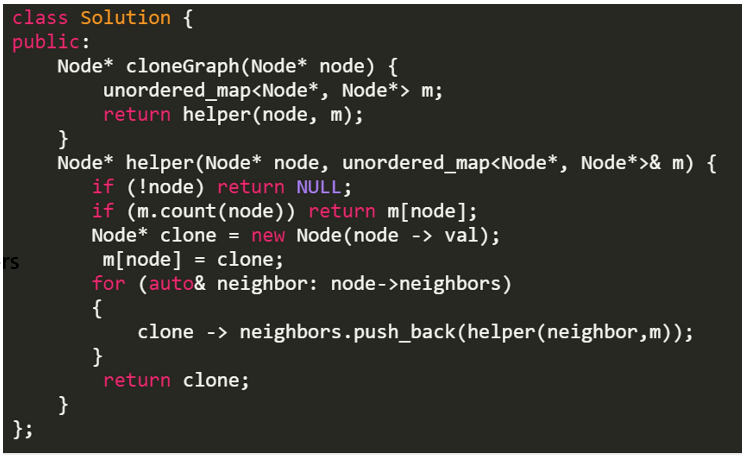
Graph with BFS and DFS

2019年10月25日 下午 2:28

- **Common Methods:**
  DFS, BFS, Union Fine, Topologic Sorting

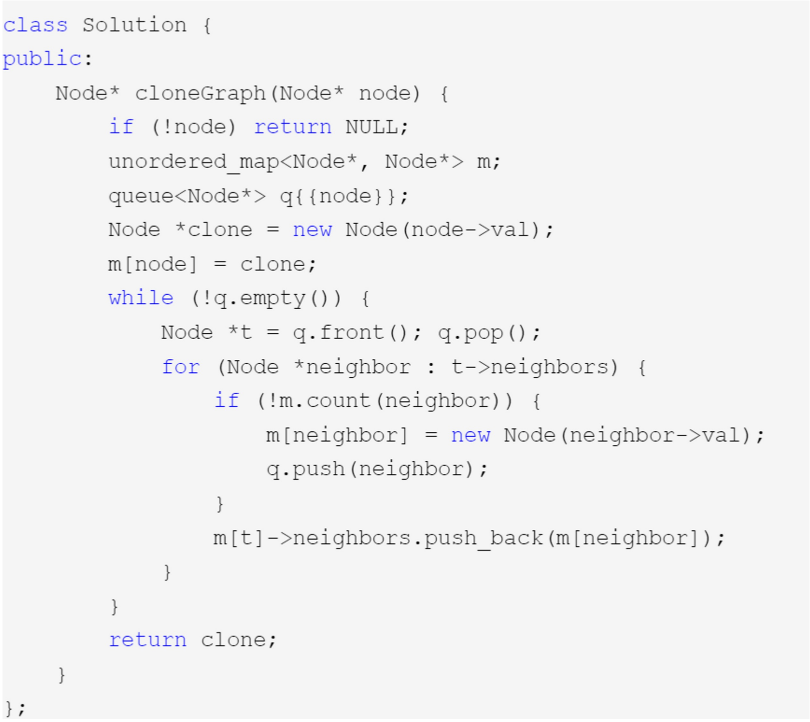
核心是想办法把一个问题看成graph问题

★ **图的DFS遍历，用hashmap存每个节点的neighbors**



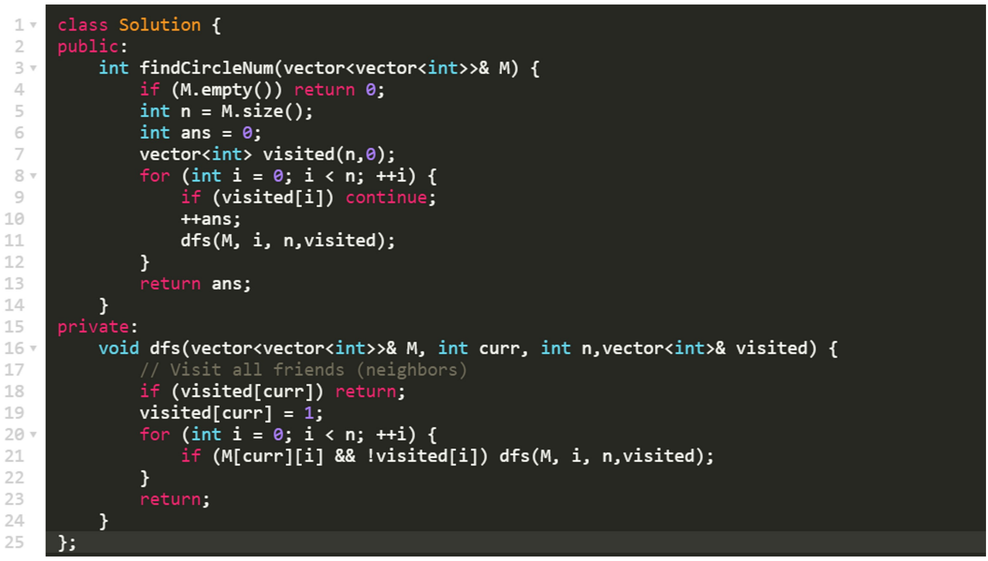
```cpp
class Solution {
public:
    Node* cloneGraph(Node* node) {
        unordered_map<Node*, Node*> m;
        return helper(node, m);
    }
    Node* helper(Node* node, unordered_map<Node*, Node*>& m) {
       if (!node) return NULL;
       if (m.count(node)) return m[node];
       Node* clone = new Node(node -> val);
        m[node] = clone;
       for (auto& neighbor: node->neighbors)
       {
          clone -> neighbors.push_back(helper(neighbor,m));
       }
        return clone;
    }
};
```

★ **图的BFS遍历，用hashmap存每个节点的neighbors，queue去遍历**



```cpp
class Solution {
public:
    Node* cloneGraph(Node* node) {
        if (!node) return NULL;
        unordered_map<Node*, Node*> m;
        queue<Node*> q{{node}};
        Node *clone = new Node(node->val);
        m[node] = clone;
        while (!q.empty()) {
            Node *t = q.front(); q.pop();
            for (Node *neighbor : t->neighbors) {
                if (!m.count(neighbor)) {
