

Syntax.

Term variables	$x, y \in Var$	Type variables	$t, u \in TVar$
Type constructors	$T^\kappa \in \mathcal{T}^\kappa$ where $\{-*\bullet, -*^\circ, \rightarrow\bullet, \rightarrow^\circ\} \subseteq \mathcal{T}^{*\rightarrow**}$		
Kinds	$\kappa ::= \star \mid \kappa \rightarrow \kappa$		
Types	$\tau^\kappa ::= t \mid T^\kappa \mid \tau^{\kappa' \rightarrow \kappa} \tau^{\kappa'}$		
Predicates	$\pi ::= \text{Un } \tau \mid \text{SeFun } \tau \mid \text{ShFun } \tau \mid \tau \geq v$		
Qualified types	$\rho ::= \tau^\star \mid \pi \Rightarrow \rho$		
Type schemes	$\sigma ::= \rho \mid \forall t. \sigma$		
Environments	$H ::= \varepsilon \mid x : \sigma \mid H, H \mid H; H$		
Environment contexts	$\mathcal{H} ::= \varepsilon \mid x : \sigma \mid \square \mid \mathcal{H}, H \mid H, \mathcal{H} \mid H; H$		
Expressions	$M, N ::= x \mid \lambda * x. M \mid \lambda \& x. M \mid M N \mid \underline{\text{let}} \ x = M \ \underline{\text{in}} \ N$		

Figure 1: Types and terms.

