

Team Notebook

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1 Boilerplate

```
#include<bits/stdc++.h>
using namespace std;
#define pi acos(-1)
#define MOD 1000000007
#define inf 10000000010
#define endl "\n"
#define ull unsigned long long
#define con (f?"YES":"NO")
#define yes cout<<"YES"<<endl
#define no cout<<"NO"<<endl

#define dpos(n) fixed << setprecision(n)

#define clear1(a) memset(a, -1, sizeof(a))
#define clear0(a) memset(a, 0, sizeof(a))

#define sortn(a,x,n) sort(a+x, a+x+n)
#define sortv(s) sort(s.begin(), s.end())
#define reversev(s) reverse(s.begin(), s.end())
#define rsortv(s) sort(s.rbegin(),s.rend())
#define unik(a) unique(a.begin(), a.end()) - a.begin()
#define iotav(s, x) iota(s.begin(), s.end(), x)

#define lowerbound(v,x) lower_bound(v.begin(), v.end(), x)-v.begin()
#define upperbound(v,x) upper_bound(v.begin(), v.end(), x)-v.begin()

#define pb push_back
#define loj(i,j) "Case "<<i<<": "<<j
#define gap " "

#define auto(x,a) for (auto& x : a)
#define print(x) cout << #x << " = " << x << endl

long long dx[] = {1, -1, 0, 0, 1, 1, -1, -1};
long long dy[] = {0, 0, 1, -1, 1, -1, 1, -1};

int main() {
    ios_base::sync_with_stdio(false); cin.tie(0),cout.tie(0);

    #ifndef ONLINE_JUDGE
        freopen("input.txt", "r", stdin);
        freopen("output.txt", "w", stdout);
    #endif

    long long t;
    cin >> t;
```

```
while (t--) {
    long long n;
    cin>>n;

    long long a[n+2];
    for(long long i=1;i<=n;i++) cin>>a[i];

    for(long long i=1;i<=n;i++) cout<<a[i]<<" ";
}
}
```

2 DP

2.1 Knapsack

```
long long knapSack(long long w, long long i, long long *
marks, long long *cap, vector<vector<long long>> &dp)
{
    if (i < 0)
        return 0;
    if (dp[i][w] != -1)
        return dp[i][w];

    if (cap[i] > w) dp[i][w] = knapSack(w, i - 1, marks, cap,
dp);
    else dp[i][w] = max(marks[i] + knapSack(w - cap[i], i -
1, marks, cap, dp), knapSack(w, i - 1, marks, cap,
dp));

    return dp[i][w];
}
```

2.2 Min Coin to Make given Value

```
long long coinChange(vector<long long>&v, long long val,
long long n, vector<long long>&dp){
    if(val==0) return 0;
    if(dp[val]!=-1) return dp[val];

    long long ans = LLONG_MAX;

    for(long long i=0;i<n;i++){
        if(v[i]<=val){
            long long subAns = coinChange(v, val-v[i], n, dp)
;
```

```
        if(subAns!=long long_MAX && subAns+1<ans) ans =
subAns+1;
    }
}

dp[val] = ans;
return ans;
}
```

3 Data Structure

3.1 BIT with Lazy

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

template <class T>
struct Fenwick { // 1-indexed
    int n;
    vector<T> t;

    Fenwick() {}

    Fenwick(int _n) {
        n = _n;
        t.assign(n + 1, 0);
    }

    T query(int i) {
        T ans = 0;
        for (; i >= 1; i -= (i & -i))
            ans += t[i];
        return ans;
    }

    void upd(int i, T val) {
        if (i <= 0)
            return;
        for (; i <= n; i += (i & -i))
            t[i] += val;
    }

    void upd(int l, int r, T val) {
        upd(l, val);
        upd(r + 1, -val);
    }

    T query(int l, int r) {
```

```

        return query(r) - query(l - 1);
    }
};

int main() {
    long long t;
    // cin >> t;
    t = 1;
    while (t--) {
        long long n, q;
        cin >> n >> q;
        long long a[n + 2];
        Fenwick<long long> tree(n);

        for (long long i = 1; i <= n; i++)
            cin >> a[i];

        for (long long i = 1; i <= n; i++)
            tree.upd(i, i, a[i]);

        while (q--) {
            int type;
            cin >> type;
            if (type == 1) {
                long long x, y, val;
                cin >> x >> y >> val;
                tree.upd(x, y, val);
            } else {
                long long x, y;
                cin >> x;
                cout << tree.query(x) << endl;
            }
        }
    }
    return 0;
}

```

3.2 BIT

