Plan your Open Spaces

Silicon Mountain is made up of a network of highly specialised companies. And each one is full of expert engineers and computer scientists with an incredible variety of skills.

Teamwork and collaboration in our co-working spaces are key to our success, as they allow us to share knowledge, expertise and experience in a way that achieves the best results for our clients around the world.

In fact, when we are working on a project, it is essential to have the right people with the right skills close by. So, in Silicon Mountain, we like to move Techies around our spaces regularly.

We need your help to allocate Techies to the correct empty seats in a Silicon Mountain's co-working space in the most efficient way. A way that will improve the chances of project success.

1 PROBLEM STATEMENT

The aim of this problem is to assign Techies, either **Developers** or **Project Managers (PM)**, to empty seats in the Silicon Mountain co-working space in the most efficient way. Thus, a map of the co-working space will be provided with a list of Developers $\mathbf{D}$ and a list of Project Managers $\mathbf{M}$.

A Developer $\mathbf{D}_i$ is defined as a triplet containing:

- a company $\mathbf{C}_i$ to which he or she belongs.
- a bonus $\mathbf{B}_i$ given for each Developer or Project Manager from the same company next to them.
- a set of skills $\mathbf{S}_i$.

A Project Manager $\mathbf{M}_j$ is defined as a tuple containing:

- a company $\mathbf{C}_j$ to which they belong.
- a bonus $\mathbf{B}_j$ given for each Developer or Project Manager from the same company next to them.

While working, it's always good to have skilled colleagues nearby. So, people with some common skills to complete the tasks, but also specific skills that they can share with, or learn from, other colleagues. Your task is to find the best place in the co-working space for each Techie, so that the work potential is maximized. You can decide not to assign a Developer or Project Manager, but this means missing the potential they would provide.

2 SCORING

When two Developers $\mathbf{D}_i$ and $\mathbf{D}_j$ sit together in adjacent tiles, they have a work potential $\boldsymbol{WP}$ equal to the product of the following two factors:

- the number of common skills shared by both Developers (i.e, the shared skill sets of both Developers):

$$|\mathbf{S}_i \cap \mathbf{S}_j|$$

- the number of distinct skills of the two Developers (i.e, the joined skill sets of both Developers minus the set of common skills):

$$|\mathbf{S}_i \cup \mathbf{S}_j| - |\mathbf{S}_i \cap \mathbf{S}_j|$$

Therefore, given two adjacent Developers, their work potential $\boldsymbol{WP}(\mathbf{D}_i,\mathbf{D}_j)$ is

$$\boldsymbol{WP}(\mathbf{D}_i,\mathbf{D}_j) = |\mathbf{S}_i \cap \mathbf{S}_j| \cdot (|\mathbf{S}_i \cup \mathbf{S}_j| - |\mathbf{S}_i \cap \mathbf{S}_j|) \qquad (1)$$

Note: this means that if both Developers have only common skills or have no skill in common, their work potential will be 0.

In addition to the work potential, each pair of adjacent Developers D_i and D_j gets a bonus potential BP if they belong to the same company:

$$BP(\mathcal{D}_i, \mathcal{D}_j) = \begin{cases} \mathcal{B}_i \cdot \mathcal{B}_j & \mathcal{C}_i = \mathcal{C}_j \\ 0 & \mathcal{C}_i \neq \mathcal{C}_j \end{cases} \qquad (2)$$

The Project Managers behave like any other Developer with one caveat: Project Managers only have bonus potential **(BP)**, so for them the work potential **(WP)** is not taken into account. The total potential **(TP)** given by a pair of adjacent Techies, whether they are Developers or Project Managers, $\boldsymbol{P}(\mathbf{R}_i,\mathbf{R}_j)$ (where $\mathbf{R}$ represents either $\mathbf{D}$ or $\mathbf{M}$) is the addition of their work potential and their bonus potential:

$$\boldsymbol{TP}(\mathbf{R}_i,\mathbf{R}_j) = \boldsymbol{WP}(\mathbf{R}_i,\mathbf{R}_j) + \boldsymbol{BP}(\mathbf{R}_i,\mathbf{R}_j) \qquad (3)$$

The overall grading of a given distribution of workers is the sum of the total potential of each pair of adjacent workers.

You will need to consider three things:

- The total potential contributed by a pair of adjacent employees is counted on the edge between their desks, not on their desks. This means that given the pair of adjacent employees, their contribution to the overall grading is counted only once (as there is only one common edge between their tiles).
- Given an employee in position **(X,Y)**, the adjacent employees are only those placed directly **above (position ($X,Y-1$)), below (position ($X,Y+1$)),** on the **left (position ($X-1,Y$))** or on the **right (position ($X+1,Y$)).** In particular, any other employee placed on the diagonal **(positions ($X \pm 1$, $Y \pm 1$))** is NOT considered to be adjacent to the given worker.
- In the work space there are three kinds of tiles:
  - Project Manager desks cells, represented with the character **'M'.**
  - Developer desks cells, represented with the character**'_'**.
  - Unavailable cells (walls, corridors...), represented with the character**'#'**.

  Project Managers and Developers can only be placed on the desks matching their role (i.e., Developers on Developer desks and Project Managers on Project Managers Desks). On the unavailable cells no Techie can be placed.

3 CONSTRAINTS

The number of Developers, Project Managers and skills and the size of the map are constrained in the following way:

- Number of Developers: $10 \leq |\mathrm{D}| \leq 100000$
- Number of Project Managers: $2 \leq |\mathrm{M}| \leq 20000$

- Number of skills (assigned to a Developer): $1 \leq |S_i| \leq 100$
- Width of the work space floor: $10 \leq W \leq 1000$
- Height of the work space floor: $10 \leq H \leq 1000$

4 INPUT FORMAT

Input data will be provided in a text file in plain ASCII format.

