$tmvar$, x, y, f, m, n	variables
$covar$, c	coercion variables
$datacon$, K	
$const$, T, F, Age	
$index$, i	indices

relflag, ρ	::=			relevance flag
	|	$+$		
	|	$-$		
	|	**app_rho** ν	S	
	|	(ρ)	S	
appflag, ν	::=			applicative flag
	|	R		
	|	ρ		
role, R	::=			Role
	|	**Nom**		
	|	**Rep**		
	|	$R_1 \cap R_2$	S	
	|	**param** $R_1\ R_2$	S	
	|	**app_role** $\nu\ R$	S	
	|	(R)	S	
constraint, ϕ	::=			props
	|	$a \sim_R b : A$		
	|	(ϕ)	S	
	|	$\phi\{b/x\}$	S	
	|	$\|\phi\|$	S	
	|	$a \sim_R b$	S	
	|	$a \sim b$	S	
tm, a, b, p, v, w, A, B, C	::=			types and kinds
	|	$\star$		
	|	x		
	|	$\lambda^\rho x\!:\!A.b$	bind x in b	
	|	$\lambda^\rho x.b$	bind x in b	
	|	$a\ b^\nu$		
	|	$\Pi^\rho x\!:\!A \to B$	bind x in B	
	|	$\Lambda c\!:\!\phi.b$	bind c in b	
	|	$\Lambda c.b$	bind c in b	
	|	$a[\gamma]$		
	|	$\forall c\!:\!\phi.B$	bind c in B	
	|	$a \triangleright_R \gamma$		
	|	F		
	|	$\square$		
	|	case a of $F \to b_1 \|\|_{\_} \to b_2$		
	|	**apply** a *pattern_args*	M	
	|	K		
	|	**match** a **with** *brs*		
	|	**sub** $R\ a$		
	|	**coerce** a		
	|	$a\ b$		

	$\vert$	$a\{b/x\}$	S	
	$\vert$	$a\{\gamma/c\}$	S	
	$\vert$	$a\{b/x\}$	S	
	$\vert$	$a\{\gamma/c\}$	S	
	$\vert$	a	S	
	$\vert$	a	S	
	$\vert$	(a)	S	
	$\vert$	a	S	parsing precedence is hard
	$\vert$	$\vert a \vert_R$	S	
	$\vert$	**Int**	S	
	$\vert$	**Bool**	S	
	$\vert$	Nat	S	
	$\vert$	**Vec**	S	
	$\vert$	0	S	
	$\vert$	S	S	
	$\vert$	**True**	S	
	$\vert$	**Fix**	S	
	$\vert$	**Maybe**	S	
	$\vert$	**Just**	S	
	$\vert$	**Nothing**	S	
	$\vert$	$a \to b$	S	
	$\vert$	$\phi \Rightarrow A$	S	
	$\vert$	$\lambda x.a$	S	
	$\vert$	$\lambda x : A.a$	S	
	$\vert$	$\forall\, x : A \to B$	S	
	$\vert$	$\mathbf{if}\, \phi\, \mathbf{then}\, a\, \mathbf{else}\, b$	S	
brs	$::=$			case branches
	$\vert$	**none**		
	$\vert$	$K \Rightarrow a; brs$		
	$\vert$	$brs\{a/x\}$	S	
	$\vert$	$brs\{\gamma/c\}$	S	
	$\vert$	(brs)	S	
$co,\ \gamma$	$::=$			explicit coercions
	$\vert$	$\bullet$		
	$\vert$	c		
	$\vert$	$\mathbf{red}\, a\, b$		
	$\vert$	$\mathbf{refl}\, a$		
	$\vert$	$(a \mid=\mid_{\gamma}\ b)$		
	$\vert$	$\mathbf{sym}\, \gamma$		
	$\vert$	$\gamma_1; \gamma_2$		
	$\vert$	$\mathbf{sub}\, \gamma$		
	$\vert$	$\Pi^{R,\rho} x : \gamma_1.\gamma_2$	bind x in γ_2	
	$\vert$	$\lambda^{R,\rho} x : \gamma_1.\gamma_2$	bind x in γ_2	
	$\vert$	$\gamma_1\ \gamma_2^{R,\rho}$		

