EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Fachbereich Informatik

Programmiersprachen und Softwaretechnik

Prof. Dr. Klaus Ostermann

Responsible for the lab
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Programming Languages 2

Homework 12 – WS 18

Tübingen, 24. Januar 2019

In order to be admitted to the exam, you have to successfully submit your homework every week, except for 2 weeks. A successful submission is one where you get at least 1 point.

Handin Please submit this homework until Thursday, January 31, either via email to Philipp Schuster (philipp.schuster@uni-tuebingen.de) before 12:00, or on paper at the beginning of the lab.

Groups You can work in groups of up to 2 people. Please include the names and Matrikelnummern of all group members in your submission.

Points For each of the Tasks you get between 0 and 2 points for a total of 6 points. You get:
1 point, if your submission shows that you tried to solve the task.
2 points, if your submission is mostly correct.

Task 1: Infinite streams

Consider the type $\{\exists S, \{\mathrm{seed} : S, \mathrm{step} : S \to \{\mathrm{Nat}, S\}\}\}$ as the type of infinite streams of natural numbers. Define a term that given two streams of natural numbers returns a stream of pairs of natural numbers by zipping the two streams pointwise.
The term should have type:
$\{\exists S, \{\mathrm{seed} : S, \mathrm{step} : S \to \{\mathrm{Nat}, S\}\}\} \to$
$\{\exists S, \{\mathrm{seed} : S, \mathrm{step} : S \to \{\mathrm{Nat}, S\}\}\} \to$
$\{\exists S, \{\mathrm{seed} : S, \mathrm{step} : S \to \{\{\mathrm{Nat}, \mathrm{Nat}\}, S\}\}\}$

Task 2: Derivation tree with existential types

Show that your term from Task 1 indeed has the required type by drawing a derivation tree.

Task 3: Universal quantification in terms of existential quantification

In classical logic we have that $\forall x.A \leftrightarrow \neg\exists x.\neg A$. Which problem do you encounter when you try to remove *all* universal quantification from a program by replacing it by existential quantification exploiting this equivalence?