Two Pass Typing Rules

Rules

We use the following notations:

- Γ compute the size of an atom.

- Φ compute the size of a lvalue.

Base cases

$$\frac{s = \Gamma(e) \qquad e \in \mathcal{A}}{\vdash e : n[s]}$$

Operators

- $\oplus \in \{+, -, *, /, \%, \&, |, \hat{\ }, \hat{\ }\sim, \sim\hat{\ }\}$:

$$\frac{\vdash a : n[s_a] \qquad \vdash b : n[s_b] \qquad s = \max\{s_a, s_b\}}{\vdash a \oplus b : n[s]}$$

- $\oplus \in \{+, -, \texttt{++}, \texttt{--}, \sim\}$:

$$\frac{\vdash e : n[s]}{\vdash \oplus e : n[s]}$$

- $\oplus \in \{\texttt{\$signed}, \texttt{\$unsigned}\}$:

$$\frac{\vdash e : s[s]}{\vdash \oplus(e) : n[s]}$$

- $\oplus \in \{\texttt{===}, \texttt{!==}, \texttt{==?}, \texttt{!=?}, \texttt{==}, \texttt{!=}, \texttt{>}, \texttt{>=}, \texttt{<}, \texttt{<=}\}$:

$$\frac{\vdash a : s[s_a] \qquad \vdash b : s[s_b] \qquad s = \max\{s_a, s_b\}}{\vdash a \oplus b : n[1]}$$

- $\oplus \in \{\texttt{\&\&}, \texttt{||}, \texttt{->}, \texttt{<->}\}$:

$$\frac{\vdash a : s_a[s_a] \qquad \vdash b : s_b[s_b]}{\vdash a \oplus b : n[1]}$$

- $\oplus \in \{\texttt{\&}, \texttt{\textasciitilde\&}, \texttt{|}, \texttt{\textasciitilde|}, \hat{\ }, \sim\hat{\ }, \hat{\ }\sim, \texttt{!}\}$:

$$\frac{\vdash e : s[s]}{\vdash \oplus e : n[1]}$$

- $\oplus \in \{\texttt{>>}, \texttt{<<}, \texttt{**}, \texttt{>>>}, \texttt{<<<}\}$:

$$\frac{\vdash a : n[s] \qquad \vdash b : s_b[s_b]}{\vdash a \oplus b : n[s]}$$

- $\oplus \in \{\texttt{=}, \texttt{+=}, \texttt{-=}, \texttt{*=}, \texttt{/=}, \texttt{\%=}, \texttt{\&=}, \texttt{|=}, \hat{\ }\texttt{=}\}$:

$$\frac{s = \Phi(l) \qquad \vdash e : n_e[s_e] \qquad n_e = \max\{s_a, s\}}{\vdash l \oplus e : n[s]}$$

- $\oplus \in \{\texttt{<<=}, \texttt{>>=}, \texttt{<<<=}, \texttt{>>>=}\}$:

$$\frac{s = \Phi(l) \qquad \vdash e : s_e[s_e]}{\vdash l \oplus e : n[s]}$$

- If expression:

$$\frac{\vdash e : s_e[s_e] \qquad \vdash a : n[s_a] \qquad \vdash b : n[s_b] \qquad s = \max\{s_a, s_b\}}{\vdash e\,?\,a\,{:}\,b : n[s]}$$

- Concatenation:

$$\frac{\vdash e_1 : s_1[s_1] \qquad \ldots \qquad \vdash e_k : s_k[s_k] \qquad s = \sum_{i=1}^{k} s_i}{\vdash \{e_1, ..., e_k\} : n[s]}$$

- Replication:

$$\frac{i \in \mathbb{N} \qquad \vdash e : s_e[s_e] \qquad s = i \times s_e}{\vdash \{i\ e\} : n[s]}$$

- Inside:

$$\frac{\vdash a : s[s_a] \qquad \vdash e_1 : s[s_1] \qquad \ldots \qquad \vdash e_k : s[s_k] \qquad s = \max\{s_a, s_1, \ldots, s_k\}}{\vdash a\ \texttt{inside}\ \{e_1, ..., e_k\} : n[1]}$$