## Assignment \#3: Records and Variants

## Overview

This assignment extends the type system implementation to support records and variants (and unit, for convenience).

## Starting Point and Data Extensions

Extend your solution to Assignment \#2. Extend your type representation to include representations for records, variants, and unit. There should be no explicit restrictions on the number of fields within a record or the number of labels within a variant. Extend your expression representation to include terms for record construction, record projection, variant construction, case, and unit.

## Tests

Include in your submission a set of tests verifying that your implementation works as expected, both for terms that are well-typed and terms that are not.

As before, include a set of tests translated from the examples in the Ungraded Problem Set $\# 3$.

## Typing Function

Extend your typing function to implement the new typing rules given on the last page.

## Grading

Grading will be divided as follows, and will be based on both functionality and quality of implementation.

| Part | Percentage |
| ---: | ---: |
| Unit (T-UnIT) | 5 |
| Records (T-RcD, T-Proj) | 45 |
| Variants (T-VARIANT, T-CASE) | 45 |
| Tests | 5 |

The terms for the expression language are to be inferred from the rules below coupled with the discussion in lecture (and in the textbook). Your implementation, of course, will work on the internal AST representation of such expressions, so you should be able to map the terms used in the typing rules to the variants declared in the Rust code.
$n v$ is for numeric values.

$$
\begin{gather*}
\Gamma \vdash \text { true : Bool }  \tag{T-True}\\
\Gamma \vdash \text { false : Bool }  \tag{T-FALSE}\\
\frac{\Gamma \vdash t_{1}: \text { Bool } \quad \Gamma \vdash t_{2}: \tau \quad \Gamma \vdash t_{3}: \tau}{\Gamma \vdash \text { if } t_{1} \text { then } t_{2} \text { else } t_{3}: \tau} \tag{T-IF}
\end{gather*}
$$

$$
\begin{equation*}
\Gamma \vdash n v: \text { Int } \tag{T-IntConst}
\end{equation*}
$$

$$
\begin{equation*}
\frac{\Gamma \vdash t_{1}: \text { Int } \Gamma \vdash t_{2}: \text { Int }}{\Gamma \vdash t_{1}+t_{2}: \text { Int }} \tag{T-ADD}
\end{equation*}
$$

$$
\begin{equation*}
\frac{\Gamma \vdash t_{1}: \text { Int } \Gamma \vdash t_{2}: \text { Int }}{\Gamma \vdash t_{1}-t_{2}: \text { Int }} \tag{T-Sub}
\end{equation*}
$$

$$
\begin{equation*}
\frac{t_{1}: \text { Int }}{\Gamma \vdash \text { iszero } t_{1}: \text { Bool }} \tag{T-IsZERO}
\end{equation*}
$$

$$
\begin{equation*}
\frac{\mathrm{x}: \tau \in \Gamma}{\Gamma \vdash \mathrm{x}: \tau} \tag{T-VAR}
\end{equation*}
$$

$$
\begin{equation*}
\frac{\Gamma, \mathrm{x}: \alpha \vdash t_{1}: \beta}{\Gamma \vdash \lambda \mathrm{x}: \alpha \cdot t_{1}: \alpha \rightarrow \beta} \tag{T-ABS}
\end{equation*}
$$

$$
\begin{equation*}
\frac{\Gamma \vdash t_{1}: \alpha \rightarrow \beta \quad \Gamma \vdash t_{2}: \alpha}{\Gamma \vdash t_{1} t_{2}: \beta} \tag{T-APP}
\end{equation*}
$$

$$
\begin{equation*}
\frac{\Gamma \vdash t_{j}: \tau_{j}}{\Gamma \vdash\left\langle l_{j}=t_{j}\right\rangle \text { as }\left\langle l_{i}: \tau_{i}{ }^{i \in 1 . . n}\right\rangle:\left\langle l_{i}: \tau_{i}{ }^{i \in 1 . . n}\right\rangle} \tag{T-VARIANT}
\end{equation*}
$$

$$
\begin{equation*}
\frac{\Gamma \vdash t_{0}:\left\langle l_{i}: \tau_{i}{ }^{i \in 1 . . n}\right\rangle \text { for each } i \quad \Gamma, x_{i}: \tau_{i} \vdash t_{i}: \tau}{\Gamma \vdash \text { case } t_{0} \text { of }\left\langle l_{i}=r_{i}\right\rangle \Rightarrow t_{i} i \in 1 . . n \cdot \tau} \tag{T-CASE}
\end{equation*}
$$

$$
\begin{equation*}
\Gamma \vdash \text { unit : Unit } \tag{T-UnIT}
\end{equation*}
$$

