Container with Most Water

Difficulty Level : Medium • Last Updated : 20 Jan, 2022

Given n non-negative integers $a_1, a_2, ..., a_n$ where each represents a point at coordinate (i, a_i). ' n ' vertical lines are drawn such that the two endpoints of line i is at (i, a_i) and $(i, 0)$.
Find two lines, which together with x-axis forms a container, such that the container contains the most water.
The program should return an integer which corresponds to the maximum area of water that can be contained (maximum area instead of maximum volume sounds weird but this is the 2D plane we are working with for simplicity).

Note: You may not slant the container.

Examples :

```
Input: array = [1, 5, 4, 3]
Output: 6
Explanation :
5 and 3 are distance 2 apart.
So the size of the base = 2.
Height of container = min(5, 3) = 3.
So total area = 3 * 2 = 6

Input: array = [3, 1, 2, 4, 5]
Output: 12
Explanation :
```

```
5 and 3 are distance 4 apart.
So the size of the base = 4.
Height of container = min(5, 3) = 3.
So total area = 4 * 3 = 12
```

Recommended Practice

Container With Most Water

Try It!

Naive Solution:

- **Approach:** The idea is quite simple and involves checking every pair of boundaries or array element and find out the maximum area under any pair of boundaries.
- **Algorithm:**
  1. Create a nested loop, the outer loop traverses the array from 0 to end (index of this loop is *i*).
  2. The inner loop traverses the array from *i + 1* to end (index of this loop is *j*).
  3. Find the water that can be contained in the container with height of boundaries as array[i] and array[j], i.e *area = (j - i) * min(array[i],array[j])*, if this area is greater than current maximum, update the current maximum
  4. Print the current maximum.

- **Implementation:**

C++14

```
// C++ code for Max
// Water Container
#include <iostream>
using namespace std;

int maxArea(int A[], int len)
```

```
{
    int area = 0;
    for (int i = 0; i < len; i++) {
        for (int j = i + 1; j < len; j++) {
            // Calculating the max area
            area = max(area, min(A[j], A[i]) * (j - i));
        }
    }
    return area;
}

// Driver code
int main()
{
    int a[] = { 1, 5, 4, 3 };
    int b[] = { 3, 1, 2, 4, 5 };

    int len1 = sizeof(a) / sizeof(a[0]);
    cout << maxArea(a, len1);

    int len2 = sizeof(b) / sizeof(b[0]);
    cout << endl << maxArea(b, len2);
}
```

Java

```
// Java code for Max
// Water Container
import java.io.*;

class GFG{

public static int maxArea(int[] a)
{

    int Area = 0;

    for(int i = 0; i < a.length; i++)
    {
        for(int j = i + 1; j < a.length; j++)
        {
            Area = Math.max(
                Area, Math.min(a[i], a[j]) *
                              (j - i));
        }
    }
    return Area;
}

// Driver code
public static void main(String[] args)
{
    int a[] = { 1, 5, 4, 3 };
    int b[] = { 3, 1, 2, 4, 5 };

    System.out.println(maxArea(a));
    System.out.println(maxArea(b));
}
}

// This code is contributed by mulchandanimanisha5
```

Python3

```
# Python3 code for Max
# Water Container
def maxArea(A, Len) :
    area = 0
    for i in range(Len) :
        for j in range(i + 1, Len) :

            # Calculating the max area
            area = max(area, min(A[j], A[i]) * (j - i))
    return area

# Driver code
a = [ 1, 5, 4, 3 ]
b = [ 3, 1, 2, 4, 5 ]

len1 = len(a)
print(maxArea(a, len1))

len2 = len(b)
print(maxArea(b, len2))

# This code is contributed by divyesh072019.
```

C#

```
// C# code for Max
// Water Container
using System;
class GFG
{

public static int maxArea(int[] a)
{

    int Area = 0;

    for(int i = 0; i < a.Length; i++)
    {
        for(int j = i + 1; j < a.Length; j++)
        {
            Area = Math.Max(Area, Math.Min(a[i], a[j]) *
                            (j - i));
        }
    }
    return Area;
}

// Driver code
public static void Main(String[] args)
{
    int []a = { 1, 5, 4, 3 };
    int []b = { 3, 1, 2, 4, 5 };

    Console.WriteLine(maxArea(a));
    Console.Write(maxArea(b));
}
}

// This code is contributed by shivanisinghss2110
```

