11. Container With Most Water

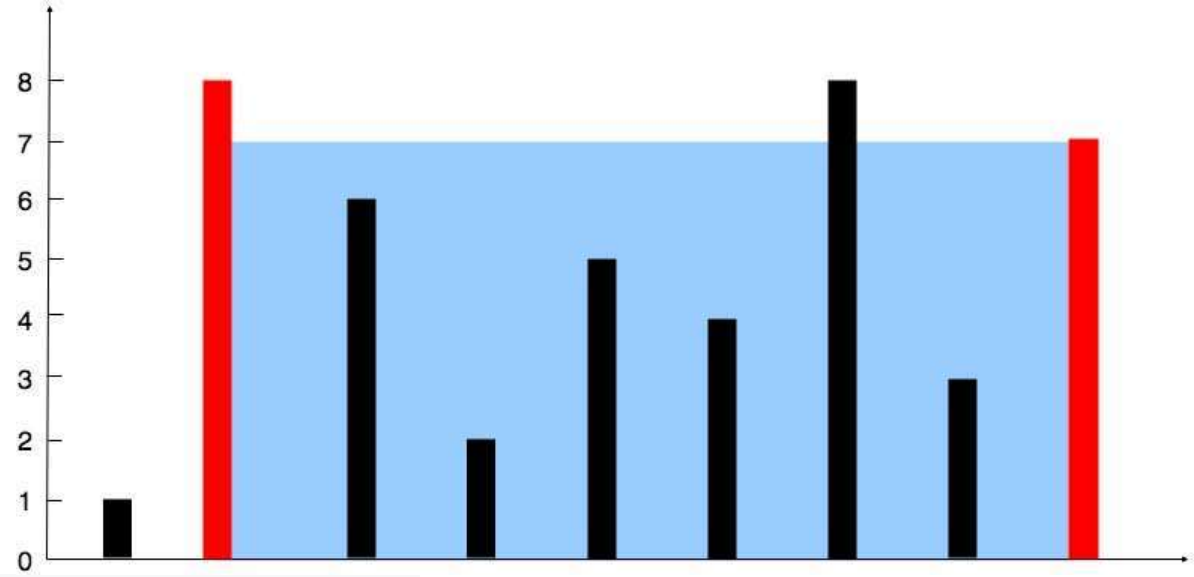
You are given an integer array height of length n. There are n vertical lines drawn such that the two endpoints of the ith line are (i, 0) and (i, height[i]).

Find two lines that together with the x-axis form a container, such that the container contains the most water.

Return *the maximum amount of water a container can store*.

Notice that you may not slant the container.

Example 1:



Input: height = [1,8,6,2,5,4,8,3,7]

Output: 49

Explanation: The above vertical lines are represented by array [1,8,6,2,5,4,8,3,7]. In this case, the max area of water (blue section) the container can contain is 49.

Example 2:

Input: height = [1,1]

Output: 1

Constraints:

- n == height.length
- 2 <= n <= 105
- 0 <= height[i] <= 104

```
def max_area(height):
    left = 0
    right = len(height) - 1
    max_area = 0

    while left < right:
        current_area = min(height[left], height[right]) * (right - left)
        max_area = max(max_area, current_area)
```

```
        if height[left] < height[right]:
            left += 1
        else:
            right -= 1

    return max_area

height1 = [1, 8, 6, 2, 5, 4, 8, 3, 7]
print("Max area for height1:", max_area(height1))
```

output

Max area for height1: 49

Time complexity

O(n)

12. Integer to Roman

Roman numerals are represented by seven different symbols: I, V, X, L, C, D and M.

Symbol	Value
I	1
V	5
X	10
L	50
C	100
D	500
M	1000

For example, 2 is written as II in Roman numeral, just two one's added together. 12 is written as XII, which is simply X + II. The number 27 is written as XXVII, which is XX + V + II.

Roman numerals are usually written largest to smallest from left to right. However, the numeral for four is not IIII. Instead, the number four is written as IV. Because the one is before the five we subtract it making four. The same principle applies to the number nine, which is written as IX. There are six instances where subtraction is used:

- I can be placed before V (5) and X (10) to make 4 and 9.
- X can be placed before L (50) and C (100) to make 40 and 90.
- C can be placed before D (500) and M (1000) to make 400 and 900.

Given an integer, convert it to a roman numeral.

Example 1:
Input: num = 3
Output: "III"
Explanation: 3 is represented as 3 ones.

Example 2:
Input: num = 58
Output: "LVIII"
Explanation: L = 50, V = 5, III = 3.

