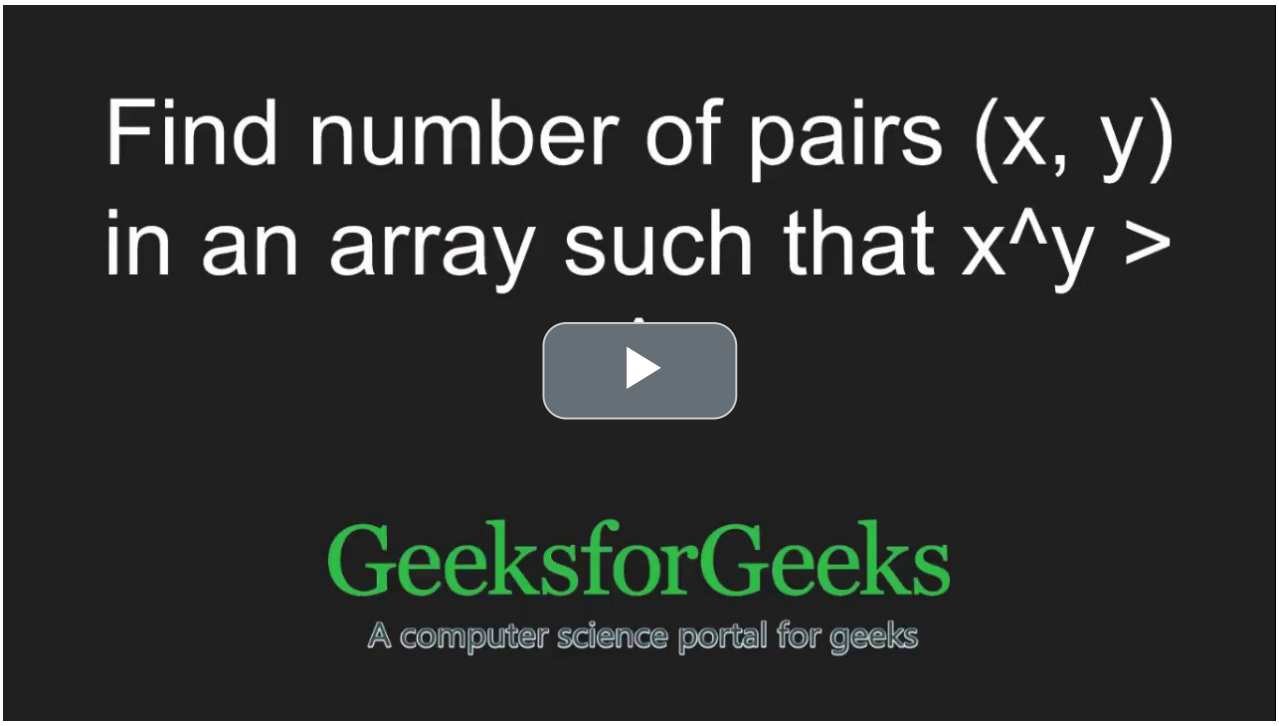
Find number of pair… that x^y > y^x

Difficulty Level : Hard • Last Updated : 13 Aug, 2022

Given two arrays X[] and Y[] of positive integers, find a number of pairs such that **x^y > y^x** where x is an element from X[] and y is an element from Y[].

Examples:



Array Matrix Strings Hashing Linked List Stack Queue Binary Tree Binary Search Tr

Input: *X[] = {2, 1, 6}, Y = {1, 5}*

Output: *3*

Explanation: *There are total 3 pairs where pow(x, y) is greater than pow(y, x)*
Pairs are (2, 1), (2, 5) and (6, 1)

```
long long countPairsBruteForce(long long X[], long long Y[],
                               long long m, long long n)
{
    long long ans = 0;

    for (int i = 0; i < m; i++)
        for (int j = 0; j < n; j++)
            if (pow(X[i], Y[j]) > pow(Y[j], X[i]))
                ans++;
    return ans;
}
```

Java

```
public static long countPairsBruteForce(long X[], long Y[],
                                        int m, int n)
{
    long ans = 0;
    for (int i = 0; i < m; i++)
        for (int j = 0; j < n; j++)
            if (Math.pow(X[i], Y[j]) > Math.pow(Y[j], X[i]))
                ans++;
    return ans;
}
```

