Ceng 315 Algorithms
Fall 2004
Assignment 4


Submission: https://submit.ceng.metu.edu.tr

Important Note: Obey the specifications (algorithmic or IO) strictly. Failing to do so, you will loose significantly much points.

In this last homework, you will analyze the critical time of an automated manufacturing line. Critical time is defined as the worst possible (longest) time that is required to produce a final product.

A manufacturing line is a one-way moving band with stations along the line (Figure 1). Each station has different number of robots, only one of which can be activated by a previous robot acted on the material or the special robot S which puts the material on the line.

![Figure 1](image)

Figure 1. Manufacturing Line with start robot S, end robot E and with N stations.

Each robot may require different amount of time for its job to be completed, except robots S and E which you will assume to be working in 0 time since they have to run for every product. As mentioned above, each station can have different number of robots. When the material stops in front of a station, only one of the robots performs a job and the line moves on. Each robot can activate a different subset of robots downstream of the production line. But note that for a specific production, currently active robot chooses only one robot from this subset and then the manufacturing line moves the material in front of the station that the selected robot resides. Continuing like this, final product arrives at the end of the line where the robot E removes the product from the line. Robot E must also be activated by the previous robot. The robots at the final station N can only activate the robot E. A product does not have to stop on each station. It totally depends on which of the robots are activated. Also note that each robot should activate at least one another robot in station downstream or robot E.

You are required to find the longest possible time and the list of robots activated in that case.

Input:

You will read from the standard input. The input is the manufacturing line specifications. The first line is a single integer (N) specifying the number of stations. The second line contains N integers representing the number of robots on each station. The robot S
is represented with 0_1, and the robot E is represented with (N+1)_1. Suppose there are 3 robots on station 2, then the robots are represented with, 2_1, 2_2 and 2_3, for the first, second and third robot, respectively.

After first 2 lines comes m lines (where m is the total number of robots E) specifying the running time and possible activation connections for each robot.

Suppose there are 6 stations, then the following line says that, the 5th robot on station 3 has a running time of 17 units and after its execution it can possibly activate the 2nd robot on station 4 or 3rd robot on station six or can activate the robot E.

```
3_5  17  4_2  6_3  7_1
```

There will be such a line for each robot except for E. There will be no line for E. Running time of S is always 0. The line for S is the 3rd line and might be as follows:

```
0_1  0  1_2  1_3  3_5  6_2
```

Robot S can not activate robot E directly.

**Output:**

You will write to standard output. The output will be 2 lines, first line will contain a single integer representing the maximum possible time and the second line is the list of robots activated for that worst case (separated by a single blank). Note that this path may not be unique. Printing any one of them (only one by the way) will suffice.

**Important:**

You are required to find an efficient algorithm for this homework. There will be a reasonable time limit while running your codes with the test cases.

**Sample Input:**

```
>hw4
3
3 2 4
0_1  0  1_1  1_2  1_3  2_1  3_3
1_1  5  3_1  3_2
1_2  3  2_2  4_1
1_3  2  2_1  2_2  3_4
2_1  7  3_1  3_2
2_2  20  4_1  3_4  3_2
3_1  4  4_1
3_2  3  4_1
3_3  10  4_1
3_4  8  4_1
```

**Sample output:**

```
31
0_1  1_2  2_2  3_4  4_1
```