2162 S-Trees

A Strange Tree (S-tree) over the variable set $X_n = \{x_1, \ldots, x_n\}$ is a **complete** binary tree representing a Boolean function $f : \{0,1\}^n \to \{0,1\}$. Each of the S-tree's nodes has a depth, defined as the number of nodes in the path from the root to itself minus 1 (so the root has depth 0). The depth of any node in an S-tree is at most n. The nodes with depth less than n are called *non-terminal nodes*, each having two children: the right child and the left child. Each non-terminal node is labeled with some variable x_i from the variable set X_n. All non-terminal nodes with the same depth are labeled with the same variable, and non-terminal nodes with different depth are labeled with different variables. So, there is a unique variable x_{i_0} corresponding to the root, a unique variable x_{i_1} corresponding to the nodes with depth 1, and so on. The sequence of the variables $x_{i_0}, x_{i_1}, \ldots, x_{i_{n-1}}$ is called the variable ordering. The nodes having depth n are called *terminal nodes*. They have no children and are labeled with either '0' or '1'. Note that the variable ordering and the distribution of 0's and 1's on terminal nodes are sufficient to completely describe an S-tree.

As stated earlier, each S-tree represents a Boolean function f. If you have an S-tree and values for the variables $x_1, \ldots, x_n$, then it is quite simple to evaluate $f(x_1, \ldots, x_n)$: Start at the root and repeat the following steps: if the node you are at is labeled with a variable x_i, then depending on whether the value of x_i is '1' or '0', you go to its right or left child, respectively. Once you reach a terminal node, its label gives the value of the function.

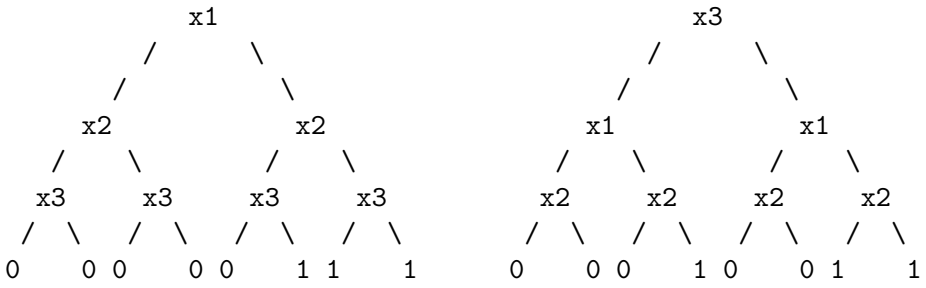

Fig. 1.- S-trees for the function x_1 and (x_2 or x_3)

In the picture, the two S-trees represent the same Boolean function:

$$f(x_1, x_2, x_3) = x_1 \ and \ (x_2 \ or \ x_3)$$

For the left tree, the variable ordering is x_1, x_2, x_3, and for the right tree it is x_3, x_1, x_2. The values of the variables $x_1, \ldots, x_n$, are given as a Variable Value Assignment (VVA) $(x_1 = b_1, x_2 = b_2, \ldots, x_n = b_n)$ with $b_1, b_2, \ldots b_n \in \{0,1\}$. For instance, $(x_1 = 1, x_2 = 1, x_3 = 0)$ would be a VVA for $n = 3$, resulting, for the sample function above, in the value $f(1,1,0) = 1 \ and \ (1 \ or \ 0) = 1$.

Your task is to write a program which takes an S-tree and some VVAs and computes $f(x_1, \ldots, x_n)$ as described above.

Input

The input file contains the description of several S-trees with associated VVAs which you have to process. Each description begins with a line containing a single integer n, $1 \leq n \leq 7$, the depth of the S-tree. This is followed by a line describing the variable ordering the S-tree. The format of that line is $x_{i_1} x_{i_2} \ldots x_{i_n}$. (There will be exactly n different single space-separated strings). So, for $n = 3$ and the variable ordering x_3, x_1, x_2, this line would look as follows

```
x3 x1 x2
```

In the next line the distribution of '0's and '1's over the terminal nodes is given. There will be exactly 2^n characters (each of which can be '0' or '1'), followed by the new-line character. The characters are given in the order in which they appear in the S-tree, the first character corresponds to the leftmost terminal node of the S-tree, the last one to its rightmost terminal node.

The next line contains a single integer m, the number of VVAs, followed by m lines describing them. Each of the m lines contains exactly n characters (each of which can be 0 or 1), followed by a new-line character. Regardless of the variable ordering of the S-tree, the first character always describes the value of x_1, the second character describes the value of x_2, and so on. So, the line

```
110
```

corresponds to the VVA $(x_1 = 1, x_2 = 1, x_3 = 0)$.

The input is terminated by a test case starting with $n = 0$. This test case should not be processed.

Output

For each S-tree, output the line '`S-Tree #`j', where j is the number of the S-tree. Then print a line that contains the value of $f(x_1, x_2, \ldots, x_n)$ for each of the given m VVAs, where f is the function defined by the S-tree. Output a blank line after each test case.

Sample Input

```
3
x1 x2 x3
00000111
4
000
010
111
110
3
x3 x1 x2
00010011
4
000
010
111
110
0
```

Sample Output

```
S-Tree #1
0011

S-Tree #2
0011
```