Python3

```
def countPairsBruteForce(X, Y, m, n):
    ans = 0
    for i in range(m):
```

```
public static int countPairsBrut

{
    int ans = 0;
    for (int i = 0; i < m; i++)
        for (int j = 0; j < n; j++)
            if (Math.Pow(X[i], Y[j]) > Math.Pow(Y[j], X[i]))
                ans++;

    return ans;
}
```

Javascript

```
function countPairsBruteForce(X, Y, m, n){
    let ans = 0;
    for(let i=0; i<m; i++ ){
        for(let j=0;j<n;j++){
            if ((Math.pow(X[i], Y[j]) > Math.pow(Y[j], X[i]))){
                ans += 1;
             }
        }
    }
    return ans;
}
```

Time Complexity: O(M*N) where **M** and **N** are sizes of given arrays.

Efficient Solution:

The problem can be solved in **O(nLogn + mLogn)** time. The trick here is if **y > x** then **x^y > y^x** with some exceptions.

Following are simple steps based on this trick.

- Sort array Y[].
- For every x in X[], find the index idx of the smallest number greater than x (also called ceil of x) in Y[] using **binary search, or** we can use the inbuilt function upper_bound() in algorithm library.

- If x = 1, then the count of pairs for t
- If x>1, then we also need to add co
- x smaller than y means x^y is great
  1. x = 2, y = 3 or 4
  2. x = 3, y = 2

Note that the case where x = 4 and y = 2 is not there

Following diagram shows all exceptions in tabular form. The value 1 indicates that the corresponding (x, y) form a valid pair.

	0	1	2	3	4
0	0	0	0	0	0
1	1	0	0	0	0
2	1	1	0	0	0
3	1	1	1	0	1
4	1	1	0	0	0

In the following implementation, we pre-process the Y array and count 0, 1, 2, 3 and 4 in it, so that we can handle all exceptions in constant time. The array NoOfY[] is used to store the counts.

Below is the implementation of the above approach:

```
// C++ program to finds the number of pairs (x, y)
// in an array such that x^y > y^x
```

```
{
    // If x is 0, then there can
    // that x^Y[i] > Y[i]^x
    if (x == 0)
        return 0;

    // If x is 1, then the numbe
    // of zeroes in Y[]
    if (x == 1)
        return NoOfY[0];

    // Find number of elements in Y[] with values greater
    // than x upper_bound() gets address of first greater
    // element in Y[0..n-1]
    int* idx = upper_bound(Y, Y + n, x);
    int ans = (Y + n) - idx;

    // If we have reached here, then x must be greater than
    // 1, increase number of pairs for y=0 and y=1
    ans += (NoOfY[0] + NoOfY[1]);

    // Decrease number of pairs for x=2 and (y=4 or y=3)
    if (x == 2)
        ans -= (NoOfY[3] + NoOfY[4]);

    // Increase number of pairs for x=3 and y=2
    if (x == 3)
        ans += NoOfY[2];

    return ans;
}

// Function to return count of pairs (x, y) such that
// x belongs to X[], y belongs to Y[] and x^y > y^x
int countPairs(int X[], int Y[], int m, int n)
{
    // To store counts of 0, 1, 2, 3 and 4 in array Y
    int NoOfY[5] = { 0 };
    for (int i = 0; i < n; i++)
        if (Y[i] < 5)
            NoOfY[Y[i]]++;

    // Sort Y[] so that we can do binary search in it
    sort(Y, Y + n);

    int total_pairs = 0; // Initialize result
```

```
// Driver program
int main()
{
    int X[] = { 2, 1, 6 };
    int Y[] = { 1, 5 };

    int m = sizeof(X) / sizeof(X[0]);
    int n = sizeof(Y) / sizeof(Y[0]);

    cout << "Total pairs = " << countPairs(X, Y, m, n);

    return 0;
}
```