	$\mid$	$\mathbf{piFst}\,\gamma$		
	$\mid$	$\mathbf{cpiFst}\,\gamma$		
	$\mid$	$\mathbf{isoSnd}\,\gamma$		
	$\mid$	$\gamma_1 @ \gamma_2$		
	$\mid$	$\forall c{:}\gamma_1.\gamma_3$	bind c in γ_3	
	$\mid$	$\lambda c{:}\gamma_1.\gamma_3 @ \gamma_4$	bind c in γ_3	
	$\mid$	$\gamma(\gamma_1, \gamma_2)$		
	$\mid$	$\gamma @(\gamma_1 \sim \gamma_2)$		
	$\mid$	$\gamma_1 \triangleright_R \gamma_2$		
	$\mid$	$\gamma_1 \sim_A \gamma_2$		
	$\mid$	$\mathbf{conv}\ \phi_1 \sim_\gamma \phi_2$		
	$\mid$	$\mathbf{eta}\,a$		
	$\mid$	$\mathbf{left}\,\gamma\,\gamma'$		
	$\mid$	$\mathbf{right}\,\gamma\,\gamma'$		
	$\mid$	(γ)	S	
	$\mid$	γ	S	
	$\mid$	$\gamma\{a/x\}$	S	
App	$::=$			
	$\mid$	$\mathbf{Tm}\,\nu$		
	$\mid$	$\mathbf{Co}$		
$Apps$	$::=$			
	$\mid$	$\mathbf{emptyA}$		
	$\mid$	$Apps, App$	M	
	$\mid$	$App, Apps$		
	$\mid$	$(Apps)$	M	
$role\_context,\ \Omega$	$::=$			$\mathrm{role}_c ontexts$
	$\mid$	$\varnothing$		
	$\mid$	$x : R$		
	$\mid$	$\Omega, x : R$		
	$\mid$	Ω, Ω'	M	
	$\mid$	$\mathbf{var\_pat}\,p$	M	
	$\mid$	(Ω)	M	
	$\mid$	Ω	M	
$roles,\ Rs$	$::=$			
	$\mid$	$\cdot$		
	$\mid$	R, Rs		
	$\mid$	$\mathbf{range}\,\Omega$	S	
	$\mid$	(Rs)	S	
	$\mid$	$Rs \mathbin{++} Rs'$	S	
sig_sort	$::=$			signature classifier
	$\mid$	${}_{Rs}\ A$		
	$\mid$	${}_{Rs}\ p \sim_R a : A$		

sort	::=			binding classifier
	|	$\mathbf{Tm}\, A$		
	|	$\mathbf{Co}\, \phi$		
context, Γ	::=			contexts
	|	$\varnothing$		
	|	$\Gamma, x : A$		
	|	$\Gamma, c : \phi$		
	|	$\Gamma\{b/x\}$	M	
	|	$\Gamma\{\gamma/c\}$	M	
	|	Γ, Γ'	M	
	|	$\|\Gamma\|$	M	
	|	(Γ)	M	
	|	Γ	M	
sig, Σ	::=			signatures
	|	$\varnothing$		
	|	$\Sigma \cup \{F : \mathit{sig\_sort}\}$		
	|	Σ_0	M	
	|	Σ_1	M	
	|	$\|\Sigma\|$	M	
available_props, Δ	::=			
	|	$\varnothing$		
	|	Δ, x		
	|	Δ, c		
	|	$\mathsf{fv}\, a$	M	
	|	Δ, Δ'	M	
	|	$\widetilde{\Gamma}$	M	
	|	$\widetilde{\Omega}$	M	
	|	(Δ)	M	
Nat, $\mathbb{N}$	::=			
	|	0	M	
	|	$\Sigma\, \mathbb{N}$	M	
	|	$(\mathbb{N})$	M	
	|	$\|a\|$	S	
pattern_arg	::=			Pattern arguments
	|	$\mathbf{Tm}\, \nu\, a$		
	|	$\mathbf{Co}\, \gamma$		
pattern_args, *PA*	::=			
	|	**none**		
	|	$\mathit{pattern\_arg}, PA$		
terminals	::=			

