

kintsugi-stack-dsa-cpp:

COMPETITIVE_PROGRAMMING

"Talk is cheap. Show me the time complexity."

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Disclaimer: The content presented here is a curated blend of my personal learning journey, experiences, open-source documentation, and invaluable knowledge gained from diverse sources. I do not claim sole ownership over all the material; this is a community-driven effort to learn, share, and grow together.

- <https://codeforces.com/profile/kintsugi-programmer>
- <https://www.tle-eliminators.com/cp-sheet>

Table of Contents

- [kintsugi-stack-dsa-cpp: COMPETITIVE_PROGRAMMING](#)
 - [Table of Contents](#)
- [R800](#)
 - [01 A Halloumi Boxes](#)
 - [02 A Line Trip](#)
 - [03 A Cover in Water](#)
 - [04 A Game with Integers](#)
 - [05 A Jagged Swaps](#)
 - [06 A Doremy's Paint 3](#)
 - [07 A Don't Try to Count](#)
 - [08 A How Much Does Daytona Cost?](#)
 - [09 Goals of Victory](#)
 - [10 Target Practice](#)
- [TipsCollectedFromExperiences](#)
- [Array Coloring \[ONSIGHT\]](#)

R800

01 A Halloumi Boxes

- <https://codeforces.com/problemset/problem/1903/A>
- brute force, greedy, sortings, *800
- Analysis
 - n boxes/array a1 a2 ... an
 - a = {a0, a1, a2 ... an-1}
 - subarray = subsegment = segment taken out of array not manipulated ,no change in order
 - eg: {a0, a1}, {a1,a2,a3}, etc
 - He wants to sort them in non-decreasing order based on their number

- non-decreasing = increasing
- s is atmost k , means : $s \leq k$
- however, his machine works in a strange way. It can only reverse any subarray of boxes with length **at most k**
- subarrsize $\leq k$
- Find if it's possible to sort the boxes using any number of reverses.
- So, if $K \geq 2$,Machine's sort is 100%possible at **any number of reverses ANY_TIMES**
 - if $k=2$ atleast \Rightarrow i have power to shift any element anywhere
- eg:
 - 6421
 - 6421 rev 2 nos sub array my initial thought
 - 6412 rev 2 nos sub array
 - 6142 rev 2 nos sub array
 - 1642 rev 2 nos sub array
 - 1624 rev 2 nos sub array
 - 1264 rev 2 nos sub array
 - 1246 rev 2 nos sub array
 - sorting done :0
 - 6421
 - 1246 rev 4 nos sub array optimal from tuts
- atq : according to question
- tl per test = 1sec atq
 - 1sec = 10^8 Operations = per test operations
 - $1 \leq k \leq n$ (minitests) ≤ 100 acc.to ques (atq)
 - consider $n=100$ upperbound
 - tl per mini test = 1sec / 100
 - per mini test operations = $10^8 / 100 = 10^6$
 - if tc per mini test = $O(n^3)$
 - so $n=100$, then operation = $O(n^3) = O(100^3) =$ per mini test operations
 - so $O(n^3)$ is the upper bound
 - even sol. can have $O(n^2)$, $O(n)$, $O(n \log n)$ etc. anything below $O(n^3)$, but not above $O(n^3)$
 - Expected TC = $O(n^3)$
- ml per test = 256mB atq
- at $k=1$, no sorting is possible
 - because the foundation of reverse is actually swap any atleast 2 stuff
 - if stuff is only one then it wont make sense to reverse as we lost power to shift any element
- Approach
 - Passing Condition where return YES
 - $K \geq 2$
 - or given array is already sorted
 - else, return False

```
#include<bits/stdc++.h>
using namespace std;
```

```

int main(){
    // at extreme proof case use :
    // long long t;
    int t;
    cin>>t;
    while(t--){
        int n,k;
        cin>>n>>k;
        vector<int> v(n);
        int i=0;
        //input
        while(i<n){
            cin>>v[i]; // n order
            i++;
        }
        vector<int> v2=v; // copy // n order
        sort(v2.begin(), v2.end()); // nlogn order
        if ((v2==v)or(k>=2)){ // to check whether initial array is sorted
or not // n order
            cout<<"YES\n";
        } else {
            cout<<"NO\n";
        }
    }
    return 0;
}
// tc O(nlogn) // highest order here
// at n = 100 , tc = 100log100 = 100*7 = 700
// 2^7 ~ 100
// log2(n) = ln n / ln 2
// sc O(n)

```

02 A Line Trip

- <https://codeforces.com/problemset/problem/1901/A>
- greedy, math, *800
- Analysis
 - location&road on number line
 - 0 , a1 , a2 , ... , x
 - Round Trip i.e. total path => 0, a1, ... an, x, an, ..., a1,0
 - a1,a2 ... Gas station for Tanki Full/ Refill
 - 0 start point
 - if stop at non-station location due to gas empty = gameover
 - no refuel at dest x
 - In this ques, we have to find the capacity of gas tank car should take it for journey, efficiently without stopping
 - tl per test = 2secs
 - 2secs = 2*(10^8) operations
 - t=1000 atq
 - time/testcase = O(2* 10^5)

