

Competitive programming Notebook

Meia noite eu te conto

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1 General

1.1 Random

```

1 random_device dev;
2 mt19937 rng(dev());
3
4 uniform_int_distribution<mt19937::result_type> dist
  (1, 6); // distribution in range [1, 6]
5
6 int val = dist(rng);

```

1.2 Split

```

1 vector<string> split(string s, char key=' ') {
2     vector<string> ans;
3     string aux = "";
4
5     for (int i = 0; i < (int)s.size(); i++) {
6         if (s[i] == key) {
7             if (aux.size() > 0) {
8                 ans.push_back(aux);
9                 aux = "";
10            }
11        } else {
12            aux += s[i];
13        }
14    }
15
16    if ((int)aux.size() > 0) {
17        ans.push_back(aux);
18    }
19
20    return ans;
21 }

```

1.3 Base Converter

```

1 const string digits = "0123456789
  ABCDEFGHIJKLMNOPQRSTUVWXYZ";
2
3 ll tobase10(string number, int base) {
4     map<char, int> val;
5     for (int i = 0; i < digits.size(); i++) {
6         val[digits[i]] = i;
7     }
8
9     ll ans = 0, pot = 1;
10
11    for (int i = number.size() - 1; i >= 0; i--) {
12        ans += val[number[i]] * pot;
13        pot *= base;
14    }
15
16    return ans;
17 }
18
19 string frombase10(ll number, int base) {
20     if (number == 0) return "0";
21
22     string ans = "";
23
24     while (number > 0) {
25         ans += digits[number % base];
26         number /= base;
27     }
28
29     reverse(ans.begin(), ans.end());
30
31     return ans;
32 }

```

```

33
34 // verifica se um número está na base especificada
35 bool verify_base(string num, int base) {
36     map<char, int> val;
37     for (int i = 0; i < digits.size(); i++) {
38         val[digits[i]] = i;
39     }
40
41     for (auto digit : num) {
42         if (val[digit] >= base) {
43             return false;
44         }
45     }
46
47     return true;
48 }

```

1.4 Template

```

1 // MEIA NOITE EU TE CONTO
2 #include <bits/stdc++.h>
3
4 using namespace std;
5
6 #define _ ios_base::sync_with_stdio(0);cin.tie(0);
7
8 typedef long long ll;
9
10 const int INF = 0x3f3f3f3f;
11 const ll LINF = 0x3f3f3f3f3f3f3f3f;
12
13 int main() { _
14     return 0;
15 }

```

2 Math

2.1 2sat

```

1 // 2SAT
2 //
3 // verifica se existe e encontra solução
4 // para fórmulas booleanas da forma
5 // (a or b) and (!a or c) and (...)
6 //
7 // indexado em 0
8 // n(a) = 2*x e n(~a) = 2*x+1
9 // a = 2 ; n(a) = 4 ; n(~a) = 5 ; n(a)^1 = 5 ; n(~a)
10 // ^1 = 4
11 // https://cses.fi/problemset/task/1684/
12 // https://codeforces.com/gym/104120/problem/E
13 // (add_eq, add_true, add_false e at_most_one não
14 // foram testadas)
15 // 0(n + m)
16
17 struct sat {
18     int n, tot;
19     vector<vector<int>> adj, adjt; // grafo original,
20     // grafo transposto
21     vector<int> vis, comp, ans;
22     stack<int> topo; // ordem topológica
23
24     sat() {}
25     sat(int n_) : n(n_), tot(n), adj(2*n), adjt(2*n) {}
26
27     void dfs(int x) {
28         vis[x] = true;

