网络流、费用流 题解

A - Marriage Match II (HDU - 3081)

题意

N个男孩和女孩，每个女孩有自己喜欢的对象，女孩可以喜欢朋友的喜欢的男孩，现在有一个游戏，每轮游戏女孩和自己喜欢过的男孩（这个男孩在之前的游戏中没有被选择过）结合在一起，问这种关系能够玩几轮游戏?

思路

- 可以一直跑匹配，把匹配过的边删除接着跑匹配。
- 网络流 + 二分

二分枚举一共能进行的轮数，网络流判断是否可行

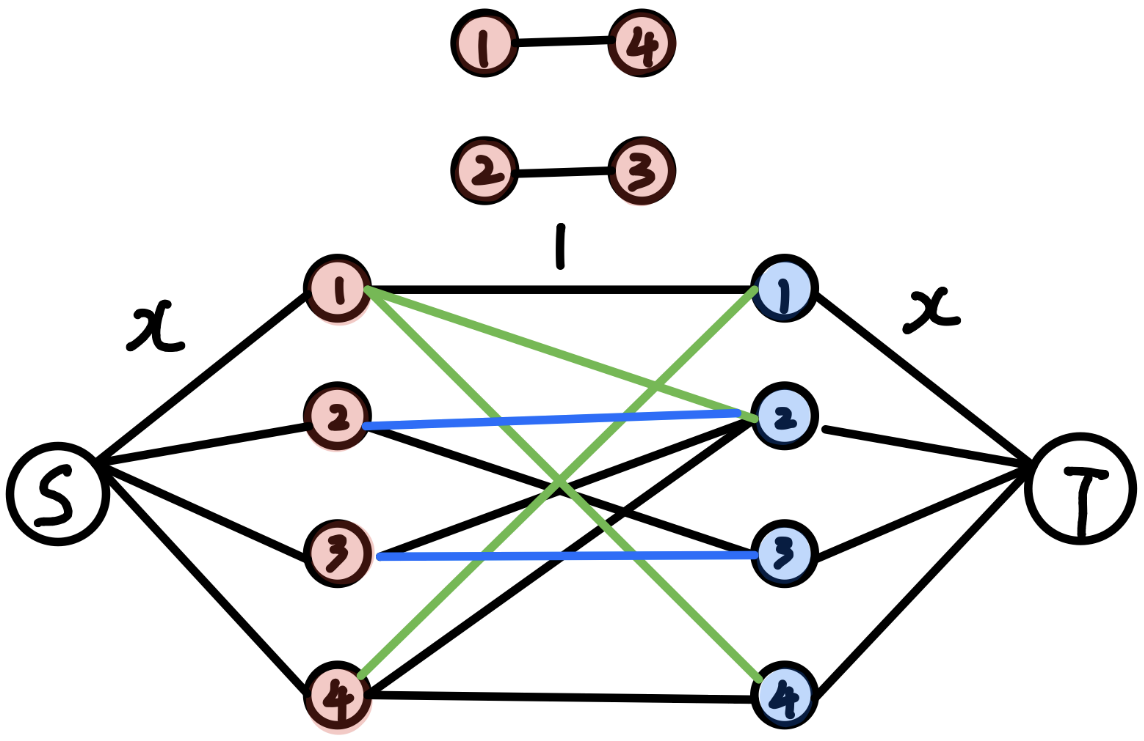
假设当前枚举进行x轮游戏

建图：

- 源点到女孩建边，流量=x (限制每个女孩最多可以选择x个男孩)
- 男孩到汇点建边，流量=x (限制每个男孩最多可以被选择x次)
- 女孩到男孩按照喜好建边，流量=1 (表示选择过的男孩不能第二次选择)

