Índice

1. Setup

1.1. Template

```
#include <bits/stdc++.h>
using namespace std;
using i64 = int64_t;
#define endl         '\n'
#define forn(i,N)    for (int i = 0; i < int(N); i++)
#define dbg(x)       cerr << #x << " = " << (x) << endl
#define raya         cerr << "================" << endl
#define all(v)       begin(v), end(v)
#define pb           push_back
#define mp           make_pair
#define fst          first
#define snd          second
#define forall(it,v) for (auto it = begin(v); it != end(v); it++)
#define printall(v)  forall(x,v) { cout << *x << " "; } cout << endl
#define printpair(p) cout << "(" << p.fst << ", " << p.snd << ")" << endl

int main (void) {
    ios::sync_with_stdio(0); cin.tie(0);



    return 0;
}
```

1.2. Makefile

```
CPPFLAGS = -std=c++17 -O0 -Wall -g
CC = g++
```

1.3. Compilar

Compilar $1 y mostrar primeras $2 lineas de error

```
rm -f $1
clear
make $1 2>&1 | head -$2
```

1.4. Correr

Correr $1 con el input $2

```
rm -f $1
clear
make $1 && ./$1 < $2
```

2. STL

2.1. Búsqueda binaria en vector ordenado

```
template <class T> int primer_igual (vector<T>& arr, T x) {
    auto it = lower_bound(all(arr), x);
    if (it == arr.end() || *it != x) return -1;
    return it - arr.begin();
}

template <class T> int ultimo_igual (vector<T>& arr, T x) {
    if (arr.begin() == arr.end()) return -1;
    auto it = prev(upper_bound(all(arr), x));
    if (*it != x) return -1;
    return it - arr.begin();
}

template <class T> int ultimo_menor (vector<T>& arr, T x) {
    if (arr.begin() == arr.end()) return -1;
    auto it = prev(lower_bound(all(arr), x));
    if (*it >=) return -1;
    return it - arr.begin();
}

template <class T> int primer_mayor (vector<T>& arr, T x) {
    auto it = upper_bound(all(arr), x);
    if (it == arr.end()) return -1;
    return it - arr.begin();
}
```

2.2. Priority queue custom compare

```
priority_queue<pair<T, int>, vector<pair<T, int>>, greater<pair<T, int>>> pq;
template <typename T> using MinHeap = // ...
```

2.3. Intervalos consecutivos

```
struct IntervalosConsecutivos {
    set<int> I;
    map<int, int> L;
    IntervalosConsecutivos (int i, int j) {
        I.insert(i);
        I.insert(j);
        L[j - i]++;
    }
    void cortar (int k) {
        int i = *prev(I.lower_bound(k));
```

```
        int j = *(I.lower_bound(k));
        L[j - i]--;
        if (L[j - i] == 0) L.erase(j - i);
        L[k - i]++;
        L[j - k]++;
        I.insert(k);
    }
    i64 max_intervalo () {
        return (*L.rbegin()).fst;
    }
};
```

2.4. Indexed set y multiset

```
#include <ext/pb_ds/assoc_container.hpp>
#include <ext/pb_ds/tree_policy.hpp>
using namespace  __gnu_pbds;

template<class T> struct IndexedSet {
    tree<
        T, null_type, less<T>,
        rb_tree_tag, tree_order_statistics_node_update
    > s;
    void add  (T   x) { ms.insert(x); }
    int  idx  (T   x) { return  ms.order_of_key(x); }
    bool has  (T   x) { return  ms.find(x) != ms.end(); }
    T    ith  (int i) { return *ms.find_by_order(i); }
};

template<class T> struct IndexedMultiset {
    int t = 0; tree<
        pair<T, int>, null_type, less<pair<T, int>>,
        rb_tree_tag, tree_order_statistics_node_update
    > ms;
    void add  (T   x) { ms.insert(mp(x, t++)); }
    int  nle  (T   x) { return ms.order_of_key(mp(x, -1)); }
    int  nleq (T   x) { return ms.order_of_key(mp(x, INT_MAX)); }
    int  cnt  (T   x) { return nleq(x) - nle(x); }
    T    ith  (int i) { return (*ms.find_by_order(i)).fst; }
};
```

3. Range queries

3.1. Prefix + diff arrays

3.1.1. 1D

Usar array indexado desde 1 con `A[0] = 0`.
Usar intervalos cerrado-cerrado (indexados desde 1).

```
vector<int> make_diff_array (vector<int>& A) {
    vector<int> D(A.size() - 1);
    forn(i, A.size() - 1) D[i] = A[i+1] - A[i];
    return D;
}

void diff_array_range_update (vector<int>& D, int i, int j, int v) {
    D[i-1] += v;
    D[j]   -= v;
}

vector<int> make_prefix_array (vector<int>& A) {
    vector<int> P(A.size() + 1);
    P[0] = 0;
    forn(i, A.size()) P[i+1] = P[i] + A[i];
    return P;
}

int prefix_array_range_query (vector<int>& P, int i, int j) {
    return P[j+1] - P[i];
}
```