- $n=50$ max atq
- then at $O(n^3) = O(125000) = O(1.25 * 10^5) \leq O(2 * 10^5)$
- TC for minitest = Expected TC = $O(n^3)$ upper bound
- tlpt = time limit per test
- mlpt = 256mB
- in test case 1
 - $n=3$
 - $x=7$
 - $a\{1,2,5\}$
 - 0-1-2-5-7-5-2-1-0
 - output = 4
 - gaschanges=
 - 4 start
 - 3 at 1
 - 4 refill
 - 3 at 2
 - 4 refill
 - 1 at 5
 - 4 refill
 - 2 at 7
 - NO Refill at dest x
 - 0 at 5 ,biggest gas consumption, 5->7->5 , 4 units distance
 - 4 refill
 - 1 at 2
 - 4 refill
 - 3 at 1
 - 4 refill
 - 3 end, fully reached ,gas still remaining
 - biggest gas consumption, 5->7->5 , 4 units distance
 - thus min threshold gas capacity is 4 units ,as below it , car would stop at 5->7->5
- now the max capacity of gas tank in any journey = max distance of any 2 gas stations throughout journey
- throughout journey means a round trip
 - so, after lastGasStation, car will go to x(dest), and find lastGasStation first in return journey
 - so, that distance is $(\text{lastGasStation} - x) * 2$
- Approach
 - C1= cal. firstGasStation-0
 - C2= max(allDistances(cal. dist b/w eachGasStation))
 - C3= cal. $(\text{lastGasStation} - x) * 2$
 - return max(C1,C2,C3)

```
#include<bits/stdc++.h>
using namespace std;
int main(){
    long long t;
```

```

cin>>t;
while(t--){
    long long n,x;
    cin>>n>>x;
    long long i=1;
    long long smax=0;
    vector<long long> v1(n+1,0); //initialize safety //O(n)
    v1[0]=0;
    while(i<=n){// O(n)
        cin>>v1[i];
        // cout<<v1[i];
        long long buff=smax;
        smax=max(buff,(v1[i]-v1[i-1]));
        i++;
    }
    long long smax2=(x-v1[n])*2; // O(1)
    cout<< max(smax,smax2)<<endl;
    // cout<< smax<<" "<<v1[n-1]<<" "<<smax2<<endl;

}return 0;
}
// Time Complexity: O(n)
// Space Complexity: O(n)

// max(a, b); O(1) // just checks (a < b)
// min(a, b); O(1) // just checks (a < b)
// max_element(v.begin(), v.end()) O(n)
// min_element(v.begin(), v.end()) O(n)

```

- my code is more optimised than tut ;0

03 A Cover in Water

- <https://codeforces.com/problemset/problem/1900/A>
- constructive algorithms, greedy, implementation, strings, *800
- Analysis
 - Filip has a row of cells, some of which are blocked, and some are empty.
 - He wants all empty cells to have water in them.
 - He has two actions at his disposal
 - 1. place water in an empty cell. **FINITE_TIMES**
 - 2. remove water from a cell and place it in any other empty cell. **ANY_TIMES**
 - autoOperation
 - if at some moment cell i ($2 \leq i \leq n-1$) is empty and both cells $i-1$ and $i+1$ contains water, then it becomes filled with water. **ANY_TIMES**
 - magic autofill
 - $N \Rightarrow s = s_1, s_2, s_3, \dots, s_n$
 - $= \dots \#\#\# \dots \#\#$
 - now in ...
 - if we just w.w (w=water) \Rightarrow www
 - then we can transfer the middle water to other cells one by one

- w.w sill it get refill=> www
- ...##.#....##
 - w.w##.#....## 2times fill water manual
 - www##.#....## autofill
 - w.w##.#w...## swap water
 - www##.#w...## autofill
 - w.w##w#w...## swap water
 - www##w#w...## autofill
 - w.w##w#ww..## swap water
 - www##w#ww..## autofill
 - w.w##w#www.## swap water
 - www##w#www.## autofill
 - w.w##w#wwww## swap water
 - www##w#wwww## auto fill
 - all buckets filled ;0, count=2 operation 1
- C1: if no. of Consecutive dots(emptyBoxes) >= 3
 - then we only need 1 operation only 2TIMES as we could fill at corner of 3 boxes and middle box will autoOperationAutoFillWater and we can transfer that water to other cells
ANY_TIMES 2 operation, and regenerate autoOperationAutoFillWater
- C2: else we need to fill all boxes by 1 operation only as here autoOperationAutoFillWater fails
- Expected TC
 - tlpt 1sec atq
 - mt = t max= 100 atq
 - tlpmt = $10^8 / 100 = 10^6$
 - n = 100 atq
 - TCpmt = $O(n^3)$ upperbound
 - as $O(100^3) = O(10^6) = \text{order of tlpmt}$
 - mlpt 256mB atq
- Approach
 - count no. of dots(emptyBoxes)
 - count no. of Consecutive dots(emptyBoxes)
 - if no. of Consecutive dots(emptyBoxes) >= 3
 - return 2
 - else
 - return no. of dots(emptyBoxes)
- AnotherApproach
 - if i have 3 contineous empty cell, answer is 2 else ,answer is count of all empty cells
 - similar
 - ... => (i-1), (i), (i+1)
 - just fill i-1, i+1
 - if (**s[i]=="." && i+1<n && s[i+1]=="." && i+2<n && s[i+2]=="."**)
 - return 2
 - else
 - return no. of dots(emptyBoxes)

```
#include<bits/stdc++.h>
using namespace std;
int main(){
    long long t;
    cin>>t;
    while (t--){
        long long n;
        cin>>n;

        string s;
        cin>>s;

        int sum=0;
        int i=0;
        int dot=0;

        while(i<s.size()){
            if (s[i]=='.' & sum!=3)
            {
                sum++;
                dot++;
            }
            else if (s[i]=='#' & sum!=3)
            {
                sum=0;
            }
            i++;
        }

        if (sum>=3)
        {
            cout<<2<<endl;
        }
        else
        {
            cout<<dot<<endl;
        }

    }
    return 0;
}
// TC O(n)
// SC O(n)
```