Java

```
// Java program to finds number of pairs (x, y)
// in an array such that x^y > y^x

import java.util.Arrays;

class Test {
    // Function to return count of pairs with x as one
    // element of the pair. It mainly looks for all values
    // in Y[] where x ^ Y[i] > Y[i] ^ x
    static int count(int x, int Y[], int n, int NoOfY[])
    {
        // If x is 0, then there cannot be any value in Y
        // such that x^Y[i] > Y[i]^x
        if (x == 0)
            return 0;

        // If x is 1, then the number of pairs is equal to
        // number of zeroes in Y[]
        if (x == 1)
            return NoOfY[0];

        // Find number of elements in Y[] with values
        // greater than x getting upperbound of x with
        // binary search
        int idx = Arrays.binarySearch(Y, x);
        int ans;
        if (idx < 0) {
```

```
            ans = Y.length - idx
        }

        // If we have reached he
        // than 1, increase numb
        ans += (NoOfY[0] + NoOfY

        // Decrease number of pairs for x=2 and (y=4 or y=3)
        if (x == 2)
            ans -= (NoOfY[3] + NoOfY[4]);

        // Increase number of pairs for x=3 and y=2
        if (x == 3)
            ans += NoOfY[2];

        return ans;
    }

    // Function to returns count of pairs (x, y) such that
    // x belongs to X[], y belongs to Y[] and x^y > y^x
    static long countPairs(int X[], int Y[], int m, int n)
    {
        // To store counts of 0, 1, 2, 3 and 4 in array Y
        int NoOfY[] = new int[5];
        for (int i = 0; i < n; i++)
            if (Y[i] < 5)
                NoOfY[Y[i]]++;

        // Sort Y[] so that we can do binary search in it
        Arrays.sort(Y);

        long total_pairs = 0; // Initialize result

        // Take every element of X and count pairs with it
        for (int i = 0; i < m; i++)
            total_pairs += count(X[i], Y, n, NoOfY);

        return total_pairs;
    }

    // Driver method
    public static void main(String args[])
    {
        int X[] = { 2, 1, 6 };
        int Y[] = { 1, 5 };
```

Python3

```
# Python3 program to find the nu
# of pairs (x, y) in an array
# such that x^y > y^x
import bisect

# Function to return count of pairs
# with x as one element of the pair.
# It mainly looks for all values in Y
# where x ^ Y[i] > Y[i] ^ x


def count(x, Y, n, NoOfY):

    # If x is 0, then there cannot be
    # any value in Y such that
    # x^Y[i] > Y[i]^x
    if x == 0:
        return 0

    # If x is 1, then the number of pairs
    # is equal to number of zeroes in Y
    if x == 1:
        return NoOfY[0]

    # Find number of elements in Y[] with
    # values greater than x, bisect.bisect_right
    # gets address of first greater element
    # in Y[0..n-1]
    idx = bisect.bisect_right(Y, x)
    ans = n - idx

    # If we have reached here, then x must be greater than 1,
    # increase number of pairs for y=0 and y=1
    ans += NoOfY[0] + NoOfY[1]

    # Decrease number of pairs
    # for x=2 and (y=4 or y=3)
    if x == 2:
        ans -= NoOfY[3] + NoOfY[4]

    # Increase number of pairs
    # for x=3 and y=2
    if x == 3:
```

```
def count_pairs(X, Y, m, n):

    # To store counts of 0, 1, 2
    # and 4 in array Y
    NoOfY = [0] * 5
    for i in range(n):
        if Y[i] < 5:
            NoOfY[Y[i]] += 1

    # Sort Y so that we can do binary search in it
    Y.sort()
    total_pairs = 0  # Initialize result

    # Take every element of X and
    # count pairs with it
    for x in X:
        total_pairs += count(x, Y, n, NoOfY)

    return total_pairs


# Driver Code
if __name__ == '__main__':

    X = [2, 1, 6]
    Y = [1, 5]
    print("Total pairs = ",
          count_pairs(X, Y, len(X), len(Y)))

# This code is contributed by shaswatd673
```