                    m[neighbor] = new Node(neighbor->val);
                    q.push(neighbor);
                }
                m[t]->neighbors.push_back(m[neighbor]);
            }
        }
        return clone;
    }
};
```

Leetcode 200 islands or 695 以及 547 Friend Circles 一模一样的题目，联通分量，DFS
只不过双重for循环，一个for循环放在dfs里面
visited 一维数组表示friends circles



```cpp
1  class Solution {
2  public:
3      int findCircleNum(vector<vector<int>>& M) {
4          if (M.empty()) return 0;
5          int n = M.size();
6          int ans = 0;
7          vector<int> visited(n,0);
8          for (int i = 0; i < n; ++i) {
9              if (visited[i]) continue;
10             ++ans;
11             dfs(M, i, n,visited);
12         }
13         return ans;
14     }
15 private:
16     void dfs(vector<vector<int>>& M, int curr, int n,vector<int>& visited) {
17         // Visit all friends (neighbors)
18         if (visited[curr]) return;
19         visited[curr] = 1;
20         for (int i = 0; i < n; ++i) {
21             if (M[curr][i] && !visited[i]) dfs(M, i, n,visited);
22         }
23         return;
24     }
25 };
```

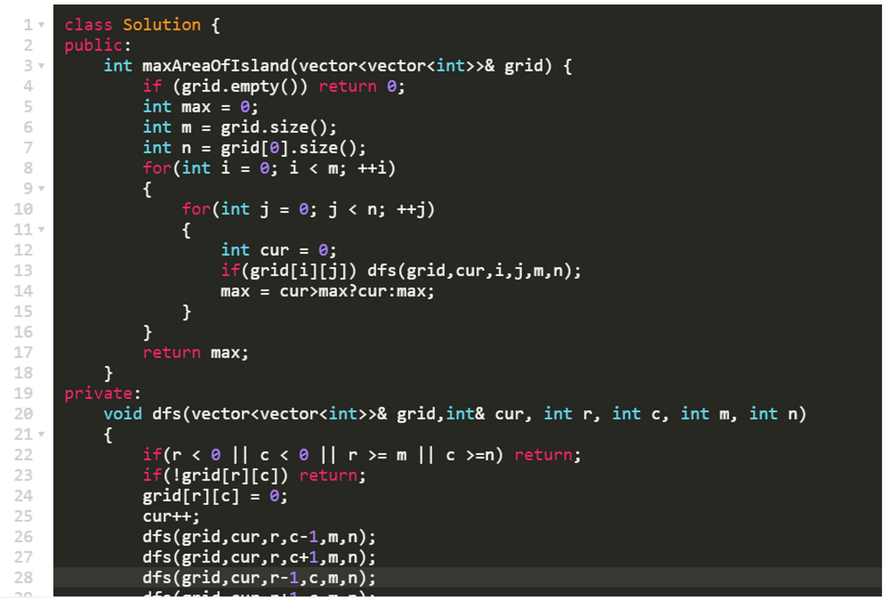
18 行不是多余的，当recursive调用的时候很有用

用visited,表示这个人的所有朋友都访问过，所以不用再访问;

