1. **Perfect Number -** [**https://codeforces.com/problemset/problem/919/B**](https://codeforces.com/problemset/problem/919/B)

#include<bits/stdc++.h>

using namespace std;

int main() {

    int n;

    cin >> n;

    int count = 0;

    for (int i = 19; ; i++) {

        int temp = i, sum = 0;

        while (temp) {

            sum += temp % 10;

            temp /= 10;

        }

        if (sum == 10) count++;

        if (count == n) {

            cout << i << endl;

            break;

        }

    }

}

1. Aggressive cows - <https://vjudge.net/problem/SPOJ-AGGRCOW>

#include <bits/stdc++.h>

using namespace std;

bool canPlaceCows(vector<int> &stalls, int cows, int minDist) {

    int count = 1;  // First cow placed at first stall

    int lastPos = stalls[0];

    for (int i = 1; i < stalls.size(); i++) {

        if (stalls[i] - lastPos >= minDist) {

            count++;

            lastPos = stalls[i];

        }

        if (count >= cows) return true;

    }

    return false;

}

int aggressiveCows(vector<int> &stalls, int cows) {

    sort(stalls.begin(), stalls.end());

    int low = 1;  // minimum possible distance is at least 1

    int high = stalls.back() - stalls[0];

    int ans = 0;

    while (low <= high) {

        int mid = low + (high - low) / 2;

        if (canPlaceCows(stalls, cows, mid)) {

            ans = mid;

            low = mid + 1;

        } else {

            high = mid - 1;

        }

    }

    return ans;

}

int main() {

    int t;

    cin >> t;

    while (t--) {

        int n, c;

        cin >> n >> c;

        vector<int> stalls(n);

        for (int i = 0; i < n; i++) {

            cin >> stalls[i];

        }

        int result = aggressiveCows(stalls, c);

        cout << result << endl;

    }

    return 0;

}

1. **Chat Ban -** [**https://vjudge.net/problem/CodeForces-1612C**](https://vjudge.net/problem/CodeForces-1612C)

Newton’s School =>

#include<bits/stdc++.h>

using namespace std;

#define ll long long

int main()

{

    ios\_base::sync\_with\_stdio(false);

    cin.tie(NULL);

    cout.tie(NULL);

    ll t, k, x, ans, l, c;

    long double x1, ans1;

    cin>>t;

    for(;t--;)

    {

        cin>>k>>x;

        c=k\*k;

        if(c<=x){

            cout<<2\*k-1<<"\n";

            continue;

        }

        c=(k\*(k+1))/2;

        if(c<=x){

            x=x-c;

            x=(k\*(k-1))/2-x;

            x1=x;

            ans1=floor((sqrt(1+8\*x1)-1)/2);

            ans=2\*k-1-ans1;

            cout<<ans<<"\n";

        }else{

            x1=x;

            ans1=ceil((sqrt(1+8\*x1)-1)/2);

            ans=ans1;

            cout<<ans<<"\n";

        }

    }

}

Another Approach 🡺

#include <iostream>

using namespace std;

typedef long long ll;

ll emotesSent(ll k, ll m) {

    if (m <= k) {

        return m \* (m + 1) / 2;

    } else {

        ll full = k \* (k + 1) / 2;

        ll rem = m - k;

        ll tail = k - 1;

        ll last = tail - rem + 1;

        return full + (tail + last) \* rem / 2;

    }

}

ll solve(ll k, ll x) {

    ll low = 1, high = 2 \* k - 1, ans = 2 \* k - 1;

    while (low <= high) {

        ll mid = (low + high) / 2;

        if (emotesSent(k, mid) >= x) {

            ans = mid;

            high = mid - 1;

        } else {

            low = mid + 1;

        }

    }

    return ans;

}

int main() {

    int t;

    cin >> t;

    while (t--) {

        ll k, x;

        cin >> k >> x;

        cout << solve(k, x) << "\n";

    }

    return 0;

}

**⏱️ Time Complexity**

**Per Test Case:**

* All operations are constant-time except for sqrt() and some arithmetic.
* So: **O(1)** per test case

1. **K-th Not Divisible by n -** [**https://vjudge.net/problem/CodeForces-1352C**](https://vjudge.net/problem/CodeForces-1352C)

Approach :

1 2 ‘3’ 4 5 ‘6’ 7 8 ‘9’ 10 11 12

n=3

k=7

🡪 10 = k + x

So, we have to find, x = ?

We can see the pattern/logic , like this => ( such as, ( 7 + 3 )/3 = 3.3333… ~ 3 )

x = (k + x) / n

=> nx = k + x;

=> x = k / (n - 1)

For,

1st test case : n=3, k=7

( 7+3 ) % 3 != 0

ans = 7 + 7 / (3-1)

2nd test case : n=4, k=12

( 12+4 ) % 4 == 0

ans = 12 + 12 / (4-1) – 1

#include<bits/stdc++.h>

using namespace std;

typedef long long ll;

int main(){

    ll t;cin>>t;

    while (t--)

    {

        ll n, k;cin>>n>>k;

        ll x = k/(n-1);

        if((k+x)%n == 0){

            cout<<k+x-1<<endl;

        }else{

            cout<<k+x<<endl;

        }

    }

    return 0;

}

**Time Complexity**

* For each test case:
  + Division, modulo, addition, and conditional check: all are **O(1)** operations.