  这里需要用到并查集，将女孩之间的朋友关系并到一起

这样跑完最大流之后，如果是满流，证明可以玩x轮游戏，因为每个女孩都能在顺利选择x个男孩，并且这x个男孩不重复。



```
#include <iostream>
#include <stdio.h>
#include <queue>
#include <cstring>
const int maxn = 3e2 + 5;
```

```cpp
const int inf = 0x3f3f3f3f;
using namespace std;
struct ac{
    int v, c, nex;
}edge[maxn<<9];
int head[maxn], cnt;
int dis[maxn], s, e;
int curedge[maxn];
int n, m, f;
void addedge(int u, int v, int c) {
    edge[cnt] = {v, c, head[u]};
    head[u] = cnt++;
    edge[cnt] = {u, 0, head[v]};
    head[v] = cnt++;
}
int bfs() {
    memset(dis, 0, sizeof(dis));
    dis[s] = 1;
    queue<int> que;
    que.push(s);
    while (!que.empty()) {
        int u = que.front();
        que.pop();
        for (int i = head[u]; i != -1; i = edge[i].nex) {
            int v = edge[i].v;
            int c = edge[i].c;
            if (c == 0 || dis[v]) continue;
            dis[v] = dis[u] + 1;
            que.push(v);
        }
    }
    return dis[e];
}
int dfs(int u, int flow) {
    if (u == e || flow == 0) return flow;
    for (int &i = curedge[u]; i != -1; i = edge[i].nex) {
        int v = edge[i].v;
        int c = edge[i].c;
        if (c == 0 || dis[v] != dis[u] + 1) continue;
        int tmp = dfs(v, min(flow, c));
        if (tmp > 0) {
            edge[i].c -= tmp;
            edge[i^1].c += tmp;
            return tmp;
        }
    }
    dis[u] = -1;
    return 0;
}
int Dinic() {
    int ans = 0, d;
    while (bfs()) {
        for (int i = 0; i <= e; ++i) curedge[i] = head[i];
        while ((d = dfs(s, inf)) > 0) ans += d;
    }
    return ans;
}
int pre[maxn];
int find(int x) {
    return (x == pre[x]) ? x : pre[x] = find(pre[x]);
}
void join(int x, int y) {
    if (x == y) return;
    if (x > y) swap(x, y);
    pre[y] = x;
    return;
}
vector<int> g[maxn];
int vis[maxn];
int check(int x) {
    memset(head, -1, sizeof(head));
    cnt = 0;
    for (int i = 1; i <= n; ++i) {
        memset(vis, 0, sizeof(vis));
        for (int j = 0; j < (int)g[i].size(); ++j) {
            int u = g[i][j];
            if (vis[u]) continue;
            // 找girl u的朋友
            for (int k = 1; k <= n; ++k) {
                if (vis[k] || find(u) != find(k)) continue;
                addedge(k, i+n, 1);
                vis[k] = 1;
            }
        }
    }
    for (int i = 1; i <= n; ++i) addedge(s, i, x), addedge(i+n, e, x);
    return Dinic() == x*n;
}
int main () {
    ios::sync_with_stdio(false);
    cin.tie(0), cout.tie(0);
    int T;
    cin >> T;
    while (T--) {
        cin >> n >> m >> f;
        s = 0, e = n * 2 + 1;
        for (int i = 0; i <= n; ++i) g[i].clear();
        for (int i = 0; i <= n; ++i) pre[i] = i;

        for (int i = 0; i < m; ++i) {
            int u, v;
            cin >> u >> v;
            g[v].push_back(u);
        }
        for (int i = 0; i < f; ++i) {
            int u, v;
            cin >> u >> v;
            join(find(u), find(v));
        }
        int l = 0, r = n;
        while (l <= r) {
            int mid = (l + r) >> 1;
            if (check(mid)) l = mid + 1;
            else r = mid - 1;
        }
        cout << r << endl;
    }
    return 0;
}
```

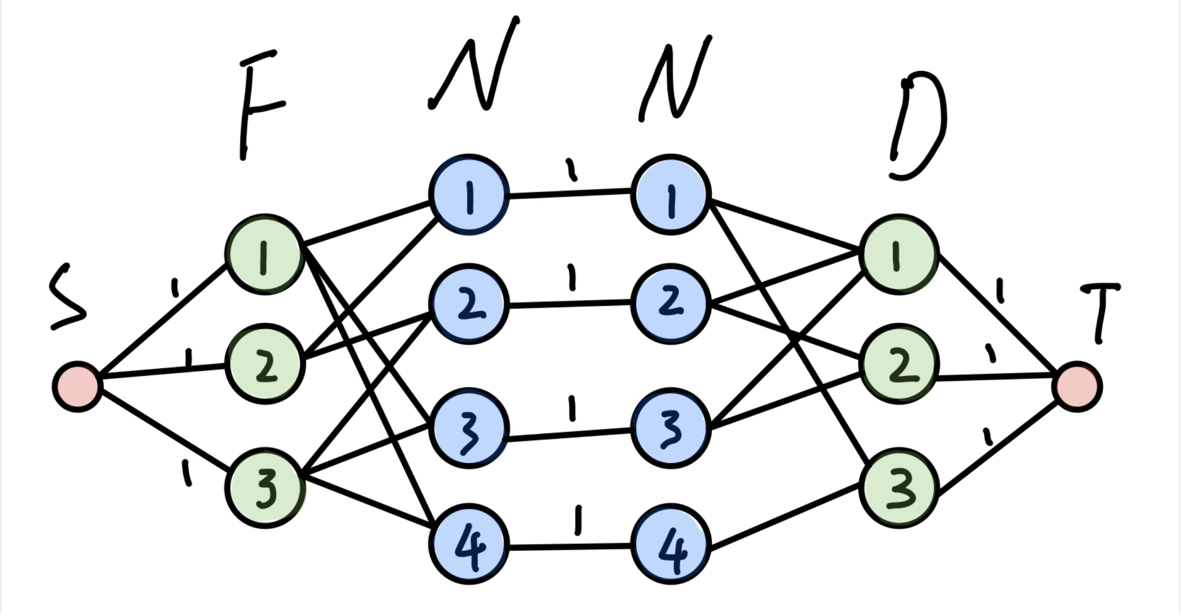
B - Dining(POJ-3281)

