x term variable
α type variable
T type constructor

t	$::=$		term
	$\vert$	x	variable
	$\vert$	$\lambda(x : \tau) \Rightarrow t$	abstraction
	$\vert$	$\lambda\{\alpha : \kappa\} \Rightarrow t$	type abstraction
	$\vert$	$t_1\, t_2$	application
	$\vert$	$t\ [\tau]$	type application
	$\vert$	$t : \tau$	type annotation
κ	$::=$		kind
	$\vert$	$*$	star
	$\vert$	$\kappa_1 \to \kappa_2$	kind arrow
τ	$::=$		type
	$\vert$	α	type variable
	$\vert$	T	type constructor
	$\vert$	$\tau_1 \to \tau_2$	$\equiv (\to)\ \tau_1\ \tau_2$
	$\vert$	$\lambda(\alpha : \kappa), \tau$	operator abstraction
	$\vert$	$\forall\,(\alpha : \kappa), \tau$	universal quantification
	$\vert$	$\tau_1\, \tau_2$	operator application
Γ	$::=$		typing environment
	$\vert$	$\emptyset$	empty
	$\vert$	$\Gamma, x : \tau$	variable
	$\vert$	$\Gamma, T : \kappa$	type constructor
	$\vert$	$\Gamma, \alpha : \kappa$	type variable
tv	$::=$		typed value
	$\vert$	$\lambda(x : \tau) \Rightarrow t$	abstraction
	$\vert$	$\lambda\{\alpha : \kappa\} \Rightarrow tv$	type abstraction
	$\vert$	$tv\ [\tau]$	type application
	$\vert$	$tv : \tau$	type annotation
v	$::=$		value
	$\vert$	$\lambda x \Rightarrow t$	abstraction

Initial environment: $\Gamma = \emptyset, (\to) : * \to * \to *$

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

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

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

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

$$\frac{\Gamma \vdash t_1 : \tau_2 \to \tau_1 \qquad \tau_2 \equiv \tau_2' \qquad \Gamma \vdash t_2 : \tau_2'}{\Gamma \vdash t_1\, t_2 : \tau_1} \quad \text{T\_App}$$

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

$$\frac{\Gamma \vdash t : \tau_2 \qquad \tau_1 \equiv \tau_2}{\Gamma \vdash (t : \tau_1) : \tau_1} \quad \text{T\_Annot}$$

$\boxed{\Gamma \vdash \tau : \kappa}$ Kinding rules

$$\frac{\alpha : \kappa \in \Gamma}{\Gamma \vdash \alpha : \kappa} \quad \text{K\_Var}$$

$$\frac{T : \kappa \in \Gamma}{\Gamma \vdash T : \kappa} \quad \text{K\_TypeConstr}$$

$$\frac{\alpha \notin \Gamma \qquad \Gamma, \alpha : \kappa_1 \vdash \tau : \kappa_2}{\Gamma \vdash (\lambda(\alpha : \kappa_1), \tau) : \kappa_1 \to \kappa_2} \quad \text{K\_Abs}$$

$$\frac{\Gamma \vdash \tau_1 : \kappa_2 \to \kappa_1 \qquad \Gamma \vdash \tau_2 : \kappa_2}{\Gamma \vdash \tau_1\, \tau_2 : \kappa_1} \quad \text{K\_App}$$

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

$\boxed{\tau_1 \equiv \tau_2}$ Type equivalence

$$\frac{}{\tau \equiv \tau} \quad \text{EQ\_Refl}$$

$$\frac{\tau_2 \equiv \tau_1}{\tau_1 \equiv \tau_2} \quad \text{EQ\_Sym}$$

$$\frac{\tau_1 \equiv \tau_2 \qquad \tau_2 \equiv \tau_3}{\tau_1 \equiv \tau_3} \quad \text{EQ\_Trans}$$

$$\frac{}{\alpha \equiv \alpha} \quad \text{EQ\_Var}$$

$$\frac{}{T \equiv T} \quad \text{EQ\_TypeConstr}$$

$$\frac{\tau_1 \equiv \tau_2}{\forall\,(\alpha : \kappa), \tau_1 \equiv \forall\,(\alpha : \kappa), \tau_2} \quad \text{EQ\_Forall}$$

$$\frac{\tau_1 \equiv \tau_2}{\lambda(\alpha : \kappa), \tau_1 \equiv \lambda(\alpha : \kappa), \tau_2} \quad \text{EQ\_Abs}$$

$$\frac{\tau_1 \equiv \tau_1' \qquad \tau_2 \equiv \tau_2'}{\tau_1\, \tau_2 \equiv \tau_1'\, \tau_2'} \quad \text{EQ\_App}$$

$$\frac{[\alpha \mapsto \tau_2]\ \tau_1 \rhd \tau_1'}{(\lambda(\alpha : \kappa), \tau_1)\, \tau_2 \equiv \tau_1'} \quad \text{EQ\_AppAbs}$$

