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UPC2

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Contest (1)

template.cpp16 lines

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

typedef long long ll;
typedef pair<int, int> pii;
typedef vector<int> vi;

const ll oo = 0x3f3f3f3f3f3f3f3f;

#define FOR(i, a, b) for(ll i = (a); i < (b); i++)
#define has(c, e) ((c).find(e) != (c).end())

int main() {
    cin.sync_with_stdio(0); cin.tie(0);
    cin.exceptions(cin.failbit);
}
```

.bashrc3 lines

```
alias c='g++ -Wall -Wconversion -Wfatal-errors -g -std=c++14 \
-fsanitize=undefined,address'
xmodmap -e 'clear lock' -e 'keycode 66=less greater' #caps =◇
```

troubleshoot.txt52 lines

```
Pre-submit:
Write a few simple test cases, if sample is not enough.
Are time limits close? If so, generate max cases.
Is the memory usage fine?
Could anything overflow?
Make sure to submit the right file.
```

```
Wrong answer:
Print your solution! Print debug output, as well.
Are you clearing all datastructures between test cases?
Can your algorithm handle the whole range of input?
Read the full problem statement again.
Do you handle all corner cases correctly?
Have you understood the problem correctly?
Any uninitialized variables?
Any overflows?
Confusing N and M, i and j, etc.?
Are you sure your algorithm works?
What special cases have you not thought of?
Are you sure the STL functions you use work as you think?
Add some assertions, maybe resubmit.
Create some testcases to run your algorithm on.
Go through the algorithm for a simple case.
Go through this list again.
Explain your algorithm to a team mate.
Ask the team mate to look at your code.
Go for a small walk, e.g. to the toilet.
Is your output format correct? (including whitespace)
Rewrite your solution from the start or let a team mate do it.
```

```
Runtime error:
Have you tested all corner cases locally?
Any uninitialized variables?
Are you reading or writing outside the range of any vector?
Any assertions that might fail?
Any possible division by 0? (mod 0 for example)
Any possible infinite recursion?
Invalidated pointers or iterators?
Are you using too much memory?
Debug with resubmits (e.g. remapped signals, see Various).
```

```
Time limit exceeded:
Do you have any possible infinite loops?
What is the complexity of your algorithm?
Are you copying a lot of unnecessary data? (References)
How big is the input and output? (consider scanf)
Avoid vector, map. (use arrays/unordered_map)
What do your team mates think about your algorithm?

Memory limit exceeded:
What is the max amount of memory your algorithm should need?
Are you clearing all datastructures between test cases?
```

Data structures (2)

Numerical (3)

Number theory (4)

Combinatorial (5)

Graph (6)

Geometry (7)

Strings (8)

PalindromeTree.h61 lines

```
const int maxN = 1000010; // at least sz(s) + 3
struct Node {
    int suffix;
    int len;
    map<char, int> children;

    // not needed for construction, add if needed
    int parent;
    vector<int> suffixof;
};

int nodeid;
Node tree[maxN]; // 0: -1 root, 1: empty string

int add(int parent, char c) {
    if(has(tree[parent].children, c)) {
        return tree[parent].children[c];
    }
    int newid = nodeid++;
    tree[newid].suffix = -1;
    tree[newid].len = tree[parent].len + 2;
    tree[newid].parent = parent;
    tree[parent].children[c] = newid;
    return newid;
}

void build(string& s) {
    nodeid = 2;
    tree[0].parent = -1;
    tree[0].len = -1;
    tree[1].parent = -1;
```