On the first line you will find two integers, $\boldsymbol{W}$ and $\boldsymbol{H}$, separated by a space character. They represent the width and the height of the co-working space floor respectively.
Then comes a section representing the working space floor itself. It consists of $\boldsymbol{H}$ lines containing a string of length $\boldsymbol{W}$.
These strings are composed by a succession of any of the characters described in the following table:

Character	Description
#	Unavailable cell
_	Developer desk cell
M	Project Manager desk cell

After the floor section you will find a line containing an integer representing the number of Developers, $\mathbf{|D|}$**,** followed by that many lines containing text strings describing the Developers themselves.
Each Developer $\mathbf{D}_i$ is described with the following information separated by space characters:

- A string indicating the Silicon Mountain company C_i the Developer works for.
- An integer indicating the bonus potential B_i this Developer contributes.
- An integer indicating the number of skills (the cardinality of the skill set) $|S_i|$ of that Developer.
- $|S_i|$ text strings describing each skill of the Developer.

Finally, you will find a line with an integer representing the number of Project Managers, $|M|$, followed by that many lines containing text strings describing the Project Managers themselves.
The Project Managers, like the Developers, are described by text strings containing information separated by space characters. In the case of the managers, these lines contain the following information:

- A string indicating the Silicon Mountain company C_i the Project Manager works for.
- An integer indicating the bonus potential B_i this Project Manager contributes.

Input example

```
5 3
#####
#_##_
#MM_ _
10
nkwa 7 2 java bpm
gce_box 5 2 python azure
nkwa 8 2 python java
flp2rd 4 3 java cybersecurity big_data
mkth 1 2 nlp big_data
gce_box 3 2 azure c#
flp2rd 6 2 cybersecurity python
nkwa 2 3 bpm python project_management
ble 5 4 java c sql junit
gce_box 1 4 python c java bpm
3
nkwa 2
ble 1
mkth 5
```

5 OUTPUT FORMAT

The output data will have to be saved into a file in plain ASCII format.

The output file consists of $|\mathbf{D}| + |\mathbf{M}|$ lines with a text string each. The first $|\mathbf{D}|$ lines represent the Developers and the last $|\mathbf{M}|$ lines represent the Project Managers.
Each line consists of either the letter $\boldsymbol{X}$ if that Developer or Project Manager is not placed or two integers separated by a space character:

- the **horizontal** coordinate of the desk from the **left.**
- the **vertical** coordinate of the desk from the **top**.

In both cases, the coordinate is zero-based. This means that the top left corner of the map has coordinates $(0,0)$. The order of the Developers and Project Managers in the output file is assumed to be the same as that of the input file.

Output example

```
1 1
4 1
```

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

6 Scoring and visualization

Let’s consider the specific example of an input and an output presented above for a demonstration of the scoring.
If we index the chosen Techies in the following way (in the parenthesis is their position if they have been assigned a place):

1. $D_0(1,1)$ → nkwa 7 2 java bpm
2. $D_1(4,1)$ → gce_box 5 2 python azure
3. $D_2(3,2)$ → mkth 1 2 nlp big_data
4. $D_3(4,2)$ → gce_box 3 2 azure c#
5. $M_0(1,2)$ → nkwa 2
6. $M_1(2,2)$ → mkth 5

With the provided work space map and Techies distribution, all the pairs of adjacent workers we get and their respective total scores are:

- $D_0(1,1)$ and $M_0(1,2)$
  - $TP\,(D_0,M_0) = 0+14 = 14$:
    - $*$ $WP\,(D_0,M_0) = 0$ (Managers have no Work Potential)
    - $*$ $BP\,(D_0,M_0) = 7{\cdot}2 = 14$ (Both belong to the same company)
- $M_0(1,2)$ and $M_1(2,2)$
  - $TP\,(M_0,M_1) = 0+0 = 0$:
    - $*$ $WP\,(M_0,M_1) = 0$ (Managers have no Work Potential)
    - $*$ $BP\,(M_0,M_1) = 0$ (They belong to different companies)
- $M_1(2,2)$ and $D_2(3,2)$
  - $TP\,(M_1,D_2) = 0+5 = 5$:

- $*$ WP $(M_1,D_2) = 0$ (Managers have no Work Potential)
- $*$ BP $(M_1,D_2) = 5{\cdot}1 = 5$ (Both belong to the same company)

- $D_2(3,2)$ and $D_3(4,2)$
  - TP $(D_2,D_3) = 0+0 = 0$:
    - $*$ WP $(D_2,D_3) = 0 \cdot 4 = 0$ (0 common skills, 4 different skills)
    - $*$ BP $(D_2,D_3) = 0$ (They belong to different companies)
- $D_3(4,2)$ and $D_1(4,1)$
  - TP $(D_3,D_1) = 2+15 = 17$:
    - $*$ WP $(D_3,D_1) = 1 \cdot 2 = 2$ (1 common skill, 2 different skills)
    - $*$ BP $(D_3,D_1) = 3{\cdot}5 = 15$ (Both belong to the same company)

The potential given by all the adjacent pairs is:

$$TP = 14+0+5+0+17 = 36 \tag{4}$$

Please note that the bonus given by an adjacent pair is counted only once (on the edge between the Techies) NOT twice (on each of the seats the Techies are placed on).

HAPPY HACKING!!!