MAU11602 Assignment 4, Due Wednesday 28 February 2024

1. An old German puzzle toy has a set of blocks of square or rectangular shape which can be slid within a frame. The goal is to get from the position

to

As you can probably guess, the images above are from a computerised version of the original mechanical toy. The dark grey squares or rectangles represent spaces without a block, which are necessary because if you're sliding a block you need a free space to slide it to.

(a) Can you formulate this as a non-deterministic computation?

(b) Is it possible for your algorithm to terminate unsuccessfully?

(c) Consider the tree of all possible states reachable from the initial state. Can you be sure that if the puzzle is solvable then a breadth first traversal of this tree will find a solution?

(d) Can you be sure that if the puzzle is solvable then a depth first traversal of this tree will find a solution?

Note: You don't have to give a very detailed answer to the first question. The only reason I'm asking you that question at all is that there is in fact

more than one way to formulate this as a non-deterministic computation and the answer to at least one of the subsequent questions depends on which formulation you pick so your description should be clear enough that your marker can figure out whether your subsequent answers are correct for your formulation of the problem.

2. As explained in the notes, one shouldn't strictly speaking refer to free variables or bound variables in an expression but rather to free and bound occurences of a variable. Normally the distinction isn't relevant because either all occurences of a variable are free or all of them are bound, but it is possible for a variable to have some free occurences and some bound occurences in an expression.

   (a) Give an example of an expression where at least one variable has at least one free occurence and at least one bound occurence.

   (b) Writing expressions like this is generally discouraged. Why do you think it isn't simply forbidden?