Algorithms Tasks Spring 2024

Grading and Policies

1. Students who use the Internet to plagiarize the task, or copy from his/her colleagues, will take zero.
2. The task grade is 15.

Deliverables

1. **Implementation** of at **least two** algorithms. Algorithms can be recursive and non-recursive algorithms.
2. **Documentation** includes pseudo-code of the used algorithms, analysis of the used algorithm and computing its time complexity with comparison between them.
3. **GitHub or drive link** include documentation and implementations. It will be submitted before Discussion 06/05/2024.
4. **The** Discussion will be on Tuesday 07/05/2024.

Projects Ideas

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1- Max Product of Three

A non-empty zero-indexed array A consisting of N integers is given. The *product* of triplet (P, Q, R) equates to A[P] * A[Q] * A[R] ($0 \leq P < Q < R < N$).

For example, array A such that:

A[0] = -3   A[1] = 1   A[2] = 2   A[3] = -2   A[4] = 5   A[5] = 6

contains the following example triplets:

- (0, 1, 2), product is −3 * 1 * 2 = −6
- (1, 2, 4), product is 1 * 2 * 5 = 10
- (2, 4, 5), product is 2 * 5 * 6 = 60

Your goal is to find the maximal product of any triplet. Write a function that given a non-empty zero-indexed array A, returns the value of the maximal product of any triplet.

Example 1:

Input: nums = [1,2,3]

Output: 6

Example 2:

Input: nums = [1,2,3,4]

Output: 24

2- Triangle

A zero-indexed array A consisting of N integers is given. A triplet (P, Q, R) is *triangular* if $0 \leq P < Q < R < N$ and:

1. A[P] + A[Q] > A[R],
2. A[Q] + A[R] > A[P],
3. A[R] + A[P] > A[Q].

For example, consider array A such that:

A[0] = 10 A[1] = 2 A[2] = 5 A[3] = 1 A[4] = 8 A[5] = 20

Triplet (0, 2, 4) is triangular.

Write a function that, given a zero-indexed array A consisting of N integers, returns 1 if there exists a triangular triplet for this array and returns 0 otherwise.

Example 1:

Input: nums = [10 , 50 , 1]

Output: 0

Example 2:

Input: nums = [10 , 2 , 5 ,1 , 8 , 20]

Output: 1

3- balanced string

A string is balanced if it consists of exactly two different characters and both of those characters appear exactly the same number of times.

For example: "aabbab" is balanced (both 'a' and 'b' occur three times) but "aabba" is not balanced ('a' occurs three times, 'b' occurs two times).

String "aabbcc" is also not balanced (it contains three different letters).

A substring of string S is a string that consists of consecutive letters in S. For example: "ompu" is a substring of "computer" but "cmptr" is not.

Examples:

1. Given S = "cabbacc", the function should return 4 ("abba" is the longest balanced substring).

2. Given S = "abababa", the function should return 6 ("ababab" and "bababa" are the longest balanced substrings).

3. Given S = "aaaaaaa", the function should return 0 (S does not contain a balanced substring).

Write an efficient algorithm to get the length of the longest balanced substring of given string S.

3- Birthday Cake Candles

You are in charge of the cake for a child's birthday. You have decided the cake will have one candle for each year of their total age. They will only be able to blow out the tallest of the candles. Count how many candles are tallest.

Example

Candles = [4,4,1,3]

The maximum height candles are 4 units high. There are 2 of them, so return 2.

Function Description

Write a function birthdayCakeCandles that has the following parameter(s):

- int *candles[n]*: the candle heights

Returns

- int: the number of candles that are tallest.

Example 1:

Input:

```
4
3 2 1 3
```

Output:

```
2
```

4- Diagonal Difference

Given a square matrix, calculate the absolute difference between the sums of its diagonals. For example, the square matrix is shown below:

```
1 2 3
4 5 6
9 8 9
```

The left-to-right diagonal = 1+5+9 =15 . The right to left diagonal = 3+5+9 = 17. Their absolute difference is |15-17| = 2.

Input Format

The first line contains a single integer,n , the number of rows and columns in the square matrix arr.

Each of the next n lines describes a row, arr[i], and consists of n space-separated integers arr[i][j] .

Constraints

-100 < arr[i][j] < 100

Output Format

Return the absolute difference between the sums of the matrix's two diagonals as a single integer.

Sample Input

```
3
11 2 4
4 5 6
10 8 -12
```

Sample Output :

```
15
```

6- Wiggle Sort

Given an integer array nums, reorder it such that:

nums[0] < nums[1] > nums[2] < nums[3]....

You may assume the input array always has a valid answer.

Example 1:

Input: nums = [1,5,1,1,6,4]

Output: [1,6,1,5,1,4]

Explanation: [1,4,1,5,1,6] is also accepted.

Example 2:

Input: nums = [1,3,2,2,3,1]

Output: [2,3,1,3,1,2]

Constraints:

- 1 <= nums.length <= 5 * 104
- 0 <= nums[i] <= 5000
- It is guaranteed that there will be an answer for the given input nums.

7- K-th Element of Two Sorted Arrays

Given two sorted arrays of size m and n respectively, you are tasked with finding the element that would be at the k'th position of the final sorted array.

Example 1:

Input: **Array 1 = { 2 ,3, 6, 7, 9}**

Array 2 = {1, 4, 8, 10}

k = 5

Output: **6**

Explanation: The final sorted array would be – {1, 2, 3, 4, 6, 7, 8, 9, 10 }

The 5th element of this array is 6.

Example 2:

Input: **Array 1 = { 100, 112 ,256 ,349 ,770}**

Array 2 = {72**, 86 ,113 ,119 ,265 ,445 ,892}**

k = 7

Output: **256**

8- Dominator

An array A consisting of N integers is given. The dominator of array A is the value that occurs in more than half of the elements of A.

For example, consider array A such that

A[0] = 3 A[1] = 4 A[2] = 3 A[3] = 2 A[4] = 3 A[5] = -1 A[6] = 3 A[7] = 3

The dominator of A is 3 because it occurs in 5 out of 8 elements of A (namely in those with indices 0, 2, 4, 6 and 7) and 5 is more than a half of 8.

Write an efficient algorithm for the following assumptions:

- given an array A consisting of N integers, returns index of any element of array A in which the dominator of A occurs. The function should return −1 if array A does not have a dominator.
- N is an integer within the range [0..100,000];
- each element of array A is an integer within the range [−2,147,483,648..2,147,483,647]

Sample Input:

A[0] = 3

A[1] = 4

A[2] = 3

A[3] = 2

A[4] = 3

A[5] = -1

A[6] = 3

A[7] = 3

Sample Output:

0, 2, 4, 6 or 7

9- Distinct

Write a function that, given a zero-indexed array A consisting of N integers, returns the number of distinct values in array A.
Assume that:

- N is an integer within the range [0..100,000];
- each element of array A is an integer within the range [−1,000,000..1,000,000].

For example, given array A consisting of six elements such that:

A[0] = 2

A[1] = 1

A[2] = 1

A[3] = 2

A[4] = 3

A[5] = 1

the function should return 3, because there are 3 distinct values appearing in array A, namely 1, 2 and 3.