PLC: Workout 6 [90 points + 5 extra]

Due date: Wednesday, April 15th by midnight

About This Homework

This assignment is about theorem proving in Agda for the booleans and also using simple equational reasoning. See the course materials for the week of April 6 - 10.

How to Turn In Your Solution

Please submit your solution via ICON. The required files for this assignment are these (you can just turn in your whole `workout6` directory):

- `ial-screenshot.png` (or `.jpg` or other standard image format)
- `bools.agda`
- `equational.agda`

Please use exactly the file names we are requesting. We will require you to resubmit your homework with a 5-point penalty if the names are not exactly as we are requesting. This is for purposes of grading scripts. It is ok if ICON adds a number to your file name on multiple submission (which is allowed up to the deadline).

Partners Allowed

You may work alone or with one partner. You should both turn in your solution to the assignment, which we expect will be the same (but is allowed to be different, if you worked together but then you decided to add to your solution – or whatever the scenario). Also, you need to turn in a file called `partner.txt` which lists your partner's name. This will let us know that you worked with that person (lest we incorrectly think you plagiarized another student's similar submission).

How To Get Help

You can post questions in the `workouts` section on Piazza.

The course staff will be holding office hours by Zoom, at times to be announced on Piazza. Please check Piazza and the course calendar for these:

`https://calendar.google.com/calendar/embed?src=a5d6qokrert25ce093iksp8np0%40group.calendar.google.com&ctz=America%2FChicago`

1 Reading

Read Chapters 2, 3, and 4 of Verified Functional Programming in Agda, available for free (on campus or VPN) here:

`https://dl-acm-org.proxy.lib.uiowa.edu/doi/book/10.1145/2841316`

2 Installing Agda

Agda is installed on the CS Windows computers. You will probably want to install it also on your own computer. For Windows, the easiest thing is to use our installer (which we have updated now and it works):

`https://homepage.divms.uiowa.edu/~astump/agda/Agda2.6.0.1.v1.msi`

Otherwise, try following the directions on the Agda wiki, here:

`http://wiki.portal.chalmers.se/agda/pmwiki.php`

Essentially you first do `cabal install Agda` and then `agda-mode setup` (the latter probably requires that you add `~/.cabal/bin` to your path).

3 Installing the IAL

You clone the repo here from github:

`https://github.com/cedille/ial`

4 Configuring and testing Agda and the IAL [5 points]

Finally, you need to tell Agda how to find the Iowa Agda Library. If you are using a CS Windows machine, then open the file `h:/.emacs`. Otherwise, open `~/.emacs` in emacs (you type "Control-x Control-f /.emacs"). Add the following text, where instead of the word `PATH`, you should have the path to your copy of the IAL (wherever you put it):

```
(custom-set-variables
 '(agda2-program-args (quote ("--include-path=PATH"))))
```

That should be a single forward tick mark on the second line of that code (might render incorrectly in this PDF). On Windows, I found I could put backslashes if I escaped them (double backslash), like this (where `Myself` is, of course, your actual Windows username):

`C:\\Users\\Myself\\Documents\\ial`

To prove that all this is working for you, open `bool.agda` in the IAL and type Control-c Control-l to load the file with Agda. If this succeeds you should get syntax highlighting for the file. Now

take a screenshot called `ial-screenshot.YYY`, capturing your Emacs window with `bool.agda` highlighted. (I found that for some reason, Agda often says "Another command is currently in progress" when I do this, and I must first type Control-c Control-x Control-r to restart Agda, and then do Control-c Control-l.)

5 Boolean theorems [48 points]

In `bools.agda` in the `hw4` directory, you will find eight lemmas to prove. When you load the file with Control-c Control-l, you will see holes on the right-hand sides of the definitions of those lemmas. Remove those holes (Control-k with your cursor right before the hole will cut it out), and fill the definitions in with proofs. [6 points each]

6 Simple equational theorems [42 points]

In `equational.agda` you will find seven problems similar to ones I did in the screencast for April 7th. They are worth 6 points each.