04 A Game with Integers

- <https://codeforces.com/problemset/problem/1899/A>

- games, math, number theory, *800
- Analysis
 - Vanya and Vova are playing a game. Players are given an integer n . On their turn, the player can add 1 to the current integer or subtract 1
 - Operations any ne
 - $n=n-1$
 - $n=n+1$
 - The players take turns; Vanya starts. If after Vanya's move the integer is divisible by 3, then he wins. If 10 moves have passed and Vanya has not won, then Vova wins.
 - if both players play optimally
 - then in each of player turn he/she will try move to make other one lose
 - eg: if nos is 5
 - $nos = 5$
 - 6 (vanya $n++$) OR 4 (vanya $n--$)
 - 5 (vova $n--$) or 7 (vova $n++$) OR 3 (vova $n--$) or 5 (vova $n++$)
 - 6 (vanya $n++$) OR 4 (vanya $n--$) or 6 (vanya $n--$) OR 8 (vanya $n++$) or 2 (vanya $n--$) OR 4 (vanya $n++$) or 4 (vanya $n--$) OR 6 (vanya $n++$)
 - basically she will counter , to remake it even, repetitive till 10
 - she won
 - Expected TC ?
 - $tlpt = 1sec \text{ atq}$
 - $mlpt = 256mB \text{ atq}$
 - $t = 100 \text{ atq}$
 - $n = 1000 \text{ atq}$
 - $1sec = 10^8 \text{ ops}$
 - $tlpmt = 10^8 / t = 10^8 / 100 = 10^6$
 - Expected TC = $O(n^2)$
 - not $O(n^3)$
 - as $1000^3 = 10^9 < tlpmt$
 - as putting n in $mt O(n^2)$
 - $= 1000^2$
 - $= 10^6$
 - $= tlpmt$
 - NOW , if both play most optimal, then they will reverse each other operations and exhaust the turns
 - eg: $n=6 \Rightarrow 7$ (vanya $n++$) $\Rightarrow 6$ (vova $n--$) \Rightarrow infinite loop
 - $n\%3 == 0$
 - if True, divisible before vanya move
 - even vanya could $+1/-1$
 - it will not be divisible by 3
 - & vova will cancel the effect $-1/+1$ of vanya till 10 rounds
 - ultimate vova win
 - if False, not divisible before vanya move
 - vanya could $+1/-1$
 - it will be divisible by 3 after vanya move
 - & vova will do something

- & vova will cancel the effect -1/ +1 of vova
- and still it will be divisible by 3 after vanya move till 10 rounds
- ultimate vanya win
- numbers
 - 0 DIV
 - 1 (-1=0)
 - 2 (+1=3)
 - 3 DIV
 - 4 (-1)
 - 5 (+1)
 - 6 DIV
 - 7
 - 8
 - 9 DIV
- Eg: 6
 - => 7 => 8 => 9 => vanya win
 - => 7 => 6 => 7 => 6 ... vova win if played optimally
- Approach
 - if $n \% 3 == 0$
 - vova win, return Second
 - else if $n \% 3 != 0$
 - vanya win, return Second

```
#include<bits/stdc++.h>
using namespace std;
int main(){
    long long t=0;
    cin>>t;
    while(t--){
        long long n=0;
        cin>>n;
        if (n%3==0){cout<<"Second\n";}
        else{cout<<"First\n";}
    }
    return 0;
}
// TC O(1)
// SC O(1)
```

05 A Jagged Swaps

- <https://codeforces.com/problemset/problem/1896/A>
- sortings, *800
- Analysis
 - here, permutation is an array
 - of unique elements
 - if array of n integers, then integer exists of all $1, \dots, n$

- => ORDER DOES NOT MATTER
- we want to check if we could sort the permutation with special operation **ANY_TIMES**
- special operation
 - if $a[i-1] < a[i] > a[i+1]$
 - then swap $a[i], a[i+1]$
- eg: 1 3 2 5 4
 - target: 1 2 3 4 5
 - now
 - 1 3 2 5 4
 - $1 < 3 > 2$ 5 4 satisfies spec ops
 - 1 2 3 5 4 swap :0
 - $1 < 2 < 3 < 5 > 4$ satisfies spec ops
 - 1 2 3 4 5 swap :0
 - = target
- Expected TC
 - tlpmt 1sec atq
 - t max 5000 atq
 - n max 10 atq
 - 1 sec = 10^8 ops
 - $tlpmt = 10^8 / 5 * 10^3$
 - = $10^5 / 5$
 - = $2 * 10^4$ ops
 - $O(10^4) < tlpmt$
 - $O(n^4) = \text{Expected TC} = tcpmt$
 - mlpt 256mB atq
- Approach Optimised
 - IF THE FIRST NUMBER IN THE INITIAL ARRAY IS 1, THEN ANSWER IS YES , ELSE ANSWER IS NO
 - if not 1st element is 1 ,then that element can never shift towards its desired side
 - this is technically bubble sort
 - as if a number is largest, then it would be $a[i-1] < a[i] > a[i+1]$ obviously
 - our input arrays are already a permutation perfect, so no need to crosscheck

```
#include<bits/stdc++.h>
using namespace std;

int main(){

    long long t;
    cin>>t;
    while(t--){
        int n;
        cin>>n;
        vector<int> arr(n,0);
        for (int i=0; i<n; i++) cin>>arr[i];
        if (arr[0]==1) cout<<"YES\n";
        else cout<<"NO\n";
    }
}
```

```

        return 0;
    }
    // TC O(n)
    // SC O(n)

