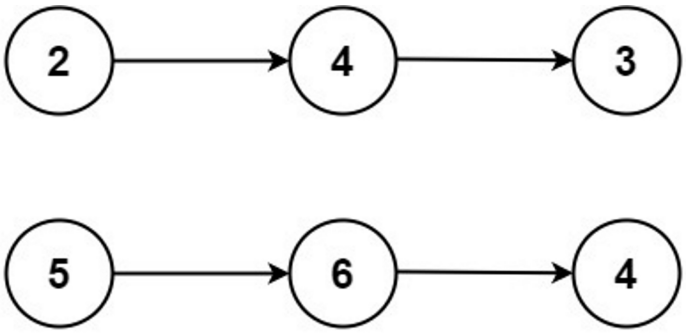
Medium

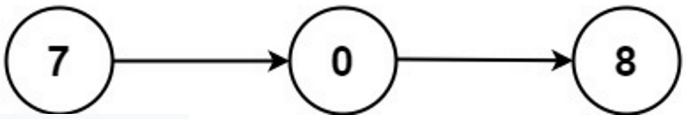
156593387Add to ListShare

You are given two **non-empty** linked lists representing two non-negative integers. The digits are stored in **reverse order**, and each of their nodes contains a single digit. Add the two numbers and return the sum as a linked list.

You may assume the two numbers do not contain any leading zero, except the number 0 itself.

Example 1:





Input: l1 = [2,4,3], l2 = [5,6,4]
Output: [7,0,8]
Explanation: 342 + 465 = 807.

Example 2:

Input: l1 = [0], l2 = [0]
Output: [0]

Example 3:

Input: l1 = [9,9,9,9,9,9,9], l2 = [9,9,9,9]
Output: [8,9,9,9,0,0,0,1]

Constraints:

- The number of nodes in each linked list is in the range [1, 100].
- 0 <= Node.val <= 9
- It is guaranteed that the list represents a number that does not have leading zeros.

Accepted
2,415,624
Submissions
6,432,773

Seen this question in a real interview before?

Yes
No

Companies
Related Topics
Linked ListMathRecursion
Similar Questions
Multiply Strings

Medium

Add Binary
Easy

Sum of Two Integers
Medium

Add Strings
Easy

Add Two Numbers II
Medium

Add to Array-Form of Integer
Easy

Add Two Polynomials Represented as Linked Lists
Medium

From <https://leetcode.com/problems/add-two-numbers/>

Solution

Approach 1: Elementary Math

Intuition
Keep track of the carry using a variable and simulate digits-by-digits sum starting from the head of list, which contains the least-significant digit.
Figure 1. Visualization of the addition of two numbers: 342 + 465 = 807342+465=807.
Each node contains a single digit and the digits are stored in reverse order.