Let:

* t = number of test cases

Then:

* **Total Time Complexity:** O(t)

**Space Complexity**

* No extra data structures used.
* Just a few variables per test case.

So:

* **Total Space Complexity:** O(1)

**E- 10474 Where is the Marble? –** [**https://vjudge.net/problem/UVA-10474**](https://vjudge.net/problem/UVA-10474)

[**https://onlinejudge.org/external/104/10474.pdf**](https://onlinejudge.org/external/104/10474.pdf)

#include <bits/stdc++.h>

using namespace std;

int main() {

    int N, Q;

    int caseNum = 1;

    while (cin >> N >> Q, N || Q) {

        vector<int> marbles(N);

        for (int i = 0; i < N; ++i) {

            cin >> marbles[i];

        }

        // Sort the marbles

        sort(marbles.begin(), marbles.end());

        cout << "CASE# " << caseNum++ << ":\n";

        while (Q--) {

            int query;

            cin >> query;

            // lower\_bound returns an iterator to the first element >= query

            auto it = lower\_bound(marbles.begin(), marbles.end(), query);

            if (it != marbles.end() && \*it == query) {

                // +1 for 1-based index

                cout << query << " found at " << (it - marbles.begin() + 1) << '\n';

            } else {

                cout << query << " not found\n";

            }

        }

    }

    return 0;

}

**⏱ Time Complexity**

* For each test case:
  + Sorting marbles: O(N log N)
  + Query processing: Q × O(log N) due to binary search

Overall:

* Efficient even for maximum constraints (N, Q ≤ 10,000).

**F. Points in Segments -** [**https://vjudge.net/problem/LightOJ-1088**](https://vjudge.net/problem/LightOJ-1088)

**✅ Approaches / Explanation:**

* **Test case 1**:
  + Points: [1, 4, 6, 8, 10] (Already **sorted**)
  + Segments (queries):
    1. [0, 5]
    2. [6, 10]
    3. [7, 100000]

**🔍 Segment 1: [0, 5]**

We want all points p such that 0 ≤ p ≤ 5.

From the points [1, 4, 6, 8, 10], the points 1 and 4 fall in this range → **Answer: 2**

**🔹 Binary Search Method:**

* Use lower\_bound(0) → first point ≥ 0 → index 0
* Use upper\_bound(5) → first point > 5 → index 2
* Count = upper\_bound - lower\_bound = 2 - 0 = 2

**🔍 Segment 2: [6, 10]**

We want points p such that 6 ≤ p ≤ 10.

From the list: 6, 8, 10 fall in range → **Answer: 3**

**🔹 Binary Search:**

* lower\_bound(6) = index 2
* upper\_bound(10) = index 5
* Count = 5 - 2 = 3

**🔍 Segment 3: [7, 100000]**

We want points p such that 7 ≤ p ≤ 100000.

From the list: 8, 10 fall in this range → **Answer: 2**

**🔹 Binary Search:**

* lower\_bound(7) = index 3
* upper\_bound(100000) = index 5
* Count = 5 - 3 = 2

Code :

#include <bits/stdc++.h>

using namespace std;

int main() {

    ios::sync\_with\_stdio(false); // Fast I/O

    cin.tie(nullptr);            // Disable C-style sync

    int T;

    cin >> T;

    for (int cs = 1; cs <= T; ++cs) {

        int n, q;

        cin >> n >> q;

        vector<int> points(n);

        for (int i = 0; i < n; ++i) {

            cin >> points[i];

        }

        cout << "Case " << cs << ":\n";

        while (q--) {

            int A, B;

            cin >> A >> B;

            // Use binary search (lower\_bound and upper\_bound)

            int left = lower\_bound(points.begin(), points.end(), A) - points.begin();

            int right = upper\_bound(points.begin(), points.end(), B) - points.begin();

            cout << (right - left) << '\n';

        }

    }

    return 0;

}

**📈 Time Complexity:**

* Each query runs in **O(log n)** due to binary search
* Total: O((n + q) \* log n) → efficient for constraints (n ≤ 1e5, q ≤ 5e4)

**G. Minion Chef and Bananas -** [**https://vjudge.net/problem/CodeChef-MINEAT**](https://vjudge.net/problem/CodeChef-MINEAT)

#include <iostream>

#include <vector>

#include <algorithm>

using namespace std;

typedef long long ll;

bool canEatAll(const vector<ll>& A, ll H, ll K) {

    ll totalHours = 0;

    for (ll bananas : A) {

        totalHours += (bananas + K - 1) / K;  // ceil(bananas / K)

    }

    return totalHours <= H;

}

int main() {

    int T;

    cin >> T;

    while (T--) {

        ll N, H;

        cin >> N >> H;

        vector<ll> A(N);

        ll maxBananas = 0;

        for (ll i = 0; i < N; i++) {

            cin >> A[i];

            maxBananas = max(maxBananas, A[i]);

        }

        // Binary search for the minimum possible K

        ll low = 1, high = maxBananas, result = maxBananas;

        while (low <= high) {

            ll mid = low + (high - low) / 2;

            if (canEatAll(A, H, mid)) {

                result = mid;  // try to find smaller K

                high = mid - 1;

            } else {

                low = mid + 1;

            }

        }

        cout << result << endl;

    }

    return 0;

}

**⏱ Time Complexity:**

* Binary search: O(log(max(A)))
* For each check: O(N)
* Total: O(T \* N \* log(max(A))) → Efficient even for large inputs.