C#

```
// C# program to finds number of pairs (x, y)
// in an array such that x^y > y^x
using System;

class GFG {

    // Function to return count of pairs
    // with x as one element of the pair.
    // It mainly looks for all values in Y[]
```

```
        // If x is 1, then the n
        // is equal to number of
        if (x == 1)
            return NoOfY[0];

        // Find number of elemen
        // values greater than x getting
        // upperbound of x with binary search
        int idx = Array.BinarySearch(Y, x);
        int ans;
        if (idx < 0) {
            idx = Math.Abs(idx + 1);
            ans = Y.Length - idx;
        }

        else {
            while (idx < n && Y[idx] == x) {
                idx++;
            }
            ans = Y.Length - idx;
        }

        // If we have reached here, then x
        // must be greater than 1, increase
        // number of pairs for y = 0 and y = 1
        ans += (NoOfY[0] + NoOfY[1]);

        // Decrease number of pairs
        // for x = 2 and (y = 4 or y = 3)
        if (x == 2)
            ans -= (NoOfY[3] + NoOfY[4]);

        // Increase number of pairs for x = 3 and y = 2
        if (x == 3)
            ans += NoOfY[2];

        return ans;
    }

    // Function to that returns count
    // of pairs (x, y) such that x belongs
    // to X[], y belongs to Y[] and x^y > y^x
    static int countPairs(int[] X, int[] Y, int m, int n)
    {
        // To store counts of 0, 1, 2, 3 and 4 in array Y
```

```
        int total_pairs = 0; //

        // Take every element of
        for (int i = 0; i < m; i
            total_pairs += count

        return total_pairs;
    }

    // Driver method
    public static void Main()
    {
        int[] X = { 2, 1, 6 };
        int[] Y = { 1, 5 };

        Console.Write(
            "Total pairs = "
            + countPairs(X, Y, X.Length, Y.Length));
    }
}

// This code is contributed by Sam007
```

Javascript

```
<script>

// JavaScript program to finds number of pairs (x, y)
// in an array such that x^y > y^x

// Iterative function to implement Binary Search
 function  binarySearch(arr, x) {

    let start=0, end=arr.length-1;

    // Iterate while start not meets end
    while (start<=end){

        // Find the mid index
        let mid=parseInt((start + end)/2);

        // If element is present at mid, return True
        if (arr[mid]===x) return mid;
```

```
    return -1;
}
    // Function to return count
    // element of the pair. It m
    // in Y where x ^ Y[i] > Y[i
    function count(x , Y , n , N
        // If x is 0, then there cannot be any value in Y
        // such that x^Y[i] > Y[i]^x
        if (x == 0)
            return 0;

        // If x is 1, then the number of pairs is equal to
        // number of zeroes in Y
        if (x == 1)
            return NoOfY[0];

        // Find number of elements in Y with values
        // greater than x getting upperbound of x with
        // binary search
        var idx = binarySearch(Y, x);
        var ans;
        if (idx < 0) {
            idx = Math.abs(idx + 1);
            ans = Y.length - idx;
        } else {
            while (idx < n && Y[idx] == x) {
                idx++;
            }
            ans = Y.length - idx;
        }

        // If we have reached here, then x must be greater
        // than 1, increase number of pairs for y=0 and y=1
        ans += (NoOfY[0] + NoOfY[1]);

        // Decrease number of pairs for x=2 and (y=4 or y=3)
        if (x == 2)
            ans -= (NoOfY[3] + NoOfY[4]);

        // Increase number of pairs for x=3 and y=2
        if (x == 3)
            ans += NoOfY[2];

        return ans;
    }
```

```
            if (Y[i] < 5)
                NoOfY[Y[i]]++;

        // Sort Y so that we can
        Y.sort((a,b)=>a-b);

        var total_pairs = 0; //

        // Take every element of X and count pairs with it
        for (var i = 0; i < m; i++)
            total_pairs += count(X[i], Y, n, NoOfY);

        return total_pairs;
    }

    // Driver method

        var X = [ 2, 1, 6 ];
        var Y = [ 1, 5 ];

        document.write("Total pairs = " +
        countPairs(X, Y, X.length, Y.length));

// This code contributed by umadevi9616

</script>
```

Output

```
Total pairs = 3
```

Time Complexity: O(nLogn + mLogn), where m and n are the sizes of arrays X[] and Y[] respectively. The sort step takes O(nLogn) time. Then every element of X[] is searched in Y[] using binary search. This step takes O(mLogn) time.
Auxiliary Space: O(1)

https://www.youtube.com/watch?v=chYKJGPNEvg

This article is contributed by **Aarti_Rathi** and **Shubham_Mittal**. Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above.

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