Competive Coding
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(4)

experiments

we define f(x,y) as number of different corresponding bits in the binary representation of x and y. for eg → f(2,7) = 2, since the binary representation of 2 and 7 are 010 and 111, respectively. the first and the third bit differs, so f(2,7) = 2

Test Cases: ① Input A = [1,3,5] Output A = 8

② Input A = [2,3] Output A = 2

You are given an array of N positive integers $A_1, A_2, A_3 \ldots A_n$. find sum of $f(A_i, A_j)$ for all pairs (i,j) such that $1 \le i, j \le N$.

Return the ans modulo $10^9 + 7$.

Solution → Given

$f(x,y)$ = no. of different bits in binary of x and y

[checking every pair of bits → TC = (n^2) → TLE]

To solve this, we can use the concept of bit manipulation By checking the bits of x and y.

Lets look at a particular K^{th} bit

if K^{th} bit of x is 1 and K^{th} bit of y is 0.

or, vice versa

so ans = 2 for pair (x,y) and (y,x)

→ Let cnt1 = nos having bit k = 1

cnt0 = nos having bit k = 0

contribution = (2) × cnt1 × cnt0

(for (x,y) and (y,x))

→ Steps to solve
for every bit (0 → 31)
1) Count numbers having that bit set.
2) Compute pairs
3) Add to answer

Code :
```
#include <bits/stdc++.h>
using namespace std;
const long long MOD = 1e9 +7;
long long totalpairs( vector< int> & A) {
    long long n = A.size();
    long long ans=0;
  for (int bit = 0;  bit<32; b++) {
     long long cnt1 = 0;
     for (int i=0 ; i< n;i++) {
        if (A[i] & (1<< bit)) {
           cnt1 ++ ; } }
     long long cnt0 = n-cnt1;
     long long Contribution =(cnt1 * cnt0) % MOD;
     contribution =(2* contribution) % MOD;
      ans= (ans+ contribution) % MOD ; }
     return ans; }
```

DRy Run

Input = {1, 3, 5}
1 → 001
3 → 011
5 → 101

for Bit0 → 1(1), 3(1), 5(1)

⇒ Cnt 1 = 0
Cnt 0 = 0
Contribution = 2 x 3 x 0 = 0

for Bit 1 ⇒ 1(0), 3(1), 5(0)
⇒ Cnt 1 = 1
Cnt 0 = 2
Contribution = 2 x 1 x 2 = 4

for Bit 2 → 1(0), 3(0), 5(1)
⇒ Cnt 1 = 1
Cnt 0 = 2
Contribution = 2 x 1 x 2 = 4

Total answer = 0 + 4 + 4 = 8

pairs	f(x,y)
(1,1)	0
(1,3)	1
(1,5)	1
(3,1)	1
(3,3)	0
(3,5)	2
(5,1)	1
(5,3)	2
(5,5)	0