2019 Canadian Computing Olympiad
Day 1, Problem 1
Human Error

Time Limit: 1 second

Problem Description

Justin and Donald are playing their favourite game: hop chess. You probably haven't heard of it, but the rules are pretty simple.

The board is a rectangular grid, with each square of the board initially having exactly one player's piece on it. Justin's pieces are denoted as `J`, with Donald's being `D`. Each player has at least one piece on the grid initially.

The game begins with Justin playing first. On a turn, a player may move one of his pieces to capture (and thus remove from the board) a neighbouring piece (not necessarily the opponent's). A piece X is said to be neighbouring Y if it is either up, down, left, or right of Y. If such a move cannot be made, then the active player loses.

In an ideal world, both Justin and Donald are perfect logicians, and capable of discerning an optimal strategy for any board. Then perhaps we might be interested in who of the two would win. But that wouldn't be very realistic. Indeed, when playing, Justin and Donald can both come up with a relatively good solution; exactly how good it tends to be is determined by their error factors, J and D respectively.

Formally, the active player with error factor A first chooses a *proposal set*: either the set of all possible moves if there are A or less possible moves or some subset of size A from the set of possible moves if he has more than A possible moves. Then, from this *proposal set*, the player selects a move randomly with equal probability.

Both players, when given the choice of choosing their *proposal set*, chooses the most optimal such set (one which produces the highest probability of winning), knowing that the other player always chooses their *proposal set* optimally as well.

The natural question is then: exactly what is the probability that Justin wins a game of hop chess, given the initial board, J, and D?

Input Specification

Input will begin with two space-separated positive integers R, C $(R \cdot C \leq 13)$. On the next R lines will be strings of C characters drawn from the set $\{$`J, D`$\}$, describing the initial board state. Finally, there will be two space-separated integers, J, D $(1 \leq J, D \leq 13)$

Output Specification

Output a single floating point number rounded to 3 decimal places: the probability that Justin wins.

Sample Input 1

```
1 3
JJD
3 1
```

Output for Sample Input 1

```
0.667
```

Explanation of Output for Sample Input 1

Note that Justin has 3 possible moves (note that _ indicates an empty cell in all explanations below):

- he moves his first piece right, capturing his second piece, and ensuring his loss by having the board appear as `_JD`;
- he moves his second piece right, capturing Donald's piece and securing victory, with the board as `J_J`;
- or he moves his second piece left, capturing his own piece, but leaving Donald unable to move, thus also winning, with the board as `J_D`.

Clearly the latter 2 cases are optimal—but since Justin has error factor 3, there is a 1/3 chance that he chooses the option causing him to lose. Thus he wins with probability 2/3.

Sample Input 2

```
2 2
JJ
DD
3 1
```

Output for Sample Input 2

```
0.000
```

Explanation of Output for Sample Input 2

There is no hope for Justin to win.

To see why, notice that Justin has 4 possible first moves:

```
J_    _J    J_    _J
DD    DD    DJ    JD
```

He can pick any subset of size three from the above moves.

However, Donald will always pick his most optimal move. Regardless of Justin's first move, Donald will leave the board in one of the following configurations:

```
D_    _J    _D    J_
_D    D_    D_    _D
```

all of which will cause Justin to lose.

2019 Canadian Computing Olympiad
Day 1, Problem 2
Sirtet

Time Limit: 2 seconds

Problem Description

In a fancy new zero-person video game, Sirtet, the game is a rectangular grid with N rows and M columns. Before the game begins, some grid cells are blank (denoted as `.`) and others are filled (denoted as #). The filled squares represent a set of objects, and the filled squares that are adjacent (horizontally or vertically) should be considered to be part of the same rigid object. For example, this initial grid:

```
..#.
##.#
.##.
#...
#...
```

has four objects, shown below:

```
##    #    #    #
 ##   #
```

When the game begins, the objects fall straight down the grid, all at the same speed. Each object continues to fall straight down until it either touches the bottom row, or has some part of it land directly on top of another object, at which point it stops. What will be the final state of the grid?

Input Specification

The first line contains two space-separated positive integers N and M $(N \cdot M \leq 10^6)$.

The following N lines contain M characters each, describing the initial state of the grid. If the j-th column of the i-th row of the grid contains a block, the corresponding character in the input will be a #, otherwise it will be a `.` character.

For 10 of the 25 available marks, $N \cdot M \leq 2000$.

For an additional 6 of the 25 available marks, $M = 2$.

Output Specification

Output N lines contain M characters each, describing the final state of the grid. If the j-th column of the i-th row of the grid contains a block, the corresponding character in the input will be a `#`, otherwise it will be a `.` character.