```

void update(int i, int val, int n, int *tree)
{
    while (i <= n)
    {
        tree[i] += val;
        i += (i & -i);
    }
}

//sum from 1 to i
int getSum(int i, int *tree)

```

```

{
    int sum = 0;
    while (i > 0)
    {
        sum += tree[i];
        i ^= (i & -i);
    }
    return sum;
}

```

3.3 Segement Tree

```

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

void build(long long *tree, long long *a, long long node,
           long long l, long long r)
{
    if (l == r)
    {
        tree[node] = a[l];
        return;
    }

    long long left = 2 * node, right = left + 1;
    long long mid = l + (r-l)/2;

    build(tree, a, left, l, mid);
    build(tree, a, right, mid + 1, r);

    tree[node] = tree[left] + tree[right];
}

long long query(long long *tree, long long *a, long long
               node, long long l, long long r, long long begin, long
               long end)
{
    if (r < begin || end < l)
        return 0;

    if (begin <= l && r <= end)
    {
        return tree[node];
    }

    long long left = 2 * node, right = left + 1;
    long long mid = l + (r-l)/2;

```

```

    long long left_value = query(tree, a, left, l, mid, begin
                                , end);
    long long right_value = query(tree, a, right, mid + 1, r,
                                begin, end);

    return left_value + right_value;
}

void update(long long *tree, long long *a, long long node,
           long long l, long long r, long long index, long long
           value)
{
    if (l == r)
    {
        a[l] = value;
        tree[node] = a[l];
        return;
    }

    long long left = 2 * node, right = left + 1;
    long long mid = l + (r-l)/2;

    if (index <= mid)
        update(tree, a, left, l, mid, index, value);
    else
        update(tree, a, right, mid + 1, r, index, value);

    tree[node] = tree[left] + tree[right];
}

int main()
{
    long long n;
    cin >> n;
    long long q;
    cin >> q;

    long long a[n + 2], tree[4 * n];
    for (long long i = 1; i <= n; i++)
        cin >> a[i];

    build(tree, a, 1, 1, n);

    while (q--)
    {
        long long tt, x, y;
        cin >> tt >> x >> y;
        if (tt == 1) {
            update(tree, a, 1, 1, n, x, y);
            continue;

```

```

    }
    long long desire_value = query(tree, a, 1, 1, n, x, y);
    cout << desire_value << endl;
}

```

3.4 Segment Tree with Lazy

```

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

void build(long long *tree, long long *lazy, long long *a,
           long long node, long long l, long long r)
{
    lazy[node] = 0;
    if (l == r)
    {
        tree[node] = a[l];
        return;
    }

    long long left = 2 * node, right = left + 1, mid = l + (r - l) / 2;

    build(tree, lazy, a, left, l, mid);
    build(tree, lazy, a, right, mid + 1, r);
    tree[node] = tree[left] + tree[right];
}

void propagate(long long *tree, long long *lazy, long long
               node, long long l, long long r)
{
    if (lazy[node])
    {
        tree[node] += (r - l + 1) * lazy[node];
        if (l != r)
        {
            lazy[2 * node] += lazy[node];
            lazy[2 * node + 1] += lazy[node];
        }
        lazy[node] = 0;
    }
}

long long query(long long *tree, long long *lazy, long long
                *a, long long node, long long l, long long r, long long
                b, long long e)
{
    propagate(tree, lazy, node, l, r);
    if (r < b || e < l)
        return 0;

    if (b <= l && r <= e)
        return tree[node];

    long long mid = l + (r - l) / 2;

    return query(tree, lazy, a, 2 * node, l, mid, b, e) +
           query(tree, lazy, a, 2 * node + 1, mid + 1, r, b, e);
}

void update_range(long long *tree, long long *lazy, long
                  long *a, long long node, long long l, long long r, long
                  long b, long long e, long long val)
{
    propagate(tree, lazy, node, l, r);
    if (r < b || e < l)
        return;
    if (b <= l && r <= e)
    {
        tree[node] += (r - l + 1) * val;

        if (l != r)
        {
            lazy[2 * node] += val;
            lazy[2 * node + 1] += val;
        }
        return;
    }

    long long mid = l + (r - l) / 2;

    update_range(tree, lazy, a, 2 * node, l, mid, b, e, val);
    update_range(tree, lazy, a, 2 * node + 1, mid + 1, r, b,
                  e, val);

    tree[node] = tree[2 * node] + tree[2 * node + 1];
}

int main()
{
    long long t;
    // cin >> t;
    t=1;
    while (t--)
    {
        long long n, q;

```