**H. Shake Shake Shaky -** [**https://vjudge.net/problem/SPOJ-MAIN8\_C**](https://vjudge.net/problem/SPOJ-MAIN8_C)

**Approach to Solve**

This is a **search problem** — more specifically, a **Binary Search on the answer**.

**Why Binary Search?**

* We are looking for the **maximum number of candies per student** (x) that can be given.
* If we can give x candies to each student, then we can definitely give **less than x** candies too.
* If we **cannot** give x candies, then we cannot give **more than x** candies either.
* This monotonic property allows binary search.

**Steps:**

1. **Find search space**:
   * Minimum = 1 (at least 1 candy per student)
   * Maximum = max(candies in any box) (cannot give more than biggest box’s candies).
2. **Binary Search**:
   * For a mid value mid, check if we can serve **K students** such that each gets mid candies.
   * To check:
     + For each box with candies[i], students served = candies[i] / mid.
     + Sum up over all boxes.
     + If total served ≥ K → Possible, move to higher side (low = mid + 1).
     + Else, move to lower side (high = mid - 1).
3. **Store the last successful mid** as the answer.

**Code :**

#include <bits/stdc++.h>

using namespace std;

bool canDistribute(vector<long long> &candies, long long K, long long mid) {

    long long count = 0;

    for (long long c : candies) {

        count += c / mid; // students from this box

        if (count >= K) return true; // early exit

    }

    return count >= K;

}

int main() {

    ios::sync\_with\_stdio(false);

    cin.tie(nullptr);

    int T;

    cin >> T;

    while (T--) {

        int N;

        long long K;

        cin >> N >> K;

        vector<long long> candies(N);

        long long maxCandy = 0;

        for (int i = 0; i < N; i++) {

            cin >> candies[i];

            maxCandy = max(maxCandy, candies[i]);

        }

        long long low = 1, high = maxCandy, ans = 0;

        while (low <= high) {

            long long mid = (low + high) / 2;

            if (canDistribute(candies, K, mid)) {

                ans = mid;      // possible, try bigger

                low = mid + 1;

            } else {

                high = mid - 1; // not possible, try smaller

            }

        }

        cout << ans << "\n";

    }

    return 0;

}

I. Phone Numbers- <https://vjudge.net/problem/CodeForces-940C>

<https://codeforces.com/problemset/problem/940/C>

**Problem Restatement**

We are given:

* A string s of length n
* An integer k (length of required string t)
* We must find the **smallest lexicographical string t of length k**:
  + The **set of characters** in t must be a **subset** of characters in s.
  + t must be **lexicographically greater** than s.

**Key Points**

1. We only care about the **set of letters** in s (duplicates don't matter).
2. We want **the smallest lexicographical string** that is **just greater** than s.
3. Two cases:
   * If k > n:  
     → We can extend s by adding the **smallest character** from its set until length k.
   * If k <= n:  
     → We find the **rightmost position** where we can replace a character with the next bigger available character from our set, then fill the rest with the smallest available character.

**Step-by-Step Approach**

**Step 1:**

Find the **sorted set** of characters in s.  
Example:  
s = "ayy" → unique letters = {a, y} → sorted = "ay"

**Step 2:**

Two scenarios:

**Case 1: k > n**

We can simply append smallest char to s until length k:

* Example: s = "ba", k = 3  
  smallest char = 'a' → "ba" + 'a' → "baa"

**Case 2: k <= n**

We:

1. Start from position k-1 (rightmost position in t).
2. Try to replace it with the next larger available letter from our sorted set.
3. If possible → replace, and fill all positions after it with the smallest letter.
4. If not possible → move one position left and repeat.

**Example Walkthrough**

Example:

ini

CopyEdit

n = 3, k = 3

s = "abc"

* unique sorted letters = "abc"
* k = n, so we try to modify:
  + From right:  
    position 2 (c) → no bigger letter available. Move left.
  + position 1 (b) → next letter after b is c.  
    Replace → "ac", then fill remaining with smallest (a) → "aca"

✅ Answer: "aca"

**Code :**

#include <bits/stdc++.h>

using namespace std;

int main() {

    ios::sync\_with\_stdio(false);

    cin.tie(nullptr);

    int n, k;

    cin >> n >> k;

    string s;

    cin >> s;

    // Step 1: get sorted unique letters

    set<char> st(s.begin(), s.end());

    vector<char> letters(st.begin(), st.end());

    if (k > n) {

        // Case 1: just append smallest char until length k

        cout << s;

        for (int i = n; i < k; i++) cout << letters[0];

        cout << "\n";

        return 0;