Javascript

```
<script>
    // Javascript code for Max
    // Water Container
    function maxArea(A, len)
    {
        let area = 0;
        for (let i = 0; i < len; i++) {
            for (let j = i + 1; j < len; j++) {
                // Calculating the max area
                area = Math.max(area, Math.min(A[j], A[i]) * (j - i));
            }
        }
        return area;
    }

      let a = [ 1, 5, 4, 3 ];
    let b = [ 3, 1, 2, 4, 5 ];

    let len1 = a.length;
    document.write(maxArea(a, len1) + "</br>");

    let len2 = b.length;
    document.write(maxArea(b, len2));

    // This code is contributed by mukesh07.
</script>
```

Output:

```
6
12
```

Complexity Analysis:

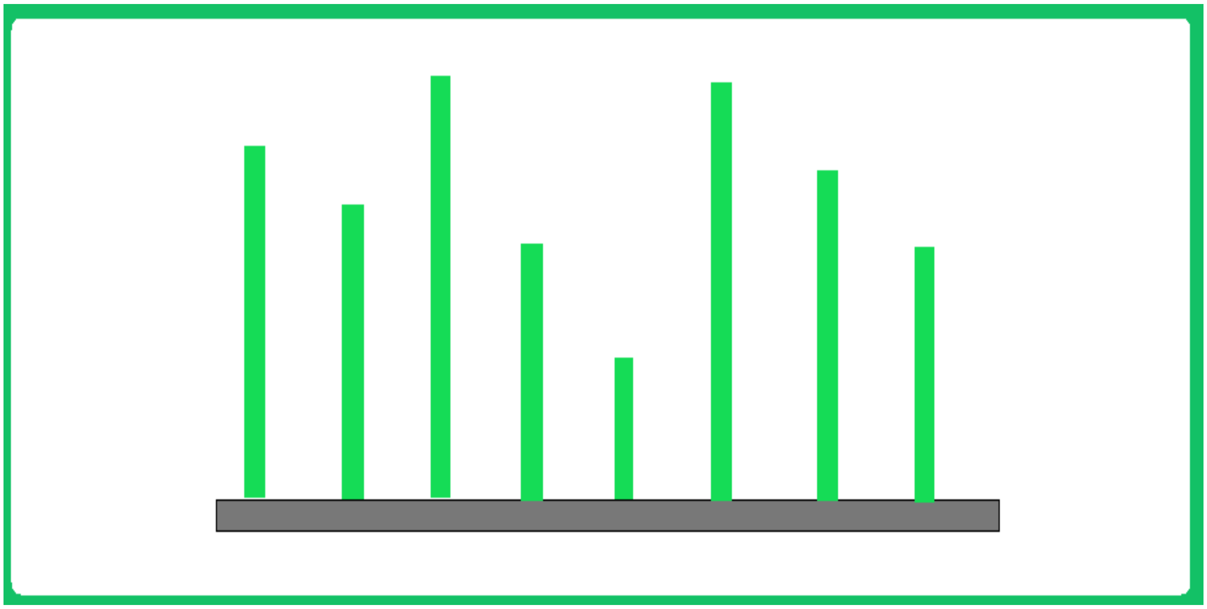
- **Time Complexity:** O(n^2).

  As nested traversal of the array is required, so time complexity is O(n^2)
- **Space Complexity:** O(1).

  As no extra space is required, so space complexity is constant.

Efficient Solution:

- **Approach:** Given an array of heights of lines of boundaries of the container, find the maximum water that can be stored in a container. So start with the first and last element and check the amount of water that can be contained and store that container. Now the question arises is there any better boundaries or lines that can contain maximum water. So there is a clever way to find that. Initially, there are two indices the first and last index pointing to the first and the last element (which acts as boundaries of the container), if the value of first index is less than the value of last index increase the first index else decrease the last index. As the decrease in width is constant, by following the above process the optimal answer can be reached.
  The GIF below explains the approach