```

    cin >> n >> q;
    long long a[n + 2], tree[4 * n], lazy[4 * n];

    for (long long i = 1; i <= n; i++)
        cin >> a[i];
    build(tree, lazy, a, 1, 1, n);

    while (q--)
    {
        int type;
        cin >> type;
        if (type == 1)
        {
            long long x, y, val;
            cin >> x >> y >> val;
            update_range(tree, lazy, a, 1, 1, n, x, y, val);
            continue;
        }
        long long x;
        cin >> x;
        cout << query(tree, lazy, a, 1, 1, n, x, x) <<
            endl;
    }
}

```

4 Graph

4.1 DFS on Tree

```

vector<vector<int>> p;
vector<long long> depth;
vector<long long> reverse_depth;
void dfs(int u, int par)
{
    if (p[u].size() == 1 && p[u][0] == par){
        depth[u] = depth[par] + 1;
        reverse_depth[u] = 1;
    }
    else
    {
        for (auto v : p[u])
        {
            if (v != par)
            {
                depth[v] = 1 + depth[u];
                dfs(v, u);
            }
        }
    }
}

```

```

        reverse_depth[u] = 1 + reverse_depth[v];
    }
}
}
void solve(int n)
{
    p.assign(n + 2, vector<int>());
    depth.assign(n + 2, 0);
    reverse_depth.assign(n + 2, 0);
    for (int i = 1; i < n; i++)
    {
        int x, y;
        cin >> x >> y;
        p[x].push_back(y);
        p[y].push_back(x);
    }
    depth[1]=1;
    dfs(1, -1);
    int x = 2;
    cout<<depth[x]<<" "<<reverse_depth[x]<<endl;
}

```

4.2 Detect Cycle in Tree

```

void dfs(int u, vector<bool> &vis, vector<vector<int>>&p,
        int prev)
{
    if(vis[u]){
        cycle = true;
        return;
    }

    vis[u] = true;

    for (int i = 0; i < p[u].size(); i++)
    {
        int v = p[u][i];
        if(prev!=v){
            dfs(v, vis, p, u);
        }
    }
}

```

4.3 Dijkstra

```
#include <bits/stdc++.h>
```

```

using namespace std;

const long long N = 2e5 + 3;
const long long inf = 1e18;

vector<pair<long long, long long>> edges[N];
vector<long long> dist(N, inf);

int main()
{
    long long n, m;
    cin >> n >> m;

    while (m--)
    {
        long long x, y, w;
        cin >> x >> y >> w;
        edges[x].push_back({y, w});
    }

    dist[1] = 0;

    priority_queue<pair<long long, long long>, vector<pair<
        long long, long long>>, greater<pair<long long, long
        long>>> pq;

    pq.push({0, 1});

    while (!pq.empty())
    {
        long long u = pq.top().second, d = pq.top().first;
        pq.pop();
        if (dist[u] < d)
            continue;
        for (auto e : edges[u])
        {
            long long w = e.second, v = e.first;
            if (dist[v] > dist[u] + w)
            {
                dist[v] = dist[u] + w;
                pq.push({dist[v], v});
            }
        }
    }

    for (long long i = 1; i <= n; i++)
        cout << dist[i] << " ";
}

```

4.4 Distance of Leaf from root

```

#include<bits/stdc++.h>
using namespace std;
//K= root, n=node
void find(vector<long long>a[], long long n, long long k)
{
    queue<long long>q;
    long long vis[n+2]={};
    long long dis[n+2]={},maxx=0;
    vis[k]=0;
    dis[k]=1;
    q.push(k);
    while(!q.empty())
    {
        long long x=q.front();
        q.pop();
        long long l=a[x].size();
        for(long long i=0;i<l;i++)
        {
            long long y=a[x][i];
            if(!vis[y])
            {
                q.push(y);
                vis[y]=1;
                dis[y]=dis[x]+1;
                maxx=max(maxx,dis[y]);
            }
        }
    }
    cout<<maxx<<endl;
}

```

5 Math

5.1 Sum of Absolute Diff of All Pairs