    }

    // Case 2: modify s

    string t = s.substr(0, k); // start with first k chars of s

    // Go from right to left to find position to change

    for (int i = k - 1; i >= 0; i--) {

        // find next larger letter than t[i] in letters[]

        auto it = upper\_bound(letters.begin(), letters.end(), t[i]);

        if (it != letters.end()) {

            t[i] = \*it; // replace with next bigger char

            // fill rest with smallest char

            for (int j = i + 1; j < k; j++) t[j] = letters[0];

            cout << t << "\n";

            return 0;

        }

    }

}

**Complexity**

* **Time**:
  + O(n log n) for set creation and sorting
  + O(k log m) for binary search per position (m = number of unique letters ≤ 26)
* **Space**: O(n) for storing letters

J. Recursive Queries - <https://vjudge.net/problem/CodeForces-932B>

<https://codeforces.com/problemset/problem/932/B>



**🧩 Problem Understanding**

You're given two functions:

* **f(n)**: product of digits of n
* **g(n)**: recursively applies f until the result is a single-digit number

**✨ Function Definition**

f(n): product of digits of n, ignoring zeros

g(n):

if n < 10 → return n

else → return g(f(n))

**🔍 Task**

You’re given **Q queries**. Each query contains three integers: l, r, and k. You must count how many integers x in the range [l, r] satisfy g(x) = k.

**📌 Example Test Case**

**Input:**

4

22 73 9

45 64 6

47 55 7

2 62 4

**Output:**

1

4

0

8

**Explanation:**

Let’s walk through the first query: 22 73 9

We need to count how many numbers x in [22, 73] satisfy g(x) = 9.

* Try x = 33:
  + Digits: 3 and 3 → product = 9
  + g(33) = g(9) = 9 ✅
* Try x = 39:
  + Digits: 3 and 9 → product = 27 → g(27) = g(2×7) = g(14) = g(1×4) = g(4) = 4 ❌

Only x = 33 satisfies g(x) = 9 in that range → **Answer: 1**

**🧠 Solution Approach**

**🔍 Key Observations:**

* g(x) always reduces to a digit between 1 and 9.
* We can precompute g(x) for all x from 1 to 10⁶.
* For each digit k from 1 to 9, we build a prefix sum array cnt[k][x] that stores how many numbers ≤ x have g(x) = k.

**⚙️ Steps:**

1. **Precompute** g(x) for all x in [1, 10⁶].
2. **Build prefix sums**: For each digit k, store cumulative counts of g(x) = k.
3. **Answer each query in O(1)** using:

cnt[k][r]−cnt[k][l−1]

**Code:**

#include <bits/stdc++.h>

using namespace std;

const int MAX = 1e6 + 5;

int cnt[10][MAX]; // cnt[k][i] = count of g(x) == k for x in [1..i]

// Correct g(x) function: skips zeros in digit product

int g(int x) {

while (x >= 10) {

int prod = 1;

while (x > 0) {

int d = x % 10;

if (d != 0) prod \*= d;

x /= 10;

}

x = prod;

}

return x;

}

// Precompute g(x) and build prefix sums

void preprocess() {

for (int i = 1; i < MAX; ++i) {

int val = g(i);

for (int k = 1; k <= 9; ++k) {

cnt[k][i] = cnt[k][i - 1] + (val == k);

}

}

}

// Answer each query in O(1)

int query(int l, int r, int k) {

return cnt[k][r] - cnt[k][l - 1];

}

int main() {

ios::sync\_with\_stdio(false);

cin.tie(nullptr);

preprocess();

int Q;

cin >> Q;

while (Q--) {

int l, r, k;

cin >> l >> r >> k;

cout << query(l, r, k) << '\n';

}

return 0;

}

**🧮 Time and Space Complexity**

| **Operation** | **Complexity** |
| --- | --- |
| Preprocessing | O(N × D) where D is number of digits in x (≈ log₁₀N) |
| Query Processing | O(1) per query |
| Space | O(9 × N) for prefix sums |

K. Print The Pattern - <https://vjudge.net/problem/SPOJ-ABACABA>

**🧩 Problem Understanding**

You're given a number N (1 ≤ N ≤ 15). You need to print a specific pattern based on this number.

**🔁 Pattern Rule:**

The pattern follows a recursive structure:

* P(1) = A
* P(2) = P(1) + B + P(1) = ABA
* P(3) = P(2) + C + P(2) = ABACABA
* P(4) = P(3) + D + P(3) = ABACABADABACABA
* ...
* P(N) = P(N-1) + char(N) + P(N-1)

Where char(N) is the N-th uppercase letter: 'A' + N - 1

**🧠 Solution Approach**

This is a classic recursive pattern generation problem.