题意

每头牛都有各自喜欢的食物和饮料，而每种食物或饮料只能分配给一头牛。最多能有多少头牛可以同时得到喜欢的食物和饮料？

思路

最大流
将牛拆成点，限制牛的流量。保证增光路上对应得是牛喜欢的食物和水



```
#include <iostream>
#include <queue>
#include <cstring>
const int maxn = 4e2 + 5;
const int inf = 0x3f3f3f3f;
using namespace std;
struct ac{
    int v, c, nex;
}edge[maxn << 4];
int head[maxn], curedge[maxn], cnt, s, e;
int dis[maxn];
void init() {
    memset(head, -1, sizeof(head));
    cnt = 0;
}
void addedge(int u, int v, int c) {
    edge[cnt] = {v, c, head[u]};
    head[u] = cnt++;
    edge[cnt] = {u, 0, head[v]};
    head[v] = cnt++;
}
int bfs() {
    memset(dis, 0, sizeof(dis));
    dis[s] = 1;
    queue<int> que;
    que.push(s);
    while (!que.empty()) {
        int u = que.front();
        que.pop();
        for (int i = head[u]; i != -1; i = edge[i].nex) {
            int v = edge[i].v;
            int c = edge[i].c;
            if (dis[v] || c == 0) continue;
            dis[v] = dis[u] + 1;
            que.push(v);
        }
    }
    return dis[e] > 0;
}
int dfs(int u, int flow) {
    if (u == e || flow == 0) return flow;
    for (int &i = curedge[u]; i != -1; i = edge[i].nex) {
        int v = edge[i].v;
        int c = edge[i].c;
        if (dis[v] != dis[u] + 1) continue;
        int tmp = dfs(v, min(flow, c));
        if (tmp > 0) {
            edge[i].c -= tmp;
            edge[i^1].c += tmp;
            return tmp;
        }
    }
    dis[u] = -1;
    return 0;
}
int Dinic() {
    int ans = 0, tmp;
    while (bfs()) {
        for (int i = 0; i <= e; ++i) curedge[i] = head[i];
        while ((tmp = dfs(s, inf)) > 0) ans += tmp;
    }
    return ans;
}
int main () {
    ios::sync_with_stdio(false);
    cin.tie(0), cout.tie(0);
    int n, f, d;
    while (cin >> n >> f >> d) {
        init();
        s = 0, e = n*2 + f + d + 1;
        for (int i = 1; i <= n; ++i) {
            int a, b, t;
            cin >> a >> b;
            for (int j = 1; j <= a; ++j) {
                cin >> t;
                addedge(t, f+i, 1);
            }
            for (int j = 1; j <= b; ++j) {
                cin >> t;
                addedge(f+n+i, n*2+f+t, 1);
            }
        }
        for (int j = 1; j <= f; ++j) addedge(s, j, 1);
        for (int j = 1; j <= d; ++j) addedge(n*2+f+j, e, 1);
        for (int j = 1; j <= n; ++j) addedge(f+j, f+n+j, 1);
        cout << Dinic() << endl;
    }
    return 0;
}
```

C - A Plug for UNIX (POJ-1087)

