

Hinting for records and variants

Wojciech Kołowski

Types, hints and signatures

Signatures:

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

Types:

$$A, B ::= A \rightarrow B \mid \text{Record } \Sigma \mid \text{Variant } \Sigma$$

Hints:

$$H ::= ? \mid H_1 \rightarrow H_2 \mid \text{Record } \Sigma \mid \text{Variant } \Sigma$$

Terms, records and variants

Terms:

$e ::=$

$$\begin{aligned} & x \mid (e : H) \mid \\ & \lambda x. e \mid e_1 e_2 \mid \\ & r \mid e.\ell \\ & c\ e \mid \text{vcase } e_1 \text{ of } e_2 \end{aligned}$$

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.

Well-formed signatures

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

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

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

Signatures for pattern-matching

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

$$\emptyset \rightarrow B = \emptyset$$

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

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

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

$$\frac{\Gamma \vdash f : A \rightarrow B \quad \Gamma \vdash a : A}{\Gamma \vdash f\ a : B}$$

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

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

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

$$\frac{\Gamma \vdash e_1 : \text{Variant } \Sigma \quad \Gamma \vdash e_2 : \text{Record } (\Sigma \rightarrow A)}{\Gamma \vdash \text{vcase } e_1 \text{ of } e_2 : A}$$

Algorithmic typing – basic rules

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

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

Algorithmic typing – functions

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

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

Algorithmic typing – records

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

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

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

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

Algorithmic typing – variants

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

$$\frac{\Gamma \vdash e_1 \Leftarrow ? \Rightarrow \text{Variant } \Sigma \quad \Gamma \vdash e_2 \Leftarrow \text{Record } (\Sigma \rightarrow H) \Rightarrow \text{Record } (\Sigma \rightarrow A)}{\Gamma \vdash \text{vcase } e_1 \text{ of } e_2 \Leftarrow H \Rightarrow A}$$