$\boxed{t \longrightarrow tv}$ Operational semantics

$$\frac{t_2 \longrightarrow tv_2 \qquad t_1\, tv_2 \longrightarrow tv_3}{t_1\, t_2 \longrightarrow tv_3} \quad \text{E\_App1}$$

$$\frac{t \longrightarrow tv_1 \qquad tv_1\ tv_2 \longrightarrow tv_3}{t\ tv_2 \longrightarrow tv_3} \quad \text{E\_APP2}$$

$$\frac{[x \mapsto tv_1]\ t \rhd t' \qquad t' \longrightarrow tv_2}{(\lambda(x : \tau) \Rightarrow t)\ tv_1 \longrightarrow tv_2} \quad \text{E\_APPABS}$$

$$\frac{t \longrightarrow tv}{(\lambda\{\alpha : \kappa\} \Rightarrow t) \longrightarrow (\lambda\{\alpha : \kappa\} \Rightarrow tv)} \quad \text{E\_TABS}$$

$$\frac{t \longrightarrow tv}{t\ [\tau] \longrightarrow tv\ [\tau]} \quad \text{E\_TAPP}$$

$$\frac{[\alpha \mapsto \tau]\ t \rhd t' \qquad t' \longrightarrow tv}{(\lambda\{\alpha : \kappa\} \Rightarrow t)\ [\tau] \longrightarrow tv} \quad \text{E\_TAPPABS}$$

$$\frac{t \longrightarrow tv}{(t : \tau) \longrightarrow (tv : \tau)} \quad \text{E\_ANNOT}$$

$\boxed{tv \longrightarrow v}$ type erasure

$$\frac{}{(\lambda(x : \tau) \Rightarrow t) \longrightarrow (\lambda x \Rightarrow t)} \quad \text{ERASE\_ABS}$$

$$\frac{tv \longrightarrow v}{(\lambda\{\alpha : \kappa\} \Rightarrow tv) \longrightarrow v} \quad \text{ERASE\_TABS}$$

$$\frac{tv \longrightarrow v}{(tv\ [\tau]) \longrightarrow v} \quad \text{ERASE\_TAPP}$$

$$\frac{tv \longrightarrow v}{(tv : \tau) \longrightarrow v} \quad \text{ERASE\_ANNOT}$$

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

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

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

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

$$\frac{\alpha_1 \neq \alpha_2 \qquad [\alpha_1 \mapsto \tau_1]\ \tau_2 \rhd \tau_2'}{[\alpha_1 \mapsto \tau_1]\ (\lambda(\alpha_2 : \kappa), \tau_2) \rhd (\lambda(\alpha_2 : \kappa), \tau_2')} \quad \text{SUBSTT\_ABS}$$

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

$$\frac{[\alpha \mapsto \tau_1]\ \tau_2 \rhd \tau_2' \qquad [\alpha \mapsto \tau_1]\ \tau_3 \rhd \tau_3'}{[\alpha \mapsto \tau_1]\ \tau_2\,\tau_3 \rhd \tau_2'\,\tau_3'} \quad \text{SUBSTT\_APP}$$

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

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

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

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

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

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

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

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

$$\frac{[x \mapsto tv]\ t_1 \rhd t_2}{[x \mapsto tv]\ (t_1 : \tau) \rhd (t_2 : \tau)} \quad \text{SUBST\_ANNOT}$$

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

$$\frac{}{[\alpha \mapsto \tau]\ x \rhd x} \quad \text{TTSUBST\_VAR}$$

$$\frac{[\alpha \mapsto \tau_1]\ \tau_2 \rhd \tau_2' \qquad [\alpha \mapsto \tau_1]\ t_1 \rhd t_2}{[\alpha \mapsto \tau_1]\ (\lambda(x : \tau_2) \Rightarrow t_1) \rhd (\lambda(x : \tau_2') \Rightarrow t_2)} \quad \text{TTSUBST\_ABS}$$

$$\frac{\alpha_1 \neq \alpha_2 \qquad [\alpha_1 \mapsto \tau]\ t_1 \rhd t_2}{[\alpha_1 \mapsto \tau]\ (\lambda\{\alpha_2 : \kappa\} \Rightarrow t_1) \rhd (\lambda\{\alpha_2 : \kappa\} \Rightarrow t_2)} \quad \text{TTSUBST\_TABS}$$

$$\frac{[\alpha \mapsto \tau]\ t_1 \rhd t_1' \qquad [\alpha \mapsto \tau]\ t_2 \rhd t_2'}{[\alpha \mapsto \tau]\ t_1\ t_2 \rhd t_1'\ t_2'} \quad \text{TTSUBST\_APP}$$

$$\frac{[\alpha \mapsto \tau_1]\ t_1 \rhd t_2 \qquad [\alpha \mapsto \tau_1]\ \tau_2 \rhd \tau_2'}{[\alpha \mapsto \tau_1]\ (t_1\ [\tau_2]) \rhd (t_2\ [\tau_2'])} \quad \text{TTSUBST\_TAPP}$$

$$\frac{[\alpha \mapsto \tau_1]\ t_1 \rhd t_2 \qquad [\alpha \mapsto \tau_1]\ \tau_2 \rhd \tau_2'}{[\alpha \mapsto \tau_1]\ (t_1 : \tau_2) \rhd (t_2 : \tau_2')} \quad \text{TTSUBST\_ANNOT}$$

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Definition rules:        51 good    0 bad
Definition rule clauses: 93 good    0 bad
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