

CP31

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

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R800

1 Halloumi Boxes

- <https://codeforces.com/problemset/problem/1903/A>
- brute force, greedy, sortings, *800
- Analysis
 - n boxes/array $a_1 a_2 \dots a_n$
 - $a = \{a_0, a_1, a_2 \dots a_{n-1}\}$
 - subarray = segment taken out of array not manipulated ,no change in order
 - eg: $\{a_0, a_1\}$, $\{a_1, a_2, a_3\}$, 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 = $1\text{sec} / 100$
 - per mini test operations = $10^8 / 100 = 10^6$
 - if tc per mini test = $O(n^3)$
 - so $n=100$, then operation = $O(n^3) = O(100^3) = \text{per mini test operations}$
 - 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)

```

2 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 = $2 \cdot (10^8)$ operations
 - $t = 1000$ atq
 - time/testcase = $O(2 \cdot 10^5)$
 - $n = 50$ max atq
 - then at $O(n^3) = O(125000) = O(1.25 \cdot 10^5) \leq O(2 \cdot 10^5)$
 - 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 (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)

```
#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 //0(n)
        v1[0]=0;
        while(i<=n){// 0(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; // 0(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); 0(1) // just checks (a < b)
// min(a, b); 0(1) // just checks (a < b)
// max_element(v.begin(), v.end()) 0(n)
// min_element(v.begin(), v.end()) 0(n)

```

- my code is more optimised than tut;0

3 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 \Rightarrow www
 - $\dots \# \# \# \dots \# \#$
 - 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)

```

4 WTF 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 ?
 - tlpmt = 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 $1000^3 = 10^9 < \text{tlpmt}$
 - 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
 - $\Rightarrow 7 \Rightarrow 8 \Rightarrow 9 \Rightarrow \dots$ vanya win
 - $\Rightarrow 7 \Rightarrow 6 \Rightarrow 7 \Rightarrow 6 \dots$ 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)
```

5 WTF 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 $1, \dots, n$
 - \Rightarrow 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
 - $O(10^4) < \text{tlpmt}$
 - $O(n^4) = \text{Expected TC} = \text{tcpmt}$
 - 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;
}

```

6 WTF 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?
 - $t_{lpt} = 1 \text{ sec atq}$
 - $= 10^8 \text{ ops}$
 - $t_{\text{max}} = 100 = m_{\text{t atq}}$
 - $t_{lmt} = 10^8 / 100 = 10^6$
 - $n = 100$
 - $O(n^3) = 100^3 = 10^6 = t_{lmt}$
 - Expected TC = $O(n^3)$
 - $m_{lpt} = 256 \text{ MB atq}$
 - 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
 - $O(n^1)$ 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
- 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. $a_1=a_3=a_4=a_5=\dots$ && $a_2=a_4=a_6=\dots$
- 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 N1 & N2, freq. f1, f2
 - 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
 - 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  $O(n \log 2n) = O(100 * \log_2(100)) = O(100 * 7) = O(700)$ 
// 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;
}

```

7 WTF 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
 - $t \cdot 10^4$ 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 ?
 - $x \rightarrow x+x \rightarrow x+x+x+x \rightarrow \dots \rightarrow$ 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
 - $a \Rightarrow aa \Rightarrow aaaa \Rightarrow a.8..a \Rightarrow a..16..a \Rightarrow a..32..a$
 - $1 \Rightarrow 2 \Rightarrow 4 \Rightarrow 8 \Rightarrow 16 \Rightarrow 32$ (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 $\Rightarrow -1$


```

#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).

```

8 How Much Does Daytona Cost?

- <https://codeforces.com/problemset/problem/1878/A>
- greedy, *800
- Analysis
 - array a
 - size n
 - int k
 - Find?
 - subsegment of a where k is most common element
 - 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
- Approach
 - FREAKING, the the limits, loopholes are hidden
 - functions returns > if else with breaks
 - if number exists
 - then its largest at subarray len = 1

10 Target Practice

- 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

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 = 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 = $1\text{sec} / 100$
- 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
- WTF : 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;
```

Ambitious Kid

```
#include<bits/stdc++.h>
using namespace std;
int main(){
    int n;
    cin >> n;
    vector<int> v1(n,0);
    for (int i=0; i<n;i++){
```

```

        int i1 =0;
        cin>>i1;
        v1[i]=(i1>=0) ? i1: (i1*-1); // or v1[i] = abs(i1);
    }
    cout<<*min_element(v1.begin(),v1.end()); // min_element & max_element
    return pointer
    // not sort then v1[1] as its nlogn
    return 0;
}
// TC O(n)
// SC O(n)

```

Target Practice

```

#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;
}

```

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] 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;
}
```