```

- Approach Brute Force
 - if this is permutation
 - if permutation is already sorted
 - return "YES"
 - else
 - try sort by special operation n times
 - if sorted
 - return "YES"
 - else
 - return "NO"
 - else
 - return "NO"
 - TTYL

```

#include<bits/stdc++.h>
using namespace std;

string checkSort(vector<int> arr,vector<int> arr2, int n){
    for ( int faltu=0; faltu<n; faltu++){
        for ( int idx=0; idx<n; idx++){
            if (
                arr[idx]<arr[idx+1] &&
                arr[idx+1]>arr[idx+2] &&
                idx+2<n
            ){
                int temp= arr[idx+1];
                arr[idx+1]= arr[idx+2];
                arr[idx+2]=temp;
            }
        }
        if(arr2==arr) { return "YES"; }
    }
    return "NO";
}

// NO NEED
string checkPert(int n){
    vector<int> arr(n);
    for (int i=0; i<n; i++) cin>>arr[i];

    vector<int> arr2=arr;
    sort(arr2.begin(),arr2.end());

```

```

    for ( int idx=0; idx<n; idx++){if (arr2[idx]!=idx+1) {return "NO";}}
    if(arr2==arr) { return "YES"; } // already sorted
    return checkSort(arr,arr2, n); // we dont feed data types as arguments
}

int main(){

    long long t;
    cin>>t;
    while(t--){
        int n;
        cin>>n;
        cout<<checkPert(n)<<"\n";

    }

    return 0;
}

```

06 A Doremy's Paint 3

- <https://codeforces.com/problemset/problem/1890/A>
- constructive algorithms, *800
- Analysis
 - array $a = \{a_1, a_2, a_3 \dots a_n\}$
 - n sized array
 - you want equality among the adjacent sums
 - array is good for this ques as
 - there exists a k such that $a_1 + a_2 = a_2 + a_3 = \dots = a_{n-1} + a_n = k$
 - Can you reorder the elements such that the condition becomes true ???
 - **permute its element** = change its order
 - eg : $\{1, 1, 2\}$
 - 1, 2, 1 permute done
 - now $1+2 = 2+1 = 3$:0 Done
 - "YES"
 - Expected TC?
 - $tlpt = 1\text{sec atq}$
 - $= 10^8 \text{ ops}$
 - $t_{\text{max}} = 100 = mt \text{ atq}$
 - $tlmt = 10^8 / 100 = 10^6$
 - $n = 100$
 - $O(n^3) = 100^3 = 10^6 = tlmt$
 - Expected TC = $O(n^3)$
 - $mlpt = 256\text{mB atq}$
 - if Expected TC = $O(n^3)$,then
 - $O(n^4)$ NO ABOVE UPPER BOUND

- $O(n^3)$ YES UPPER BOUND
- $O(n^2)$ YES BELOW UPPER BOUND
- $O(n)$ YES BELOW UPPER BOUND
- $O(n \log_2(n))$ YES BELOW UPPER BOUND
- $O(n!)$ YES BELOW UPPER BOUND
- this helps in thinking solution limits and optimisation
- solution can be minimal, not exact $O(n^3)$
- but still we got to know our limits
- Approach Optimised
 - \Rightarrow Generalise the condition
 - $a_1 + a_2 = a_2 + a_3 = \dots = a_{n-1} = a_n$ atq
 - $\Rightarrow a_{i-1} + a_i = a_i + a_{i+1}$
 - $\Rightarrow a_{i-1} + a_i(\text{cancelled}) = a_i(\text{cancelled}) + a_{i+1}$
 - $\Rightarrow a_{i-1} = a_{i+1} !!!$
 - i.e. $a_1 = a_3 = a_5 = \dots$ && $a_2 = a_4 = a_6 = \dots$
 - odd index positions should have same nos && even index positions should have same nos
 - NO when i have more than or equal to 3 distinct integers in my array, eg: 1 1 2 3 \Rightarrow no, you cant create any fair ordering
 - \Rightarrow Case of 3 Distinct Integers
 - ELSE NOW if we have N_1 & N_2 , freq. f_1, f_2
 - we want either of both cases in $n=6$
 - $\{ N_1 N_2 N_1 N_2 N_1 N_2 \}$
 - $\{ N_2 N_1 N_2 N_1 N_2 N_1 \}$
 - $\Rightarrow f_1 = f_2$ AT ODD N
 - YES
 - $n=7$
 - $\{ N_1 N_2 N_1 N_2 N_1 N_2 N_1 \}$
 - $\{ N_2 N_1 N_2 N_1 N_2 N_1 N_2 \}$
 - $\Rightarrow f_1 = f_2 + 1$
 - $\Rightarrow f_2 = f_1 + 1$
 - $\Rightarrow \text{abs}(f_1 - f_2) = 1$ AT EVEN N
 - if not then we cant achieve our $a_{i-1} = a_{i+1} !!!$, then NO
 - \Rightarrow Case of 2 Distinct Integers
 - \Rightarrow Case of 1 Distinct Integers
 - N_1 , any n
 - then $N_1 N_1 N_1 N_1 \dots$
 - whole array same
 - direct YES
 - else NO

```
#include<bits/stdc++.h>
using namespace std;
int main(){

    // t
    // mini tests
    int t;
```

```

cin>> t;
while (t--){
    long long n;
    cin>>n;
    vector<long long> a(n,0);
    // vector input
    for (long long i=0; i<n; i++) {cin>>a[i];} //n

    // freq map
    map<long long, long long> freq_map;
    for (long long i =0; i<n; i++){//n
        freq_map[a[i]]++;//logn
    }
    //nlogn

    if (freq_map.size()>=3) cout<<"No"<<endl;
    else {

        // begin- first element
        // rbegin- last element

        long long freq1 = freq_map.begin()->second;
        long long freq2 = freq_map.rbegin()->second;

        //odd size array
        if (freq1==freq2) cout<<"Yes"<<endl;
        else if ( n%2 ==1 && abs(freq1-freq2)==1) cout<<"Yes"<<endl;
        else cout<<"No"<<endl;
    }
}
return 0;
}

// TC  $O(n \log 2n) = O(100 * \log_2(100)) = O(100 * 7) = O(700)$ 
// SC  $O(n+n) = O(2n) = O(200)$ 

// this problem is imp to teach map,begin,rbegin iterators