Example 3:
Input: num = 1994
Output: "MCMXCIV"
Explanation: M = 1000, CM = 900, XC = 90 and IV = 4.

```
def int_to_roman(num):
    value_map = [
        (1000, 'M'), (900, 'CM'), (500, 'D'), (400, 'CD'),
        (100, 'C'), (90, 'XC'), (50, 'L'), (40, 'XL'),
        (10, 'X'), (9, 'IX'), (5, 'V'), (4, 'IV'), (1, 'I')
    ]

    roman_numeral = ""
    for value, symbol in value_map:
        while num >= value:
            roman_numeral += symbol
            num -= value
    return roman_numeral

print(int_to_roman(3))
print(int_to_roman(58))
print(int_to_roman(1994))
```

output
III
LVIII
MCMXCIV

Time
complexity

O(n)

13. Roman to Integer

Roman numerals are represented by seven different symbols: I, V, X, L, C, D and M.

Symbol	Value
I	1
V	5
X	10
L	50
C	100
D	500
M	1000

For example, 2 is written as II in Roman numeral, just two ones added together. 12 is written as XII, which is simply X + II. The number 27 is written as XXVII, which is XX + V + II.

Roman numerals are usually written largest to smallest from left to right. However, the numeral for four is not IIII. Instead, the number four is written as IV. Because the one is before the five we subtract it making four. The same principle applies to the number nine, which is written as IX. There are six instances where subtraction is used:

- I can be placed before V (5) and X (10) to make 4 and 9.
- X can be placed before L (50) and C (100) to make 40 and 90.
- C can be placed before D (500) and M (1000) to make 400 and 900.

Given a roman numeral, convert it to an integer.

Example 1:
Input: s = "III"
Output: 3
Explanation: III = 3.

Example 2:
Input: s = "LVIII"
Output: 58
Explanation: L = 50, V= 5, III = 3.

Example 3:
Input: s = "MCMXCIV"
Output: 1994
Explanation: M = 1000, CM = 900, XC = 90 and IV = 4.

Constraints:

- 1 <= s.length <= 15
- s contains only the characters ('I', 'V', 'X', 'L', 'C', 'D', 'M').

It is guaranteed that s is a valid roman numeral in the range [1, 3999].

```
def roman_to_int(s):
    roman_map = {'I': 1, 'V': 5, 'X': 10, 'L': 50, 'C': 100, 'D': 500, 'M': 1000}
    total = 0
    prev_value = 0

    for char in reversed(s):
        value = roman_map[char]
```

```
        if value < prev_value:
            total -= value
        else:
            total += value
        prev_value = value

    return total

print(roman_to_int("III"))
print(roman_to_int("LVIII"))
print(roman_to_int("MCMXCIV"))
```

output
3
58
1994

Time complexity
O(n)

14. Longest Common Prefix
Write a function to find the longest common prefix string amongst an array of strings.
If there is no common prefix, return an empty string "".

Example 1:
Input: strs = ["flower","flow","flight"]
Output: "fl"

Example 2:
Input: strs = ["dog","racecar","car"]
Output: ""
Explanation: There is no common prefix among the input strings.

Constraints:

- 1 <= strs.length <= 200
- 0 <= strs[i].length <= 200
- strs[i] consists of only lowercase English letters.

```
def longest_common_prefix(strs):
    if not strs:
        return ""

    prefix = strs[0]
    for s in strs[1:]:
        while not s.startswith(prefix):
            prefix = prefix[:-1]
            if not prefix:
```

```
            return ""
    return prefix

print(longest_common_prefix(["flower","flow","flight"]))
```

output

fl

time complexity

$O(n \cdot m)$

15. 3sums
Given an integer array nums, return all the triplets [nums[i], nums[j], nums[k]] such that i != j, i != k, and j != k, and nums[i] + nums[j] + nums[k] == 0.
Notice that the solution set must not contain duplicate triplets.

Example 1:
Input: nums = [-1,0,1,2,-1,-4]
Output: [[-1,-1,2],[-1,0,1]]
Explanation:
nums[0] + nums[1] + nums[2] = (-1) + 0 + 1 = 0.
nums[1] + nums[2] + nums[4] = 0 + 1 + (-1) = 0.
nums[0] + nums[3] + nums[4] = (-1) + 2 + (-1) = 0.
The distinct triplets are [-1,0,1] and [-1,-1,2].
Notice that the order of the output and the order of the triplets does not matter.

Example 2:
Input: nums = [0,1,1]
Output: []
Explanation: The only possible triplet does not sum up to 0.