| $\leftrightarrow$
| $\Leftrightarrow$
| $\longrightarrow$
| min
| $\equiv$
| $\forall$
| $\in$
| $\notin$
| $\Leftarrow$
| $\Rightarrow$
| $\Rightarrow^*$
| $\rightarrow$
| Λ
|
| $\Box$
| $\vdash$
| $\dashv$
| $\models$
| $\models$
| $\models_{\mathsf{src}}$
| $\neq$
| $\triangleright$
| ok
| -
| $\rightsquigarrow$
| $\rightsquigarrow^*$
| $\rightsquigarrow$
| $\varnothing$
| $\circ$
| fv
| dom
| $\sim$
| $\asymp$
| $|$
| $\bullet$
| $\mathbf{fst}$
| $\mathbf{snd}$
| $\mathbf{as}$
| $|\Rightarrow|$
| $\vdash_=$
| $\mathbf{refl_2}$
| $++$
| $\{$
| $\}$
| $\nrightarrow$

$formula,\ \psi$	$::=$		
	$\mid$	$judgement$	
	$\mid$	$x : A\ \in\ \Gamma$	
	$\mid$	$x : R\ \in\ \Omega$	
	$\mid$	$c : \phi\ \in\ \Gamma$	
	$\mid$	$F : sig\_sort\ \in\ \Sigma$	
	$\mid$	$x\ \in\ \Delta$	
	$\mid$	$c\ \in\ \Delta$	
	$\mid$	$c\,\mathbf{not\ relevant}\ \in\ \gamma$	
	$\mid$	$x\ \notin\ \Delta$	
	$\mid$	$uniq\,\Gamma$	
	$\mid$	$uniq(\Omega)$	
	$\mid$	$c\ \notin\ \Delta$	
	$\mid$	$T\ \notin\ \mathsf{dom}\,\Sigma$	
	$\mid$	$F\ \notin\ \mathsf{dom}\,\Sigma$	
	$\mid$	$\mathbb{N}_1 < \mathbb{N}_2$	
	$\mid$	$\mathbb{N}_1 \leq \mathbb{N}_2$	
	$\mid$	$\nu = \rho$	
	$\mid$	$R_1 = R_2$	
	$\mid$	$a = b$	
	$\mid$	$\phi_1 = \phi_2$	
	$\mid$	$\Gamma_1 = \Gamma_2$	
	$\mid$	$\gamma_1 = \gamma_2$	
	$\mid$	$\neg\psi$	
	$\mid$	$\psi_1 \wedge \psi_2$	
	$\mid$	$\psi_1 \vee \psi_2$	
	$\mid$	$\psi_1 \Rightarrow \psi_2$	
	$\mid$	(ψ)	
	$\mid$	ψ	
	$\mid$	$c : (a : A \sim b : B)\ \in\ \Gamma$	
	$\mid$		suppress lc hypothesis generated by Ott
$JSubRole$	$::=$		
	$\mid$	$R_1 \leq R_2$	Subroling judgement
$JRolePath$	$::=$		
	$\mid$	$\mathsf{RolePath}\ a = F@Rs$	Type headed by constant (partial function)
$JAppsPath$	$::=$		
	$\mid$	$\mathbf{AppsPath}\,R\,a \nrightarrow F\ Apps$	Type headed by constant (partial function)
$JSat$	$::=$		
	$\mid$	$Apps \sim Rs$	
	$\mid$	$\mathbf{Sat}\,F\ Apps$	
$JPatCtx$	$::=$		
	$\mid$	$\Omega; \Gamma \vDash p :_F B \Rightarrow A$	Contexts generated by a pattern (variables bound by t