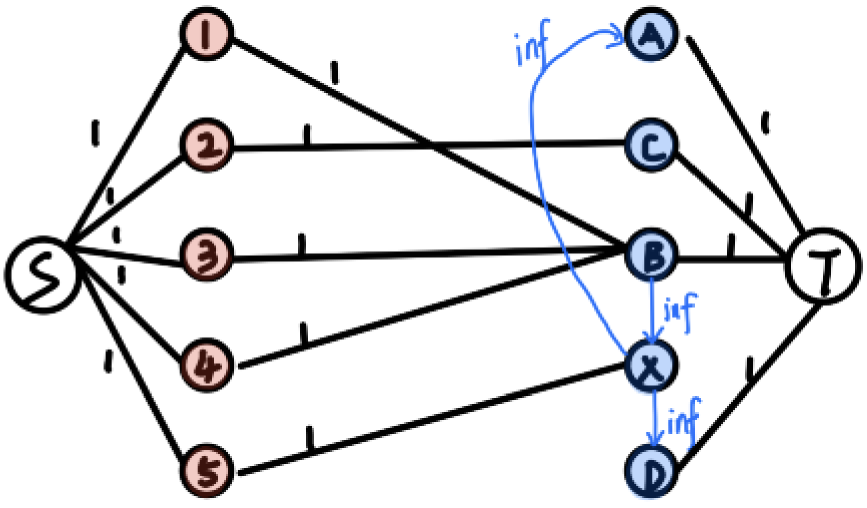
题意

一共有N个插座，M个设备，K个转换器，转换器可以无限提供，问最少有多少个设备不能连接电源

思路

最大流
建图：

- 源点到设备流量1
- 插座到汇点流量1
- 转换器之间流量inf



```
#include <iostream>
#include <stdio.h>
#include <queue>
#include <map>
#include <cstring>
const int maxn = 4e2 + 5;
const int inf = 0x3f3f3f3f;
using namespace std;
struct ac{
    int v, c, nex;
}edge[maxn << 7];
int head[maxn], curedge[maxn], cnt, s, e;
int dis[maxn];
int a[maxn][maxn];
void init() {
    memset(head, -1, sizeof(head));
    memset(a, 0, sizeof(a));
    cnt = 0;
}
void addedge(int u, int v, int c) {
    edge[cnt] = {v, c, head[u]};
    head[u] = cnt++;
    edge[cnt] = {u, 0, head[v]};
    head[v] = cnt++;
}
int bfs() {
    memset(dis, 0, sizeof(dis));
    dis[s] = 1;
    queue<int> que;
    que.push(s);
    while (!que.empty()) {
        int u = que.front();
        que.pop();
        for (int i = head[u]; i != -1; i = edge[i].nex) {
            int v = edge[i].v;
            int c = edge[i].c;
            if (dis[v] || c == 0) continue;
            dis[v] = dis[u] + 1;
            que.push(v);
        }
    }
    return dis[e] > 0;
}
int dfs(int u, int flow) {
    if (u == e || flow == 0) return flow;
    for (int &i = curedge[u]; i != -1; i = edge[i].nex) {
        int v = edge[i].v;
        int c = edge[i].c;
        if (dis[v] != dis[u] + 1) continue;
        int tmp = dfs(v, min(flow, c));
        if (tmp > 0) {
            edge[i].c -= tmp;
            edge[i^1].c += tmp;
            return tmp;
        }
    }
    dis[u] = -1;
    return 0;
}
int Dinic() {
    int ans = 0, tmp;
    while (bfs()) {
        for (int i = 0; i <= e; ++i) curedge[i] = head[i];
        while ((tmp = dfs(s, inf)) > 0) ans += tmp;
    }
    return ans;
}
int main () {
    ios::sync_with_stdio(false);
    cin.tie(0), cout.tie(0);
    int n, m, q;
    while (cin >> n) {
        init();
        map<string, int> mp;
        int num = 0;
        vector<string> have(maxn), device(maxn);
        for (int i = 0; i < n; ++i) {
            cin >> have[i];
            if (mp[have[i]] == 0) mp[have[i]] = ++num;
        }
        cin >> m;
        for (int j = 0; j < m; ++j) {
            cin >> device[j] >> device[j];
            if (mp[device[j]] == 0) mp[device[j]] = ++num;
        }
        cin >> q;
        for (int i = 0; i < q; ++i) {
            string l, r;
            cin >> l >> r;
            if (mp[l] == 0) mp[l] = ++num;
            if (mp[r] == 0) mp[r] = ++num;
            addedge(mp[l], mp[r], inf);
        }
        s = 0, e = num + 1;
        for (int i = 0; i < m; ++i) addedge(s, mp[device[i]], 1);
        for (int i = 0; i < n; ++i) addedge(mp[have[i]], e, 1);
        cout << m - Dinic() << endl;
    }
    return 0;
}
```

D - Going Home(POJ-2195)

题意

n个人要进到房子里面，每个人的花费是他移动的距离。求n个人进房子的最小花费

思路

费用流

```
#include <iostream>
#include <queue>
#include <cmath>
#include <cstring>
const int maxn = 1e4 + 5;
const int inf = 0x3f3f3f3f;
using namespace std;
int path[maxn], dis[maxn], head[maxn], vis[maxn];
int cnt, s, e;
void init() {
    memset(head, -1, sizeof(head));
    cnt = 0;
}
struct ac{
    int v, c, cost, nex;
}edge[maxn << 11];
void addedge(int u, int v, int c, int cost) {
    edge[cnt] = {v, c, cost, head[u]};
    head[u] = cnt++;
    edge[cnt] = {u, 0, -cost, head[v]};
    head[v] = cnt++;
```

```
}
int spfa(int s, int e) {
    memset(vis, 0, sizeof(vis));
    memset(dis, inf, sizeof(dis));
    memset(path, -1, sizeof(path));
    queue<int> que;
    que.push(s);
    dis[s] = 0;
    vis[s] = 1;
    while (!que.empty()) {
        int u = que.front();
        que.pop();
        vis[u] = 0;
        for (int i = head[u]; i != -1; i = edge[i].nex) {
            int v = edge[i].v;
            int c = edge[i].c;
            int cost = edge[i].cost;
            if (dis[v] > dis[u] + cost && c > 0) {
                dis[v] = dis[u] + cost;
                path[v] = i;
                if (vis[v]) continue;
                vis[v] = 1;
                que.push(v);
            }
        }
    }
    return dis[e] != inf;
}
int MincostMaxflow(int s, int e, int &cost) {
    int maxflow = 0;
    while (spfa(s, e)) {
        int flow = inf;
        for (int i = path[e]; i != -1; i = path[edge[i^1].v]) {
            flow = min(flow, edge[i].c);
        }
        for (int i = path[e]; i != -1; i = path[edge[i^1].v]) {
            edge[i].c -= flow;
            edge[i^1].c += flow;
            cost += flow * edge[i].cost;
        }
        maxflow += flow;
    }
    return maxflow;
}
int main () {
    ios::sync_with_stdio(false);
    cin.tie(0), cout.tie(0);
    int n, m; char c;
    while (cin >> n >> m, n) {
        init();
        vector<pair<int,int> > H, M;
        for(int i = 0; i < n; ++i) {
            for (int j = 0; j < m; ++j) {
                cin >> c;
                if (c == 'm') M.push_back(make_pair(i, j));
                if (c == 'H') H.push_back(make_pair(i, j));
            }
        }
        int cntH = H.size();
        int cntM = M.size();
        s = 0, e = cntH + cntM + 1;
        for (int i = 0; i < cntM; ++i) {
            addedge(s, i+1, 1, 0);
        }
        for (int i = 0; i < cntH; ++i) {
            addedge(cntM+i+1, e, 1, 0);
        }
        for (int i = 0; i < cntH; ++i) {
            for (int j = 0; j < cntM; ++j) {
                int cost = fabs(H[i].first - M[j].first) + fabs(H[i].second -
M[j].second);
                addedge(j+1, cntM+i+1, 1, cost);
            }
        }
        int cost = 0;
        MincostMaxflow(s, e, cost);
        cout << cost << endl;
    }
    return 0;
}
```