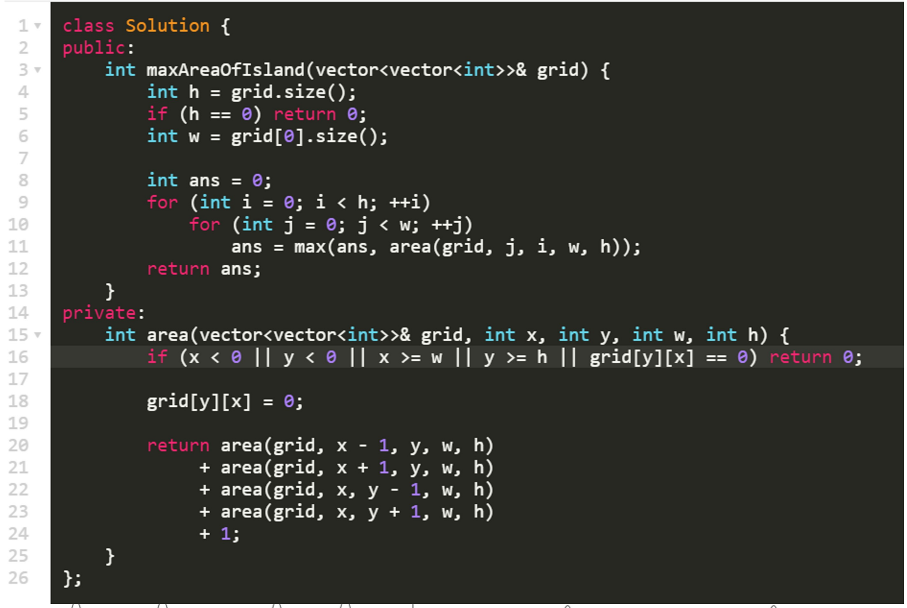
18 行不是多余的，当recursive调用的时候很有用

用visited,表示这个人的所有朋友都访问过，所以不用再访问；

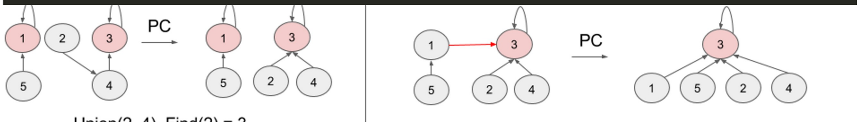
- ★ 能返回int值就返回int值的比较快，不用传入值进去；
- ★ 上下进行比较 void dfs(max...) or int dfs()



```
1  class Solution {
2  public:
3      int maxAreaOfIsland(vector<vector<int>>& grid) {
4          if (grid.empty()) return 0;
5          int max = 0;
6          int m = grid.size();
7          int n = grid[0].size();
8          for(int i = 0; i < m; ++i)
9          {
10             for(int j = 0; j < n; ++j)
11             {
12                 int cur = 0;
13                 if(grid[i][j]) dfs(grid,cur,i,j,m,n);
14                 max = cur>max?cur:max;
15             }
16         }
17         return max;
18     }
19 private:
20     void dfs(vector<vector<int>>& grid,int& cur, int r, int c, int m, int n)
21     {
22         if(r < 0 || c < 0 || r >= m || c >=n) return;
23         if(!grid[r][c]) return;
24         grid[r][c] = 0;
25         cur++;
26         dfs(grid,cur,r,c-1,m,n);
27         dfs(grid,cur,r,c+1,m,n);
28         dfs(grid,cur,r-1,c,m,n);
```



```
1  class Solution {
2  public:
3      int maxAreaOfIsland(vector<vector<int>>& grid) {
4          int h = grid.size();
5          if (h == 0) return 0;
6          int w = grid[0].size();
7
8          int ans = 0;
9          for (int i = 0; i < h; ++i)
10             for (int j = 0; j < w; ++j)
11                 ans = max(ans, area(grid, j, i, w, h));
12         return ans;
13     }
14 private:
15     int area(vector<vector<int>>& grid, int x, int y, int w, int h) {
16         if (x < 0 || y < 0 || x >= w || y >= h || grid[y][x] == 0) return 0;
17
18         grid[y][x] = 0;
19
20         return area(grid, x - 1, y, w, h)
21              + area(grid, x + 1, y, w, h)
22              + area(grid, x, y - 1, w, h)
23              + area(grid, x, y + 1, w, h)
24              + 1;
25     }
26 };
```



