kintsugi-stack-dsa-cpp: COMPETITIVE_PROGRAMMING

> “Talk is cheap. Show me the time complexity.”

- Author: Kintsugi-Programmer

> 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

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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<=k
    - however, his machine works in a strange way. It can only reverse any subarray of boxes with length `at most k`
    - subarrsize<=k
    - Find if it's possible to sort the boxes using any number of reverses.
    - So, if K>=2 ,Machine's sort is 100%possible at `any number of reverses` ANY_TIMES
        - if k=2 atleast => 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 <=k <= 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(100^6) = per mini test operations
            - so O(n^3) is the upper bound
            - even sol. can have O(n^2), O(n), O(nlogn) 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>=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) <= 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
    - througout 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 (lastGasStation - x)*2
- Approach
    - C1= cal. firstGasStation-0
    - C2= max(allDistances(cal. dist b/w eachGasStation))
    - C3= cal. (lastGasStation - x)*2
    - return max(C1,C2,C3)

```cpp
#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≤i≤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 => s = s1,s2,s3....,sn
        - = ...##.#....##
        - now in ...
            - if we just w.w (w=water) => 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) = 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 atq
        - mlpt = 256mB atq
        - t = 100 atq
        - n = 1000 atq
        - 1sec = 10^8 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 exhause the turns
        - eg: n=6 => 7 (vanya n++) => 6 (vova n--) => 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 10rounds
                - 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 10rounds
            - 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 optimaly
- Approach
    - if n%3 == 0
        - vova win, return Second
    - else if n%3 != 0
        - vanya win, return Second

```cpp
#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 integet exists of all 1,..to.,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
        - tlpt 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) = 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 permution
        - 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 arguements
}


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 = { a1,a2,a3...an}
  - n sized array
  - you want equality among the adjacent sums
  - array is good for this ques as
  - there exists a k such that a1+a2=a2+a3=…=an−1+an=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 = 1sec atq
    - = 10^8 ops
    - t max=100 = mt atq
    - tlmt = 10^8 / 100 = 10^6
    - n = 100
    - O(n^3) = 100^3 = 10^6 = tlmt
    - Expected TC = O(n^3)
    - mlpt = 256mB 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(nlog2(n)) YES BELOW UPPER BOUND
      - O(n1) 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
  - => Generalise the condition
    - a1 + a2 = a2 + a3 = ... = an-1 = an atq
    - => ai-1 + ai = ai + ai+1
    - => ai-1 + ai(cancelled) = ai(cancelled) + ai+1
    - => `ai-1 = ai+1` !!!
    - i.e. a1=a3=a4=a5=.... && a2=a4=a6=....
  - 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 => no, you cant create any fair ordering
    - => Case of 3 Distinct Integers
  - ELSE NOW if we have N1 & N2, freq. f1, f2
    - we want either of both cases in n=6
      - { N1 N2 N1 N2 N1 N2 }
      - { N2 N1 N2 N1 N2 N1 }
      - => f1=f2 AT ODD N
      - YES
    - n=7
      - { N1 N2 N1 N2 N1 N2 N1 }
      - { N2 N1 N2 N1 N2 N1 N2 }
      - => f1= f2 +1
      - => f2= f1 +1
      - => abs(f1-f2) = 1 AT EVEN N
    - if not then we cant achieve our `ai-1 = ai+1` !!!, then NO
    - => Case of 2 Distinct Integers
  - => Case of 1 Distinct Integers
    - N1 , any n
    - then N1 N1 N1 N1 ...
    - 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(nlog2n) = O(100*log2(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 <=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 10^4 max atq
      - 1sec = 2*10^8 ops per test
      - ops/minitests = 2*10^8 / 10^4 = 2*10^4 ops = 20000 ops = 25*10^2 ops
      - n*m 25 max atq
      - O(n*m*10^2) Upper bound Expected TC
    - mlpt 256mB atq
- Approach Brute Force Tuts
  - where do i finally say ,this is the end ?
    - x-> x+x -> x+x + x+x -> ... -> not infinity but a upperbound
    - arguement = upper bound is 5
    - should not go beyond 5
    - n-> x, m-> 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 more ... .answer 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 posible
- counter=0
- while counter<=5
  - concatnate 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 = { a0,a1,... an-1}
  - n,k
  - subarray
    - {a1,a2,a3}
    - {a1}
    - {a1 ,a2}
    - {a3,a4}
  - eg: n=5,k=4, a={1,4,3,4,1}
    - => {4,3,4}
    - => YES
  - Expected TC?
    - tlpt 1sec atq
    - mlpt 256mB atq
    - t max 1000 atq
    - n max 100 atq
    - 1 sec = 10^8 ops
    - tlpmt = 10^8 / 1000 = 10^5
    - O(100^3) = 10^6 NO
    - O(100^2) = 10^4 YES
    - Expected TC = tcpmt = O(n^2)
- Approach Optimised