Example 3:
Input: nums = [0,0,0]
Output: [[0,0,0]]
Explanation: The only possible triplet sums up to 0.

Constraints:

- 3 <= nums.length <= 3000
- -105 <= nums[i] <= 105

```
def three_sum(nums):
    nums.sort()
    result = []

    for i in range(len(nums) - 2):
        if i > 0 and nums[i] == nums[i - 1]:
            continue
        left, right = i + 1, len(nums) - 1
        while left < right:
            total = nums[i] + nums[left] + nums[right]
            if total == 0:
                result.append([nums[i], nums[left], nums[right]])
                while left < right and nums[left] == nums[left + 1]:
                    left += 1
                while left < right and nums[right] == nums[right - 1]:
                    right -= 1
                left += 1
                right -= 1
```

```
            elif total < 0:
                left += 1
            else:
                right -= 1

    return result

print(three_sum([-1,0,1,2,-1,-4]))
```

output

[[-1, -1, 2], [-1, 0, 1]]

Time complexity

$O(n^2)$

16. 3Sum Closest

Given an integer array nums of length n and an integer target, find three integers in nums such that the sum is closest to target.

Return *the sum of the three integers*.

You may assume that each input would have exactly one solution.

Example 1:

Input: nums = [-1,2,1,-4], target = 1

Output: 2

Explanation: The sum that is closest to the target is 2. (-1 + 2 + 1 = 2).

Example 2:

Input: nums = [0,0,0], target = 1

Output: 0

Explanation: The sum that is closest to the target is 0. (0 + 0 + 0 = 0).

Constraints:

- 3 <= nums.length <= 500
- -1000 <= nums[i] <= 1000
- **-104 <= target <= 104**

```
def three_sum_closest(nums, target):
    nums.sort()
    closest_sum = float('inf')

    for i in range(len(nums) - 2):
        left, right = i + 1, len(nums) - 1
        while left < right:
            current_sum = nums[i] + nums[left] + nums[right]
            if abs(current_sum - target) < abs(closest_sum - target):
                closest_sum = current_sum

            if current_sum < target:
                left += 1
            elif current_sum > target:
                right -= 1
            else:
                return target

    return closest_sum

print(three_sum_closest([-1,2,1,-4], 1))
```

output

2

Time complexity
$O(n^2)$

17. Letter Combinations of a Phone Number
Given a string containing digits from 2-9 inclusive, return all possible letter combinations that the number could represent. Return the answer in any order.
A mapping of digits to letters (just like on the telephone buttons) is given below. Note that 1 does not map to any letters.

Example 1:
Input: digits = "23"
Output: ["ad","ae","af","bd","be","bf","cd","ce","cf"]

Example 2:
Input: digits = ""
Output: []

Example 3:
Input: digits = "2"
Output: ["a","b","c"]

Constraints:

- 0 <= digits.length <= 4
- digits[i] is a digit in the range ['2', '9'].

```
def letter_combinations(digits):
    if not digits:
        return []

    mapping = {
        '2': 'abc', '3': 'def', '4': 'ghi', '5': 'jkl',
        '6': 'mno', '7': 'pqrs', '8': 'tuv', '9': 'wxyz'
    }

    result = ['']
```

```
    for digit in digits:
        result = [prefix + letter for prefix in result for letter in mapping[digit]]

    return result
print(letter_combinations("23"))
```

output

['ad', 'ae', 'af', 'bd', 'be', 'bf', 'cd', 'ce', 'cf']

Time complexity

O(n)

18. 4Sum

Given an array nums of n integers, return *an array of all the unique quadruplets* [nums[a], nums[b], nums[c], nums[d]] such that:

a. 0 <= a, b, c, d < n
b. a, b, c, and d are distinct.
c. nums[a] + nums[b] + nums[c] + nums[d] == targetYou may return the answer in any order.

Example 1:
Input: nums = [1,0,-1,0,-2,2], target = 0
Output: [[-2,-1,1,2],[-2,0,0,2],[-1,0,0,1]]

Example 2:
Input: nums = [2,2,2,2,2], target = 8
Output: [[2,2,2,2]]

Constraints:

d. 1 <= nums.length <= 200
e. -109 <= nums[i] <= 109
f. -109 <= target <= 109

```
def four_sum(nums, target):
    nums.sort()
    n = len(nums)
    result = []

    for i in range(n - 3):
        if i > 0 and nums[i] == nums[i - 1]:
            continue
        for j in range(i + 1, n - 2):
            if j > i + 1 and nums[j] == nums[j - 1]:
                continue
            left, right = j + 1, n - 1
            while left < right:
                total = nums[i] + nums[j] + nums[left] + nums[right]
                if total == target:
                    result.append([nums[i], nums[j], nums[left], nums[right]])
                    while left < right and nums[left] == nums[left + 1]:
                        left += 1
                    while left < right and nums[right] == nums[right - 1]:
                        right -= 1
                    left += 1
                    right -= 1
                elif total < target:
                    left += 1
                else:
                    right -= 1
```

