

# Lab11 - Advanced Graph

## #A - Dijkstra

### 总结:

有向有权图，从一个vertex到各个vertex的最短距离（最短路径），该题是dijk裸题。dijk强调每一步都寻找距离初始点距离最短的点（而不涉及集合）。本质上与prim相同，都是bfs+二叉堆，复杂度为 $O((|V| + |E|)\log|V|)$ 。

### Information

Time Limit	Memory Limit	Data Amount	Problem Type
2000ms	128MiB	10	Tradition

### Description

This is a model of Dijkstra algorithm.

Given a **directed weighted** graph, where the starting point is 1. please print the values of shortest path from 1 to each vertex.

### Input

The first line contains two integers  $n, m$ : number of vertexes, number of edges.

For the next  $m$  lines, each line contains 3 integers:  $x, y, z$ , representing an edge  $x \rightarrow y$  with weight  $z$ .

### Output

$n$  integers.

The  $i$ -th integer is the value of shortest path from 1 to  $i$ .

If  $i$  is unreachable from 1, please print -1.

### Sample Test Data

#### Input #1

```
4 6
1 3 1
2 1 2
4 2 3
3 3 4
1 2 5
3 4 6
```

#### Output #1

0 5 1 7

### Tips

For 100% cases:  $1 \leq n \leq 10000$ ,  $0 \leq m \leq 100000$ ,  $1 \leq z \leq 100$ .

It's guaranteed that there are no duplicate edges in the graph.

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## #B - Prim

### Information

Time Limit	Memory Limit	Data Amount	Problem Type
2000ms	128MiB	10	Tradition

### 总结:

无向有权图，从一个点到其它点的最短距离（最短路径），该题是prim算法裸题。prim强调，每一步都寻找距离集合最短的点（而不是初始点）。本质上与dijk相同，都是bfs+二叉堆，复杂度为 $O((|V| + |E|)\log|V|)$

### Description

This is a model of prim algorithm.

Given an **weighted undirected** graph, please calculate the value of the minimum spanning tree.

### Input

The first line contains two integers  $n, m^*$ : number of vertexes, number of edges.

For the next  $m$  lines, each line contains 3 integers:  $x, y, z$ , representing an edge  $x \rightarrow y$  with weight  $z$ .

### Output

The answer.

### Sample Test Data

#### Input #1

```
5 5
1 2 1
2 3 2
3 4 3
4 5 4
2 5 1
```

#### Output #1

```
7
```

### Data Limit

For 100% cases:  $1 \leq n \leq 5000, 0 \leq m \leq 100000, 1 \leq z \leq 100$ .

It's guaranteed that there are no duplicate edges in the graph.

## #C - Kosaraju

### 总结:

Kosaraju用来求SCC(Strongly connected Component)。思路是先求反图拓扑序，再根据反图拓扑序在原图中跑dfs

### Information

Time Limit	Memory Limit	Data Amount	Problem Type
2000ms	128MiB	4	Tradition

### Description

This is a model of Kosaraju algorithm.

Given an **directed** graph, please determine if the whole graph is a SCC.

### Input

The first line contains two integers  $n, m$ : number of vertexes, number of edges.

For the next  $m$  lines, each line contains two integers:  $x, y$ , representing an edge  $x \rightarrow y$ .

### Output

If yes, print "Yes"; otherwise print "No".

### Sample Test Data

#### Input #1

```
4 6
1 3
2 1
4 2
3 3
1 2
3 4
```

#### Output #1

```
Yes
```

### Data Limit

For 100% cases:  $1 \leq n \leq 10000, 0 \leq m \leq 100000$ .

It's guaranteed that there are no duplicate edges in the graph.

## #D 被砍了

## #E - Shortest path counting

### Information

Time Limit	Memory Limit	Data Amount	Problem Type
2000ms	128MiB	10	Tradition

### Description

Given a **undirected unweighted** graph, where the starting point is 1. please print the **total number** of shortest path from 1 to each vertex.

### Input

The first line contains two integers  $n, m$ : number of vertexes, number of edges.

For the next  $m$  lines, each line contains 2 integers:  $x, y$ , representing an edge  $x - y$ .

### Output

$n$  integers.

The  $i$ -th integer is the number of shortest path from 1 to  $i$ .

The answer is modulo 100003.

If  $i$  is unreachable from 1, please print 0.

Note that 1 is always reachable from 1.

### Sample Test Data

#### Input #1

```
4 5
1 3
2 1
4 2
1 2
3 4
```

#### Output #1

```
1
2
1
3
```

## Data Limit

For 100% cases:  $1 \leq n \leq 10000, 0 \leq m \leq 100000, 0 < z < 101$ .

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