Homework 5

Chirag Sachdev

Week 5

Abstract

This project is a part of HW5 of Assurance Foundations. The homework deals with integration of ML and HOL to LaTeX. The goal of this report is to show reproducibility which is the groundwork for credibility that I have done this on my own without any external help. Every Chapter demonstrates the following sections:

- Problem Statement
- Relevant Code
- Test Results

This project includes the following packages:

634format.sty A format style for this course

listings Package for displaying and inputting ML source code

holtex HOL style files and commands to display in the report

This document also demonstrates my ability to :

- Easily generate a table of contents,
- Refer to chapter and section labels

My skills and my professional details can be found at `https://www.linkedin.in/in/chiragsachdev`.

Acknowledgments

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Contents

Chapter 1

Executive Summary

All requirements for this project are satisfied. Specifically,

Report Contents
Our report has the following content:

Reproducibility in ML and LaTeX
The ML and LaTeX source files compile with no errors.

Chapter 2

Excercise 8.4.1

2.1 Problem statement

Prove the following theorem

```
> val problem1Thm =
        [] |- p ==> (p ==> q) ==> (q ==> r) ==> r
        : thm
```

2.2 Relevant Code

```
val problem1Thm =
let
 val th1 = ASSUME ``p:bool``
 val th2 = ASSUME ``p ==> q``
 val th3 = ASSUME ``q ==> r``
 val th4 = MP th2 th1 (*Modus Ponens*)
 val th5 = MP th3 th4 (*Modus Ponens*)
 val t1  = hd(hyp th1)
 val t2  = hd(hyp th2)
 val t3  = hd(hyp th3)
 val th6 = DISCH t3 th4
 val th7 = DISCH t2 th6
in
 DISCH t3 th7
end

val _ = save_thm("problem1Thm",problem1Thm);
```

2.3 Session Transcript

```
---------------------------------------------------------------------
       HOL-4 [Kananaskis 11 (stdknl, built Sat Aug 19 09:30:06 2017)]        1

       For introductory HOL help, type: help "hol";
       To exit type <Control>-D
---------------------------------------------------------------------
> > > > # # # # # # # # # # # # # # # # # val problem1Thm =
    [.] |- (q  r)  (p  q)  (q  r)  q:
   thm
> >
*** Emacs/HOL command completed ***

>
Process HOL finished
```

Chapter 3

Excercise 8.4.2

3.1 Problem statement

Prove the following theorem:

```
> val conjSymThm =
      [] |- p /\ q <=> q /\ p
      : thm
```

3.2 Relevant Code

```
val conjSymThm =
let
 val th1 = ASSUME ``p/\q``
 val th2 = ASSUME ``q/\p``
 val xp  = CONJUNCT1 th1
 val xq  = CONJUNCT2 th1
 val yp  = CONJUNCT2 th2
 val yq  = CONJUNCT1 th2
 val th3 = CONJ xq xp
 val th4 = CONJ yp yq
 val t1  = hd(hyp th1)
 val t2  = hd(hyp th2)
 val th5 = DISCH t1 th3
 val th6 = DISCH t2 th4
in
 IMP_ANTISYM_RULE th5 th6
end

val _ = save_thm("conSymThm",conjSymThm);
```

3.3 Session Transcript

2

```
---------------------------------------------------------------------
       HOL-4 [Kananaskis 11 (stdknl, built Sat Aug 19 09:30:06 2017)]

       For introductory HOL help, type: help "hol";
       To exit type <Control>-D
---------------------------------------------------------------------
> > > > # # # # # # # # # # # # # # # # # # val conjSymThm =
   |- p  q  q  p:
   thm
> >
*** Emacs/HOL command completed ***

>
Process HOL finished
```

Chapter 4

Excercise 8.4.3

4.1 Problem statement

Extend your proof in Problem 2 by one step and prove:

```
> val conjSymThmAll =
        [] |- !p q. p /\ q <=> q /\ p
        : thm
```

4.2 Relevant Code

```
val conjSymThmAll = GENL [``p:bool``,``q:bool``] conjSymThm;
val _ = save_thm("conSymThmAll",conjSymThmAll);
```

4.3 Test Case

```
---------------------------------------------------------------------
       HOL-4 [Kananaskis 11 (stdknl, built Sat Aug 19 09:30:06 2017)]

       For introductory HOL help, type: help "hol";
       To exit type <Control>-D
---------------------------------------------------------------------
> > > > # # # # # # # # # # # # # # # # # # val conjSymThm =
   |- p  q  q  p:
   thm
> > >
*** Emacs/HOL command completed ***

> val conjSymThmAll =
   |- p q. p  q  q  p:
   thm
> > >
Process HOL finished
```

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Appendix A

Source code

```
(* ====================================================================== *)
(* Chirag Sachdev                                                          *)
(* 02/19/19                                                                *)
(* ====================================================================== *)

structure hw5Script = struct

open HolKernel Parse boolLib bossLib;

val _ = new_theory "hw5";


(*************************************************************************)
(* 8.4.1                                                                  *)
(*************************************************************************)

val problem1Thm =
let
 val th1 = ASSUME ``p:bool``
 val th2 = ASSUME ``p ==> q``
 val th3 = ASSUME ``q ==> r``
 val th4 = MP th2 th1 (*Modus Ponens*)
 val th5 = MP th3 th4 (*Modus Ponens*)
 val t1  = hd(hyp th1)
 val t2  = hd(hyp th2)
 val t3  = hd(hyp th3)
 val th6 = DISCH t3 th4
 val th7 = DISCH t2 th6
in
 DISCH t3 th7
end

val _ = save_thm("problem1Thm",problem1Thm);



(*************************************************************************)
(*8.4.2                                                                   *)
(*************************************************************************)

val conjSymThm =
```

```
let
  val th1 = ASSUME ``p/\q``
  val th2 = ASSUME ``q/\p``
  val xp  = CONJUNCT1 th1
  val xq  = CONJUNCT2 th1
  val yp  = CONJUNCT2 th2
  val yq  = CONJUNCT1 th2
  val th3 = CONJ xq xp
  val th4 = CONJ yp yq
  val t1  = hd(hyp th1)
  val t2  = hd(hyp th2)
  val th5 = DISCH t1 th3
  val th6 = DISCH t2 th4
in
 IMP_ANTISYM_RULE th5 th6
end

val _ = save_thm("conSymThm",conjSymThm);



(****************************************************************************)
(* 8.4.3                                                                    *)
(****************************************************************************)

val conjSymThmAll = GENL [``p:bool``,``q:bool``] conjSymThm;
val _ = save_thm("conSymThmAll",conjSymThmAll);

val _ = export_theory();

end (* structure *)
```