```

- this problem is imp to teach map,begin,rbegin iterators

```

// freq map
map<long long, long long> freq_map;
for (long long i =0; i<n; i++){//n
    freq_map[a[i]]++;//logn
}

```

```

if (freq_map.size()>=3) cout<<"No"<<endl;

```

```
// begin- first element
// rbegin- last element

long long freq1 = freq_map.begin()->second;
long long freq2 = freq_map.rbegin()->second;
```

- Approach Brute force
 - Similar thinking but not organised enough at first try out of clue
 - Read number of test cases `t`
 - For each test case:
 - Read array size `x`
 - Read `x` elements into array `v1`
 - Make a copy `v2` and sort it
 - Make a copy `v3` from `v2` and remove duplicates from `v3`
 - If `v3.size() > 2`, return "NO"
 - If all elements are equal, return "YES"
 - If array size is even:
 - If frequency of smallest and largest elements is equal, return "YES"
 - If array size is odd:
 - If the frequency difference between smallest and largest elements is exactly 1, return "YES"
 - If array size is 2, return "YES"
 - Else, return "NO"

```
#include<bits/stdc++.h>
using namespace std;
string goodAPCheck(int x){
    vector<int> v1(x);
    for ( int i=0; i<x; i++) cin>>v1[i];
    vector<int> v2=v1;
    sort(v2.begin(),v2.end());

    vector<int> v3=v2;
    // remove duplicates
    v3.erase(unique(v3.begin(),v3.end()),v3.end());
    if (v3.size()>2 ) return "NO";

    if (count(v1.begin(), v1.end(),v2[0])==x) return "YES";
    if (x%2==0 && count(v1.begin(), v1.end(),v2[0])==count(v1.begin(),
v1.end(),v2[x-1])) return "YES";
    if(x%2!=0 && (count(v1.begin(), v1.end(),v2[0])==count(v1.begin(),
v1.end(),v2[x-1])+1 ||count(v1.begin(),
v1.end(),v2[0])+1==count(v1.begin(), v1.end(),v2[x-1]) )) return "YES";
    if(x==2) return "YES";
    else return "NO";
```

```

}
int main(){

    long long t;
    cin>>t;
    while(t--){
        int x = 0;
        cin>>x;
        cout<<goodAPCheck(x)<<"\n";
    }
    return 0;
}

```

07 A Don't Try to Count

- <https://codeforces.com/problemset/problem/1881/A>
- brute force, strings, *800
- Analysis
 - string x, len n
 - string s, len m
 - $n*m \leq 25$
 - 1, 25
 - 5, 5
 - 25, 1
 - operation **ANY_TIMES**
 - if x= "abc"
 - x= x+x "abcabc"
 - Find
 - min. no of operation by which
 - s is substring of x
 - Expected TC?
 - tlpt 2sec atq
 - $t \leq 10^4$ max atq
 - 1sec = $2 \cdot 10^8$ ops per test
 - ops/minitests = $2 \cdot 10^8 / 10^4 = 2 \cdot 10^4$ ops = 20000 ops = $25 \cdot 10^2$ ops
 - $n*m \leq 25$ max atq
 - $O(nm \cdot 10^2)$ Upper bound Expected TC
 - mlpt 256mB atq
- Approach Brute Force Tuts
 - where do i finally say ,this is the end ?
 - $x \rightarrow x+x \rightarrow x+x+x \rightarrow \dots \rightarrow$ not infinity but a upperbound
 - argument = upper bound is 5
 - should not go beyond 5
 - $n \rightarrow x, m \rightarrow s$
 - worst, $n=1, m=25$
 - eg : $x='a', s='aa...25times...a'$

- `x.size() < s.size()`, till this condition is true, you can never find `s` within `x`
- `a => aa => aaaa => a.8..a => a..16..a => a..32..a`
- `1 => 2 => 4 => 8 => 16 => 32` (its enough, more than 25 to become super set), these changes done within 5 operation
- if not done in even 5 operations then, at 6, `x = a...64..a`
- if couldnt find str in 25, then you can't find in 64 or moreanswer is impossible => -1

```
#include<bits/stdc++.h>
using namespace std;
bool check(string s, string x)
{
    if (x.size() < s.size()) return false;
    for (int i=0; i<x.size()- s.size()+1; i++) if (x.substr(i, s.size())==s)
return true; //x.substr(i, s.size())==s substring extract
    return false;
} // O((n-m+1)*m) = O(n*m)
int main(){
    int t;
    cin >> t;
    while (t--){
        long long n, m;
        cin >> n >> m;
        string x, s;
        cin >> x >> s;

        string x0 = x;
        string x1 = x0+x0;
        string x2 = x1+x1;
        string x3 = x2+x2;
        string x4 = x3+x3;
        string x5 = x4+x4;

        long long ans = -1;
        if (check(s, x0)) ans = 0;
        else if (check(s, x1)) ans = 1;
        else if (check(s, x2)) ans = 2;
        else if (check(s, x3)) ans = 3;
        else if (check(s, x4)) ans = 4;
        else if (check(s, x5)) ans = 5;
        cout << ans << endl;

    } return 0;
}
//187 ms    100 KB
// TC O(2^5 * n*m) = O(32*n*m)
// SC O(2^5*n) = O(32*n)
```