3.1.2. 2D

3.2. Fenwick tree

3.2.1. Range query point update

3.2.2. Range update point query

3.2.3. Range update range query

3.3. Operaciones sin inverso

3.3.1. Sparse table

Operacion asociativa **idempotente**

```
// Operacion IDEMPOTENTE

#define log2fl(x) (x ? 63 - __builtin_clzll(x) : -1)
```

```
struct STable {
    vector<int>& arr; int N;
    vector<vector<int>> st;
    int op (int a, int b) { return min(a,b); }
    void make () {
        st.resize(20, vector<int>(N));
        st[0] = arr; scn(w,1,19) scn(i,0,N - (1 << w))
            st[w][i] = op(st[w-1][i], st[w-1][i + (1 << (w-1))]);
    }
    int q (int i, int j) {
        int w = log2fl(j - i + 1);
        return op(st[w][i], st[w][j - (1 << w) + 1]);
    }
};
```

3.3.2. Segment tree: range query point set

Recordatorio: modificar elemento neutro

```
template<class T> struct SegTree {
    vector<T>& arr; int N; T id;
    T op (T a, T b) { return 0; } // !
    vector<T> t;
    void make () {
        t.resize(N << 1); rep(i,N) t[i+N] = arr[i];
        for (int i = N - 1; i; i--) t[i] = op(t[i<<1], t[i<<1|1]);
    }
    void set (int i, T v) {
        for(t[i += N] = v; i > 1; i >>= 1) t[i>>1] = op(t[i], t[i^1]);
    }
    T q (int l, int r) {
        T res = id;
        for (l += N, r += N; l < r; l >>= 1, r >>= 1) {
            if (l&1) res = op(res, t[l++]);
            if (r&1) res = op(res, t[--r]);
        } return res;
    }
};
```

4. Grafos

4.1. Preprocesamiento

4.1.1. Clasificación de aristas

4.1.2. Puentes y puntos de articulación

4.1.3. DAG condensado

4.1.4. Kruskal

4.2. Menor camino

4.2.1. BFS

4.2.2. Dijkstra

4.2.3. Floyd-Warshall

4.3. Flujo y corte

4.3.1. Dinics

4.3.2. Maximum matching

4.4. Árboles

4.4.1. Aplanamiento

4.4.2. Ancestro común menor

5. Strings

5.1. Trie: policy based

5.2. Trie genérico

5.3. Rabin-Karp

5.4. Suffix Automata

6. Matemática

6.1. Aritmética

6.1.1. Techo de la división, piso de la raiz cuadrada, piso del log2

```
#define ceildiv(a,b) ((a+b-1)/b)

i64 isqrt (i64 x) {
    i64 s = 0; for (i64 k = 1 << 30; k; k >>= 1)
        if ((s+k)*(s+k) <= x) s += k;
```

```
    return s;
}

#define log2fl(x) (x ? 63 - __builtin_clzll(x) : -1)
```

6.1.2. Aritmética en Zp

```
const i64 mod = 1e9 + 7;

i64 resta_mod (i64 a, i64 b) { return (a - b + mod) % mod; }

i64 pow_mod (i64 x, i64 n) {
    i64 res = 0;
    while (n) {
        if (n % 2) res = res * x % mod;
        n /= 2;
        x = x * x % mod;
    } return res;
}

i64 div_mod (i64 a, i64 b) { return a * pow_mod(b, mod - 2) % mod; }
```

6.1.3. Números combinatorios

6.2. Teoría de números

6.2.1. Test de primalidad

```
struct primetest {
    bool c[1000001]; vector<int> p;
    primetest () {
        p.reserve(1<<16); scn(i,2,1000000) if (!c[i]) {
            p.pb(i); for (int j = 2; i*j < 1000001; j++) c[i*j] = 1;
        }
    }
    bool isprime (int x) {
        for (int i = 0, d = p[i]; d*d <= x; d = p[++i])
            if (!(x % d)) return false;
        return x >= 2;
    }
};
```

6.3. Geometría

6.3.1. Template base

```
using flt = long double;
const flt EPS = 1e-9;
bool  flt_leq (flt a, flt b) { return a < b + EPS; }
bool  flt_eq  (flt a, flt b) { return -EPS <= a - b && a - b <= EPS; }

struct Vec {
    int x, y;
    Vec operator+(Vec p) { return {x + p.x, y + p.y}; }
    Vec operator-(Vec p) { return {x - p.x, y - p.y}; }
    int operator*(Vec p) { return x * p.x + y * p.y; }
    int operator^(Vec p) { return x * p.y + y * p.x; }
};

int norma2 (Vec p) { return p.x * p.x + p.y * p.y; }

// TODO: area triangulo, formula de heron
```