E - Minimum Cost(POJ-2516)

题意

N个商店每个商店需要K个货物，需求量各不相同，M个供应商每个供应商都提供K个货物，供应量各不相同，货物不同的供应商提供的价格不同，求最小的花费满足N个商店的需求

思路

费用流
每种货物互相不影响，每种货物可以单独考虑，简化建图
建图：

- 源点到供应商 流量为存货量，费用为0
- 供应商到商店 流量为inf，费用为对应的单价
- 商店到汇点 流量为需求量，费用为0

w5

```
#include <iostream>
#include <stdio.h>
#include <cstring>
#include <queue>
const int maxn = 1e2 + 5;
const int inf = 0x3f3f3f3f;
using namespace std;
struct ac{
    int v, c, cost, nex;
}edge[maxn << 5];
int dis[maxn], vis[maxn];
int head[maxn], cnt, path[maxn];
void addedge(int u, int v, int c, int cost) {
    edge[cnt] = {v, c, cost, head[u]};
    head[u] = cnt++;
    edge[cnt] = {u, 0, -cost, head[v]};
    head[v] = cnt++;
}
void init() {
    memset(head, -1, sizeof(head));
    cnt = 0;
}
int spfa(int s, int e) {
    memset(vis, 0, sizeof(vis));
    memset(dis, inf, sizeof(dis));
    memset(path, -1, sizeof(path));
    dis[s] = 0;
    vis[s] = 1;
    queue<int> que;
    que.push(s);
    while (!que.empty()) {
        int u = que.front();
        que.pop();
        vis[u] = 0;
        for (int i = head[u]; i != -1; i = edge[i].nex) {
            int v = edge[i].v;
            int c = edge[i].c;
            int cost = edge[i].cost;
            if (c == 0 || dis[v] <= dis[u] + cost) continue;
            path[v] = i;
            dis[v] = dis[u] + cost;
            if (vis[v]) continue;
            vis[v] = 1;
            que.push(v);
        }
    }
    return dis[e] != inf;
}
int MCMF(int s, int e, int &cost) {
    int maxflow = 0;
    while (spfa(s, e)) {
        int flow = inf;
        for (int i = path[e]; i != -1; i = path[edge[i^1].v]) {
            flow = min(flow, edge[i].c);
        }
        for (int i = path[e]; i != -1; i = path[edge[i^1].v]) {
            edge[i].c -= flow;
            edge[i^1].c += flow;
            cost += flow * edge[i].cost;
        }
        maxflow += flow;
    }
    return maxflow;
}
int supply[55][55];
int need[55][55];
int price[55][55][55];
int main() {
    ios::sync_with_stdio(false);
    cin.tie(0), cout.tie(0);
    int n, m, k;
    while (cin >> n >> m >> k, n) {
        for (int i = 1; i <= n; ++i) {
            for (int j = 1; j <= k; ++j) {
                cin >> need[i][j]; // 商店i需要货物j
            }
        }
        for (int i = 1; i <= m; ++i) {
            for (int j = 1; j <= k; ++j) {
                cin >> supply[i][j]; // 供应商i提供货物j
            }
        }
        for (int q = 1; q <= k; ++q) {
            for (int i = 1; i <= n; ++i) {
                for (int j = 1; j <= m; ++j) {
                    cin >> price[q][j][i]; // 货物q从j到i的价格
                }
            }
        }
        // 分开对每个货物求费用流
        int s = 0, e = m + n + 1;
        int ans = 0;
        for (int q = 1; q <= k; ++q) {
            int sum = 0;
            for (int i = 1; i <= n; ++i) {
                sum += need[i][q];
            }
            init();
            for (int i = 1; i <= m; ++i) addedge(s, i, supply[i][q], 0);
            for (int i = 1; i <= n; ++i) addedge(m+i, e, need[i][q], 0);
            for (int i = 1; i <= m; ++i) {
                for (int j = 1; j <= n; ++j) {
                    addedge(i, m+j, inf, price[q][i][j]);
                }
            }
            int maxflow = MCMF(s, e, ans);
            if (maxflow != sum) {
                ans = -1;
                break;
            }
        }
        cout << ans << endl;
    }
    return 0;
}
```

F - Power Network(POJ - 1459)