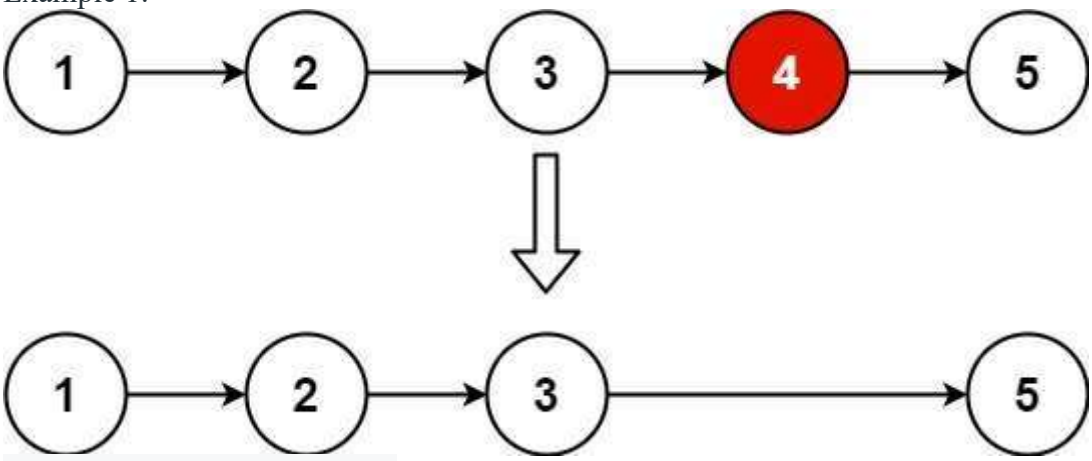
```
    return result

# Example usage
print(four_sum([1,0,-1,0,-2,2], 0))
```

Output
[[-2,-1,1,2],[-2,0,0,2],[-1,0,0,1]]

Time complexity
$O(n^3)$

19. Remove Nth Node From End of List
Given the head of a linked list, remove the nth node from the end of the list and return its head.

Example 1:



Input: head = [1,2,3,4,5], n = 2
Output: [1,2,3,5]

Example 2:
Input: head = [1], n = 1
Output: []

Example 3:
Input: head = [1,2], n = 1
Output: [1]

Constraints:

- The number of nodes in the list is sz.
- 1 <= sz <= 30
- 0 <= Node.val <= 100
- 1 <= n <= sz

```
class ListNode:
    def __init__(self, val=0, next=None):
        self.val = val
        self.next = next

def remove_nth_from_end(head, n):
    dummy = ListNode(0)
    dummy.next = head
    fast = slow = dummy

    for _ in range(n + 1):
        fast = fast.next

    while fast:
        fast = fast.next
        slow = slow.next

    slow.next = slow.next.next

    return dummy.next

head = ListNode(1)
head.next = ListNode(2)
head.next.next = ListNode(3)
head.next.next.next = ListNode(4)
head.next.next.next.next = ListNode(5)

new_head = remove_nth_from_end(head, 2)
while new_head:
    print(new_head.val, end=" -> ")
    new_head = new_head.next
```

output

1 -> 2 -> 3 -> 5 ->

Time complexity

O(n)

20. Valid Parentheses

Given a string s containing just the characters '(', ')', '{', '}', '[' and ']', determine if the input string is valid.

An input string is valid if:

1. Open brackets must be closed by the same type of brackets.
2. Open brackets must be closed in the correct order.
3. Every close bracket has a corresponding open bracket of the same type.

Example 1:
Input: s = "()"
Output: true

Example 2:
Input: s = "()[]{}"
Output: true

Example 3:
Input: s = "(]"
Output: false

Constraints:

- 1 <= s.length <= 104
- s consists of parentheses only '()[]{}'.

```
def is_valid(s):
    stack = []
    mapping = {')': '(', ']': '[', '}': '{'}

    for char in s:
        if char in mapping:
            top_element = stack.pop() if stack else '#'
            if mapping[char] != top_element:
                return False
        else:
            stack.append(char)

    return not stack
print(is_valid("()"))
```

output

True

Time complexity

O(n)