South African Computer Olympiad
Training Camp 2, 2006
Day 2

Overview

Author	**Brian Dean**	**Carl Hultquist**	**Bruce Merry**
Problem	**matches**	**change**	**site**
Source	matches.c matches.cpp matches.pas	change.c change.cpp change.pas	site.c site.cpp site.pas
Input file	matches.in	change.in	site.in
Output file	matches.out	change.out	site.out
Time limit	1 second	1 second	1 second
Number of tests	10	10	10
Points per test	10	10	10
Total points	**100**	**100**	**100**

The maximum total score is 300 points.

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Matchstick madness

Author

Brian Dean

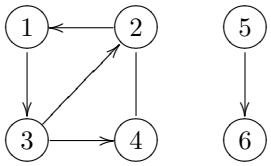
Introduction

Fred the manic storekeeper has a complicated piece of art on display in his store window, made out of toothpicks. However, he wishes to replace as many of the toothpicks as possible with matchsticks, as advertising (since his store is in Cape Town where there are imminent power cuts). However, safety regulations require that no two match-heads can touch each other.

Task

The sculpture consists of a number of nodes, where the ends of zero or more toothpicks coincide. Each toothpick connects exactly two nodes. Your task is to find the largest set of toothpicks that can be replaced by matches in such a way that no two match-heads meet at a node (you may choose how to orient the matches).

Example



The circled numbers are nodes and the lines are toothpicks. The arrow-heads show where match-heads can be placed to replace five of the six toothpicks with matchsticks. It is not possible to replace all six toothpicks.

Input (matches.in)

The first line of input contains two integers, N and T, separated by a space. N is the number of nodes (numbered 1 to T) and T is the number of toothpicks. Each of the next T lines describes a toothpick as a pair of distinct integers (the nodes at the endpoints of the toothpick), separated by a space.

Sample input

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

Output (matches.out)

The first line of output is M, the maximum number of matchsticks that can be used. This is followed by M lines, each describing one of these matches. Each line contains two integers, t and h, separated by a space. t is the number of the toothpick that is replaced (numbered 1 to T as they appear in the input file) and h is the number of the node at which the match-head is placed.

You may output the matches in any order, and if there is more than one optimal solution you may output any one of them.

Sample output

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

Constraints

- $1 \leq N \leq 20000$
- $0 \leq T \leq 30000$

50% constraints

- $1 \leq N \leq 1000$
- $0 \leq T \leq 1500$

Time limit

1 second.

Scoring

A correct value for M is worth 50%. If in addition the arrangement of matches is correct, you will score 100%.

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Making Change

Author

Carl Hultquist

Introduction

Fred the storekeeper is a little bit crazy. When customers pay for their goods, Fred will only be happy if the transaction involves the fewest number of coins possible (that is, the sum of the number of coins the customer uses to pay and the number of coins that Fred must give back in change must be minimal). In fact, if the customer pays in such a way that uses more coins than necessary, Fred goes into a blind rage which sometimes involves shooting the customer for their stupidity. For this reason, Fred's customers are eager to please him and need your help in working out what coins they should give Fred so as to avoid being shot.

Task

Given the coins that a customer has and the amount that they owe Fred, determine how they should pay so as to minimise the total number of coins used in the transaction. Due to political instability the values of coins available as legal tender change often, and so you will also be told what the values of coins available at the time of the transaction are. If the customer pays a total for which Fred is unable to give change, then Fred get particularly angry; you must ensure that it is possible for the change to be made up from the coin denominations available in the currency. To this end, you can assume that Fred will be able to provide change using the fewest number of coins possible (in other words, Fred has an infinite supply of all the different denominations of coins).

Example

Suppose that there are 3 types of coins available, with values 5, 25 and 50, and that the customer owes Fred an amount of 70. The customer has in their possession 5 coins of value 5, 2 coin of value 25, and 1 coin of value 50. The customer should pay Fred using two coins, one of value 25 and one of value 50, for which Fred will give them a single coin of value 5 back — a total of 3 coins used in the transaction.

Input (change.in)

The first line of input will contain 2 space-separated integers, N and T. N is the number of different coin denominations in the currency and T is the amount that the customer needs to pay Fred. The second line of input will contain N space-separated integers, $V_1, V_2, \ldots, V_N$ which is the value of each coin in the currency. The third line of input will also contain N space-separated integers, $C_1, C_2, \ldots, C_N$ which are the number of each coin that the customer has. Each coin in the currency will have a unique value.

Sample input

```
3 70
5 25 50
5 2 1
```

Output (change.out)

Your output should consist of a single line with N space-separated integers, indicating how many of each coin the customer should give Fred. If there is more than one solution in which the least number of coins is exchanged, then you need only output one of them.

Sample output

```
0 1 1
```

Constraints

- $1 \leq N \leq 20$
- $1 \leq T \leq 10000$
- $1 \leq V_i \leq 100$ for $1 \leq i \leq N$
- $0 \leq C_i \leq 25$ for $1 \leq i \leq N$

50% constraints

- $1 \leq N \leq 5$
- $0 \leq C_i \leq 5$

Time limit

1 second.

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Scoring

If your solution results in the correct minimum number of coins being exchanged, then you will score 100%. If your solution causes more coins to be used, or if your output format is incorrect, then you will score 0%.

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Castle site

Author

Bruce Merry

Introduction

Herbert's father (the owner of swamp castle) is planning to build a new castle on his soon-to-be-acquired land. He is now tired of building castles in swamps and watching them sink, so he wants to build his new castle on completely solid ground. He also wants as big a castle as he can, to really impress those other lords who said he was daft to build his castle in a swamp.

Task

You will be given a map of the new rectangular area of land that Herbert's father will be acquiring. The map is divided into a grid, with each cell in the grid marked as either solid ground or swamp. Determine the largest area of a castle that can be built. The castle must be rectangular (with the sides parallel to the sides of the land) and must rest only on areas marked as solid ground.

Example

Figure 1 shows an example of the map, with the swamps shown in grey. The largest rectangle that fits without occupying any swap is indicated by the dashed lines.

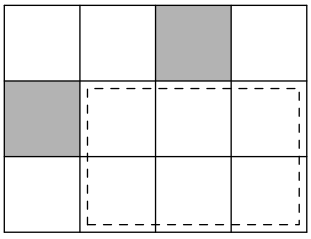

Figure 1: The map of the new land.

Input (site.in)

The first line contains three integers, R, C and P, separated by spaces. The map contains R rows and C columns, and P of the cells contain swamp. The remaining P lines of the file describe the cells that contain swamp. Each line contains two integers, r and c ($1 \leq r \leq R, 1 \leq c \leq C$), separated by a space, indicating that the cell in row r and column c contains swamp. The swamp locations in the input are all distinct.

Sample input

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

Output (site.out)

The output contains a single integer, the area of the largest castle that Herbert's father can build.

Sample output

```
6
```

Constraints

- $1 \leq R, C \leq 3000$
- $0 \leq P \leq 30000$

50% constraints

- $1 \leq R, C \leq 200$

Time limit

1 second.

Scoring

A correct answer scores 100%, an incorrect one scores 0%.