题意

np个发电站供电，nc个用户消耗，m条线路，求最大的消耗量

思路

最大流

```
#include <iostream>
#include <stdio.h>
```

```
#include <queue>
#include <cstring>
const int maxn = 2e2 + 5;
const int inf = 0x3f3f3f3f;
using namespace std;
struct ac{
    int v, c, nex;
}edge[maxn << 8];
int head[maxn], cnt;
int dis[maxn], s, e;
int curedge[maxn];
void addedge(int u, int v, int c) {
    edge[cnt] = {v, c, head[u]};
    head[u] = cnt++;
    edge[cnt] = {u, 0, head[v]};
    head[v] = cnt++;
}
int bfs() {
    memset(dis, 0, sizeof(dis));
    dis[s] = 1;
    queue<int> que;
    que.push(s);
    while (!que.empty()) {
        int u = que.front();
        que.pop();
        for (int i = head[u]; i != -1; i = edge[i].nex) {
            int v = edge[i].v;
            int c = edge[i].c;
            if (c == 0 || dis[v]) continue;
            dis[v] = dis[u] + 1;
            que.push(v);
        }
    }
    return dis[e];
}
int dfs(int u, int flow) {
    if (u == e || flow == 0) return flow;
    for (int &i = curedge[u]; i != -1; i = edge[i].nex) {
        int v = edge[i].v;
        int c = edge[i].c;
        if (c == 0 || dis[v] != dis[u] + 1) continue;
        int tmp = dfs(v, min(flow, c));
        if (tmp > 0) {
            edge[i].c -= tmp;
            edge[i^1].c += tmp;
            return tmp;
        }
    }
    dis[u] = -1;
    return 0;
}
int Dinic() {
    int ans = 0, d;
    while (bfs()) {
        for (int i = 0; i <= e; ++i) curedge[i] = head[i];
        while ((d = dfs(s, inf)) > 0) ans += d;
    }
    return ans;
}
int main () {
    ios::sync_with_stdio(false);
    cin.tie(0), cout.tie(0);
    int n, np, nc, m;
    while (scanf("%d %d %d %d", &n, &np, &nc, &m) != EOF) {
        s = n, e = n + 1;
        memset(head, -1, sizeof(head));
        cnt = 0;
        int u, v, c;
        for (int i = 0; i < m; ++i) {
            scanf(" (%d,%d)%d", &u, &v, &c);
            addedge(u, v, c);
        }
        for (int i = 0; i < np; ++i) {
            scanf(" (%d)%d", &v, &c);
            addedge(s, v, c);
        }
        for (int i = 0; i < nc; ++i) {
            scanf(" (%d)%d", &v, &c);
            addedge(v, e, c);
        }
        printf("%d\n", Dinic());
    }
    return 0;
}
```

G - Food(HDU-4292)

题意

N个人分别有自己喜欢的食物和饮料，实物和饮料有一定的数量，最多能满足多少人的需求?

思路

把人拆点，限制人的流量

建图:

- 源点到食物按库存建边
- 食物到人按需求建边
- 人到饮料按需求建边
- 饮料到汇点按库存建边

```
#include <iostream>
#include <queue>
#include <cmath>
#include <cstring>
const int maxn = 8e2 + 5;
const int inf = 0x3f3f3f3f;
using namespace std;

int head[maxn], cnt;
int s, e;
int curedge[maxn], dis[maxn];
struct ac{
    int v, c, nex;
```

```
}edge[maxn << 8];
void addedge(int u, int v, int c) {
    edge[cnt] = {v, c, head[u]};
    head[u] = cnt++;
    edge[cnt] = {u, 0, head[v]};
    head[v] = cnt++;
}
int bfs() {
    memset(dis, 0, sizeof(dis));
    dis[s] = 1;
    queue<int> que;
    que.push(s);
    while (!que.empty()) {
        int u = que.front();
        que.pop();
        for (int i = head[u]; i != -1; i = edge[i].nex) {
            int v = edge[i].v;
            int c = edge[i].c;
            if (c == 0 || dis[v]) continue;
            dis[v] = dis[u] + 1;
            que.push(v);
        }
    }
    return dis[e];
}
int dfs(int u, int flow) {
    if (u == e || flow == 0) return flow;
    for (int &i = curedge[u]; i != -1; i = edge[i].nex) {
        int v = edge[i].v;
        int c = edge[i].c;
        if (dis[v] != dis[u] + 1 || c == 0) continue;
        int tmp = dfs(v, min(flow, c));
        if (tmp > 0) {
            edge[i].c -= tmp;
            edge[i^1].c += tmp;
            return tmp;
        }
    }
    dis[u] = -1;
    return 0;
}
int Dinic() {
    int ans = 0, d;
    while (bfs()) {
        for (int i = 0; i <= e; ++i) curedge[i] = head[i];
        while ((d = dfs(s, inf)) > 0) ans += d;
    }
    return ans;
}
int main () {
    ios::sync_with_stdio(false);
    cin.tie(0), cout.tie(0);
    int n, f, d, t;
    while (cin >> n >> f >> d) {
        memset(head, -1, sizeof(head));
        cnt = 0;
        s = 0, e = f+n+n+d+1;
        string str;
        for (int i = 1; i <= f; ++i) {
            cin >> t;
            addedge(s, i, t);
        }
        for (int i = 1; i <= d; ++i) {
            cin >> t;
            addedge(f+n+n+i, e, t);
        }
        for (int i = 1; i <= n; ++i) {
            cin >> str;
            for (int j = 0; j < f; ++j) {
                if (str[j] == 'N') continue;
                addedge(j+1, f+i, 1);
            }
        }
        for (int i = 1; i <= n; ++i) {
            cin >> str;
            for (int j = 0; j < d; ++j) {
                if (str[j] == 'N') continue;
                addedge(f+n+i, f+n+n+j+1, 1);
            }
        }
        for (int i = 1; i <= n; ++i) addedge(f+i, f+n+i, 1);
        cout << Dinic() << endl;
    }
    return 0;
}
```