Union(2, 4), Find(2) = 3

Union(5, 2) = Union(Find(5), Find(2))

Ref: https://www.cs.princeton.edu/~rs/AlgsDS07/01UnionFind.pdf

PC = path compression

- □★ 遇到图想着用 adjacency lists 来表示

  map<int, vector<int>> graph --> graph.at(边1);

Union Find!! 查找cycles

https://zxi.mytechroad.com/blog/data-structure/sp1-union-find-set/

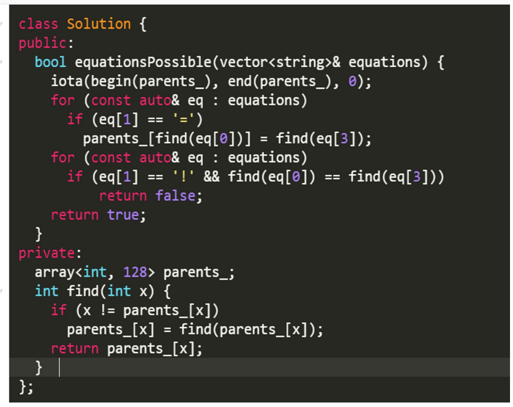
```
class UnionFindSet {
public:
  UnionFindSet(int n) {
    ranks_ = vector<int>(n + 1, 0);
    parents_ = vector<int>(n + 1, 0);

    for (int i = 0; i < parents_.size(); ++i)
      parents_[i] = i;
  }

  // Merge sets that contains u and v.
  // Return true if merged, false if u and v are already in one set.
  bool Union(int u, int v) {
```

Leetcode 684 & 685 redundant connection 1 and 2

Leetcode

Leetcode 990 Statifiablitity of equality equations

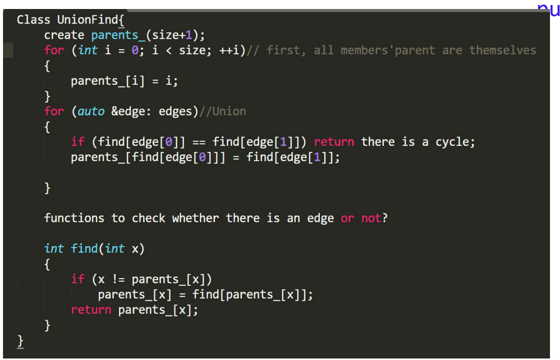
more concise Union Find



```
class Solution {
public:
  bool equationsPossible(vector<string>& equations) {
    iota(begin(parents_), end(parents_), 0);
    for (const auto& eq : equations)
      if (eq[1] == '=')
        parents_[find(eq[0])] = find(eq[3]);
    for (const auto& eq : equations)
      if (eq[1] == '!' && find(eq[0]) == find(eq[3]))
          return false;
    return true;
  }
private:
  array<int, 128> parents_;
  int find(int x) {
    if (x != parents_[x])
      parents_[x] = find(parents_[x]);
    return parents_[x];
  }
};
```

iota 用顺序递增的值存储在指定范围内

0， ……, 126,127,128



```
Class UnionFind{
    create parents_(size+1);
    for (int i = 0; i < size; ++i)// first, all members'parent are themselves
    {
        parents_[i] = i;
    }
    for (auto &edge: edges)//Union
    {
        if (find[edge[0]] == find[edge[1]]) return there is a cycle;
        parents_[find[edge[0]]] = find[edge[1]];

    }

    functions to check whether there is an edge or not?

    int find(int x)
    {
        if (x != parents_[x])
            parents_[x] = find[parents_[x]];
        return parents_[x];
    }
}
```

```
    int pu = Find(u);
    int pv = Find(v);
    if (pu == pv) return false;

    // Meger low rank tree into high rank tree
    if (ranks_[pv] > ranks_[pu])
      parents_[pu] = pv;
    else if (ranks_[pu] > ranks_[pv])
      parents_[pv] = pu;
    else {
      parents_[pv] = pu;
      ranks_[pv] += 1;
    }

    return true;
  }

  // Get the root of u.
  int Find(int u) {
    // Compress the path during traversal
    if (u != parents_[u])
      parents_[u] = Find(parents_[u]);
    return parents_[u];
  }
private:
  vector<int> parents_;
  vector<int> ranks_;
};

class Solution {
public:
  vector<int> findRedundantConnection(vector<vector<int>>& edges) {
    UnionFindSet s(edges.size());

    for(const auto& edge: edges)
      if (!s.Union(edge[0], edge[1]))
        return edge;

    return {};
  }
};
```

