

# Maximum flow

ESTE CÓDIGO NO LO ESCRIBÍ YO.

Dada una gráfica dirigida con capacidades, una fuente y un pozo, encuentra el máximo flujo. Puede usarse para resolver mínimo corte, con el teorema de mínimo corte y máximo flujo, simplemente considerando todas las parejas de flujo  $(0, v)$  con  $v > 0$ .

```
// This program was written by jaehyunp and taken from:  
// https://github.com/jaehyunp/stanfordacm/blob/master/code/  
  
#include <algorithm>  
#include <iostream>  
#include <numeric>  
#include <queue>  
#include <vector>  
  
struct Edge  
{  
    long from, to, cap, flow, index_of_twin;  
    Edge(long from, long to, long cap, long flow, long index_of_twin)  
        : from(from), to(to), cap(cap), flow(flow), index_of_twin(index_of_twin)  
    {}  
};  
  
class PushRelabel  
{  
public:  
    PushRelabel(long N)  
        : N(N), G(N), excess(N), dist(N), active(N), count(2 * N)  
    {}  
  
    void AddEdge(long from, long to, long cap)  
    {  
        G[from].emplace_back(from, to, cap, 0, G[to].size());  
  
        if (from == to)  
            ++G[from].back().index_of_twin;  
  
        G[to].emplace_back(to, from, 0, 0, G[from].size() - 1);  
    }  
  
    long GetMaxFlow(long s, long t)  
    {  
        count[0] = N - 1;  

```

```

    count[N] = 1;
    dist[s] = N;
    active[s] = active[t] = true;

    for (auto& edge : G[s])
    {
        excess[s] += edge.cap;
        Push(edge);
    }

    while (!Q.empty())
    {
        long v = Q.front();
        Q.pop();
        active[v] = false;
        Discharge(v);
    }

    long totflow = 0;

    for (auto& edge : G[s])
        totflow += edge.flow;

    return totflow;
}

private:
    long N;
    std::vector<std::vector<Edge>> G;
    std::vector<long> excess;
    std::vector<long> dist, active, count;
    std::queue<long> Q;

    void Enqueue(long v)
    {
        if (!active[v] && excess[v] > 0)
        {
            active[v] = true;
            Q.push(v);
        }
    }

    void Push(Edge& e)
    {
        long amt = std::min<long>(excess[e.from], e.cap - e.flow);

```

```

    if (dist[e.from] <= dist[e.to] || amt == 0)
        return;

    e.flow += amt;
    G[e.to][e.index_of_twin].flow -= amt;
    excess[e.to] += amt;
    excess[e.from] -= amt;
    Enqueue(e.to);
}

void Gap(long k)
{
    for (long v = 0; v < N; ++v)
    {
        if (dist[v] < k)
            continue;

        --count[dist[v]];
        dist[v] = std::max(dist[v], N + 1);
        ++count[dist[v]];
        Enqueue(v);
    }
}

void Relabel(long v)
{
    --count[dist[v]];
    dist[v] = 2 * N;

    for (auto& edge : G[v])
    {
        if (edge.cap - edge.flow > 0)
            dist[v] = std::min(dist[v], dist[edge.to] + 1);
    }

    ++count[dist[v]];
    Enqueue(v);
}

void Discharge(long v)
{
    for (auto& edge : G[v])
    {
        if (excess[v] <= 0)

```

```

        break;
    Push(edge);
}

if (excess[v] > 0)
{
    if (count[dist[v]] == 1)
        Gap(dist[v]);
    else
        Relabel(v);
}
}
};

int main()
{
    PushRelabel G(5);

    G.AddEdge(0, 1, 8);
    G.AddEdge(0, 2, 3);
    G.AddEdge(1, 2, 2);
    G.AddEdge(1, 4, 4);
    G.AddEdge(1, 3, 1);
    G.AddEdge(3, 4, 4);

    std::cout << "Max flow: " << G.GetMaxFlow(0, 4) << std::endl;

    return 0;
}

```

**Output:**

Max flow: 5