Contents

1 Notas Útiles

$O(f(n))$	Limite
$O(n!)$	10...11
$O(2^n n^2)$	15...18
$O(2^n n)$	18...21
$O(n^4)$	100
$O(n^3)$	500[1]
$O(n^2 \log^2 n)$	1000
$O(n^2 \log n)$	2000
$O(n^2)$	1e4[2]
$O(n \log^2 n)$	3e5
$O(n \log n)$	1e6
$O(n)$	1e8[3]

Primos hasta	
1e2	25
1e3	168
1e4	1229
1e5	9592
1e6	78.498
1e7	664.579
1e8	5.761.455
1e9	50.487.534

El mayor HCN[4] menor a 1e9 tiene 1344 divisores.
El "prime gap" hasta 1e9 es menor a 288

[1] Este caso esta justo en el limite de tiempo, además en 256 MB cabe a los una matriz de 400^3 ints

[2] En general solo funciona hasta 6e3

[3] En general solo funciona hasta 4e7

[4] Highly Compositve Number, números que tienen más divisores que cualquier número más pequeño

2 ./headers/headers/headers.h

3 ./strings/trie/trie.cpp

4 ./trees/segment/lazySegmentTree.cpp

5 ./trees/segment/segmentTree.cpp

6 ./trees/fenwick/fenwickTree2D.cpp

7 ./trees/fenwick/fenwickTree.cpp

8 ./graphs/dinic/dinic.cpp

```cpp
#include "../../headers/headers/headers.h"
class Dinic
{
    struct edge
    {
        int to, rev;
        ll f, cap;
    };

    vector<vector<edge>> g;
    vector<ll> dist;
    vector<int> q, work;
    int n, sink;

    bool bfs(int start, int finish)
    {
        dist.assign(n, -1);
        dist[start] = 0;
        int head = 0, tail = 0;
        q[tail++] = start;
        while (head < tail)
        {
            int u = q[head++];
            for (const edge &e : g[u])
            {
                int v = e.to;
                if (dist[v] == -1 and e.f < e.cap)
                {
                    dist[v] = dist[u] + 1;
                    q[tail++] = v;
                }
            }
        }
        return dist[finish] != -1;
    }

    ll dfs(int u, ll f)
    {
        if (u == sink)
            return f;
        for (int &i = work[u]; i < (int)g[u].size(); ++i)
        {
            edge &e = g[u][i];
            int v = e.to;
```

```
            if (e.cap <= e.f or dist[v] != dist[u] + 1)
                continue;
            ll df = dfs(v, min(f, e.cap - e.f));
            if (df > 0)
            {
                e.f += df;
                g[v][e.rev].f -= df;
                return df;
            }
        }
        return 0;
    }

  public:
    Dinic(int n)
    {
        this->n = n;
        g.resize(n);
        dist.resize(n);
        q.resize(n);
    }

    void add_edge(int u, int v, ll cap)
    {
        edge a = {v, (int)g[v].size(), 0, cap};
        edge b = {u, (int)g[u].size(), 0, 0}; //Poner cap en vez de 0 si la arista es bidir
        g[u].pb(a);
        g[v].pb(b);
    }

    ll max_flow(int source, int dest)
    {
        sink = dest;
        ll ans = 0;
        while (bfs(source, dest))
        {
            work.assign(n, 0);
            while (ll delta = dfs(source, LLONG_MAX))
                ans += delta;
        }
        return ans;
    }
};
```

9 ./graphs/dijsktra/dijsktra.cpp

```cpp
#include "../../headers/headers/headers.h"
//g has vectors of pairs of the form (w, index)
int dijsktra(wgraph g, int start, int end)
{
    int n = g.size();
    vi cost(n, 1e9); //~INT_MAX/2
    priority_queue<ii, greater<ii>> q;

    q.emplace(0, start);
    cost[start] = 0;
    while (not q.empty())
    {
        int u = q.top().second, w = q.top().first;
        q.pop();

        for (auto v : g[u])
        {
            if (cost[v.second] > v.first + w)
            {
                cost[v.second] = v.first + w;
                q.emplace(cost[v.second], v.second);
            }
        }
    }

    return cost[end];
}
```

10 ./graphs/dfs/dfsRecursive.cpp

```cpp
#include "../../headers/headers/headers.h"
//Recursive (create visited filled with 1s)
void dfs_r(graph &g, vi &visited, int u)
{
    cout << u << '\n';
    visited[u] = 0;

    for (int v : g[u])
        if (visited[v])
            dfs_r(g, visited, v);
}
```

