Google Code Jam '09 Qualification Round Problem B - Watersheds

Time limit: 30.0s **Memory limit:** 1G

Geologists sometimes divide an area of land into different regions based on where rainfall flows down to. These regions are called *drainage basins*.

Given an elevation map (a 2-dimensional array of altitudes), label the map such that locations in the same drainage basin have the same label, subject to the following rules.

- From each cell, water flows down to at most one of its 4 neighboring cells.
- For each cell, if none of its 4 neighboring cells has a lower altitude than the current cell's, then the water does not flow, and the current cell is called a *sink*.
- Otherwise, water flows from the current cell to the neighbor with the lowest altitude.
- In case of a tie, water will choose the first direction with the lowest altitude from this list: North, West, East, South.

Every cell that drains directly or indirectly to the same sink is part of the same drainage basin. Each basin is labeled by a unique lower-case letter, in such a way that, when the rows of the map are concatenated from top to bottom, the resulting string is lexicographically smallest. (In particular, the basin of the most North-Western cell is always labeled 'a'.)

Input Specification

The first line of the input file will contain the number of maps, T. T maps will follow, each starting with two integers on a line -- H and W -- the height and width of the map, in cells. The next H lines will each contain a row of the map, from north to south, each containing W integers, from west to east, specifying the altitudes of the cells.

Output Specification

For each test case, output $1 + H$ lines. The first line must be of the form `Case #X:` where X is the test case number, starting from 1. The next H lines must list the basin labels for each of the cells, in the same order as they appear in the input.

Limits

Memory limit: 1 GB.

$T \leq 100$;

Small dataset

Time limit: 25 seconds.

$1 \leq H, W \leq 10$;

$0 \leq \text{altitudes} < 10$.

There will be at most two basins.

Large dataset

Time limit: 30 seconds.

$1 \leq H, W \leq 100$;

$0 \leq \text{altitudes} < 10\,000$.

There will be at most 26 basins.

Sample Input

```
4
3 3
9 6 3
5 9 6
3 5 9
1 10
0 1 2 3 4 5 6 7 8 7
2 3
7 6 7
7 6 7
5 5
1 2 3 4 5
2 9 3 9 6
3 3 0 8 7
4 9 8 9 8
5 6 7 8 9
```

Sample Output

```
Case #1:
a b b
a a b
a a a
Case #2:
a a a a a a a a a b
Case #3:
a a a
b b b
Case #4:
a a a a a
a a b b a
a b b b a
a b b b a
a a a a a
```

Notes

In Case #1, the upper-right and lower-left corners are sinks. Water from the diagonal flows towards the lower-left because of the lower altitude (5 versus 6).

This problem has different time limits for different batches. If you exceed the Time Limit for any batch, the judge will incorrectly display `>30.000s` regardless of the actual time taken. Refer to the **Limits** section for batch-specific time limits.