x term variable
α type variable

t	$::=$	term
	$\mid$ x	variable
	$\mid$ $\lambda(x : \tau) \Rightarrow t$	abstraction
	$\mid$ $\lambda\{\alpha : *\} \Rightarrow t$	type abstraction
	$\mid$ $t_1\ t_2$	application
	$\mid$ $t\ [\tau]$	type application
τ	$::=$	type
	$\mid$ α	type variable
	$\mid$ $\tau_1 \to \tau_2$	arrow
	$\mid$ $\forall\,(\alpha : *), \tau$	universal quantification
Γ	$::=$	typing environment
	$\mid$ $\emptyset$	empty
	$\mid$ $\Gamma, x : \tau$	variable
	$\mid$ $\Gamma, \alpha : *$	type variable
v	$::=$	(typed) value
	$\mid$ $\lambda(x : \tau) \Rightarrow t$	abstraction
	$\mid$ $\lambda\{\alpha : *\} \Rightarrow v$	type abstraction

Initial environment: $\Gamma = \emptyset$

$\boxed{\Gamma \vdash t : \tau}$ Typing rules

$$\frac{x : \tau \in \Gamma}{\Gamma \vdash x : \tau} \quad \text{T\_VAR}$$

$$\frac{\Gamma, x : \tau_1 \vdash t : \tau_2 \qquad \Gamma \vdash \tau_1 : *}{\Gamma \vdash (\lambda(x : \tau_1) \Rightarrow t) : \tau_1 \to \tau_2} \quad \text{T\_ABS}$$

$$\frac{\alpha \notin \Gamma \qquad \Gamma, \alpha : * \vdash t : \tau}{\Gamma \vdash (\lambda\{\alpha : *\} \Rightarrow t) : \forall\,(\alpha : *), \tau} \quad \text{T\_TYABS}$$

$$\frac{\Gamma \vdash t_1 : \tau_2 \to \tau_1 \qquad \Gamma \vdash t_2 : \tau_2}{\Gamma \vdash t_1\ t_2 : \tau_1} \quad \text{T\_APP}$$

$$\frac{\Gamma \vdash t : \forall\,(\alpha : *), \tau_2 \qquad \Gamma \vdash \tau_1 : * \qquad [\alpha \mapsto \tau_1]\tau_2 \rhd \tau_2'}{\Gamma \vdash t\ [\tau_1] : \tau_2'} \quad \text{T\_TYAPP}$$

$\boxed{\Gamma \vdash \tau : *}$ Type τ is well formed

$$\frac{\alpha : * \in \Gamma}{\Gamma \vdash \alpha : *} \quad \text{K\_VAR}$$

$$\frac{\Gamma \vdash \tau_1 : * \qquad \Gamma \vdash \tau_2 : *}{\Gamma \vdash (\tau_1 \to \tau_2) : *} \quad \text{K\_ARROW}$$

$$\frac{\alpha \notin \Gamma \qquad \Gamma, \alpha : * \vdash \tau : *}{\Gamma \vdash (\forall\,(\alpha : *), \tau) : *} \quad \text{K\_FORALL}$$

$\boxed{t \longrightarrow t'}$ Operational semantics

$$\frac{t_2 \longrightarrow t_2'}{t_1\ t_2 \longrightarrow t_1\ t_2'} \quad \text{E\_APP1}$$

$$\frac{t \longrightarrow t'}{t\ v \longrightarrow t'\ v} \quad \text{E\_APP2}$$

$$\frac{[x \mapsto v]t \rhd t'}{(\lambda(x : \tau) \Rightarrow t)\ v \longrightarrow t'} \quad \text{E\_APPABS}$$

$$\frac{t \longrightarrow t'}{(\lambda\{\alpha : *\} \Rightarrow t) \longrightarrow (\lambda\{\alpha : *\} \Rightarrow t')} \quad \text{E\_TABS}$$

$$\frac{t \longrightarrow t'}{t\ [\tau] \longrightarrow t'\ [\tau]} \quad \text{E\_TAPP}$$

$$\frac{[\alpha \mapsto \tau]v \rhd v'}{(\lambda\{\alpha : *\} \Rightarrow v)\ [\tau] \longrightarrow v'} \quad \text{E\_TAPPABS}$$