**Strategy:**

* Use a recursive function build(N) that returns the pattern for level N.
* Base case: N == 1 → return "A"
* Recursive case: build(N) = build(N-1) + char(N) + build(N-1)

**Code:**

#include <iostream>

using namespace std;

string build(int n) {

    if (n == 1) return "A";

    string prev = build(n - 1);

    char mid = 'A' + n - 1;

    return prev + mid + prev;

}

int main() {

    int N;

    cin >> N;

    cout << build(N);

    return 0;

}

**🧮 Time and Space Complexity**

| **Aspect** | **Complexity** |
| --- | --- |
| Time | O(2ⁿ) — exponential growth of pattern |
| Space | O(2ⁿ) — due to string concatenation |

For N = 15, the output length is 2¹⁵ - 1 = 32767 characters, which is acceptable within the constraints.

**L. Tower of Hanoi Movement – Easy -** [**https://vjudge.net/problem/SPOJ-TOHMOVE1**](https://vjudge.net/problem/SPOJ-TOHMOVE1)

**1. Problem Understanding**

We’re given the **Tower of Hanoi** puzzle, but we **don’t** need to print the full sequence of moves.  
Instead:

* We have **N disks**.
* We want to know **what happens in the a-th move** of the **optimal** solution sequence.

Rules:

1. Only one disk moves at a time.
2. A larger disk can’t go on top of a smaller disk.
3. Moves follow the optimal Tower of Hanoi strategy.

**Example from the problem**

**Case:** N = 3, a = 5

Full move sequence for N=3:

javascript

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1 : A => C

2 : A => B

1 : C => B

3 : A => C

1 : B => A ← 5th move

2 : B => C

1 : A => C

Output for this case:

javascript

CopyEdit

1 : B => A

Meaning: On the 5th move, disk 1 moves from rod B to rod A.

**2. Approach**

We use the recursive nature of Tower of Hanoi to **directly jump to the a-th move** instead of simulating all moves.

**Tower of Hanoi recursive structure**

For N disks (from from to to using aux):

1. Move N-1 disks from from → aux (using to) → **(First phase)**
2. Move disk N from from → to → **(Middle move)**
3. Move N-1 disks from aux → to (using from) → **(Last phase)**

Number of moves in first phase = 2^(N-1) - 1 (let’s call this half).

**Algorithm logic**

1. **Base case**: If n == 1 → only move disk 1 from from to to.
2. **Check where a lies**:
   * If a <= half → it's in **first phase** → recursively search in n-1 disks moving from from → aux.
   * If a == half + 1 → it's the **middle move** → print n : from => to.
   * If a > half + 1 → it's in **last phase** → recursively search in n-1 disks moving from aux → to.

**Code :**

#include <bits/stdc++.h>

using namespace std;

void findMove(int n, long long a, char from, char aux, char to) {

    if (n == 1) {

        cout << "1 : " << from << " => " << to << "\n";

        return;

    }

    long long half = (1LL << (n - 1)) - 1; // moves in first part

    if (a <= half) {

        // Move lies in first phase

        findMove(n - 1, a, from, to, aux);

    }

    else if (a == half + 1) {

        // This is the move of largest disk

        cout << n << " : " << from << " => " << to << "\n";

    }

    else {

        // Move lies in second phase

        findMove(n - 1, a - (half + 1), aux, from, to);

    }

}

int main() {

    ios::sync\_with\_stdio(false);

    cin.tie(nullptr);

    int T;

    cin >> T;

    while (T--) {

        int N;

        long long a;

        cin >> N >> a;

        findMove(N, a, 'A', 'B', 'C');

    }

    return 0;

}

**3. Complexity Analysis**

* **Time Complexity**:
  + Each recursive step reduces n by 1 → O(N) in worst case.
  + Much faster than O(2^N) simulation.
* **Space Complexity**:
  + Recursion depth = N → O(N) stack space.

**M. Worms -** [**https://vjudge.net/problem/CodeForces-474B**](https://vjudge.net/problem/CodeForces-474B)

[**https://codeforces.com/problemset/problem/474/B**](https://codeforces.com/problemset/problem/474/B)

**1. Problem Understanding**

We have **n piles of worms**, numbered in **order** from 1st pile to nth pile.

* **ai** = number of worms in pile i.
* Worms are labeled with **consecutive integers** starting from 1.
  + Pile 1: labels 1 to a1
  + Pile 2: labels a1+1 to a1+a2
  + Pile 3: labels (a1+a2)+1 to (a1+a2+a3)
  + … and so on.

We get **m queries**, each qi = label of a worm, and we must answer:

Which pile contains worm number qi?

**Example**

Given:

ini

CopyEdit

n = 5

a = [2, 7, 3, 4, 9]

Label mapping:

* Pile 1: 1 2
* Pile 2: 3 4 5 6 7 8 9
* Pile 3: 10 11 12
* Pile 4: 13 14 15 16
* Pile 5: 17 ... 25

Queries:

ini

CopyEdit

q = [1, 25, 11]

Answers:

csharp

CopyEdit

1 (worm 1 is in pile 1)

5 (worm 25 is in pile 5)

3 (worm 11 is in pile 3)

**2. How to Think About the Problem**

The naive way:

* For each query, loop through piles until you find where the worm label falls.
* **Bad idea** — worst case O(n\*m) → can be up to 10^10 operations for large inputs.

