Exercise (Week 7)

DUE: Thu 21 July 09:10:00

Polish Queens (9 Marks)

CSE Stack

Download the exercise tarball and extract it to a directory on your local machine. This tarball contains a file, called `Ex05.hs`, wherein you will do all of your programming.

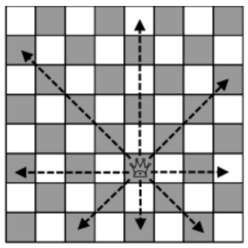
To test your code, run the following shell commands to open a GHCi session:

```
$ stack repl
Configuring GHCi with the following packages: Ex05
Using main module: 1. Package 'Ex05' component exe:Ex05 ...
GHCi, version 8.2.2: http://www.haskell.org/ghc/  :? for help
[1 of 1] Compiling Ex05             (Ex05.hs, interpreted)
Ok, one module loaded.
*Ex05>
```

Note that you will only need to submit `Ex05.hs`, so only make changes to that file.

Task 1: Eight Queens (3 marks)

The queen is the most powerful piece in the game of chess. When a queen is placed in one of the squares of the chessboard, it is able to threaten any number of squares vertically, horizontally or diagonally (corner-by-corner) along a straight line, as follows:



The eight queens puzzle is a famous exercise in both chess and computer programming: the goal is to arrange eight queens on the chessboard in such a way that no two of the queens threaten each other's location.

In a valid solution of the eight queens problem, no two queens can share the same row, the same column, or the same diagonal. Since a chessboard has exactly eight columns, each column must therefore contain exactly one queen.

a. Your first task is to define a function `extend` that takes in the locations of `n` queens placed on the first `n` columns of the board, and places, in all possible ways, a queen on the ~n+1~st column, so that no two of the queens threaten each other.

b. Your second task is to implement a function `solutionStartWith` which, given the location `l` of a queen in the first column of the board, returns all possible complete solutions to the eight queens problem in which the queen on the first column occupies the same location `l`.

Task 2: Reverse Polish Calculator (6 marks)

Reverse Polish notation (RPN) is a way of writing arithmetic expressions unambiguosly without parentheses. Apart from the lack of parentheses, its main advantage is that it's easy to type into a calculator. Handheld RPN calculators were very popular throughout the 1980s, and some people still swear by them.

Generally, evaluation on an RPN calculator proceeds by maintaining a stack of numbers, and handling each user action separately, as follows:

1. If the user entered a number (e.g. action `Enter 5`), we push the entered number onto a stack.
2. If the user pressed the button for an arithmetic operation, say `+`, we remove the two topmost numbers `x` and `y` from the stack, and put the result of the operation (in this case `y + x`) on the stack.

3. There are special buttons: `Clear`, which, when pressed, removes the topmost number from the stack; `AllClear`, which removes everything from the stack, and `Swap`, which swaps the two topmost elements on the stack.

Old calculators could store only 4-5 elements on their stack. Here, we allow our stack to be an unbounded list of numbers. The bottom of the stack is always padded with zeroes: so the stack `[]` and the stack `[0,0]` behave identically, as the stacks `[5,4]` and `[5,4,0]` behave identically as well. You can play with a simulated RPN calculator by clicking here.

As an example, the following sequence of actions: `[Enter 3, Enter 7, Enter 5, Arith (-), Arith (*)]` will result in the following final stack state: [6]. First, 3, 7 and 5 are put on the stack. Then we subtract 5 from 7, leaving 3 and 2 on the stack. Finally, we multiply these two, which yields 6.

In this exercise you will implement a Reverse Polish calculator using the `State` monad.

Your first task is to implement the `pop`, `swap`, `allClear` and `performArith` functions (*a.* to *d.*), which perform the effects of the user actions described above.

e. Your second task is to implement functions `app1` and `app`, which apply a given sequence of user actions to the stack.

Submission instructions

You can submit your exercise by typing:

```
$ give cs3141 ex05 Ex05.hs
```

on a CSE terminal, or by using the `give` web interface. Your file must be named `Ex05.hs` (case-sensitive!).

A dry-run test will *partially* autotest your solution at submission time. To get full marks, you will need to perform further testing yourself.