11 ./graphs/dfs/dfsIterative.cpp

```cpp
#include "../../headers/headers/headers.h"
//Iterative
void dfs_i(graph &g, int start)
{
    int n = g.size();
    vi visited(n, 1);
    stack<int> s;

    s.emplace(start);
    visited[start] = 0;

    while (not s.empty())
    {
        int u = s.top();
        s.pop();

        cout << u << '\n';

        for (int v : g[u])
            if (visited[v])
            {
                s.emplace(v);
                visited[v] = 0;
            }
    }
}
```

12 ./graphs/lca/lca.cpp

```
#include "../../headers/headers/headers.h"
class LcaTree
{
    int n;
    vi parent;
    vi level;
    vi root;
    graph P;
public:
    LcaTree(int n){
        this->n = n;
        parent.assign(n,-1);
        level.assign(n,-1);
        P.assign(n,vi(lg(n)+1,-1));
        root.assign(n,-1);
    }
    void addLeaf(int index, int par){
        parent[index] = par;
        level[index] = level[par] + 1;
        P[index][0] = par;
        root[index] = root[par];
        for(int j=1; (1<<j) < n; ++j){
            if(P[index][j-1] != -1)
                P[index][j] = P[P[index][j-1]][j-1];
        }
    }
    void addRoot(int index){
        parent[index] = index;
        level[index] = 0;
        root[index] = index;
    }
    int lca(int u, int v){
        if(root[u] != root[v] || root[u] == -1)
            return -1;
        if(level[u] < level[v])
            swap(u,v);
        int dist = level[u] - level[v];
        while(dist != 0){
            int raise = lg(dist);
            u = P[u][raise];
            dist -= (1<<raise);
        }
        if(u == v)
            return u;
```

```
        for(int j = lg(n); j>=0; --j){
            if(P[u][j] != -1 && P[u][j] != P[v][j]){
                u=P[u][j];
                v=P[v][j];
            }
        }
        return parent[u];
    }
};
```

13 ./graphs/kruskal/kruskal.cpp

14 ./graphs/unionFind/unionFind.cpp

```cpp
#include "../../headers/headers/headers.h"
class UnionFind
{
  private:
    int numSets;
    vi p, rank, setSize;

  public:
    UnionFind(int n)
    {
        numSets = n;
        rank.assign(n, 0);
        setSize.assign(n, 1);
        p.resize(n);
        rep(i, n) p[i] = i;
    }
    int findSet(int i)
    {
        return (p[i] == i) ? i : (p[i] = findSet(p[i]));
    }
    bool isSameSet(int i, int j)
    {
        return findSet(i) == findSet(j);
    }
    void UnionSet(int i, int j)
    {
        if (not isSameSet(i, j))
        {
            numSets--;
            int x = findSet(i), y = findSet(j);
            if (rank[x] > rank[y])
            {
                p[y] = x;
                setSize[x] += setSize[y];
            }
            else
            {
                p[x] = y;
                setSize[y] += setSize[x];
                if (rank[x] == rank[y])
                    rank[y]++;
            }
        }
    }
```

```
    int numSets()
    {
        return numSets;
    }
    int setOfSize(int i)
    {
        return setSize[i];
    }
};
```

15 ./graphs/bfs/bfs.cpp

```cpp
#include "../../headers/headers/headers.h"

void bfs(graph &g, int start)
{
    int n = g.size();
    vi visited(n, 1);
    queue<int> q;

    q.emplace(start);
    visited[start] = 0;
    while (not q.empty())
    {
        int u = q.front();
        q.pop();

        for (int v : g[u])
        {
            if (visited[v])
            {
                q.emplace(v);
                visited[v] = 0;
            }
        }
    }
}
```

16 ./graphs/bellmanFord/bellmanFord.cpp

```cpp
#include "../../headers/headers/headers.h"
bool bellman_ford(wgraph &g, int start)
{
    int n = g.size();
    vector<int> dist(n, 1e9); //~INT_MAX/2
    dist[start] = 0;
    rep(i, n - 1) rep(u, n) for (ii p : g[u])
    {
        int v = p.first, w = p.second;
        dist[v] = min(dist[v], dist[u] + w);
    }

    bool hayCicloNegativo = false;
    rep(u, n) for (ii p : g[u])
    {
        int v = p.first, w = p.second;
        if (dist[v] > dist[u] + w)
            hayCicloNegativo = true;
    }

    return hayCicloNegativo;
}
```