AR Coursework Lecture

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18th October 2018
Information

- Demonstrator/TA: Imogen Morris s1402592@ed.ac.uk
- Lab sessions: 4.12, Appleton Tower,
- Submission Deadline: 4pm 18th Nov
- Isabelle 2018 is installed on DICE machines: type 'Isabelle FOO.thy' in the terminal window.
- You should have a look at the recommended reading and try the exercises from the course website.
Coursework Part 1

- Prove some propositional and first-order proofs:
- You may use only the methods

  - rule
  - rule_tac
  - drule
  - drule_tac
  - erule
  - erule_tac
  - frule
  - frule_tac
  - assumption
Coursework Part 1

► You may use only the rules:

conjI  conjE  impl
impE   mp     iffI
iffE   notI   notE
disjI1  disjI2  disjE
exl    exE    allI
allE   spec   classical
ccontr

► No automatic proof methods (auto, blast etc) !
Coursework Part 2

- Formalising a Geometry of Sections (split into 4 locales):
  - points, regions, sectors, sections
  - incidence
  - region_to_section
  - $R$ is included in $s_1$
Coursework Part 2

- Split into 4 locales: incidence, section_bundle, comparison, crossing_sector

```plaintext
locale section_bundle = incidence incidence_points_on_sections region_to_section
for incidence_points_on_sections :: "'point ⇒ 'section ⇒ bool"
and region_to_section :: "'region ⇒ 'section" +
fixes crossing :: "'region ⇒ 'section ⇒ bool"
and incidence_sections_on_bundle :: "'section ⇒ 'bundle ⇒ bool" (infix "∩section" 80)
assumes SC1: (*Write your formalisation of Axiom SC1 here*) (*1 mark*)
and SI1: (*Write your formalisation of Axiom SI1 here*) (*1 mark*)
begin
```
Coursework Part 2

- $R$ crosses $s_1$
- $R$ overlaps $s_1$ (Axiom SC1)
Coursework Part 2

\[ \geq_o (b, R, R') \iff_{\text{def}} \forall s \left[ s \vdash b \implies (o(R', s) \implies o(R, s)) \right] \]
Coursework Part 2

- $s$ is the core of $b$, $s = \text{core}(b)$ (functional) is represented as $s \text{isCoreOf} b$ (relational).
- Functional definitions are assumed to be total.
- But the core of $b$ is not always defined.
Coursework Part 2

- $s_1$ and $s_2$ not comparable.

\[ \leq (b, s, s') \iff_{def} \ s \uplus b \land s' \uplus b \land s \subseteq s' \]

\[ s = \text{core}(b) \iff_{def} \ s \uplus b \land \forall s' \ [s' \uplus b \Rightarrow \leq (b, s, s')] \]
Coursework Part 2

▶ Formalise axioms, lemmas, definitions
▶ For universal quantifiers use meta level not object level e.g. \( \forall x. \ P \ x \) can be formalised as \( P \ x \) or \( \wedge x. \ P \ x \). Same for implication.
▶ Mechanise proofs of theorems: one-line is acceptable unless asked for structured.
▶ Structured proof should provide an explanation of why theorem is true.
Coursework Part 3

▶ Everyone can have a go: credit given for partial formalisations that demonstrate progress.
▶ If proofs are too easy/difficult then check your formalisation of the definitions.
▶ Kulik et al. give you some hints
  - what theorems might be used
  - phrasing T6-T8 in both symbols and words.
▶ Prove useful lemmas if you are stuck or overwhelmed.
▶ You may use any of the Isabelle methods except smt.
▶ You may invoke Sledgehammer to see if it can provide an automatic justification for any of your proof step.
▶ Make sure your proofs are properly structured to make the reasoning clear.
Overview

- Deadline: 18th Nov, 4pm
- Refer to recommended reading and self-help exercises for background and help.
- Inbuilt tactics/methods (auto, simp etc.) can be used from Part 2 onwards. Please bear in mind the restrictions mentioned in the handout though.
- Use the ‘query’ box or search the imported theories (at https://isabelle.in.tum.de/library/HOL/) to find theorems
- Break challenging proofs into lemmas.
- Please make use of the TA (and not just before the deadline!).