Instead:

* If we knew **the end label** for each pile, we could **binary search** for the worm’s label.

**Prefix Sums (Key Observation)**

We can precompute:

prefix[i] = total number of worms from pile 1 to pile i

From example:

a = [ 2, 7, 3, 4, 9 ]

prefix = [ 2, 9, 12, 16, 25 ]

Meaning:

* Pile 1 ends at label 2
* Pile 2 ends at label 9
* Pile 3 ends at label 12
* Pile 4 ends at label 16
* Pile 5 ends at label 25

Now, for a given worm label qi:

* We just need to find the **first prefix value ≥ qi**.
* That pile index is our answer.

This is **exactly binary search**.

**3. Solution Approach**

1. **Read input.**
2. Compute prefix sum array:

prefix[i] = prefix[i-1] + a[i]

1. For each query qi:
   * Binary search for the smallest index idx such that:

prefix[idx] >= qi

* + Output idx+1 (because piles are 1-indexed).

**Binary Search**

We can use:

* C++ lower\_bound(prefix.begin(), prefix.end(), qi) → gives position of first pile whose last worm label ≥ qi.

**Code :**

#include <bits/stdc++.h>

using namespace std;

int main() {

    ios::sync\_with\_stdio(false);

    cin.tie(nullptr);

    int n;

    cin >> n;

    vector<long long> prefix(n);

    // Read piles and compute prefix sums

    for (int i = 0; i < n; i++) {

        long long worms;

        cin >> worms;

        if (i == 0) prefix[i] = worms;

        else prefix[i] = prefix[i - 1] + worms;

    }

    int m;

    cin >> m;

    while (m--) {

        long long q;

        cin >> q;

        // Find first pile whose end label >= q

        int idx = lower\_bound(prefix.begin(), prefix.end(), q) - prefix.begin();

        // Output pile number (1-indexed)

        cout << idx + 1 << "\n";

    }

    return 0;

}

**4. Complexity**

* Prefix sum computation: **O(n)**
* Each query answered in **O(log n)** with binary search.
* Total: **O(n + m log n)** — easily fast for n, m ≤ 10^5.

N. Lexicographic Order - <https://vjudge.net/problem/AtCoder-abc217_a>

<https://atcoder.jp/contests/abc217/tasks/abc217_a>

**Code:**

#include <bits/stdc++.h>

using namespace std;

int main() {

    ios::sync\_with\_stdio(false);

    cin.tie(nullptr);

    string S, T;

    cin >> S >> T;

    if (S < T) {

        cout << "Yes\n";

    } else {

        cout << "No\n";

    }

    return 0;

}

O. Interesting drink - <https://vjudge.net/problem/CodeForces-706B#author=GPT_id>

<https://codeforces.com/problemset/problem/706/B/>

**Think About It**

**Naive approach:**

For each query, loop over all shop prices and count.

* Complexity: **O(n × q)**
* With n, q up to 100,000 → **10¹⁰** operations (too slow).

**Optimized approach:**

We can use **sorting + binary search**:

1. Sort the shop prices.
2. For each m[i], use upper\_bound to find **the index of the first shop price > m[i]**.
3. The number of shops with price ≤ m[i] is **that index**.

**Why binary search?**

* After sorting, all prices ≤ m[i] are before the first price > m[i].
* upper\_bound works in **O(log n)** per query.

**Solution Approach**

1. **Sort** the prices array → O(n log n).
2. For each m[i]:
   * Use upper\_bound(prices.begin(), prices.end(), m[i])
   * upper\_bound returns an iterator pointing to the first element greater than m[i].
   * Subtract prices.begin() to get the count.
3. Output the count.

**Code :**

#include <bits/stdc++.h>

using namespace std;

int main() {

    int n;

    cin >> n;

    vector<int> prices(n);

    for (int i = 0; i < n; i++) {

        cin >> prices[i];

    }

    // Step 1: Sort prices

    sort(prices.begin(), prices.end());

    int q;

    cin >> q;

    while (q--) {

        int m;

        cin >> m;

        // Step 2: Binary search using upper\_bound

        int count = upper\_bound(prices.begin(), prices.end(), m) - prices.begin();

        cout << count << "\n";

    }

    return 0;

}

**Complexity Analysis**

* Sorting: **O(n log n)**
* Each query: **O(log n)**
* Total: **O(n log n + q log n)** → Efficient for n, q ≤ 100,000.

P. Mergesort - <https://vjudge.net/problem/SPOJ-MERGSORT>

<https://www.spoj.com/problems/MERGSORT/>

**Approach**

* **Merge sort** is a **divide-and-conquer** algorithm:
  1. **Divide**: Recursively split the array into halves until each subarray has 1 element.
  2. **Conquer**: Merge sorted subarrays into one sorted array.
* It guarantees **O(N log N)** time complexity, which is fine for N <= 100000.
* Space complexity is **O(N)** for temporary arrays used in merging.