- Approach Optimised Mine

- SAME
- input t testcases
- each test cases
 - input n,m
 - Wrong, as babb,bbb ,its not -1
 - check if x is substring of s+s
 - if no
 - then x ,even mul by infinite can't be superset or in any combination of s
 - and we took s+s as maybe x="mara", s="rama"
 - return -1
 - if yes
 - then its possible
- counter=0
- while counter<=5
 - concatenate till s is substring of x
 - counter++
- return counter
- why counter =5 ??
 - counter=m*n
 - NO, Memory limit exceeded on test 2 1734 ms 262100 KB

```
#include<bits/stdc++.h>
using namespace std;
int checkCount(string x,string s){
    int counter = 0;

    while (counter<=5){
        if ((x).find(s) != string::npos){
            return counter;
        }
        counter++;
        x=x+x;
    }
    return -1;
};

int main(){
    long long t;
    cin >> t;
    while(t--){
        int n=0, m=0;
        string x="", s="";
        cin>>n>>m>>x>>s;

        // if ((s+s).find(x) == string::npos){
```

```

        //      cout<<-1<<"\n";
        // }
        // else{
            cout<<checkCount(x,s)<<"\n";
        // }

    }

    return 0;
}

// passed 58 tests containing test cases :)
// 109 ms    100 KB
// Time Complexity: O(n * m)
// Space Complexity: O(n + m) (worst case 32n + m).

```

08 A How Much Does Daytona Cost?

- <https://codeforces.com/problemset/problem/1878/A>
- greedy, *800
- Analysis
 - array a
 - size n
 - int k
 - Find?
 - if exists subsegment(sub array) of a where k is most common element
 - $a = \{a_0, a_1, \dots, a_{n-1}\}$
 - n, k
 - subarray
 - $\{a_1, a_2, a_3\}$
 - $\{a_1\}$
 - $\{a_1, a_2\}$
 - $\{a_3, a_4\}$
 - eg: $n=5, k=4, a=\{1, 4, 3, 4, 1\}$
 - $\Rightarrow \{4, 3, 4\}$
 - $\Rightarrow \text{YES}$
 - Expected TC?
 - tlpt 1sec atq
 - mlpt 256mB atq
 - t max 1000 atq
 - n max 100 atq
 - 1 sec = 10^8 ops
 - $\text{tlpmt} = 10^8 / 1000 = 10^5$
 - $O(100^3) = 10^6$ NO
 - $O(100^2) = 10^4$ YES
 - Expected TC = $\text{tcpmt} = O(n^2)$
- Approach Optimised

- IF k is present in array anywhere, then answer is YES, else no
- $a = \{a_0, a_1, a_2, k, a_4 \dots a_n\}$
- we haven't told length of subarray
- we can take length = 1, {k} is correct too, now in this subarray, k is the highest occurrence as k is only
-

```
#include<bits/stdc++.h>
using namespace std;
int main(){
    int t;cin>>t;while(t--){long long n,k;cin>>n>>k;
    long long a[n];for (int i=0; i<n; i++) cin>>a[i];
    long long number_is_present =0;
    for (int i=0; i<n; i++){if (a[i]==k) {number_is_present=1;break;}}
    if(number_is_present) cout<<"YES"<<endl;
    else cout<<"NO"<<endl;}return 0;
}
// TC O(n)
// SC O(n)
```

- Approach Brute Force
 - SAME nearly
 - One sec,
 - if number exists
 - if array size is 2 or 1
 - or if anywhere $a[i]=a[i+1]=k$
 - or if its>2
 - if in array bw that 1st occur and last occur ,that number the most occur
 - return yes if any satisfy, else no :0
 - FREAKING, the the limits, loopholes are hidden
 - functions returns>if else with breaks
 - if number exists
 - then its largest at subarray len = 1

```
// template miniTests int1 int2 vectorArrayInt1
#include<bits/stdc++.h>
using namespace std;
string mainGame(int x1, int x2, vector<int> v1){
    // code here
    // x1 n
    // x2 k
    // v1 a
    for ( int i =0; i<x1; i++ ){
        if (x2==v1[i]) {return "YES";}
    }
    return "NO";
}
```

```

void eachMiniTest(){
    int x1=0, x2=0; // factor1 factor2
    cin>>x1>>x2;
    vector<int> v1(x1);

    for (int i=0; i<x1; i++ ) cin>>v1[i];
    cout<< mainGame(x1,x2,v1)<<"\n";
}

int main(){
    long long t; //mini test cases
    cin>>t;
    while(t--){
        eachMiniTest();
    }

    return 0;
}

```

09 Goals of Victory

- <https://codeforces.com/problemset/problem/1877/A>
- math, *800
- Analysis
 - Expected TC ?
 - tlpt 1sec atq
 - mlpt 256 mB atq
 - t max 500 atq = 5*100
 - n max 100 atq
 - 1sec = 10^8 ops
 - tlpmt = $10^8 / 500$
- Approach

10 Target Practice

- <https://codeforces.com/problemset/problem/1873/C>
- implementationmath, *800
- Analysis
 - given board
 - 10x10
 - each ring deeper, more points, outermost is 1, innermost is 5
 - person shot "X" in grid of 10x10 "."
 - Find?
 - Scores
 - technically

```
0123456789
```

```
1111111111 0
1222222221 1
1233333321 2
1234444321 3
1234554321 4
1234554321 5
1234444321 6
1233333321 7
1222222221 8
1111111111 9
```

```
0 1234 5678 9
```

```
1 1111 1111 1 0
```

```
1 2222 2222 1 1
1 2333 3332 1 2
1 2344 4432 1 3
1 2345 5432 1 4
```

```
1 2345 5432 1 5
1 2344 4432 1 6
1 2333 3332 1 7
1 2222 2222 1 8
```

```
1 1111 1111 1 9
```

- condition of scoring

- 1

- 0,0 to 9,0 L 00 10 20 30 40 50 60 70 80 90
- 0,9 to 9,9 R 09 19 29 39 49 59 69 79 89 99
-
- 0,0 to 0,9 T 00 01 02 03 04 05 06 07 08 09
- 9,0 to 9,9 B 90 91 92 93 94 95 96 97 98 99
- relation
 - $i = 0$ or 9
 - $j = 0$ or 9
 - $1 = 0+1 == 10-9$