- **Algorithm:**
  1. Keep two index, *first = 0* and *last = n-1* and a value max_area that stores the maximum area.
  2. Run a loop until first is less than the last.
  3. Update the max_area with maximum of max_area and *min(array[first] , array[last])*(last-first)*
  4. if the value at array[first] is greater the array[last] then update

last as last - 1 else update first as first + 1

5. Print the maximum area.

- **Implementation:**

C++

```
// C++ code for Max
// Water Container
#include<iostream>
using namespace std;

int maxArea(int A[], int len)
{
    int l = 0;
    int r = len -1;
    int area = 0;

    while (l < r)
    {
        // Calculating the max area
        area = max(area, min(A[l],
                        A[r]) * (r - l));

            if (A[l] < A[r])
                l += 1;

            else
                r -= 1;
    }
    return area;
}

// Driver code
int main()
{
    int a[] = {1, 5, 4, 3};
    int b[] = {3, 1, 2, 4, 5};

    int len1 = sizeof(a) / sizeof(a[0]);
    cout << maxArea(a, len1);

    int len2 = sizeof(b) / sizeof(b[0]);
    cout << endl << maxArea(b, len2);
}

// This code is contributed by Smitha Dinesh Semwal
```

Java

```
// Java code for Max
// Water Container
import java.util.*;

class Area{

    public static int maxArea(int A[], int len)
    {
        int l = 0;
        int r = len -1;
        int area = 0;

        while (l < r)
        {
            // Calculating the max area
            area = Math.max(area,
                        Math.min(A[l], A[r]) * (r - l));

            if (A[l] < A[r])
                l += 1;

            else
                r -= 1;
        }
        return area;
    }

    public static void main(String[] args)
    {
        int a[] = {1, 5, 4, 3};
        int b[] = {3, 1, 2, 4, 5};

        int len1 = 4;
        System.out.print( maxArea(a, len1)+"\n" );

        int len2 = 5;
        System.out.print( maxArea(b, len2) );
    }
}

// This code is contributed by rishabh_jain
```

Python3

```
# Python3 code for Max
# Water Container
def maxArea( A):
    l = 0
    r = len(A) -1
    area = 0

    while l < r:
        # Calculating the max area
        area = max(area, min(A[l],
                        A[r]) * (r - l))

        if A[l] < A[r]:
            l += 1
        else:
            r -= 1
    return area

# Driver code
a = [1, 5, 4, 3]
b = [3, 1, 2, 4, 5]

print(maxArea(a))
print(maxArea(b))
```

C#

```
// C# code for Max
// Water Container
using System;

class Area{

    public static int maxArea(int []A, int len)
    {
        int l = 0;
        int r = len -1;
        int area = 0;

        while (l < r)
        {
            // Calculating the max area
            area = Math.Max(area,
                        Math.Min(A[l], A[r]) * (r - l));

            if (A[l] < A[r])
                l += 1;

            else
                r -= 1;
        }
        return area;
    }

    // Driver code
    public static void Main()
    {
        int []a = {1, 5, 4, 3};
        int []b = {3, 1, 2, 4, 5};

        int len1 = 4;
        Console.WriteLine( maxArea(a, len1));

        int len2 = 5;
        Console.WriteLine( maxArea(b, len2) );
    }
}

// This code is contributed by Vt_M
```

PHP

```
<?php
// PHP code for Max
// Water Container
function maxArea($A, $len)
{
    $l = 0;
    $r = $len -1;
    $area = 0;

    while ($l < $r)
    {
        // Calculating the max area
        $area = max($area, min($A[$l],
                    $A[$r]) * ($r - $l));

            if ($A[$l] < $A[$r])
                $l += 1;

            else
                $r -= 1;
    }
    return $area;
}

// Driver code
$a = array(1, 5, 4, 3);
$b = array(3, 1, 2, 4, 5);

$len1 = sizeof($a) / sizeof($a[0]);
echo maxArea($a, $len1). "\n";

$len2 = sizeof($b) / sizeof($b[0]);
echo maxArea($b, $len2);

// This code is contributed by mits
?>
```