**Code:**

#include <bits/stdc++.h>

using namespace std;

void merge(vector<int> &arr, int left, int mid, int right) {

    int n1 = mid - left + 1;

    int n2 = right - mid;

    vector<int> L(n1), R(n2);

    for (int i = 0; i < n1; i++) L[i] = arr[left + i];

    for (int i = 0; i < n2; i++) R[i] = arr[mid + 1 + i];

    int i = 0, j = 0, k = left;

    while (i < n1 && j < n2) {

        if (L[i] <= R[j]) {

            arr[k++] = L[i++];

        } else {

            arr[k++] = R[j++];

        }

    }

    while (i < n1) arr[k++] = L[i++];

    while (j < n2) arr[k++] = R[j++];

}

void mergeSort(vector<int> &arr, int left, int right) {

    if (left >= right) return;

    int mid = left + (right - left) / 2;

    mergeSort(arr, left, mid);

    mergeSort(arr, mid + 1, right);

    merge(arr, left, mid, right);

}

int main() {

    ios::sync\_with\_stdio(false);

    cin.tie(nullptr);

    vector<int> arr;

    int x;

    while (cin >> x) arr.push\_back(x);

    mergeSort(arr, 0, arr.size() - 1);

    for (int i = 0; i < arr.size(); i++) {

        if (i) cout << " ";

        cout << arr[i];

    }

    cout << "\n";

    return 0;

}

**Complexity**

* **Time**: O(N log N) → Best, average, and worst case.
* **Space**: O(N) → Temporary arrays for merging.

**R. 2D-SORT -** [**https://vjudge.net/problem/SPOJ-SORT2D**](https://vjudge.net/problem/SPOJ-SORT2D)

[**https://www.spoj.com/problems/SORT2D/**](https://www.spoj.com/problems/SORT2D/)

#include <bits/stdc++.h>

using namespace std;

int main()

{

    int t;

    cin >> t;

    while (t--)

    {

        int n;

        cin >> n;

        pair<int, int> p[n];

        for (int i = 0; i < n; i++)

        {

            cin >> p[i].first >> p[i].second;

        }

        sort(p, p + n, [](pair<int, int> a, pair<int, int> b)

        {

            if (a.first != b.first)

            return a.first < b.first;

        return a.second > b.second;

        });

        for (auto it : p)

        {

            cout << it.first << " " << it.second << "\n";

        }

    }

    return 0;

}

**S. Counting Sort 2 -** [**https://vjudge.net/problem/HackerRank-countingsort2**](https://vjudge.net/problem/HackerRank-countingsort2)

[**https://www.hackerrank.com/challenges/countingsort2/problem**](https://www.hackerrank.com/challenges/countingsort2/problem)

**1. Understanding the Problem**

We are given a list of integers.  
We need to **sort** them, but instead of using comparisons (<, >), we use the **counting sort algorithm**.

**Key idea of counting sort**:

1. Find the **maximum value** in the list (maxVal).
2. Create an array count where count[i] stores how many times integer i appears in the original list.
3. Rebuild the sorted list by iterating over count and writing each number the number of times it occurs.

**Why use counting sort here?**

* It’s **O(N + K)**, where:
  + N = number of elements
  + K = range of numbers (maxVal - minVal + 1)
* No comparisons — just counting and output.

**2. Approach**

**Step-by-step:**

1. **Read input** n and array arr[].
2. **Find the largest element** in arr (this determines size of count array).
3. **Initialize count array** with all zeros (size = maxVal + 1).
4. **Fill counts**: For each element x in arr, increment count[x].
5. **Output sorted list**: For each index i in count:
   * Print i exactly count[i] times.

**Code :**

#include <bits/stdc++.h>

using namespace std;

int main() {

    ios::sync\_with\_stdio(false);

    cin.tie(nullptr);

    int n;

    cin >> n; // number of elements

    vector<int> arr(n);

    int maxVal = 0;

    for (int i = 0; i < n; i++) {

        cin >> arr[i];

        if (arr[i] > maxVal) maxVal = arr[i];

    }

    vector<int> count(maxVal + 1, 0);

    // Step 1: Count occurrences

    for (int x : arr) {

        count[x]++;

    }

    // Step 2: Output sorted array

    bool first = true;

    for (int i = 0; i <= maxVal; i++) {

        while (count[i] > 0) {

            if (!first) cout << " ";

            cout << i;

            first = false;

            count[i]--;

        }

    }

    cout << "\n";

    return 0;

}

**5. Complexity Analysis**

* **Time Complexity**:
  + Counting step: O(N)
  + Output step: O(N + K)  
    → Overall: **O(N + K)**
* **Space Complexity**: O(K) for the count array.

**T. Sorting: Bubble Sort -** [**https://vjudge.net/problem/HackerRank-ctci-bubble-sort**](https://vjudge.net/problem/HackerRank-ctci-bubble-sort)

[**https://www.hackerrank.com/challenges/ctci-bubble-sort/problem**](https://www.hackerrank.com/challenges/ctci-bubble-sort/problem)

**1. Problem Restatement**

We are given:

* An integer array a of size n
* We must **sort** it **in ascending order** using the *exact bubble sort algorithm* from the problem statement.

When done, we need to **print**:

1. Array is sorted in X swaps. → X is the **total number of swaps** performed.
2. First Element: Y → Y is the **first element** after sorting.
3. Last Element: Z → Z is the **last element** after sorting.