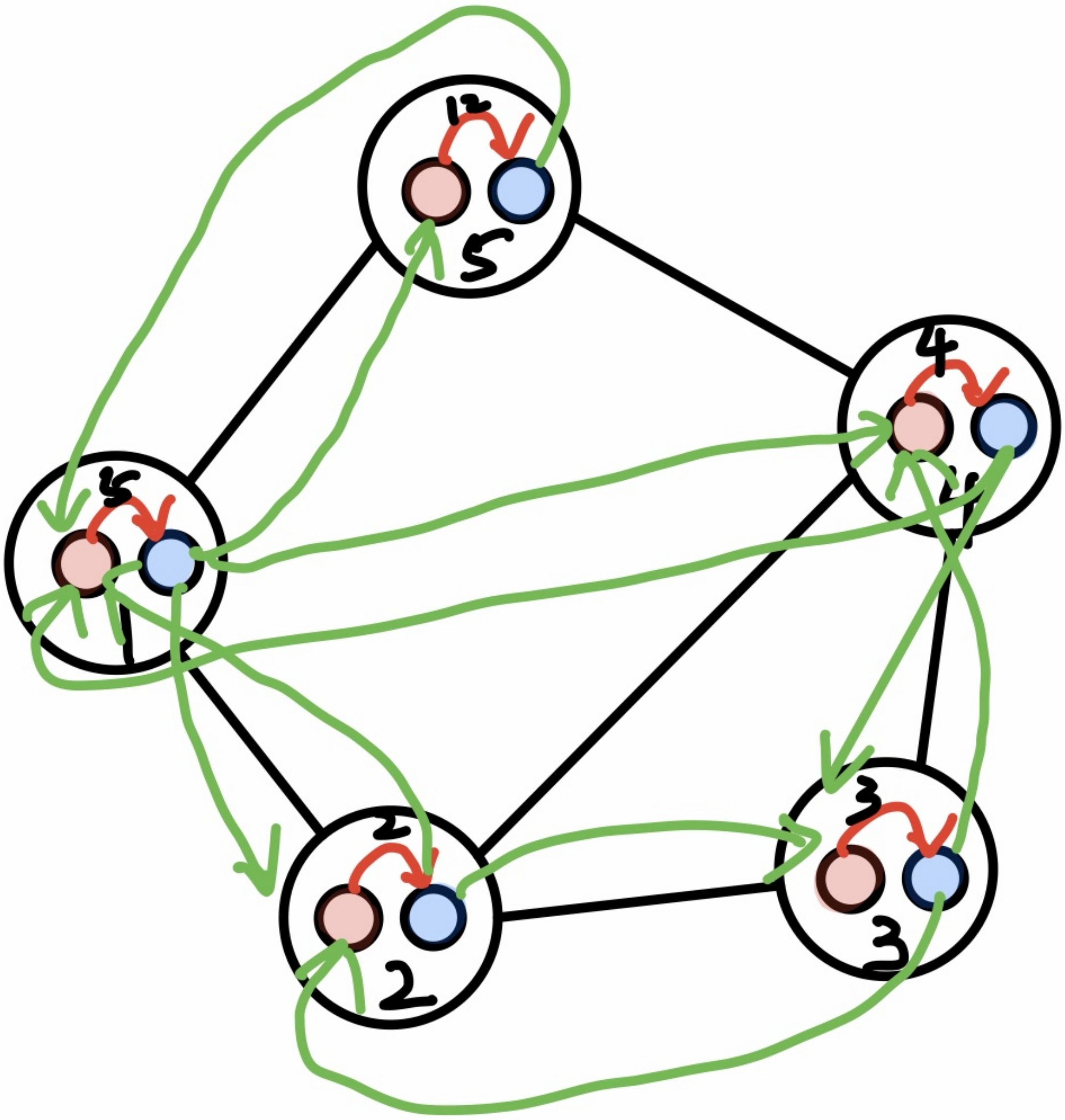
H - Control(HDU-4289)