- 2

- 1,1 to 8,1 L 11 21 31 41 51 61 71 81
- 1,8 to 8,8 R 18 28 38 48 58 68 78 88
-
- 1,1 to 1,8 T 11 12 13 14 15 16 17 18
- 8,1 to 8,8 B 81 82 83 84 85 86 87 88
- relation
 - $i, j = 1$ or 8
 - $1 = 1+1 == 10-8$

- 5
 - 4,4
 - 4,5
 - 5,4
 - 5,5
- this not 2D Array
- this is char incoming
- Approach

```
#include<bits/stdc++.h>
using namespace std;
// 1
/*
00 01 02 03 04 05 06 07 08 09
10 19
20 29
30 39
40 49
50 59
60 69
70 79
80 89
90 91 92 93 94 95 96 97 98 99
*/
// 2
/*
11 12 13 14 15 16 17 18
21 28
31 38
41 48
51 58
61 68
71 78
81 82 83 84 85 86 87 88
*/

int calScore(int row, int col, char c){
    int bound1 =0;
    int bound2 =9;

    for ( int ring =1; ring<=5; ring++){
        if ( (row==bound1) || (row==bound2) ){ return ring;}
        else if ((col==bound1) || (col==bound2)) {return ring;}

        bound1++;bound2--;
    }
    return 0; // fallback
}

void miniTest(){
    int finalScore=0;
```

```

        for (int row=0; row<10; row++){
            for (int col=0; col<10; col++){
                char c;
                cin>>c;
                if (c=='X') finalScore+=calScore(row,col,c);
            }
        }
        cout<<finalScore<<"\n";
    }
    int main(){
        ios::sync_with_stdio(0);
        cin.tie(0);;
        int t;
        cin>>t;
        while(t--){
            miniTest();
        }
        return 0;
    }
}

```

TipsCollectedFromExperiences

- when check TC& SC of program, don't consider TestCasesLoop&Spaces in counting
- 1sec = 10^8 Operations
- if 1sec = totalTests
 - operationsPerTestCase = $10^8 / \text{totalTestCases}$
 - if totalTestCases = 100
 - operationsPerTestCase = 10^6 operations
 - $O(n^3)$ is UpperLimit of the question's code
 - as $O(n^3) = O(100^3) = 10^6 === \text{operationsPerTestCase}$
- always think of extra testcases
- if Expected TC = $O(n^3)$,then
 - $O(n^4)$ NO ABOVE UPPER BOUND
 - $O(n^3)$ YES UPPER BOUND
 - $O(n^2)$ YES BELOW UPPER BOUND
 - $O(n)$ YES BELOW UPPER BOUND
 - $O(n \log_2(n))$ YES BELOW UPPER BOUND
 - $O(n^1)$ YES BELOW UPPER BOUND
 - this helps in thinking solution limits and optimisation
 - solution can be minimal, not exact $O(n^3)$
 - but still we got to know our limits
- and in cp submission , you can see testcases in ID :0

- FREAKING, the the limits, loopholes are hidden
- functions returns>if else with breaks
- => Generalise the condition in question 6R800
 - $a_1 + a_2 = a_2 + a_3 = \dots = a_{n-1} = a_n$ atq
 - => $a_{i-1} + a_i = a_i + a_{i+1}$
 - => $a_{i-1} + a_i(\text{cancelled}) = a_i(\text{cancelled}) + a_{i+1}$
 - => $a_{i-1} = a_{i+1}$!!!
 - i.e. $a_1=a_3=a_4=a_5=\dots$ && $a_2=a_4=a_6=\dots$
- put this at 1st line of main() code, to fix bug of compiler at running test cases, not interactive program

```
ios::sync_with_stdio(0);
cin.tie(0);
```

- templates

```
// template miniTests int1 int2 vectorArrayInt1
#include<bits/stdc++.h>
using namespace std;
void mainGame(int x1, int x2, vector<int> v1){
    // code here

}

void eachMiniTest(){
    int x1=0, x2=0;// factor1 factor2
    vector<int> v1;
    cin>>x1>>x2;
    for (int i=0; i<x1; i++ ) cin>>v1[i];
    mainGame(x1,x2,v1);

}

int main(){
    ios::sync_with_stdio(0);
    cin.tie(0);
    long long t; //mini test cases
    cin>>t;
    while(t--){
        eachMiniTest();
    }

    return 0;
}
```

```
// template miniTests int1 int2 string
#include<bits/stdc++.h>
using namespace std;
void mainGame(int x1, int x2, string s){
    // code here

}

void eachMiniTest(){
    int x1=0, x2=0;// factor1 factor2
    string s;
    cin>>x1>>x2>>s;
    mainGame(x1,x2,s);

}

int main(){
    ios::sync_with_stdio(0);
    cin.tie(0);
    long long t; //mini test cases
    cin>>t;
    while(t--){
        eachMiniTest();
    }

    return 0;
}
```

- Vectors CPP STL

```
vector<int> v1(n); // create ,with n elements mandatory
cin>>v1[0]; // insert
vector<int> v2 = v1; // copy
sort(v2.begin(),v2.end()); // sorting in stl, asc
bool compare= (v1==v2); // compare
```

```
#include<vector>
#include<iostream>
#include<algorithm>
```

- use `long long` instead of `int` for bigger stuff
- max/min : `max(var1 ,var2),min(var1, var2)`
 - make sure var1,var2 has SAME DATATYPE
 - inbuilt