```
tree[0].suffixof.push_back(1);
int cur = 0;
FOR(i, 0, int(s.size())) {
    int newn = -1;
    while(1) {
        int curlen = tree[cur].len;
        if(i-1-curlen >= 0 && s[i-1-curlen] == s[i]) {
            newn = add(cur, s[i]);
            break;
        }
        cur = tree[cur].suffix;
    }
    if(tree[newn].suffix != -1) {
        cur = newn;
        continue;
    }
    if(cur == 0) {
        tree[newn].suffix = 1;
    } else {
        cur = tree[cur].suffix;
        do {
            cur = tree[cur].suffix;
        } while(i-1-tree[cur].len < 0
            || s[i-1-tree[cur].len] != s[i]);
        tree[newn].suffix = tree[cur].children[s[i]];
    }
    tree[tree[newn].suffix].suffixof.push_back(newn);
    cur = newn;
}
}
```

Various (9)

Techniques (A)

techniques.txt	159 lines
Recursion	
Divide and conquer	
Finding interesting points in N log N	
Algorithm analysis	
Master theorem	
Amortized time complexity	
Greedy algorithm	
Scheduling	
Max contiguous subvector sum	
Invariants	
Huffman encoding	
Graph teory	
Dynamic graphs (extra book-keeping)	
Breadth first search	
Depth first search	
* Normal trees / DFS trees	
Dijkstra's algoritm	
MST: Prim's algoritm	
Bellman-Ford	
Konig's theorem and vertex cover	
Min-cost max flow	
Lovasz toggle	
Matrix tree theorem	
Maximal matching, general graphs	
Hopcroft-Karp	
Hall's marriage theorem	
Graphical sequences	
Floyd-Warshall	
Eulercykler	
Flow networks	
* Augumenting paths	
* Edmonds-Karp	
Bipartite matching	
Min. path cover	
Topological sorting	
Strongly connected components	
2-SAT	
Cutvertices, cutedges och biconnected components	
Edge coloring	
* Trees	
Vertex coloring	
* Bipartite graphs (=> trees)	
* 3^n (special case of set cover)	
Diameter and centroid	
K'th shortest path	
Shortest cycle	
Dynamic programming	
Knapsack	
Coin change	
Longest common subsequence	
Longest increasing subsequence	
Number of paths in a dag	
Shortest path in a dag	
Dynprog over intervals	
Dynprog over subsets	
Dynprog over probabilities	
Dynprog over trees	
3^n set cover	
Divide and conquer	
Knuth optimization	
Convex hull optimizations	
RMQ (sparse table a.k.a 2^k-jumps)	
Bitonic cycle	
Log partitioning (loop over most restricted)	
Combinatorics	

Computation of binomial coefficients	
Pigeon-hole principle	
Inclusion/exclusion	
Catalan number	
Pick's theorem	
Number theory	
Integer parts	
Divisibility	
Euklidean algorithm	
Modular arithmetic	
* Modular multiplication	
* Modular inverses	
* Modular exponentiation by squaring	
Chinese remainder theorem	
Fermat's small theorem	
Euler's theorem	
Phi function	
Frobenius number	
Quadratic reciprocity	
Pollard-Rho	
Miller-Rabin	
Hensel lifting	
Vieta root jumping	
Game theory	
Combinatorial games	
Game trees	
Mini-max	
Nim	
Games on graphs	
Games on graphs with loops	
Grundy numbers	
Bipartite games without repetition	
General games without repetition	
Alpha-beta pruning	
Probability theory	
Optimization	
Binary search	
Ternary search	
Unimodality and convex functions	
Binary search on derivative	
Numerical methods	
Numeric integration	
Newton's method	
Root-finding with binary/ternary search	
Golden section search	
Matrices	
Gaussian elimination	
Exponentiation by squaring	
Sorting	
Radix sort	
Geometry	
Coordinates and vectors	
* Cross product	
* Scalar product	
Convex hull	
Polygon cut	
Closest pair	
Coordinate-compression	
Quadtrees	
KD-trees	
All segment-segment intersection	
Sweeping	
Discretization (convert to events and sweep)	
Angle sweeping	
Line sweeping	
Discrete second derivatives	
Strings	
Longest common substring	
Palindrome subsequences	

Knuth-Morris-Pratt	
Tries	
Rolling polynom hashes	
Suffix array	
Suffix tree	
Aho-Corasick	
Manacher's algorithm	
Letter position lists	
Combinatorial search	
Meet in the middle	
Brute-force with pruning	
Best-first (A*)	
Bidirectional search	
Iterative deepening DFS / A*	
Data structures	
LCA (2^k-jumps in trees in general)	
Pull/push-technique on trees	
Heavy-light decomposition	
Centroid decomposition	
Lazy propagation	
Self-balancing trees	
Convex hull trick (wcipeg.com/wiki/Convex_hull_trick)	
Monotone queues / monotone stacks / sliding queues	
Sliding queue using 2 stacks	
Persistent segment tree	