Sample Input

```
5 4
..#.
##.#
.##.
#...
#...
```

Output for Sample Input

```
....
....
###.
###.
#..#
```

2019 Canadian Computing Olympiad
Day 1, Problem 3
Winter Driving

Time Limit: 1 second

Problem Description

In the Great White North, there are N cities numbered from 1 to N. There are A_i citizens living in city i. There are $N-1$ roads numbered from 2 to N. Road j connects city j and city P_j, where $P_j < j$. There are at most 36 roads connected to any city.

During winter, all roads will be converted into one-way highways due to dangerous driving conditions. That is, road j will become a highway that is either one-way from city j to city P_j or one-way from city P_j to city j.

Every citizen wants to send a holiday card to every other citizen. Citizen x can send a card to citizen y if it is possible to travel from the city x lives in to the city y lives in using only highways.

What is the maximum number of holiday cards that can be sent after converting all roads to highways?

Input Specification

The first line contains one integer N $(2 \le N \le 200\,000)$.

The second line contains N integers $A_1, \cdots, A_N$ $(1 \le A_i \le 10\,000)$.

The third line contains $N-1$ integers $P_2, \cdots, P_N$ $(1 \le P_j \le j)$.

Let D be the maximum number of roads connected to any city. It is guaranteed that $D \le 36$.

For 5 of the 25 available marks, $N \le 10$.

For an additional 5 of 25 available marks, $N \le 1\,000$ and $D \le 10$.

For an additional 5 of 25 available marks, $D \le 18$.

For an additional 5 of 25 available marks, there will be 37 cities, where one city is connected to 36 other cities, and these other 36 cities are only connected to this one city.

Output Specification

Print one line with one integer, the maximum number of cards that can be sent after converting all roads to highways.

Sample Input

```
4
3 3 4 1
```

```
1 2 1
```

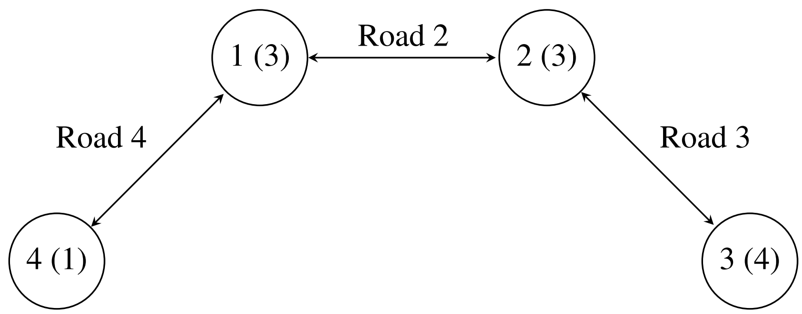
Output for Sample Input

```
67
```

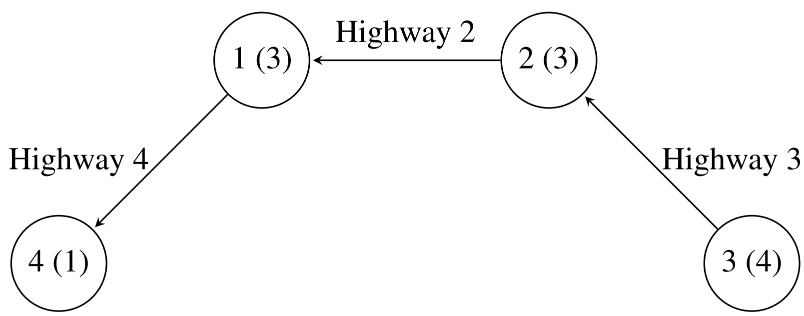
Explanation of Output for Sample Input

One possible way of converting roads to highways is for road 2 to become one-way from city 2 to city 1, road 3 to become one-way from city 3 to city 2, and road 4 to become one-way from city 1 to city 4.

Consider the following pictures, with the cities and associated population (in parentheses) for the initial roads



and what it looks like after all roads are converted to highways:



Every citizen in city 3 can send 3 holiday cards to city 3 citizens, 3 holiday cards to city 2 citizens, 3 holiday cards to city 1 citizens, and 1 holiday card to the city 4 citizen, for a total of 40 holiday cards sent out of city 3.

Similarly,

- city 2 citizens send 6 holidays cards each, for a total of 18 holiday cards.
- city 1 citizens send 3 holidays cards each, for a total of 9 holiday cards.
- the city 4 citizen cannot send any holiday cards.

A total of $40 + 18 + 9 = 67$ holiday cards are sent.