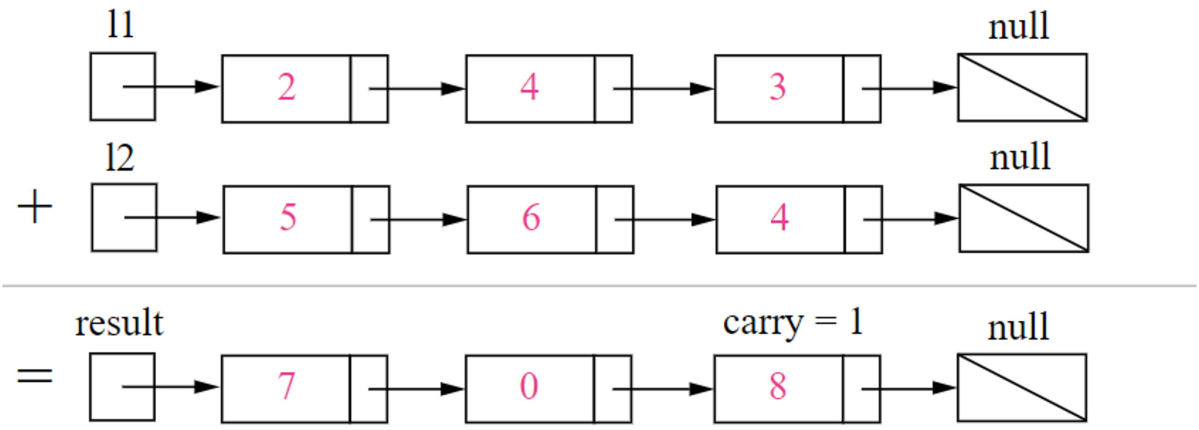


Figure 1. Visualization of the addition of two numbers: 342 + 465 = 807.
Each node contains a single digit and the digits are stored in reverse order.

Algorithm
Just like how you would sum two numbers on a piece of paper, we begin by summing the least-significant digits, which is the head of l1/1 and l2/2. Since each digit is in the range of 0 \ldots 90…9, summing two digits

may "overflow". For example 5 + 7 = 125+7=12. In this case, we set the current digit to 22 and bring over the carry = 1*carry*=1 to the next iteration. carry*carry* must be either 00 or 11 because the largest possible sum of two digits (including the carry) is 9 + 9 + 1 = 199+9+1=19.
The pseudocode is as following:

- Initialize current node to dummy head of the returning list.
- Initialize carry to 00.
- Initialize p*p* and q*q* to head of l1/1 and l2/2 respectively.
- Loop through lists l1/1 and l2/2 until you reach both ends.
    - Set x*x* to node p*p*'s value. If p*p* has reached the end of l1/1, set to 00.
    - Set y*y* to node q*q*'s value. If q*q* has reached the end of l2/2, set to 00.
    - Set sum = x + y + carry*sum*=*x*+*y*+*carry*.
    - Update carry = sum / 10*carry*=*sum*/10.
    - Create a new node with the digit value of (sum \bmod 10)(*sum*mod10) and set it to current node's next, then advance current node to next.
    - Advance both p*p* and q*q*.
- Check if carry = 1*carry*=1, if so append a new node with digit 11 to the returning list.
- Return dummy head's next node.

Note that we use a dummy head to simplify the code. Without a dummy head, you would have to write extra conditional statements to initialize the head's value.
Take extra caution of the following cases:

Test case	Explanation
l1=[0,1]/1=[0,1] l2=[0,1,2]/2=[0,1,2]	When one list is longer than the other.
l1=[]/1=[] l2=[0,1]/2=[0,1]	When one list is null, which means an empty list.
l1=[9,9]/1=[9,9] l2=[1]/2=[1]	The sum could have an extra carry of one at the end, which is easy to forget.

Complexity Analysis

- Time complexity : O(\max(m, n))*O*(max(*m*,*n*)). Assume that m*m* and n*n* represents the length of l1/1 and l2/2 respectively, the algorithm above iterates at most \max(m, n)max(*m*,*n*) times.
- Space complexity : O(\max(m, n))*O*(max(*m*,*n*)). The length of the new list is at most \max(m,n) + 1max(*m*,*n*)+1.

Follow up
What if the the digits in the linked list are stored in non-reversed order? For example:
(3 \to 4 \to 2) + (4 \to 6 \to 5) = 8 \to 0 \to 7(3→4→2)+(4→6→5)=8→0→7

From <https://leetcode.com/problems/add-two-numbers/solution/>

```
public class addTwoNumbers{
    public ListNode addTwoNumbers(ListNode l1, ListNode l2) {
        ListNode dummyHead = new ListNode(0);
        ListNode p = l1, q = l2, curr = dummyHead;
        int carry = 0;
        while (p != null || q != null) {
            int x = (p != null) ? p.val : 0;
            int y = (q != null) ? q.val : 0;
            int sum = carry + x + y;
            carry = sum / 10;
            curr.next = new ListNode(sum % 10);
            curr = curr.next;
            if (p != null) p = p.next;
            if (q != null) q = q.next;
        }
        if (carry > 0) {
            curr.next = new ListNode(carry);
        }
        return dummyHead.next;
    }
    public static void main(String[] args) {
```

```
    }
}
```