Javascript

```
<script>

// Javascript code for Max
// Water Container
function maxArea(A, len)
{
    let l = 0;
    let r = len -1;
    let area = 0;
    while (l < r)
    {

        // Calculating the max area
        area = Math.max(area, Math.min(A[l],
                        A[r]) * (r - l));

        if (A[l] < A[r])
            l += 1;
        else
            r -= 1;
    }
    return area;
}

// Driver code
let a = [ 1, 5, 4, 3 ];
let b = [ 3, 1, 2, 4, 5 ];

let len1 = a.length;
document.write(maxArea(a, len1) + "</br>");

let len2 = b.length;
document.write(maxArea(b, len2));

// This code is contributed by rameshtravel07

</script>
```

Output

```
6
12
```

Complexity Analysis:

- **Time Complexity:** O(n).
  As only one traversal of the array is required, so time complexity is O(n).
- **Space Complexity:** O(1).
  No extra space is required, so space complexity is constant.

Solution Analysis – Why this solution works?

Everytime, we are moving our pointer i ahead if height of line at ith index is smaller or j pointer if height of line at jth index is smaller. This means whichever line is smaller, we won't consider it again, because, this line could be the answer only if the other line is larger than it and at maximum width and to be noticed that this is the time when other line is larger as well as max distance apart. So, not considering it makes sense.

In other words, we are required to pair up every line with that line which is greater than it and at maximum distance apart i.e.

For example -> 8 5 9 1 10 2 6

here, if 8 has to be in the answer then other line that we choose should be 10 as it is the first line from the end that is at maximum distance apart from 8 and longer than 8. Hence, for 8 to be in the answer, other line should be 10.

Now, Lets assume i at 8 and j at 10. Compare it and move the pointer i to 5.

Now, you may ask, ok, you have moved the pointer i to 5 but can it not happen that 5 could pair up with other lines after 10 as we have neglected those lines by moving j pointer to 10.

So, to be noticed that if 5 would have been in the answer then any line after 10 must be >= 5 and if there is any line after 10 whose height is greater than or equal to 5 then its contribution would surely have been calculated while pointer 'i' was at 8.

So, for the combinations of lines which we are neglecting, have been already taken care of.

Liked 93

Next

Puzzle | Divide square land among 4 sons

RECOMMENDED ARTICLES

Page : 1 2 3

01 **Program to check if water tank overflows when n solid balls are dipped in the water tank**
19, Dec 17

02 **Minimum possible value T such that at most D Partitions of the Array having at most sum T is possible**
21, Aug 20

03 **Maximize element at index K in an array with at most sum M and difference between adjacent elements at most 1**
22, Jan 21

04 **Check if N can be obtained from 0 using at most X increment and at most Y doubling operations**
19, Jan 22

05 **Measuring 6L water from 4L and 9L buckets**
30, Mar 17

06 **Puzzle | Water Jug Problem**
10, Oct 17

07 **Puzzle | Growing Water Lilly**
23, Oct 18

08 **Puzzle | Cylindrical Glass and Water Measurement**
17, Sep 19

Article Contributed By :

Abhishek Sharma 44
@Abhishek Sharma 44

Vote for difficulty

Current difficulty : Medium

Easy Normal Medium Hard Expert

Improved By : Mithun Kumar, andrew1234, mulchandanimanisha5, khushboogoyal499, shivanisinghss2110, divyesh072019, mukesh07, rameshtravel07, kishanbhat, aayushgupta023

Article Tags : programming-puzzle, Competitive Programming, Mathematical, Puzzles

Practice Tags : Mathematical, Puzzles

Improve Article

Report Issue

Writing code in comment? Please use ide.geeksforgeeks.org, generate link and share the link here.

Load Comments

GeeksforGeeks
A-143, 9th Floor, Sovereign Corporate Tower,
Sector-136, Noida, Uttar Pradesh - 201305

feedback@geeksforgeeks.org

Company

About Us
Careers
In Media
Contact Us
Privacy Policy
Copyright Policy

Learn

Algorithms
Data Structures
SDE Cheat Sheet
Machine learning
CS Subjects
Video Tutorials
Courses

News

Top News
Technology
Work & Career
Business
Finance
Lifestyle
Knowledge

Languages

Python
Java
CPP
Golang
C#
SQL
Kotlin

Web Development

Web Tutorials
Django Tutorial
HTML
JavaScript

Contribute

Write an Article
Improve an Article
Pick Topics to Write
Write Interview Experience

NodeJS