



# Programming Languages 2

Homework 9 – WS 18

Tübingen, 2. 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 10, 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: System F

We consider System F as presented in the lecture. Show that term  $t$  has type  $T$  in context  $\Gamma$ , where

$$\begin{aligned} t &= \lambda C. \text{const } [\text{Nat}] [C] 5 \\ T &= \forall C. C \rightarrow \text{Nat} \\ \Gamma &= \text{const} : \forall A. \forall B. A \rightarrow B \rightarrow A, \text{Nat}, 5 : \text{Nat} \end{aligned}$$

Draw a derivation tree for the typing relation.

## Task 2: Self application is typeable

Find suitable substitutions for the question marks, such that the following System F term is typeable in the empty context.

$$\lambda X. \lambda f : ? . f ? (f ?)$$

Draw a derivation tree for the typing relation.

### **Task 3: Type checker for System F**

Implement a type checker for System F in a programming language of your choice. Do not try to write a parser but assume a representation of terms in memory. Examples for a representation of terms and types in Haskell and Java are on the website.