  - IF k is present in array anywhere, then answer is YES, else no
  - a = { a0,a1,a2,k,a4...an}
  - we haven't told lenght of subarray
  - we can take length =1 , {k} is correct too , now in this subarray, k is the highest occurance 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
    - given
        - n teams in tournament
        - each match
            - each pair of teams match up once
            - after every match
                - 2 int, as result of match, 2 goals of 2 teams
        - efficiency of team = total no. of goals in each of its matches. - total opponents score in each of its matches.
    - to find
        - effiency array of each team, one missing
        - a1, a2, a3, ... ,an-1
        - n-1 teams
        - efficiency of missing team?
            - it can be uniquely determined
    - input

        - t(tests)
        - n(teams) 1
        - effiencies of n-1 teams 1
        - n(teams) 2
        - effiencies of n-1 teams 2
        - ...
    - output
        - missing effiency 1
        - missing effiency 2
        - ...
- Approach 1 -- brute force -- optimal
    - suppose 4 teams
        - n1 n2 n3 n4 teams
            - matches (in pairs)
                - n1 n2 => scores a1 b1
                - n1 n3 a2 c1
                - n1 n4 a3 d1
                - n2 n3 b2 c2
                - n2 n4 b3 d2
                - n3 n4 d3 c3
        - e1 e2 e3 e4 eff.s
    - so
        - e1 = a1 + a2 + a3 - b1 - c1 - d1 = 3
        - e2 = b1 + b2 + b3 - a1 - c2 - d2 = -4
        - e3 = c1 + c2 + c3 - a2 - b2 - d3 = 5
        - e4 = d1 + d2 + d3 - a3 - b3 - c3
        - e1 + e2 + e3 + e4 = 0 (oh, just found out !!!)
            - e4 = -(e1+e2+e3) (SOLVED!!!)
            - e4 = -(3-4+5) = -4
- Formalised
    - Problem Insight
        - Each goal scored by a team increases its own efficiency by 1.
        - The same goal decreases the opponent's efficiency by 1.
        - So for every goal, the total sum of efficiencies changes by +1 and -1.
        - Net change in total efficiency is always 0.
    - Key Observation
        - Initially, before any match, all teams have efficiency 0.
        - So the total sum of efficiencies starts at 0.
        - Since the sum never changes, the final sum of efficiencies is also 0.
    - Given
        - There are n teams.
        - Efficiencies of n − 1 teams are given.
        - One team's efficiency is missing.
    - Logic to Find Missing Efficiency
        - Let the given efficiencies be: A1, A2, A3, ..., A(n−1)
        - Let the missing efficiency be An.

