E. Kia Bakes a Cake

time limit per test: 6 seconds
memory limit per test: 512 megabytes

You are given a binary string s of length n and a tree T with n vertices. Let k be the number of `1`s in s. We will construct a complete undirected weighted graph with k vertices as follows:

- For each $1 \le i \le n$ with $s_i = 1$, create a vertex labeled i.
- For any two vertices labeled u and v that are created in the above step, define the edge weight between them $w(u, v)$ as the distance* between vertex u and vertex v in the tree T.

A **simple** path† that visits vertices labeled $v_1, v_2, \ldots, v_m$ in this order is *nice* if for all $1 \le i \le m-2$, the condition $2 \cdot w(v_i, v_{i+1}) \le w(v_{i+1}, v_{i+2})$ holds. In other words, the weight of each edge in the path must be at least twice the weight of the previous edge. Note that $s_{v_i} = 1$ has to be satisfied for all $1 \le i \le m$, as otherwise, there would be no vertex with the corresponding label.

For each vertex labeled i ($1 \le i \le n$ and $s_i = 1$) in the complete undirected weighted graph, determine the maximum number of vertices in any nice simple path starting from the vertex labeled i.

*The distance between two vertices a and b in a tree is equal to the number of edges on the unique simple path between vertex a and vertex b.

†A path is a sequence of vertices $v_1, v_2, \ldots, v_m$ such that there is an edge between v_i and v_{i+1} for all $1 \le i \le m-1$. A simple path is a path with no repeated vertices, i.e., $v_i \ne v_j$ for all $1 \le i < j \le m$.

Input

Each test contains multiple test cases. The first line contains the number of test cases t ($1 \le t \le 10^4$). The description of the test cases follows.

The first line of each test case contains a single integer n ($1 \le n \le 7 \cdot 10^4$) — the length of the binary string s and the number of vertices in the tree T.

The second line of each test case contains a binary string with n characters $s_1 s_2 \ldots s_n$ ($s_i \in \{0, 1\}$) — the string representing the vertices to be constructed in the complete undirected weighted graph.

Each of the next $n-1$ lines contains two integers u and v ($1 \le u, v \le n$) — the endpoints of the edges of the tree T.

It is guaranteed that the given edges form a tree.

It is guaranteed that the sum of n over all test cases does not exceed $7 \cdot 10^4$.

Output

For each test case, output n integers, the i-th integer representing the maximum number of vertices in any nice simple path starting from the vertex labeled i. If there is no vertex labeled i, i.e., $s_i = 0$, output -1 instead.

Example

input

```
3
5
01111
1 2
2 3
3 4
4 5
17
01101011110101101
1 2
2 3
3 4
4 5
5 6
6 7
```

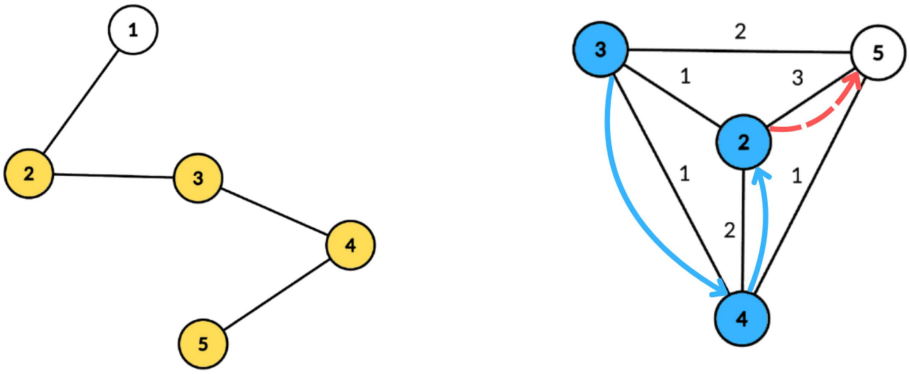
```
7 8
8 9
9 10
10 11
11 12
12 13
13 14
14 15
15 16
16 17
2
01
1 2
```

output Copy

```
-1 3 3 3 3
-1 5 4 -1 4 -1 5 5 5 -1 4 -1 5 5 -1 3
-1 1
```

Note

In the first test case, the tree T and the constructed graph are as follows:



Left side is the tree T with selected nodes colored yellow. The right side is the constructed complete graph.

The nice path shown in the diagram is $3 \to 4 \to 2$. The path is nice as $w(4,2) = 2$ is at least twice of $w(3,4) = 1$. Extending the path using $2 \to 5$ is not possible as $w(2,5) = 3$ is less than twice of $w(4,2) = 2$.

In the second test case, the tree T is a simple path of length 17. An example of a nice path starting from the vertex labeled 2 is $2 \to 3 \to 5 \to 9 \to 17$, which has edge weights of $1, 2, 4, 8$ doubling each time.