T-201-GSKI, GAGNASKIPAN
VOR 2014

BINARY TREES
DÆMATÍMAVERKEFNI 6

Assignment grading. A full mark is given for solutions implemented as specified and accepted by Mooshak. Note that points may be deducted for a solution failing to meet the implementation requirements specified below, whether it is accepted by Mooshak or not. Solutions that are not accepted by Mooshak will be given a mark of 0. Note that this assignment is optional.

Hand-in

You do **not** need to hand in your code to MySchool. You only need to submit your code to Mooshak. You are free however to submit your solution to MySchool if you wish.

The aliens of E'spolín

On the remote planet E'spolín resides a species of aliens called Tvíun'd. These aliens are very peculiar. In particular, they reproduce through binary fission; a process where the alien literally splits into two halves. The two halves are then given new names, and are referred to as the alien's children.

In the process of fission, the children are in a very fragile state and, sadly, one or even both of the children may sometimes die during this process.

Your friend, a genealogist, has decided to visit the remote planet of E'spolín to investigate these aliens. He does this by choosing an alien at random, and then keeping track of its descendants. This chosen alien is referred to as T.E. (your friend has forgotten the reason for this name, however you decide to use it to remind you to do the teaching evaluation) and we call the set if its descendants T.E.'s *family*.

Your friend, having had to sit through your ramblings about the growth of binary trees, realizes that the size of the families can potentially increase exponentially. He therefore asks you to write a program to help him keep track of the families.

In his research he mainly asks three types of questions.

- Is alien A in T.E.'s family (i.e., is A a descendant of T.E.)?
- Is alien A a descendant of B. This is a more general form of the first question. Note that an alien is considered to be a descendant of itself. *Of which generation is alien A?

The generation of an alien is specified as follows.

- T.E. is of generation 0.
- If A is of generation n, then the children of A are of generation $n + 1$.

Date: 16. febrúar 2014.

T.E. is therefore the 0th generation, its children are the 1st generation, their children the 2nd generation, and so on.

Your task is to implement a program that receives as input a family tree of aliens and then provides answers to the three types of queries.

Input and output specification. The input starts with a family tree, as shown in the example below. The ensuing line contains an integer n specifying the number of queries that follow. The following n lines then each contain a single query.

The three types of queries are show below, with `X` and `Y` denoting alien names.

- `generation X`
  - If `X` is not in T.E.'s family, output `"X is not in the family"`, otherwise output `"X is of generation n"`, where `n` is the generation of `X`.
- `in_family X`
  - If `X` is not in T.E.'s family, output `"X is not in the family"`, otherwise output `"X is in the family"`.
- `descendant X Y`
  - If `Y` is the descendant of `X` then output `"Y is the descendant of X"`, otherwise output `"Y is not the descendant of X"`.

Input example

```
(Kog
    (Laq
        (Saeb
            ()
            ())
        (Spoj
            ()
            ()))
    (To'h
        ()
        (Guhq
            ()
            ())))
25
generation Kog
generation Laq
generation Saeb
generation Spoj
generation Bij
generation To'h
generation Guhq
in_family Kog
in_family Laq
in_family Saeb
in_family Spoj
```

```
in_family To'h
in_family Guhq
in_family Co't
in_family Doz
descendant Kog Laq
descendant Kog Guhq
descendant Kog Saeb
descendant Kog Spoj
descendant To'h Guhq
descendant Guhq To'h
descendant Laq Guhq
descendant Laq Qur
descendant Qur Kog
descendant Hex Jaep
```

Output example

```
Kog is of generation 0
Laq is of generation 1
Saeb is of generation 2
Spoj is of generation 2
Bij is not in the family
To'h is of generation 1
Guhq is of generation 2
Kog is in the family
Laq is in the family
Saeb is in the family
Spoj is in the family
To'h is in the family
Guhq is in the family
Co't is not in the family
Doz is not in the family
Laq is the descendant of Kog
Guhq is the descendant of Kog
Saeb is the descendant of Kog
Spoj is the descendant of Kog
Guhq is the descendant of To'h
To'h is not the descendant of Guhq
Guhq is not the descendant of Laq
Qur is not the descendant of Laq
Kog is not the descendant of Qur
Jaep is not the descendant of Hex
```

Implementation details. You are provided with an almost complete solution. The file *main.cpp* contains a fully implemented main-program. The main program handles the input, both the family tree and the queries, and calls the appropriate methods in the partially implemented class `AlienFamilyTree`. Your task is to complete the implementation of this class. Its interface is given in *AlienFamilyTree.h* and it's partial implementation in

AlienFamilyTree.cpp. The family tree is represented as a binary tree, whose nodes are instances of the class `BinaryStringNode`, which is fully implemented in *BinaryStringNode.h* and *BinaryStringNode.cpp*.

Submitting. To submit this problem to Mooshak you must create a zip file containing *BinaryStringNode.h*, *BinaryStringNode.cpp*, *AlienFamilyTree.h*, *AlienFamilyTree.cpp* and *main.cpp*.

School of Computer Science, Reykjavík University, Menntavegi 1, 101 Reykjavík

E-mail address: `hjaltim@ru.is`