```

int
sum_of_absolute_differences_of_all_pairs_in_a_given_array
(int a[], int n)
{
    int ans = 0;
    sort(a, a + n);
    for (long long i = 0; i < n; i++)
        ans += a[i] * (2 * i - n + 1);
    return ans;
}

```

6 Number Theory

6.1 Big Mul

```
long long bigMul(long long n, long long m, long long p)
{
    if(m<=0) return 0;
    long long res = bigMul(n, m/2, p);
    long long ans = (2*res)%p;
    if(m%2) ans = (ans+n)%p;
    return ans;
}
```

6.2 Bigmod

6.2.1 Inverse MOD

6.2.2 ncr

```
#define MOD 1000000007
long long bigMod(long long a, long long b)
{
    a %= MOD;
    if (!b)
        return 1;
    long long res = bigMod(a, b / 2);
    long long ans = (res * res) % MOD;
    if (b % 2)
        ans = (ans * a) % MOD;
    return ans;
}
```

```
long long inverseMod(long long a)
{
    return bigMod(a, MOD - 2);
}
```

```
long long fact[MOD];
void factorial()
{
    fact[0] = 1;
    for (long long i = 1; i < MOD; i++)
        fact[i] = ((i % MOD) * (fact[i - 1] % MOD)) % MOD;
}
```

```
long long nCr(long long n, long long r)
{

```

```
    return ((fact[n] % MOD) * (inverseMod((fact[r] * fact[n -
        r]) % MOD) % MOD)) % MOD;
}
```

6.3 Bigmod with Loop

```
#define MOD 1000000007
long long Big(long long x, long long n)
{
    long long ans=1;
    while(n>0){
        x%=MOD;
        if(n&1) ans*=x;
        ans%=MOD;
        x*=x;
        n>>=1;
    }
    return ans;
}
```

6.4 Generate Number of Divisor 1 to N

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

/*
    1. Generate Number of divisor of 1 to n
    2. Time complexity: O(nlogn)
    3. maximum n = 10^6

Usage:
    1. Just call into main function -
    vector<int>divisor = generateNumberOfDivisor(n);
    2. divisor[12] = 6
*/
```

```
vector<int>generateNumberOfDivisor(int n= 1e6){
    vector<int>divisor(n+1, 1); // by default all divisor
        number is 1
    for(int i=2;i<=n;i++){
        if(divisor[i]==1){ // that means i is prime
            for(int j=i;j<=n;j+=i){ // selet all multiple of
                prime j
                int num = j, primeFactor = 0;
                while(num%i==0){
                    num/=i;

```

```
                    primeFactor++; //find how many prime
                        factor i lies in the j
                }
            divisor[j] *= (primeFactor+1); //multiple all
                combination of primefactor = total
                    divisor
        }
    }
    return divisor;
}
```

```
int main(){
    int n = 12;
    vector<int>divisor = generateNumberOfDivisor();
    for(int i=1;i<=n;i++){
        cout<<i<<" "<<divisor[i]<<endl;
    }
    return 0;
}
```

```
/*
Input:
12
```

```
Output:
```

```
1 1
2 2
3 2
4 3
5 2
6 4
7 2
8 4
9 3
10 4
11 2
12 6
```

```
*/
```

6.5 Get Prime

```
#define INF 1000005
int prime[INF];
bool vis[INF];

void getPrime()
{

```

```

int k = 1;
prime[k++] = 2;
for (long long i = 3; i < INF; i += 2)
{
    if (!vis[i] && i % 2)
        prime[k++] = i;
    for (long long j = i * i; j < INF; j += i)
    {
        vis[j] = true;
    }
}
}

```

6.6 Is Prime

```

vector<bool> isPrime(long long n = 1e6)
{
    vector<bool> vis(n + 5);
    vis[1] = true;
    for (long long i = 3; i <= n; i+=2)
    {
        if (!vis[i])
            for (long long j = i * i; j <= n; j += i)
                vis[j] = true;
    }
    return vis;
}