**Example:**

Input:

3

3 2 1

Output:

Array is sorted in 3 swaps.

First Element: 1

Last Element: 3

**2. How to Think About the Problem**

**Bubble Sort Recap**

Bubble sort compares **adjacent pairs** and swaps them if they are out of order.  
The given code:

for (int i = 0; i < n; i++) {

for (int j = 0; j < n - 1; j++) {

if (a[j] > a[j + 1]) {

swap(a[j], a[j + 1]);

}

}

}

This ensures the **largest** elements "bubble up" to the end with each outer loop pass.

**What’s Required**

* Keep **count** of swaps made during sorting.
* Print **first** and **last** elements after sorting.

**3. Solution Approach**

1. Read input n and array a.
2. Implement bubble sort **exactly as given** but:
   * Add a counter variable swapCount to track swaps.
3. After sorting:
   * Print swapCount
   * Print a[0] and a[n-1]

**4. C++ Implementation**

#include <bits/stdc++.h>

using namespace std;

void countSwaps(vector<int> &a) {

int n = a.size();

int swapCount = 0;

for (int i = 0; i < n; i++) {

for (int j = 0; j < n - 1; j++) {

if (a[j] > a[j + 1]) {

swap(a[j], a[j + 1]);

swapCount++;

}

}

}

cout << "Array is sorted in " << swapCount << " swaps." << endl;

cout << "First Element: " << a[0] << endl;

cout << "Last Element: " << a[n - 1] << endl;

}

int main() {

int n;

cin >> n;

vector<int> a(n);

for (int i = 0; i < n; i++) cin >> a[i];

countSwaps(a);

return 0;

}

**5. Complexity Analysis**

**Time Complexity:**

* The given bubble sort runs **n × (n-1)** comparisons regardless of sorting progress.
* So **O(n²)** in all cases.

**Space Complexity:**

* Only uses a few variables, so **O(1)** extra space.

**U. Lexicographical ordering -** [**https://vjudge.net/problem/SPOJ-MAIN71**](https://vjudge.net/problem/SPOJ-MAIN71)

[**https://www.spoj.com/problems/MAIN71/**](https://www.spoj.com/problems/MAIN71/)

**1. Problem Understanding**

Normally, strings are compared lexicographically using the **usual English alphabet order**:

a < b < c < ... < z

In this problem, you are **given your own custom ordering of the alphabet** — any permutation of the 26 lowercase letters.

You then get **two strings** A and B (of equal length) and you must compare them **using this custom order**.

You print:

* ">" if A > B
* "<" if A < B
* "=" if A == B (exact match in this custom order)

**Example**

Ordering: abcdefghijklmnopqrstuvwxyz

A: nsit

B: nits

Step-by-step:

* Compare first letters: n vs n → equal (same position in ordering)
* Compare second letters: s vs i → in normal order, s > i → so A > B

Output:

>

**2. How to Think About It**

The key difficulty is **you can’t use the normal < and > operators for strings** because the order of letters is not standard.  
We must:

1. **Build a mapping** from each character → its position in the custom alphabet.
2. Compare A and B **character-by-character**, using this mapping.
3. As soon as you find a difference:
   * If A[i] comes before B[i] in custom order → print "<".
   * If A[i] comes after → print ">".
4. If all characters are equal → print "=".

**3. Solution Approach**

**Step 1:** Read number of test cases T.  
**Step 2:** For each test case:

* Read the 26-char ordering.
* Build an integer array pos[26] such that pos['a' - 'a'] = position of 'a' in ordering.
* Read strings A and B.
* Compare them character-by-character using pos.
* Output the result.

**4. Complexity Analysis**

* Building mapping: **O(26)** per test case → negligible.
* Comparing strings: **O(L)** where L is the string length.
* For T test cases: **O(T × L)** total.
* Space complexity: **O(26)** extra for the mapping.

**5. C++ Implementation**

#include <bits/stdc++.h>

using namespace std;

int main() {

ios::sync\_with\_stdio(false);

cin.tie(NULL);

int T;

cin >> T;

while (T--) {

string order;

cin >> order;

vector<int> pos(26); // position of each letter in custom order

for (int i = 0; i < 26; i++) {

pos[order[i] - 'a'] = i;

}

string A, B;

cin >> A >> B;

char result = '='; // assume equal unless proven otherwise

for (int i = 0; i < (int)A.size(); i++) {

if (pos[A[i] - 'a'] < pos[B[i] - 'a']) {

result = '<';

break;

} else if (pos[A[i] - 'a'] > pos[B[i] - 'a']) {

result = '>';

break;

}

}

cout << result << "\n";

}

return 0;

}

**6. Dry Run on Given Example**

Input:

1

abcdefghijklmnopqrstuvwxyz

nsit

nits

Mapping: pos['a']=0, pos['b']=1, ... pos['n']=13, pos['s']=18, pos['i']=8, ...

Compare:

* 'n' vs 'n' → equal
* 's'(18) vs 'i'(8) → 18 > 8 → A > B  
  Output: