Cographs

Cographs are a class of undirected graphs defined recursively as follows.

1. The graph with a single node is a cograph.
2. If G_1, G_2 are cographs with disjoint sets of nodes, then $G_1 \cup G_2$, the disjoint union of G_1 and G_2, is also a cograph. The set of nodes/edges in $G_1 \cup G_2$ is the union of the sets of nodes/edges in G_1 and G_2, respectively.
3. If G_1, G_2 are cographs with disjoint sets of nodes, then $G_1 \vee G_2$, the join of G_1 and G_2 is also a cograph. $G_1 \vee G_2$ is obtained from $G_1 \cup G_2$ by adding edges uv for all nodes u in G_1 and v in G_2. In other words, every node in G_1 is joined to every node in G_2.

A cograph can be represented by a labelled binary tree as follows. The single node graph is represented by the empty tree. The binary tree representing $G_1 \cup G_2$ has a root node labelled `0`, with the left subtree corresponding to G_1 and the right subtree corresponding to G_2. Similarly, $G_1 \vee G_2$ has root node labelled `1`, and left and right subtrees corresponding to G_1 and G_2, respectively.

Given the binary tree representation of a cograph, in the first part of the problem, you have to compute the number of edges in the graph. In the second part of the problem, you have to compute the length of the longest path in the graph.

Note that the graph is undirected and an edge is an unordered pair of nodes. The length of a path is the number of edges in it.

Input/Output: The only input is a string of length $2n - 1$ which gives a postorder traversal of the binary tree representing the graph. This is similar to the postfix representation of an expression tree. The empty tree is represented by `e` and internal nodes by `0` or `1`, depending on the label of the node. For example, the string `ee0ee01` represents the complete bipartite graph $K_{2,2}$. Note that the number of edges in the graph may be large, so use long long int for computing it. It is easier to solve the problem without actually constructing the tree, but if you do, and use recursion, you may need to set ulimit -s unlimited. The number of nodes in the graph n will be at least 1 and at most 10^6.

Please print the output of the first part as soon as it is computed.

Submission: Submit a single file named RollNo_2.cpp .