$\boxed{[\alpha \mapsto \tau_1]\tau_2 \rhd \tau_3}$ Type substitution

$$\frac{}{[\alpha \mapsto \tau]\alpha \rhd \tau} \quad \text{SUBSTT\_VAR1}$$

$$\frac{\alpha_1 \neq \alpha_2}{[\alpha_1 \mapsto \tau]\alpha_2 \rhd \alpha_2} \quad \text{SUBSTT\_VAR2}$$

$$\frac{[\alpha \mapsto \tau_1]\tau_2 \rhd \tau_2' \qquad [\alpha \mapsto \tau_1]\tau_3 \rhd \tau_3'}{[\alpha \mapsto \tau_1](\tau_2 \to \tau_3) \rhd \tau_2' \to \tau_3'} \quad \text{SUBSTT\_ARROW}$$

$$\frac{\alpha_1 \neq \alpha_2 \qquad [\alpha_1 \mapsto \tau_1]\tau_2 \rhd \tau_2'}{[\alpha_1 \mapsto \tau_1](\forall\,(\alpha_2 : *), \tau_2) \rhd (\forall\,(\alpha_2 : *), \tau_2')} \quad \text{SUBSTT\_FORALL}$$

$\boxed{[x \mapsto t]t_1 \rhd t_2}$ substitution

$$\frac{}{[x \mapsto t]x \rhd t} \quad \text{SUBST\_VAR1}$$

$$\frac{x_1 \neq x_2}{[x_1 \mapsto t]x_2 \rhd x_2} \quad \text{SUBST\_VAR2}$$

$$\frac{}{[x \mapsto t_1](\lambda(x : \tau) \Rightarrow t_2) \rhd (\lambda(x : \tau) \Rightarrow t_2)} \quad \text{SUBST\_ABS1}$$

$$\frac{x_1 \neq x_2 \qquad x_2 \notin fv(t_1) \qquad [x_1 \mapsto t_1]t_2 \rhd t_2'}{[x_1 \mapsto t_1](\lambda(x_2 : \tau) \Rightarrow t_2) \rhd (\lambda(x_2 : \tau) \Rightarrow t_2')} \quad \text{SUBST\_ABS2}$$

$$\frac{x_1 \neq x_2 \qquad x_3 \notin fv(t_1, t_2) \qquad [x_2 \mapsto x_3]t_2 \rhd t_2' \qquad [x_1 \mapsto t_1]t_2' \rhd t_2''}{[x_1 \mapsto t_1](\lambda(x_2 : \tau) \Rightarrow t_2) \rhd (\lambda(x_3 : \tau) \Rightarrow t_2'')} \quad \text{SUBST\_ABS3}$$

$$\frac{[x \mapsto t_1]t_2 \rhd t_2'}{[x \mapsto t_1](\lambda\{\alpha : *\} \Rightarrow t_2) \rhd (\lambda\{\alpha : *\} \Rightarrow t_2')} \quad \text{SUBST\_TABS}$$

$$\frac{[x \mapsto t_1]t_2 \rhd t_2' \qquad [x \mapsto t_1]t_3 \rhd t_3'}{[x \mapsto t_1](t_2\ t_3) \rhd t_2'\ t_3'} \quad \text{SUBST\_APP}$$

$$\frac{[x \mapsto t_1]t_2 \rhd t_2'}{[x \mapsto t_1](t_2\ [\tau]) \rhd (t_2'\ [\tau])} \quad \text{SUBST\_TAPP}$$

$\boxed{[\alpha \mapsto \tau] t_1 \rhd t_2}$ substitution of type variable in term

$$\frac{}{[\alpha \mapsto \tau] x \rhd x} \quad \textsc{TtSubst\_Var}$$

$$\frac{[\alpha \mapsto \tau_1] \tau_2 \rhd \tau_2' \qquad [\alpha \mapsto \tau_1] t_1 \rhd t_2}{[\alpha \mapsto \tau_1](\lambda(x : \tau_2) \Rightarrow t_1) \rhd (\lambda(x : \tau_2') \Rightarrow t_2)} \quad \textsc{TtSubst\_Abs}$$

$$\frac{\alpha_1 \neq \alpha_2 \qquad [\alpha_1 \mapsto \tau] t_1 \rhd t_2}{[\alpha_1 \mapsto \tau](\lambda\{\alpha_2 : *\} \Rightarrow t_1) \rhd (\lambda\{\alpha_2 : *\} \Rightarrow t_2)} \quad \textsc{TtSubst\_TAbs}$$

$$\frac{[\alpha \mapsto \tau] t_1 \rhd t_1' \qquad [\alpha \mapsto \tau] t_2 \rhd t_2'}{[\alpha \mapsto \tau](t_1\ t_2) \rhd t_1'\ t_2'} \quad \textsc{TtSubst\_App}$$

$$\frac{[\alpha \mapsto \tau_1] t_1 \rhd t_2 \qquad [\alpha \mapsto \tau_1] \tau_2 \rhd \tau_2'}{[\alpha \mapsto \tau_1](t_1\ [\tau_2]) \rhd (t_2\ [\tau_2'])} \quad \textsc{TtSubst\_TApp}$$

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Definition rules:        31 good    0 bad
Definition rule clauses: 58 good    0 bad
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