        - Since total sum is 0: A1 + A2 + A3 + ... + A(n−1) + An = 0
        - Therefore: An = −(A1 + A2 + A3 + ... + A(n−1))
    - Algorithm
        - Read n.
        - Read the n − 1 efficiencies.
        - Compute their sum.
        - Output the negative of this sum.
    - Complexity
        - Time complexity: O(n)
        - Space complexity: O(1)

```
#include<bits/stdc++.h>
using namespace std;
int main(){
    // Read Question and Analyse it Bit-by-bit
    // write all pts in depth, leave no missing dots
    // then dots will connect easily and will give you answer
    ios::sync_with_stdio(0);
    cin.tie(0);
    int t=0;// safe ,no to garbage entry
    cin>>t;
    while(t--){
        int n=0;// safe ,no to garbage entry
        cin>>n;
        n--; // we have n-1 entries
        int res=0;// safe ,no to garbage entry
        while(n--){
            int buff=0;// safe ,no to garbage entry
            cin>>buff;
            res+=buff;
        }
        res=res*(-1);
        cout<<res<<"\n";

    }
    return 0;
}
```

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

int main()
{
    int t; // Variable to store the number of test cases
    cin >> t; // Read the number of test cases
    while (t--) // Loop through each test case
    {
        long long n; // Variable to store the number of teams
        cin >> n; // Read the number of teams
        long long a[n]; // Array to store the efficiency of n-1 teams
        for (long long i = 0; i < n - 1; i++) // Loop to read the efficiency of n-1 teams
            cin >> a[i]; // Read efficiency of each team
        // inputs

        long long sum = 0; // Variable to store the sum of efficiencies of n-1 teams
        for (long long i = 0; i < n - 1; i++) // Loop to calculate the sum of efficiencies
            sum += a[i]; // Add each team's efficiency to the sum

        cout << -1 * sum << endl; // Output the efficiency of the missing team, which is the negative of the sum
    }
    return 0; // Return 0 to indicate successful execution
}

// Time Complexity (TC): O(n) = O(100)
// Space Complexity (SC): O(n) = O(100)
```

10 Target Practice

- https://codeforces.com/problemset/problem/1873/C
- implementationmath, *800
- Analysis
    - tc and sc
        - 1sec = 10^8 ops
        - tlpt = 1sec
        - 1 test = 10^8 ops
        - 1 test = 1000 mtest
        - => tlpmt = 10^8 / 10^3 = 10^5 ops = O(n^5) max allowed and n = 10 (10x10matrix)
        - mlpt = 256mb
    - 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
```

- condtion 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 1 -- brute force
  - The grid is fixed at 10×10 and consists of 5 concentric square rings, where the outermost ring gives 1 point and each inner ring gives one more point, up to 5 at the center
    - For every test case, we scan the grid cell by cell
      - When a cell contains `'X'`, we must determine which ring it belongs to
        - We simulate rings using two boundaries: `bound1` starting at 0 and `bound2` starting at 9
          - Ring 1 checks the outer boundary (row or column equal to 0 or 9)
          - Ring 2 checks the next inner boundary (1 or 8)
          - This continues until ring 5
        - If the current cell lies on any side of the current boundary square
          - `(row == bound1 || row == bound2 || col == bound1 || col == bound2)`
          - The current ring number is returned as the score
        - After each ring check, the boundaries are moved inward (`bound1++`, `bound2--`)
      - The returned ring score is added to the total score
    - After processing all cells, the accumulated score is printed
  - The idea works because each cell belongs to exactly one concentric square ring, and shrinking boundaries correctly model these rings without needing an extra 2D scoring array

```
#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;
}
// Approach 1: Time complexity is O(1) per test case (100 cells × 5 rings,
all constants) and space complexity is O(1).
```

- Approach 2 -- optimal
    - The grid is fixed at 10×10 and forms 5 concentric square rings with scores from 1 (outermost) to 5 (innermost)
        - For each test case, the grid is read cell by cell
            - When a cell contains `'X'`, its score depends only on how close it is to the nearest border
                - Compute the distance from the cell to all four edges:
                    - top → `i`
                    - left → `j`
                    - bottom → `9 - i`
                    - right → `9 - j`
                - The minimum of these four values gives the ring index (0-based)
                    - `0 → outer ring`, `1 → second ring`, …, `4 → center`
                - Add `1` to convert the index into the actual score

