Interactive and Automated Theorem Proving
for Non-Classical Logics
Tutorial at GCAI 2016

Christoph Benzmüller, Alexander Steen and Max Wisniewski

Freie Universität Berlin

29th September 2016

1 Installing Isabelle/HOL

The Isabelle proof assistant is available at https://isabelle.in.tum.de/. There you'll also find various tutorials and documentations. In particular, the `prog-prove` manual[1] offers a good start and a lot of helpful examples. The Isabelle system should ideally be installed before the tutorial starts, since this will take a while. Every other files presented here (mostly theory files) can be download and installed on the fly.

The first execution of Isabelle might take a while since various theories are being compiled.

2 Install Convenient Abbreviations for Logic Embedding

Download the file http://www.christoph-benzmueller.de/2016-GCAI/abbrevs and store it on your computer at `~/.isabelle/Isabelle2016/jedit/abbrevs`.

In a shell you may simply do this as follows:

```
cd ~/.isabelle/Isabelle2016/jedit/
mv abbrevs abbrevs.save.1
wget http://www.christoph-benzmueller.de/2016-GCAI/abbrevs
```

Now go to `Isabelle2016>Preferences>Abbreviations` and activate `Space bar expands abbrevs`. Then klick `Apply` and `OK`.

By this procedure you have activated the following, very convenient abbreviations for entering connectives in the embedding approach (which are displayed in Isabelle in boldface). In order to enable their display you need to hit `space` after entering the shortcuts.

shortcut	alternative latex-like input	displayed as
mneg	\bol\not	¬
mor	\bol\or	∨
mand	\bol\and	∧
mimpl	\bol\right	→
mequiv	\bol\leftr	↔
mall	\bol\for	∀
mexi	\bol\exi	∃
mnegpred		¬
mvalid	\lf\rf	⌊⌋

---

[1] See https://isabelle.in.tum.de/dist/Isabelle2016/doc/prog-prove.pdf

3 Download the Example Files

Create a working directory and change the directory accordingly. Then download the Isabelle file http://www.christoph-benzmueller.de/2016-GCAI/examples.tar

```
mkdir ~/LogicEmbeddingsTutorial
cd ~/LogicEmbeddingsTutorial
http://www.christoph-benzmueller.de/2016-GCAI/examples.tar
tar -xf examples.tar
```

This archive contains all example file, that will be dealt with in the tutorial session.

4 Examples

4.1 ALC

Open up the file `ALC.thy`. This file contains an embedding of the ALC description logic.
  You can easily define TBoxs and ABoxs on your own following the example given in the file.
  Exercise??

4.2 Wise Men

The file `WiseMen_Explicit.thy` models and deals with the wise men puzzle (aka muddy forhead puzzle). It introduces a suitable, weak epistemic logic suitable and a formalization of the problem.
  The file `WiseMen.thy` takes one step further an formalize the problem through axiomatization schemes.

4.3 Hilbert Calculi

The file `Hilbert.thy` introduces a new propositional logic. This disables all native support of Isabelle regarding this logic. Using Hilbert style Axiom schemes and the rule Modus Ponens, we can use Isabelle as a pure Hilbert Style calculi prover.
  Using ATPs you can even try to find a minimal axiom system. In the file `HilbertEquivalence.thy` sledgehammer is used to show the equivalence of two axiom systems.