JRename	::=		
	|	rename $p \to a$ to $p' \to a'$ excluding Δ and Δ'	rename with fresh variable
JMatchSubst	::=		
	|	match a_1 with $p \to b_1 \nrightarrow b_2$	match and substitute
JPatData	::=		
	|	**uncurry** $p = F@PA$	Pattern data (head argun
JIsPattern	::=		
	|	**pattern** p	
JSubPat	::=		
	|	**subpattern** p' p	Subpattern
JTmPatternAgree	::=		
	|	$a \leftrightarrow p$	term and pattern agree
JTmSubPatternAgree	::=		
	|	$a \sqsubseteq p$	sub-pattern agrees with te
JSubTmPatternAgree	::=		
	|	$a \sqsupseteq p$	sub-term agrees with patt
JValuePath	::=		
	|	ValuePath $a \nrightarrow F$	Type headed by constant
JCasePath	::=		
	|	$\mathsf{CasePath}_R\ a \nrightarrow F$	Type headed by constant
JApplyArgs	::=		
	|	apply args a to $b \nrightarrow b'$	apply arguments of a (hea
JValue	::=		
	|	$\mathsf{Value}_R\ A$	values
JValueType	::=		
	|	$\mathsf{ValueType}_R\ A$	Types with head forms (er
Jconsistent	::=		
	|	$\mathsf{consistent}_R\ a\ b$	(erased) types do not diffe
Jroleing	::=		
	|	$\Omega \vDash a : R$	Roleing judgment
JChk	::=		
	|	$(\rho = +) \vee (x \notin \mathsf{fv}\ A)$	irrelevant argument check

Jpar	::=		
	|	$\Omega \vDash a \Rightarrow_R b$	parallel reduction (implicit language)
	|	$\Omega \vDash a \Rightarrow_R^* b$	multistep parallel reduction
	|	$\Omega \vDash a \Leftrightarrow_R b$	parallel reduction to a common term
Jbeta	::=		
	|	$\vDash a >_R b$	primitive reductions on erased terms
	|	$\vDash a \rightsquigarrow_R b$	single-step head reduction for implicit languag
	|	$\vDash a \rightsquigarrow^* b/R$	multistep reduction
JBranchTyping	::=		
	|	$\Gamma \vDash \mathsf{case}\ a : A\ \mathsf{of}\ b : B \Rightarrow C \mid C'$	Branch Typing (aligning the types of case)
Jett	::=		
	|	$\Gamma \vDash \phi\ \ \mathsf{ok}$	Prop wellformedness
	|	$\Gamma \vDash a : A$	typing
	|	$\Gamma; \Delta \vDash \phi_1 \equiv \phi_2$	prop equality
	|	$\Gamma; \Delta \vDash a \equiv b : A/R$	definitional equality
	|	$\vDash \Gamma$	context wellformedness
Jsig	::=		
	|	$\vDash \Sigma$	signature wellformedness
Jhiding	::=		
	|	$Rs_1 \Leftarrow Rs_2$	
	|	$\Sigma_1 \Leftarrow \Sigma_2$	
JSrc	::=		
	|	$\Gamma \vDash_{\mathsf{src}} a : A$	source typing
	|	$\Gamma \vDash_{\mathsf{src}} a \rightsquigarrow a' : A$	source translation
	|	$\Gamma \vDash_{\mathsf{src}} \phi \rightsquigarrow \phi'\ \ \mathsf{ok}$	Prop wellformedness
Jann	::=		
	|	$\Gamma \vdash \phi\ \ \mathsf{ok}$	prop wellformedness
	|	$\Gamma \vdash a : A/R$	typing
	|	$\Gamma; \Delta \vdash \gamma : \phi_1 \sim \phi_2$	coercion between props
	|	$\Gamma; \Delta \vdash \gamma : A \sim_R B$	coercion between types
	|	$\vdash \Gamma$	context wellformedness
Jred	::=		
	|	$\Gamma \vdash a \rightsquigarrow b/R$	single-step, weak head reduction to values for
judgement	::=		
	|	*JSubRole*	
	|	*JRolePath*	
	|	*JAppsPath*	
	|	*JSat*	