来自 <https://zxi.mytechroad.com/blog/tree/leetcode-684-redundant-connection/>

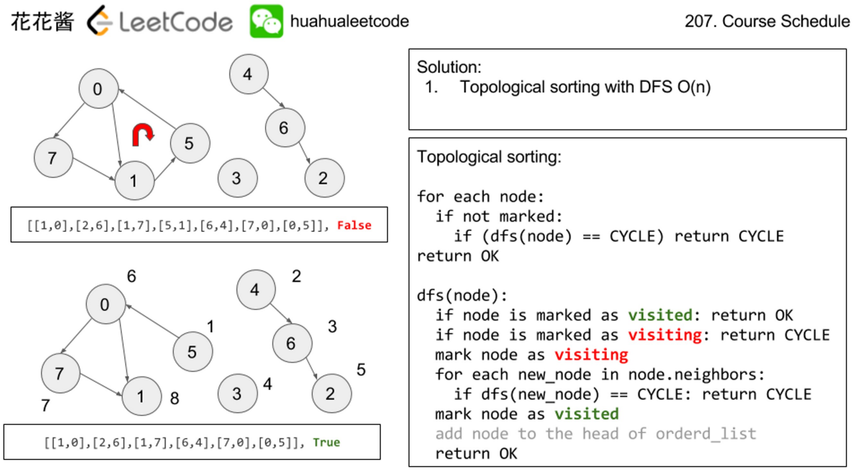
Templates

```
class UnionFindSet {
public:
   UnionFindSet(int n) {
    ranks_ = vector<int>(n + 1, 0);
      parents_ = vector<int>(n + 1, 0);

      for (int i = 0; i < parents_.size(); ++i)
      parents_[i] = i;
   }

   // Merge sets that contains u and v.
  // Return true if merged, false if u and v are already in one set.
   bool Union(int u, int v) {
    int pu = Find(u);
      int pv = Find(v);
    if (pu == pv) return false;

    // Meger low rank tree into high rank tree
      if (ranks_[pv] < ranks_[pu])
      parents_[pv] = pu;
      else if (ranks_[pu] < ranks_[pv])
      parents_[pu] = pv;
    else {
    parents_[pv] = pu;
      ranks_[pu] += 1;
   }

   return true;
  }

  // Get the root of u.
 int Find(int u) {
    // Compress the path during traversal
   if (u != parents_[u])
      parents_[u] = Find(parents_[u]);
   return parents_[u];
  }
private:
  vector<int> parents_;
 vector<int> ranks_;
};
```

来自 <https://zxi.mytechroad.com/blog/data-structure/sp1-union-find-set/>

Leetcode course schedule 207
https://zxi.mytechroad.com/blog/graph/leetcode-207-course-schedule/

there are cycles, there is impossible



花花酱 LeetCode huahualeetcode 207. Course Schedule

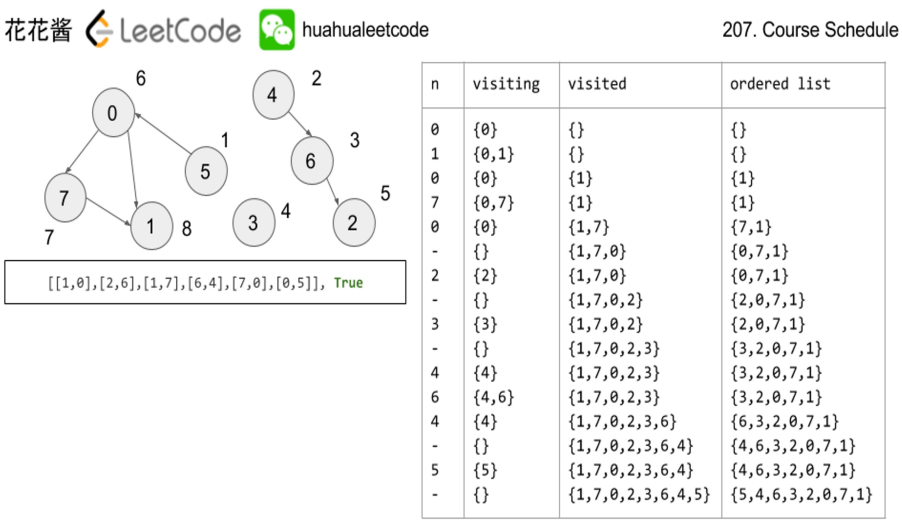
`[[1,0],[2,6],[1,7],[5,1],[6,4],[7,0],[0,5]], False`

