

# HW7 – Type Inference

SS 476, Fall 2023

## 1 Instructions

Begin by downloading the file `hw7-base.ml` from the course website and renaming it to `hw7.ml`. This file contains the functions that you will use and modify in the homework. Submit your completed `hw7.ml` via Gradescope. As always, please don't hesitate to ask for help on Piazza (<https://piazza.com/class/lkwp62qwo734i9>).

## 2 Type Inference

In this assignment, you will extend the `get_constraints` function to perform type inference for more features of our functional programming language. Recall that `get_constraints gamma e` returns a pair of a type `t` and constraint set `s`, following rules of the form  $\text{gamma} \vdash e : t \mid s$ .

1. (5 points) The type inference rule for tuples is:

$$\frac{\Gamma \vdash e_1 : \tau_1 \mid S_1 \quad \Gamma \vdash e_2 : \tau_2 \mid S_2}{\Gamma \vdash (e_1, e_2) : \tau_1 * \tau_2 \mid S_1 \cup S_2}$$

Add a case for `Tuple` expressions according to this rule. The type  $\tau_1 * \tau_2$  is represented in code by `TupleTy`  $(\tau_1, \tau_2)$ . Constraint sets  $S$  are represented by lists of pairs of types, and can be manipulated with the usual OCaml list operations `::` and `@`.

2. (6 points) The type inference rules for `fst` and `snd` are:

$$\frac{\Gamma \vdash e : \tau \mid S \quad \tau_1, \tau_2 \text{ fresh}}{\Gamma \vdash \text{fst } e : \tau_1 \mid \{\tau = \tau_1 * \tau_2\} \cup S} \qquad \frac{\Gamma \vdash e : \tau \mid S \quad \tau_1, \tau_2 \text{ fresh}}{\Gamma \vdash \text{snd } e : \tau_2 \mid \{\tau = \tau_1 * \tau_2\} \cup S}$$

Add cases for `Fst` and `Snd` expressions according to these rules. A constraint  $a = b$  is represented in OCaml code by the pair  $(a, b)$  in a constraint list. You can use the `fresh_tyvar` function to generate fresh type variables.

3. (for graduate students) The type inference rules for sum types and match statements are:

$$\frac{\Gamma \vdash e : \tau_1 \mid S \quad \tau_2 \text{ fresh}}{\Gamma \vdash \mathbf{inl} \ e : \tau_1 + \tau_2 \mid S} \qquad \frac{\Gamma \vdash e : \tau_2 \mid S \quad \tau_1 \text{ fresh}}{\Gamma \vdash \mathbf{inr} \ e : \tau_1 + \tau_2 \mid S}$$

$$\frac{\Gamma \vdash e : \tau \mid S \quad \tau_a, \tau_b \text{ fresh} \quad \Gamma[x_1 \mapsto \tau_a] \vdash e_1 : \tau_1 \mid S_1 \quad \Gamma[x_2 \mapsto \tau_b] \vdash e_2 : \tau_2 \mid S_2}{\Gamma \vdash (\mathbf{match} \ e \ \mathbf{with} \ \mathbf{inl} \ x_1 \ \mathbf{->} \ e_1 \ \mid \ \mathbf{inr} \ x_2 \ \mathbf{->} \ e_2) : \tau \mid \{\tau = \tau_a + \tau_b, \tau_1 = \tau_2\} \cup S \cup S_1 \cup S_2}$$

Add cases for `Inl`, `Inr`, and `Match` according to these rules.