题意

N个城市，每个城市建立SA有一定的花费，从出发点到目的点，在保证抓获劫匪的前提花费最小

思路

最小割 = 最大流
保证抓获所有的劫匪，等价于源点到汇点不连通



```
#include <iostream>
#include <queue>
#include <cmath>
#include <cstring>
const int maxn = 4e2 + 5;
const int inf = 0x3f3f3f3f;
using namespace std;

int head[maxn], cnt;
int s, e;
int curedge[maxn], dis[maxn];
int n, m, val;
struct ac{
    int v, c, nex;
}edge[maxn << 8];
void addedge(int u, int v, int c) {
    edge[cnt] = {v, c, head[u]};
    head[u] = cnt++;
    edge[cnt] = {u, 0, head[v]};
    head[v] = cnt++;
}
int bfs() {
    memset(dis, 0, sizeof(dis));
    dis[s] = 1;
    queue<int> que;
    que.push(s);
    while (!que.empty()) {
        int u = que.front();
        que.pop();
        for (int i = head[u]; i != -1; i = edge[i].nex) {
            int v = edge[i].v;
            int c = edge[i].c;
            if (c == 0 || dis[v]) continue;
            dis[v] = dis[u] + 1;
            que.push(v);
        }
    }
    return dis[e];
}
int dfs(int u, int flow) {
    if (u == e || flow == 0) return flow;
    for (int &i = curedge[u]; i != -1; i = edge[i].nex) {
        int v = edge[i].v;
        int c = edge[i].c;
        if (dis[v] != dis[u] + 1 || c == 0) continue;
        int tmp = dfs(v, min(flow, c));
        if (tmp > 0) {
            edge[i].c -= tmp;
            edge[i^1].c += tmp;
            return tmp;
        }
    }
    dis[u] = -1;
    return 0;
}
int Dinic() {
    int ans = 0, d;
    while (bfs()) {
        for (int i = 0; i <= n*2; ++i) curedge[i] = head[i];
        while ((d = dfs(s, inf)) > 0) ans += d;
    }
    return ans;
}
int L(int x) {return (x - 1) * 2;}
int R(int x) {return L(x) + 1;}
int main () {
    ios::sync_with_stdio(false);
    cin.tie(0), cout.tie(0);
    while (cin >> n >> m) {
        memset(head, -1, sizeof(head));
        cnt = 0;
        cin >> s >> e;
        s = L(s);
        e = R(e);
        for (int i = 1; i <= n; ++i) {
            cin >> val;
            addedge(L(i), R(i), val);
        }
        for (int i = 1; i <= m; ++i) {
            int u, v;
            cin >> u >> v;
            addedge(R(u), L(v), inf);
            addedge(R(v), L(u), inf);
        }
        cout << Dinic() << endl;
    }
    return 0;
}
```

I - Sabotage(UVA-10480)

题意

在花费最小的情况下将点1和点2分开

思路

最小割 = 最大流

```
#include <iostream>
#include <stdio.h>
#include <queue>
#include <cstring>
const int maxn = 1e2 + 5;
const int inf = 0x3f3f3f3f;
using namespace std;
struct ac{
    int v, c, nex;
}edge[maxn<<5];
int n, m;
int head[maxn], cnt;
int dis[maxn], s, e;
int curedge[maxn];
void addedge(int u, int v, int c) {
    edge[cnt] = {v, c, head[u]};
    head[u] = cnt++;
    edge[cnt] = {u, c, head[v]};
    head[v] = cnt++;
}
int bfs() {
    memset(dis, 0, sizeof(dis));
    dis[s] = 1;
    queue<int> que;
    que.push(s);
    while (!que.empty()) {
        int u = que.front();
        que.pop();
        for (int i = head[u]; i != -1; i = edge[i].nex) {
            int v = edge[i].v;
            int c = edge[i].c;
            if (c == 0 || dis[v]) continue;
            dis[v] = dis[u] + 1;
            que.push(v);
        }
    }
    return dis[e];
}
```

```cpp
int dfs(int u, int flow) {
    if (u == e || flow == 0) return flow;
    for (int &i = curedge[u]; i != -1; i = edge[i].nex) {
        int v = edge[i].v;
        int c = edge[i].c;
        if (c == 0 || dis[v] != dis[u] + 1) continue;
        int tmp = dfs(v, min(flow, c));
        if (tmp > 0) {
            edge[i].c -= tmp;
            edge[i^1].c += tmp;
            return tmp;
        }
    }
    dis[u] = -1;
    return 0;
}
int Dinic() {
    int ans = 0, d;
    while (bfs()) {
        for (int i = 0; i <= n; ++i) curedge[i] = head[i];
        while ((d = dfs(s, inf)) > 0) ans += d;
    }
    return ans;
}
int main () {
    ios::sync_with_stdio(false);
    cin.tie(0), cout.tie(0);
    while (cin >> n >> m, n&&m) {
        memset(head, -1, sizeof(head));
        cnt = 0;
        s = 1, e = 2;
        vector<pair<int,int> > edges(m);
        for (int i = 0; i < m; ++i) {
            int u, v, c;
            cin >> u >> v >> c;
            edges[i] = make_pair(u, v);
            addedge(u, v, c);
            addedge(v, u, c);
        }
        Dinic();
        for (auto it : edges) {
            int u = it.first;
            int v = it.second;
            if ((dis[u] && !dis[v]) || (!dis[u] && dis[v])) {
                cout << u << " " << v << endl;
            }
        }
        cout << endl;
    }
    return 0;
}
```