`[[1,0],[2,6],[1,7],[6,4],[7,0],[0,5]], True`

Solution:
1. Topological sorting with DFS O(n)

Topological sorting:

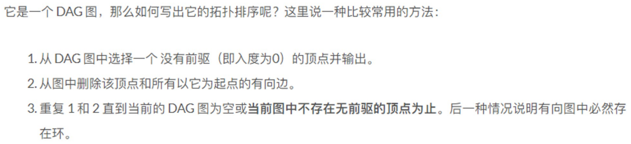
```
for each node:
  if not marked:
    if (dfs(node) == CYCLE) return CYCLE
return OK

dfs(node):
  if node is marked as visited: return OK
  if node is marked as visiting: return CYCLE
  mark node as visiting
  for each new_node in node.neighbors:
    if dfs(new_node) == CYCLE: return CYCLE
  mark node as visited
  add node to the head of orderd_list
  return OK
```



[[1,0],[2,6],[1,7],[6,4],[7,0],[0,5]], True

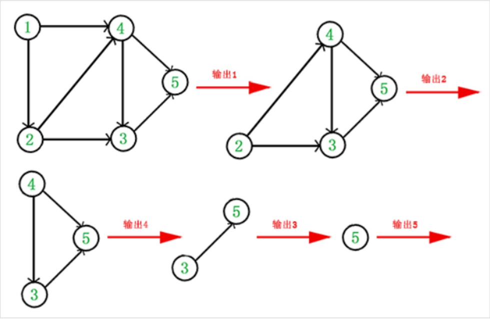
n	visiting	visited	ordered list
0	{0}	{}	{}
1	{0,1}	{}	{}
0	{0}	{1}	{1}
7	{0,7}	{1}	{1}
0	{0}	{1,7}	{7,1}
-	{}	{1,7,0}	{0,7,1}
2	{2}	{1,7,0}	{0,7,1}
-	{}	{1,7,0,2}	{2,0,7,1}
3	{3}	{1,7,0,2}	{2,0,7,1}
-	{}	{1,7,0,2,3}	{3,2,0,7,1}
4	{4}	{1,7,0,2,3}	{3,2,0,7,1}
6	{4,6}	{1,7,0,2,3}	{3,2,0,7,1}
4	{4}	{1,7,0,2,3,6}	{6,3,2,0,7,1}
-	{}	{1,7,0,2,3,6,4}	{4,6,3,2,0,7,1}
5	{5}	{1,7,0,2,3,6,4}	{4,6,3,2,0,7,1}
-	{}	{1,7,0,2,3,6,4,5}	{5,4,6,3,2,0,7,1}

topological Sorting Templates 1 -> 0 一直寻找入度为0 的节点 indegree = 0



它是一个 DAG 图，那么如何写出它的拓扑排序呢？这里说一种比较常用的方法：

1. 从 DAG 图中选择一个 没有前驱（即入度为0）的顶点并输出。
2. 从图中删除该顶点和所有以它为起点的有向边。
3. 重复 1 和 2 直到当前的 DAG 图为空或**当前图中不存在无前驱的顶点为止**。后一种情况说明有向图中必然存在环。



★ DFS topologic Sorting

这个题目是完成事件1需要先完成事件2，也就是走1 之前需要2，那么转化成图，用topological sorting

```
bool canFinish(int n, vector<pair<int, int>>& pre)
{
    vector<vector<int>> adj(n, vector<int>());
    vector<int> degree(n, 0);
    for (auto &p: pre) {
        adj[p.second].push_back(p.first);
        degree[p.first]++;
    }
    queue<int> q;
    for (int i = 0; i < n; i++)
        if (degree[i] == 0) q.push(i);
    while (!q.empty()) {
        int curr = q.front(); q.pop(); n--;
        for (auto next: adj[curr])
            if (--degree[next] == 0) q.push(next);
    }
    return n == 0;
}
```

★ 用双重map可以达到二维数组访问的效果，只不过index可以是字母！！！！

```
unordered_map<string,unordered_map<string,double>> g;
```