```

6.7 MOD Jog Gun

```

#define MOD 1000000007

long long modGunKoro(long long a, long long b){
    return ((a%MOD)*(b%MOD))%MOD;
}

long long modJogKoro(long long a, long long b){
    return ((a%MOD)+(b%MOD))%MOD;
}

```

6.8 Number of Prime Divisor

```

vector<int> generateNumberOfPrimeDivisor(int n = 1e6){
    vector<int> primeDivisor(n+1, 0);
    for(int i=2; i<=n; i++){

```

```

        if(primeDivisor[i]==0){
            for(int j=i; j<=n; j+=i){
                primeDivisor[j] ++;
            }
        }
    }
    return primeDivisor;
}

```

6.9 Sum of Divisor

```

vector<int> generateSumOfDivisor(int n = 2e6)
{
    vector<int> divSum(n + 5, 1);
    divSum[1]=0;
    for (int i = 2; i <= n; i++)
    {
        for(int j=i+i; j<=n; j+=i){
            divSum[j]+=i;
        }
    }
    return divSum;
}

```

7 String

7.1 KMP

```

vector<int> lps(string pattern)
{
    int n = pattern.size();
    vector<int> v(n);
    int index = 0;

    for (int i = 1; i < n; )
    {
        if (pattern[i] == pattern[index])
        {
            v[i] = index + 1;
            i++;
            index++;
        }
        else
        {
            if (index)
                index = v[index - 1];

```

```

        else
        {
            v[i] = 0;
            i++;
        }
    }
    return v;
}

int kmp(string s, string pattern)
{
    int n = s.size(), m = pattern.size();
    int i = 0, j = 0;
    int ans = 0;

    vector<int> v = lps(pattern);

    while (i < n)
    {
        if (s[i] == pattern[j])
        {
            i++;
            j++;
        }
        else
        {
            if (j)
                j = v[j - 1];
            else
                i++;
        }

        if (j == m) //to count how many pattern match
        {
            ans++;
            j = v[j - 1];
        }
    }

    return ans;
}

```

7.2 lcs

```

int lcs(char *X, char *Y, int m, int n, vector<vector<int>>
    &dp)
{
    if (m == 0 || n == 0)

```

```

        return 0;
    if (X[m - 1] == Y[n - 1])
        return dp[m][n] = 1 + lcs(X, Y, m - 1, n - 1, dp);

    if (dp[m][n] != -1)
    {
        return dp[m][n];
    }
    return dp[m][n] = max(lcs(X, Y, m, n - 1, dp), lcs(X, Y,
        m - 1, n, dp));
}

```

8 Trie

```

#include <bits/stdc++.h>
using namespace std;
#define endl "\n"
#define con (f ? "YES" : "NO")
#define loj(i, j) "Case " << i << ": " << j

struct Trie
{
    bool lastLetter;
    Trie *children[10];

    Trie()
    {
        for (int i = 0; i < 10; i++)
        {
            lastLetter = false;
            children[i] = nullptr;
        }
    }
}

```

```

};

void insert(string &s, Trie *root)
{
    int n = s.size();

    for (char c : s)
    {
        int index = c - '0';
        if (root->children[index] == nullptr)
            root->children[index] = new Trie();
        root = root->children[index];
    }
    root->lastLetter = true;
}

bool isPrefix(Trie *node)
{
    for (int i = 0; i < 10; i++)
    {
        if (node->children[i] != nullptr)
        {
            if (node->lastLetter)
                return true;
            if (isPrefix(node->children[i]))
                return true;
        }
    }
    return false;
}

void clear(Trie *node)
{
    for (int i = 0; i < 10; i++)
    {
        if (node->children[i] != nullptr)

```

```

    {
        clear(node->children[i]);
        node->children[i] = nullptr;
    }
    delete (node);
}

int main()
{
    ios_base::sync_with_stdio(false);
    cin.tie(0), cout.tie(0);

    long long t, k = 0;
    cin >> t;
    while (t--)
    {
        long long n;
        cin >> n;

        Trie *root = new Trie();

        while (n--)
        {
            string s;
            cin >> s;
            insert(s, root);
        }

        bool f = !isPrefix(root);
        cout << loj(++k, con) << endl;
        clear(root);
    }
}

```