```

```

29     for (auto e : adj[x]) {
30         if (!vis[e]) dfs(e);
31     }
32     topo.push(x);
33 }
34
35 void dfst(int x, int& id) {
36     vis[x] = true;
37     comp[x] = id;
38
39     for (auto e : adjt[x]) {
40         if (!vis[e]) dfst(e, id);
41     }
42 }
43
44 void add_impl(int a, int b) { // a -> b = (!a or
45 b)
46     a = (a >= 0 ? 2*a : -2*a-1);
47     b = (b >= 0 ? 2*b : -2*b-1);
48
49     adj[a].push_back(b);
50     adj[b^1].push_back(a^1);
51
52     adjt[b].push_back(a);
53     adjt[a^1].push_back(b^1);
54 }
55
56 void add_or(int a, int b) { // a or b
57     add_impl(~a, b);
58 }
59
60 void add_nor(int a, int b) { // a nor b = !(a or
61 b)
62     add_or(~a, b), add_or(a, ~b), add_or(~a, ~b);
63 }
64
65 void add_and(int a, int b) { // a and b
66     add_or(a, b), add_or(~a, b), add_or(a, ~b);
67 }
68
69 void add_nand(int a, int b) { // a nand b = !(a
70 and b)
71     add_or(~a, ~b);
72 }
73
74 void add_xor(int a, int b) { // a xor b = (a != b
75 )
76     add_or(a, b), add_or(~a, ~b);
77 }
78
79 void add_xnor(int a, int b) { // a xnor b = !(a
80 xor b) = (a = b)
81     add_xor(~a, b);
82 }
83
84 void add_true(int a) { // a = T
85     add_or(a, ~a);
86 }
87
88 void add_false(int a) { // a = F
89     add_and(a, ~a);
90 }
91
92 // magia - brunomaletta
93 void add_true_old(int a) { // a = T (n sei se
94 funciona)
95     add_impl(~a, a);
96 }
97
98 void at_most_one(vector<int> v) { // no max um
99 verdadeiro
100     adj.resize(2*(tot+v.size()));
101
102     for (int i = 0; i < v.size(); i++) {
103         add_impl(tot+i, ~v[i]);
104         if (i) {
105             add_impl(tot+i, tot+i-1);
106             add_impl(v[i], tot+i-1);
107         }
108     }
109     tot += v.size();
110 }
111
112 pair<bool, vector<int>> solve() {
113     ans.assign(n, -1);
114     comp.assign(2*tot, -1);
115     vis.assign(2*tot, 0);
116     int id = 1;
117
118     for (int i = 0; i < 2*tot; i++) if (!vis[i])
119         dfs(i);
120
121     vis.assign(2*tot, 0);
122     while (topo.size()) {
123         auto x = topo.top();
124         topo.pop();
125
126         if (!vis[x]) {
127             dfst(x, id);
128             id++;
129         }
130     }
131
132     for (int i = 0; i < tot; i++) {
133         if (comp[2*i] == comp[2*i+1]) return {
134             false, {} };
135         ans[i] = (comp[2*i] > comp[2*i+1]);
136     }
137
138     return {true, ans};
139 }
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```

3 DS

3.1 Dsu

```

1  /*
2  DSU - Disjoint Set Union (or Union Find)
3
4  find(x) -> find component that x is on
5  join(a, b) -> union of a set containing 'a' and set
6      containing b
7
8  find / join with path compression -> O(inv_Ackermann
9      (n)) [O(1)]
10 find / join without path compression -> O(logN)
11
12 https://judge.yosupo.jp/submission/126864
13 */
14
15 struct DSU {
16     int n = 0, components = 0;
17     vector<int> parent;
18     vector<int> size;
19
20     DSU(int nn){
21         n = nn;
22         components = n;
23         size.assign(n + 5, 1);
24         parent.assign(n + 5, 0);
25         iota(parent.begin(), parent.end(), 0);
26     }

```

```

27 int find(int x){
28     if(x == parent[x]) {
29         return x;
30     }
31     //path compression
32     return parent[x] = find(parent[x]);
33 }
34
35 void join(int a, int b){
36     a = find(a);
37     b = find(b);
38     if(a == b) {
39         return;
40     }
41     if(size[a] < size[b]) {
42         swap(a, b);
43     }
44     parent[b] = a;
45     size[a] += size[b];
46     components -= 1;
47 }
48
49 int sameSet(int a, int b) {
50     a = find(a);
51     b = find(b);
52     return a == b;
53 }
54
55 };

```

3.2 Ordered Set

