1997 Paper 1 Question 6

Foundations of Computer Science

This question has been translated from Standard ML to OCaml

A rooted directed graph has vertices identified by integers. Each vertex `v` has a left successor given by `left v` and a right successor given by `right v`, where `left` and `right` are OCaml functions of type `int -> int`. The graph contains the root and all vertices reachable by paths from the root.

Define a variant type `graph` that could be used to represent such a graph with given root, and left and right functions, and define a function `mkgraph root left right` that can create values of type `graph`. Show that such values can be used to represent both finite and infinite graphs. [4 marks]

A path through the graph is represented by a `bool list` with `true` and `false` indicating left and right edges, respectively.

Define the function `last : graph -> bool list -> int` that will yield, for a given graph, the identity of the vertex reached by following the given path from the root. [3 marks]

In a new application, where `last` is repeatedly called, it is required for it to return both the identity of the last vertex and a count of how often this particular vertex has been returned. Define a new version of the variant type `graph`, containing mutable values, that could be used. [3 marks]

Illustrate the use of this type by defining the new versions of `mkgraph` and `last`. [10 marks]