Hinting for records and variants

Wojciech Kołowski

Signatures:
$$\Sigma ::= \emptyset \mid \Sigma, \ell : A$$

Types:
$$A, B ::= A \to B \mid \texttt{Record } \Sigma \mid \texttt{Variant } \Sigma$$

Hints:
$$H ::= \textbf{?} \mid H_1 \to H_2 \mid \texttt{Record } \Sigma \mid \texttt{Variant } \Sigma$$

Terms, records and variants

Terms:

$e ::=$
$\quad x \mid (e : H) \mid$
$\quad \lambda x.\, e \mid e_1\ e_2 \mid$
$\quad r \mid e.\ell$
$\quad$ c $e \mid$ vcase e_1 of e_2

Records:

$r ::= \{\} \mid \{r, \ell := e\}$

Note: the terms are, in order of appearance, variables, annotated terms, functions, applications, records, record projections, applied variant constructors and pattern matching expressions.

Wut

$$\frac{}{\emptyset \text{ ok}} \text{OK-Empty}$$

$$\frac{\Sigma \text{ ok} \quad \ell \notin \Sigma}{\Sigma, \ell : A \text{ ok}} \text{OK-Extend}$$

For now we will assume that signatures are finite partial maps from labels to types. A label may appear at most once.

We define an operation on signatures which will be useful later.

$\emptyset \to B = \emptyset$

$(\Sigma, \ell : A) \to B = (\Sigma \to B, \ell : A \to B)$

Declarative typing – basics

$$\frac{(x : A) \in \Gamma}{\Gamma \vdash x : A}\text{Var}$$

$$\frac{\Gamma \vdash e : A \quad H \sqsubseteq A}{\Gamma \vdash (e : H) : A}\text{Annot}$$

Declarative typing – type-directed rules

$$\frac{\Gamma, x : A \vdash e : B}{\Gamma \vdash \lambda x. e : A \to B} \qquad \frac{\Gamma \vdash f : A \to B \quad \Gamma \vdash a : A}{\Gamma \vdash f\,a : B}$$

$$\frac{}{\Gamma \vdash \{\} : \texttt{Record}\,\emptyset} \qquad \frac{\Gamma \vdash r : \texttt{Record}\,\Sigma \quad \Gamma \vdash e : A}{\Gamma \vdash \{r, \ell := e\} : \texttt{Record}\,(\Sigma, \ell : A)}$$

$$\frac{\Gamma \vdash e : \texttt{Record}\,\Sigma \quad (\ell : A) \in \Sigma}{\Gamma \vdash e.\ell : A}$$

$$\frac{\Gamma \vdash e : A \quad (c : A) \in \Sigma}{\Gamma \vdash c\,e : \texttt{Variant}\,\Sigma}$$

$$\frac{\Gamma \vdash e_1 : \texttt{Variant}\,\Sigma \quad \Gamma \vdash e_2 : \texttt{Record}\,(\Sigma \to A)}{\Gamma \vdash \texttt{vcase}\,e_1\,\texttt{of}\,e_2 : A}$$

Algorithmic typing – basic rules

$$\frac{(x : A) \in \Gamma \quad H \sqsubseteq A}{\Gamma \vdash x \Leftarrow H \Rightarrow A} \text{Var}$$

$$\frac{\Gamma \vdash e \Leftarrow H_1 \sqcup H_2 \Rightarrow A}{\Gamma \vdash (e : H_1) \Leftarrow H_2 \Rightarrow A} \text{Annot}$$

$$\frac{\Gamma, x : A \vdash e \Leftarrow H \Rightarrow B}{\Gamma \vdash \lambda x. \, e \Leftarrow A \rightarrow H \Rightarrow A \rightarrow B}$$

$$\frac{\Gamma \vdash f \Leftarrow \mathbf{?} \rightarrow H \Rightarrow A \rightarrow B \quad \Gamma \vdash a \Leftarrow A \Rightarrow A}{\Gamma \vdash f \, a \Leftarrow H \Rightarrow B}$$

$$\frac{H \sqsubseteq \mathtt{Record}\ \emptyset}{\Gamma \vdash \{\} \Leftarrow H \Rightarrow \mathtt{Record}\ \emptyset}$$

$$\frac{H \sqcup \mathtt{Record}\ \mathbf{?} = H' \quad \Gamma \vdash \{r, \ell := e\} \Leftarrow H' \Rightarrow A}{\Gamma \vdash \{r, \ell := e\} \Leftarrow H \Rightarrow A}$$

$$\frac{\Gamma \vdash r \Leftarrow \mathtt{Record}\ H_\Sigma \Rightarrow \mathtt{Record}\ \Sigma \quad \Gamma \vdash e \Leftarrow H_A \Rightarrow A}{\Gamma \vdash \{r, \ell := e\} \Leftarrow \mathtt{Record}\ (H_\Sigma, \ell : H_A) \Rightarrow \mathtt{Record}\ (\Sigma, \ell : A)}$$

$$\frac{\Gamma \vdash e \Leftarrow \mathtt{Record}\ (\mathbf{?}, \ell : H) \Rightarrow \mathtt{Record}\ (\Sigma, \ell : A)}{\Gamma \vdash e.\ell \Leftarrow H \Rightarrow A}$$

Algorithmic typing – variants

$$\frac{H \sqcup \mathtt{Variant}\ (\textbf{?}, c : \textbf{?}) = \mathtt{Variant}\ (\Sigma, c : H_A) \quad \Gamma \vdash e \Leftarrow H_A \Rightarrow A}{\Gamma \vdash c\ e \Leftarrow H \Rightarrow \mathtt{Variant}\ (\Sigma, c : A)}$$

$$\frac{\Gamma \vdash e_1 \Leftarrow \textbf{?} \Rightarrow \mathtt{Variant}\ \Sigma \\ \Gamma \vdash e_2 \Leftarrow \mathtt{Record}\ (\Sigma \to H) \Rightarrow \mathtt{Record}\ (\Sigma \to A)}{\Gamma \vdash \mathtt{vcase}\ e_1\ \mathtt{of}\ e_2 \Leftarrow H \Rightarrow A}$$