$$
\begin{array}{lcl}
 & | & \mathit{JPatCtx} \\
 & | & \mathit{JRename} \\
 & | & \mathit{JMatchSubst} \\
 & | & \mathit{JPatData} \\
 & | & \mathit{JIsPattern} \\
 & | & \mathit{JSubPat} \\
 & | & \mathit{JTmPatternAgree} \\
 & | & \mathit{JTmSubPatternAgree} \\
 & | & \mathit{JSubTmPatternAgree} \\
 & | & \mathit{JValuePath} \\
 & | & \mathit{JCasePath} \\
 & | & \mathit{JApplyArgs} \\
 & | & \mathit{JValue} \\
 & | & \mathit{JValueType} \\
 & | & \mathit{Jconsistent} \\
 & | & \mathit{Jroleing} \\
 & | & \mathit{JChk} \\
 & | & \mathit{Jpar} \\
 & | & \mathit{Jbeta} \\
 & | & \mathit{JBranchTyping} \\
 & | & \mathit{Jett} \\
 & | & \mathit{Jsig} \\
 & | & \mathit{Jhiding} \\
 & | & \mathit{JSrc} \\
 & | & \mathit{Jann} \\
 & | & \mathit{Jred} \\
 & & \\
\mathit{user\_syntax} & ::= & \\
 & | & \mathit{tmvar} \\
 & | & \mathit{covar} \\
 & | & \mathit{datacon} \\
 & | & \mathit{const} \\
 & | & \mathit{index} \\
 & | & \mathit{relflag} \\
 & | & \mathit{appflag} \\
 & | & \mathit{role} \\
 & | & \mathit{constraint} \\
 & | & \mathit{tm} \\
 & | & \mathit{brs} \\
 & | & \mathit{co} \\
 & | & \mathit{App} \\
 & | & \mathit{Apps} \\
 & | & \mathit{role\_context} \\
 & | & \mathit{roles} \\
 & | & \mathit{sig\_sort} \\
 & | & \mathit{sort}
\end{array}
$$

$|$ *context*
$|$ *sig*
$|$ *available_props*
$|$ *Nat*
$|$ *pattern_arg*
$|$ *pattern_args*
$|$ *terminals*
$|$ *formula*

$\boxed{R_1 \leq R_2}$ Subroling judgement

$$\frac{}{\mathbf{Nom} \leq R} \quad \textsc{NomBot}$$

$$\frac{}{R \leq \mathbf{Rep}} \quad \textsc{RepTop}$$

$$\frac{}{R \leq R} \quad \textsc{Refl}$$

$$\frac{\begin{array}{c} R_1 \leq R_2 \\ R_2 \leq R_3 \end{array}}{R_1 \leq R_3} \quad \textsc{Trans}$$

$\boxed{\mathsf{RolePath}\ \ a = F@Rs}$ Type headed by constant (partial function)

$$\frac{F :_{Rs}\ \ A\ \in\ \Sigma_0}{\mathsf{RolePath}\ \ F = F@Rs} \quad \textsc{RolePath\_AbsConst}$$

$$\frac{F :_{Rs}\ \ p \sim_{R_1} a : A\ \in\ \Sigma_0}{\mathsf{RolePath}\ \ F = F@Rs} \quad \textsc{RolePath\_Const}$$

$$\frac{\mathsf{RolePath}\ \ a = F@R_1, Rs}{\mathsf{RolePath}\ \ (a\ \ b'^{R_1}) = F@Rs} \quad \textsc{RolePath\_App}$$

$$\frac{\mathsf{RolePath}\ \ a = F@Rs}{\mathsf{RolePath}\ \ (a\ \ \square^{-}) = F@Rs} \quad \textsc{RolePath\_IApp}$$

$$\frac{\mathsf{RolePath}\ \ a = F@Rs}{\mathsf{RolePath}\ \ (a[\bullet]) = F@Rs} \quad \textsc{RolePath\_CApp}$$

$\boxed{\mathbf{AppsPath}\, R\ a \nrightarrow F\ Apps}$ Type headed by constant (partial function)

$$\frac{F :_{Rs}\ \ A\ \in\ \Sigma_0}{\mathbf{AppsPath}\, R\, F \nrightarrow F\ \mathbf{emptyA}} \quad \textsc{AppsPath\_AbsConst}$$

$$\frac{\begin{array}{l} F :_{Rs}\ \ p \sim_{R_1} a : A\ \in\ \Sigma_0 \\ \neg(R_1 \leq R) \end{array}}{\mathbf{AppsPath}\, R\, F \nrightarrow F\ \mathbf{emptyA}} \quad \textsc{AppsPath\_Const}$$