            - `score += min({i, j, 9 - i, 9 - j}) + 1`
          - Repeat for all 100 cells
        - After processing the grid, output the total score
    - The intuition is that every step away from the border moves one ring inward, so the closest border uniquely determines the ring of any cell

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

int calScore(int row, int col, char c){
    int top = row;
    int left = col;
    int bottom = 9- row;
    int right = 9-col;
    return min({top,bottom,left,right})+1; // 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;
}

// Approach 2: Time complexity is O(1) per test case (100 cells, constant
work per cell) and space complexity is O(1).
```

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

int main() {
    ios::sync_with_stdio(false);
    cin.tie(nullptr);
    int t;
    cin >> t;

    while (t--) {
        int score = 0;
        for (int i = 0; i < 10; i++) {
            for (int j = 0; j < 10; j++) {
                char c;
                cin >> c;
                if (c == 'X') {
                    score += min({i, j, 9 - i, 9 - j}) + 1;
                }
            }
        }
        cout << score << '\n';
    }
}
```

- Approach 3 -- optimal
  - A predefined 10×10 `score` matrix stores the score of each cell based on its concentric ring on the target
  - The number of test cases `t` is read, and each test case is processed independently
  - For each test case, a 10×10 character grid is read row by row and stored
  - The grid is scanned cell by cell to check for the presence of `'X'` (an arrow hit)
  - Whenever an `'X'` is found, the corresponding value from the `score` matrix is added to `total_score`
  - After scanning all 100 cells, the final accumulated score is printed for that test case
  - Time complexity is O(1) per test case (fixed 10×10 grid), and space complexity is O(1) since all data structures are of constant size

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

// Predefined score matrix representing the target's rings
// Each element represents the score for that position on the target
const int score[10][10] = {
    {1,1,1,1,1,1,1,1,1,1},
    {1,2,2,2,2,2,2,2,2,1},
    {1,2,3,3,3,3,3,3,2,1},
    {1,2,3,4,4,4,4,3,2,1},
    {1,2,3,4,5,5,4,3,2,1},
    {1,2,3,4,5,5,4,3,2,1},
    {1,2,3,4,4,4,4,3,2,1},
    {1,2,3,3,3,3,3,3,2,1},
    {1,2,2,2,2,2,2,2,2,1},
    {1,1,1,1,1,1,1,1,1,1}
};

int calScore(int row, int col, char c){
    return score[row][col];
}
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;
}

// Time complexity is O(1) per test case (fixed 10×10 grid), and space complexity is O(1) since all data structures are of constant size
```

TipsCollectedFromExperiences

- Read Question and Analyse it Bit-by-bit
    - write all pts in depth, leave no missing dots
    - reconstruct the test cases with your written logic
        - test cases are misleading and full of confusion
    - then dots will connect easily and will give you answer
- when check TC& SC of program, don't consider TestCasesLoop&Spaces in counting
- 1sec = 10^8 Operations
- if 1sec = totalTests
    - operationsPerTestCase = 10^8 / 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 === 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(nlog2(n)) YES BELOW UPPER BOUND
    - O(n1) 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
    - a1 + a2 = a2 + a3 = ... = an-1 = an atq
    - => ai-1 + ai = ai + ai+1
    - => ai-1 + ai(cancelled) = ai(cancelled) + ai+1
    - => `ai-1 = ai+1` !!!
    - i.e. a1=a3=a4=a5=.... && a2=a4=a6=....
- 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<=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 <=k <= 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(100^6) = per mini test operations
      - so O(n^3) is the upper bound
      - even sol. can have O(n^2), O(n), O(nlogn) 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*(10^8) operations

- at 2R800 , 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) <= O(2* 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]]++;//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;


```

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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