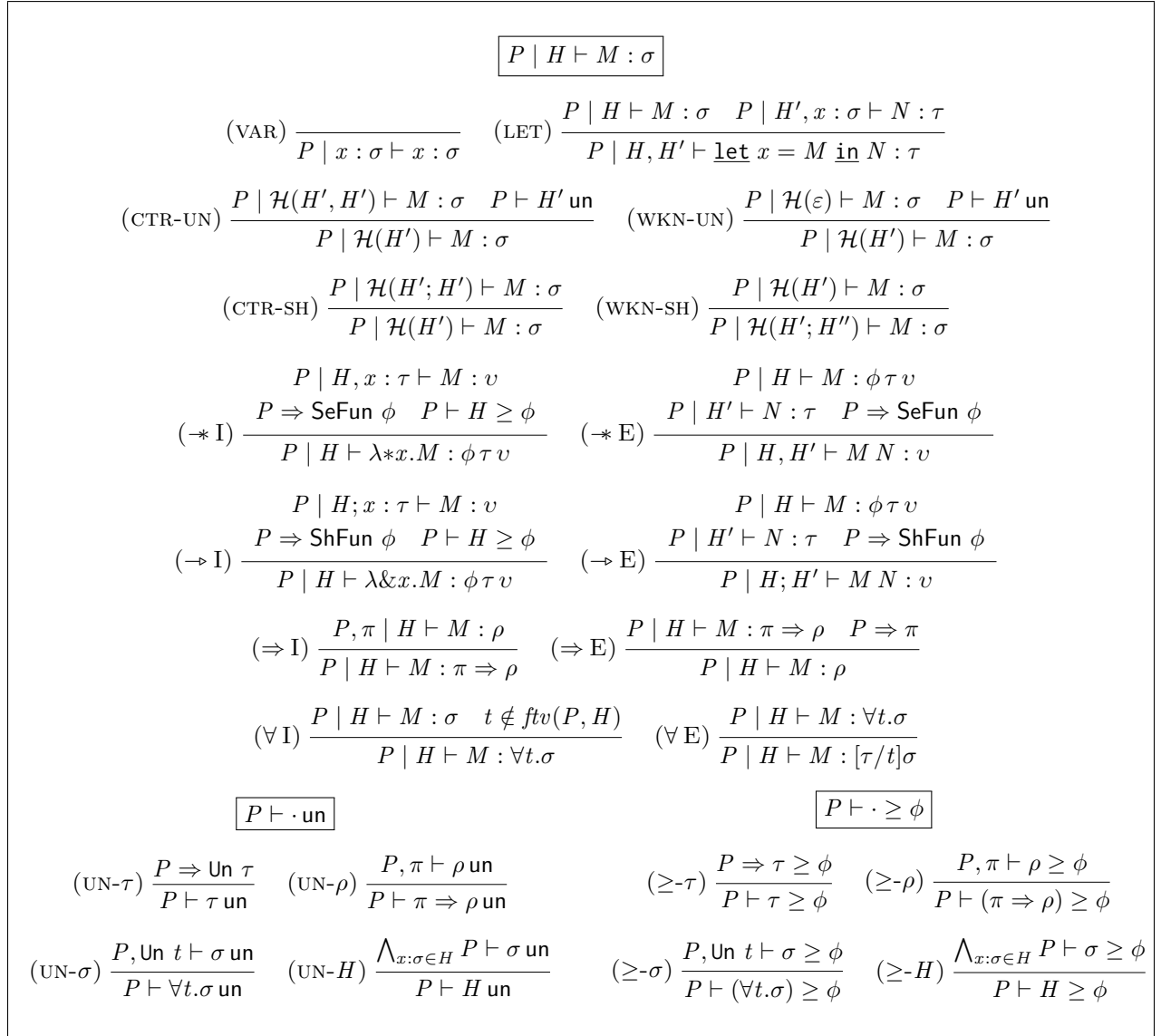


Figure 2: Typing rules.

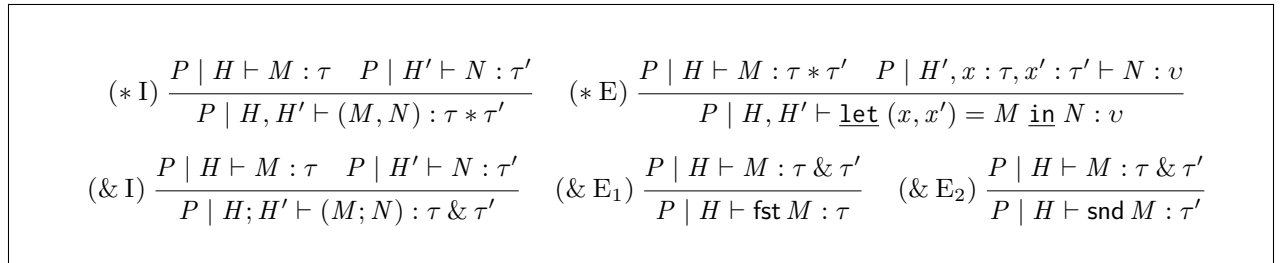


Figure 3: Derivable typing rules

$$\begin{array}{c}
\text{oops} \\
\hline
(\rightarrow \text{I}) \frac{(x : t, y : u); z : v \vdash (x, z) : t * v}{x : t, y : u \vdash \lambda \& z. (x, z) : v \rightarrow t * v} \\
(-* \text{I}) \frac{x : t \vdash \lambda y \& z. (x, z) : u -* v \rightarrow t * v}{x : t \vdash \lambda x * y \& z. (x, z) : t -* u -* v \rightarrow t * v} \\
\hline
(\text{VAR}) \frac{}{x : t \vdash x : t} \quad (\text{CTR-SH}) \frac{x : t; y : u \vdash x : t}{x : t; y : u \vdash x : t} \quad (\text{VAR}) \frac{}{z : v \vdash z : v} \\
(* \text{I}) \frac{(x : t; y : u), z : v \vdash (x, z) : t * v}{x : t; y : u \vdash \lambda * z. (x, z) : v -* t * v} \\
(\rightarrow \text{I}) \frac{x : t; y : u \vdash \lambda \& y. \lambda * z. (x, z) : u \rightarrow v -* t * v}{x : t \vdash \lambda \& y * z. (x, z) : t -* u \rightarrow v -* t * v} \\
(-* \text{I}) \frac{}{\vdash \lambda x \& y * z. (x, z) : t -* u \rightarrow v -* t * v} \\
\hline
(\text{VAR}) \frac{}{\text{Un } u \mid x : t \vdash x : t} \quad (\text{CTR-UN}) \frac{(\text{VAR}) \frac{}{\text{Un } u \mid z : v \vdash z : v}}{\text{Un } u \mid y : u, z : v \vdash z : v} \\
(* \text{I}) \frac{\text{Un } u \mid x : t, y : u, z : v \vdash (x, z) : t * v}{\text{Un } u \mid x : t, y : u \vdash \lambda z. (x, z) : v -* t * v} \\
(-* \text{I}) \frac{\text{Un } u \mid x : t \vdash \lambda y * z. (x, z) : u -* v -* t * v}{\text{Un } u \mid \varepsilon \vdash \lambda x * y * z. (x, z) : t -* u -* v -* t * v}
\end{array}$$

Figure 4: Sample derivations