```

1 // Ordered Set
2 //
3 // set roubado com mais operacoes
4 //
5 // para alterar para multiset
6 // trocar less para less_equal
7 //
8 // ordered_set<int> s
9 //
10 // order_of_key(k) // number of items strictly
    // smaller than k -> int
11 // find_by_order(k) // k-th element in a set (
    // counting from zero) -> iterator
12 //
13 // https://cses.fi/problemset/task/2169
14 //
15 // O(log N) para insert, erase (com iterator),
    // order_of_key, find_by_order
16
17 using namespace __gnu_pbds;
18 template <typename T>
19 using ordered_set = tree<T,null_type,less<T>,
    rb_tree_tag,tree_order_statistics_node_update>;

```

4 DP

4.1 Knapsack

4.2 Edit Distance

```

1 // Edit Distance / Levenshtein Distance
2 //
3 // numero minimo de operacoes
4 // para transformar
5 // uma string em outra
6 //
7 // tamanho da matriz da dp eh |a| x |b|
8 // edit_distance(a.size(), b.size(), a, b)

```

```

9 //
10 // https://cses.fi/problemset/task/1639
11 //
12 // O(n^2)
13
14 int tb[MAX][MAX];
15
16 int edit_distance(int i, int j, string &a, string &b)
    {
17     if (i == 0) return j;
18     if (j == 0) return i;
19
20     int &ans = tb[i][j];
21
22     if (ans != -1) return ans;
23
24     ans = min({
25         edit_distance(i-1, j, a, b) + 1,
26         edit_distance(i, j-1, a, b) + 1,
27         edit_distance(i-1, j-1, a, b) + (a[i-1] != b[
28             j-1])
29     });
30     return ans;
31 }

```

4.3 Lcs

```

1 // LCS (Longest Common Subsequence)
2 //
3 // maior subsequencia comum entre duas strings
4 //
5 // tamanho da matriz da dp eh |a| x |b|
6 // lcs(a, b) = string da melhor resposta
7 // dp[a.size()][b.size()] = tamanho da melhor
    // resposta
8 //
9 // https://atcoder.jp/contests/dp/tasks/dp_f
10 //
11 // O(n^2)
12
13 string lcs(string a, string b) {
14     int n = a.size();
15     int m = b.size();
16
17     int dp[n+1][m+1];
18     pair<int, int> p[n+1][m+1];
19
20     memset(dp, 0, sizeof(dp));
21     memset(p, -1, sizeof(p));
22
23     for (int i = 1; i <= n; i++) {
24         for (int j = 1; j <= m; j++) {
25             if (a[i-1] == b[j-1]) {
26                 dp[i][j] = dp[i-1][j-1] + 1;
27                 p[i][j] = {i-1, j-1};
28             } else {
29                 if (dp[i-1][j] > dp[i][j-1]) {
30                     dp[i][j] = dp[i-1][j];
31                     p[i][j] = {i-1, j};
32                 } else {
33                     dp[i][j] = dp[i][j-1];
34                     p[i][j] = {i, j-1};
35                 }
36             }
37         }
38     }
39
40     // recuperar resposta
41
42     string ans = "";
43     pair<int, int> curr = {n, m};
44

```

```
45 while (curr.first != 0 && curr.second != 0) {
46     auto [i, j] = curr;
47
48     if (a[i-1] == b[j-1]) {
49         ans += a[i-1];
50     }
51
52     curr = p[i][j];
53 }
54
55 reverse(ans.begin(), ans.end());
56
57 return ans;
58 }
```

5 Graph

5.1 Dfs

```
1 // DFS
2 //
3 // Percorre todos os vertices
4 // priorizando profundidade
5 //
6 // O(n+m)
7
8 vector<vector<int>> g;
9 vector<bool> vis;
10
11 void dfs(int s){
12     if(vis[s]) return;
13     vis[s] = true;
14     for(auto v : g[s]){
15         dfs(v);
16     }
17 }
```