CPSC 201: Introduction to Computer Science
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Homework 7

Due: Wednesday, April 9, 2003.

Exercise 1 It is in the middle of the night. The telephone rings at an elevator maintenance company. Somebody got stuck in an elevator in an apartment building, and complains that the elevator did not work as it should. When the repairman came, he could not find anything wrong, and left the premises without repairing anything.

These unproductive trips cost the elevator maintenance company a lot of money, the drive back and forth, not to mention expensive employee time. Therefore, the company is considering a a system that helps them monitor the actions of the elevator and it has therefore issued a call for proposals to provide them with an elegant solution to this problem.

Your proposal is the following. While an elevator is operating, it could generate a string of symbols corresponding to actions, such as `^^()v()()` to be stored inside the elevator control unit. Here `^` stands for up, `v` for down, `(` for open door, and `)` for close door. If there were a program that could check this string, elevators could monitor themselves and call for help if something goes wrong. For example, `((((` points to a problem, because a door can only open and close once. Another example is `(^)`, which would mean that the elevator operated with an open door, an indisputable malfunction, and `^^^^^^` is, too, invalid for a three story building. For an n story building, the following constraints apply:

1. If on the first floor, the elevator can't move down.
2. If on the nth floor, the elevator can't move up.
3. If the door is open, the only valid action is to close the door.
4. If the door is closed, it cannot be closed again.

The maintenance company is thrilled with your idea. You get the contract, and your technology (that you will be developing below) is to be employed at any building maintained by the elevator maintenance company. Your job is it therefore, to write a function

```
check : int -> string -> bool
```

which satisfies the following invariant: `check n s` $\hookrightarrow$ `true` if s describes a valid elevator movement for a building with n floors, `check n s` $\hookrightarrow$ `false`, otherwise. You can assume that the elevator is always on the ground floor `1` with the door closed before the recording of the string commences.

1. Sketch a finite state automaton for an elevator in a building with three stories.
2. Give a regular expression for your answer in 1.
3. Implement the function `check : int -> string -> bool`.