- subarray = sub segment = segment taken out of array not manipulated ,no change in order
 - eg of a = {a0, a1, a2 ... an-1}, subarrs : {a0, a1}, {a1,a2,a3}, etc
- non-decreasing = increasing
- s is atmost k , means : $s \leq k$
- atq : according to question
- How to Calculate Expected TC? eg: in 1R800
 - tl per test = 1sec atq
 - 1sec = 10^8 Operations = per test operations
 - $1 \leq k \leq n$ (minitests) ≤ 100 acc.to ques (atq)
 - consider n=100 upperbound
 - tl per mini test = 1sec / 100
 - per mini test operations = $10^8 / 100 = 10^6$
 - if tc per mini test = $O(n^3)$
 - so n=100, then operation = $O(n^3) = O(100^3) =$ per mini test operations
 - so $O(n^3)$ is the upper bound
 - even sol. can have $O(n^2)$, $O(n)$, $O(n \log n)$ etc. anything below $O(n^3)$, but not above $O(n^3)$
 - Expected TC = $O(n^3)$

```
// 1R800
// at extreme proof case use :
long long t;
```

```
// 1R800
// at n = 100 , tc = 100log100 = 100*7 = 700
// 2^7 ~ 100
// log2(n) = ln n / ln 2
```

```
// 1R800
// input, n order
cin>>v[i]; // n order

// vector copy, n order
vector<int> v2=v; // copy // n order

// sort stl func, n order
sort(v2.begin(), v2.end()); // nlogn order

// vector compare, n order
if (v2==v) // vector compare // n order
```

- tlpt = time limit per test
- 2secs = $2 \times (10^8)$ operations
- at 2R800 , tl per test = 2secs
 - 2secs = $2 \times (10^8)$ operations
 - $t = 1000$ atq
 - time/testcase = $O(2 \times 10^5)$
 - $n = 50$ max atq
 - then at $O(n^3) = O(125000) = O(1.25 \times 10^5) \leq O(2 \times 10^5)$
 - TC for minitest = Expected TC = $O(n^3)$ upper bound

- ```
// max(a, b); O(1) // just checks (a < b)
// min(a, b); O(1) // just checks (a < b)
// max_element(v.begin(), v.end()) O(n)
// min_element(v.begin(), v.end()) O(n)
```

- `vector<long long> v1(10,0);` initialize safety vector
- : What the Fish Ques
- Parity
  - Parity is simply whether a number is even or odd.
  - Even parity: divisible by 2 (like 2, 4, 6, 8...)
  - Odd parity: not divisible by 2 (like 1, 3, 5, 7...)
- 6R800 this problem is imp to teach map,begin,rbegin iterators

```
// freq map
map<long long, long long> freq_map;
for (long long i = 0; i < n; i++) { // n
 freq_map[a[i]]++; // log n
}
```

```
if (freq_map.size() >= 3) cout << "No" << endl;
```

```
// begin- first element
// rbegin- last element

long long freq1 = freq_map.begin()->second;
long long freq2 = freq_map.rbegin()->second;
```

# Array Coloring [ONSIGHT]

---

- <https://codeforces.com/problemset/problem/1857/A>
- greedy, math, \*800
- Analysis
  - given Array, n integers
  - to do
    - if you can
      - colour array elements in 2 groups/ 2 colors
      - parity of color 1 elements sum = parity of color 2 elements sum
      - print YES
    - else print NO
  - Parity
    - Parity is simply whether a number is even or odd.
    - Even parity: divisible by 2 (like 2, 4, 6, 8...)
    - Odd parity: not divisible by 2 (like 1, 3, 5, 7...)
  - eg: [1,2,4,3,2,3,5,4]
    - c1: [1,2,3], c1 sum = even parity
    - c2: [4,2,3,5,4], c2 sum = odd parity
    - YES
  - eg: [4,7]
    - NO
  - eg: [3,9,8]
    - YES
    - c1: [3,9]
    - c2: [8]
    - both sum even parity
  - eg: [1,7]
    - YES
    - c1: [1]
    - c2: [7]
    - both sum odd parity
  - eg: [5,4,3,2,1]
    - NO
    - can't make 2color groups with same parity
- Approach
  - if no. of odds = no. of evens
    - YES
  - else if n=3 && no. of odds != 3 or !=1
    - YES
    - actually if [even,even,even] works YES
    - [odd,odd,odd] NO
    - [odd,odd,even] YES
    - [odd,even,even] NO

- so iff n is odd && odd < even && abs(odd-even)!=1
  - YES
  - [odd,odd,odd,even,even] NO
  - [odd,odd,even,even,even] YES
  - [odd,odd,odd,even,even,even,even] NO

```
#include<bits/stdc++.h>
using namespace std;

int main(){
 ios::sync_with_stdio(0);
 cin.tie(0);
 int t;
 cin>> t;
 while (t--){
 int n,odd=0,even=0;
 cin>>n;
 vector<int> v1(n,0);
 for (int i=0; i<n; i++){
 cin>>v1[i];
 if (v1[i]%2==0) {even++;}
 else {odd++;}
 }
 // cout<<odd<<" "<< even<<endl;
 if (odd==even && n>2) {
 cout<<"YES\n";
 }
 else if ((n==2 && odd!=even) || (n==3 && odd>even) || (n%2!=0 &&
odd<even && abs(odd-even)!=1) || even==1 || odd==1)
 {
 cout<<"YES\n";
 }
 else
 {
 cout<<"NO\n";
 }
 }

 return 0;
}
```

---

End-of-File

The [kintsugi-stack](#) repository, authored by Kintsugi-Programmer, is less a comprehensive resource and more an Artifact of Continuous Research and Deep Inquiry into Computer Science and Software Engineering. It

serves as a transparent ledger of the author's relentless pursuit of mastery, from the foundational algorithms to modern full-stack implementation.

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