

TD4 : An Introduction to Compiler Construction

Thibaut Benjamin¹ and Burkhart Wolff²[0000-0002-9648-7663]

¹ LMF, Université Paris-Saclay, France

Thibaut Benjamin

² LMF, Université Paris-Saclay, Paris, France

wolff@lmf.cnrs.fr

Abstract. This TD gives an introduction to the concepts of higher-order abstract syntax and the resulting type-inference for some small languages.

The accompanying material can be found on the the following site: [1]

Keywords: Grammars, Higher-order Abstract Syntax, Typing, Type-inference

1 TD 4

1.1 Exo 12

Task: We define a logical language in higher-order abstract syntax (HOAS) with

1. the usual logical connectives, including existential and universal quantifiers (polymorphic)
2. polymorphic equality
3. a fragment of set-theory (polymorphic) with element test $x \in S$, set comprehension $\{x \mid P x\}$, union, intersection and complement.

It suffices to specify the constant environment Σ_0 for this language and describe informally how the concrete syntax for the abstract operators should be. In two cases, make an example how the λ -term representation looks like.

1.2 Exo 13

We define a small imperative language in HOAS. The key is to encode all operations as transitions on states, i.e. σ is a synonym for *Ident* \Rightarrow *Value* (and *Value* are just integers, to make simple). The sequential composition is then simply:

$$\Sigma_{stmt} = \{ \text{;-} \mapsto (\sigma \Rightarrow \sigma) \Rightarrow (\sigma \Rightarrow \sigma) \Rightarrow (\sigma \Rightarrow \sigma), \dots \}$$

We encode accesses to program variables ("a", "b", "c", ...) inside expressions by σa , σb , σc , etc, and arithmetic expressions by functions $\sigma \Rightarrow Value$ and boolean expressions by $\sigma \Rightarrow bool$.

Task:

1. Define the types for the constants for the assignment, the skip-statement, the *if-then-else* and the *while* - loop.
2. Give notations for these constructs.
3. Present some program fragments in concrete syntax as well as the terms that they denote.

References

1. Wolff, B.: Teaching Website: PolyTech Compiler Course. <https://usr.lmf.cnrs.fr/~wolff/teach-material/2025-2026/ET4-Compil/index.html> (2025), [Online; accessed 8-Dec-2025]