$$\frac{\mathbf{AppsPath}\, R\ a \nrightarrow F\ Apps}{\mathbf{AppsPath}\, R\, (a\ \ b'^{R_1}) \nrightarrow F\ (Apps, \mathbf{Tm}\, R_1)} \quad \textsc{AppsPath\_App}$$

$$\frac{\mathbf{AppsPath}\, R\ a \nrightarrow F\ Apps}{\mathbf{AppsPath}\, R\, (a\ \ b^{-}) \nrightarrow F\ (Apps, \mathbf{Tm}\, -)} \quad \textsc{AppsPath\_IApp}$$

$$\frac{\mathbf{AppsPath}\, R\ a \nrightarrow F\ Apps}{\mathbf{AppsPath}\, R\, (a[\bullet]) \nrightarrow F\ (Apps, \mathbf{Co})} \quad \textsc{AppsPath\_CApp}$$

$\boxed{Apps \sim Rs}$

$$\frac{}{\mathbf{emptyA} \sim \cdot} \quad \textsc{AR\_nil}$$

$$\frac{Apps \sim Rs}{\mathbf{Tm}\, R_1, Apps \sim R_1, Rs} \quad \textsc{AR\_consApp}$$

$$\frac{Apps \sim Rs}{\mathbf{Tm}\, -, Apps \sim Rs} \quad \textsc{AR\_consIApp}$$

$$\frac{Apps \sim Rs}{\mathbf{Co}, Apps \sim Rs} \quad \textsc{AR\_consCApp}$$

$\boxed{\mathbf{Sat}\, F\, Apps}$

$$\frac{\begin{array}{l} F :_{Rs}\ A \in \Sigma_0 \\ Apps \sim Rs \end{array}}{\mathbf{Sat}\, F\, Apps} \quad \textsc{Sat\_Const}$$

$$\frac{\begin{array}{l} F :_{Rs}\ p \sim_{R_1} a_0 : A_1 \in \Sigma_0 \\ \neg(R_1 \leq \mathbf{Nom}) \\ Apps \sim Rs \end{array}}{\mathbf{Sat}\, F\, Apps} \quad \textsc{Sat\_Axiom}$$

$\boxed{\Omega; \Gamma \vDash p :_F B \Rightarrow A}$ Contexts generated by a pattern (variables bound by the pattern)

$$\frac{}{\varnothing; \varnothing \vDash F :_F A \Rightarrow A} \quad \textsc{PatCtx\_Const}$$

$$\frac{\Omega; \Gamma \vDash p :_F \Pi^+ x\!:\!A' \to A \Rightarrow B}{\Omega, x : R; \Gamma, x : A' \vDash p\ x^R :_F A \Rightarrow B} \quad \textsc{PatCtx\_PiRel}$$

$$\frac{\Omega; \Gamma \vDash p :_F \Pi^- x\!:\!A' \to A \Rightarrow B}{\Omega; \Gamma, x : A' \vDash p\ \Box^- :_F A \Rightarrow B} \quad \textsc{PatCtx\_PiIrr}$$

$$\frac{\Omega; \Gamma \vDash p :_F \forall c\!:\!\phi.A \Rightarrow B}{\Omega; \Gamma, c : \phi \vDash p[\bullet] :_F A \Rightarrow B} \quad \textsc{PatCtx\_CPi}$$

$\boxed{\mathsf{rename}\ p \to a\ \mathsf{to}\ p' \to a'\ \mathsf{excluding}\ \Delta\ \mathsf{and}\ \Delta'}$ rename with fresh variables

$$\frac{}{\mathsf{rename}\ F \to a\ \mathsf{to}\ F \to a\ \mathsf{excluding}\ \Delta\ \mathsf{and}\ \varnothing} \quad \textsc{Rename\_Base}$$

$$\frac{\begin{array}{l} \mathsf{rename}\ p_1 \to a_1\ \mathsf{to}\ p_2 \to a_2\ \mathsf{excluding}\ \Delta\ \mathsf{and}\ \Delta' \\ y \notin (\Delta, \Delta') \end{array}}{\mathsf{rename}\ (p_1\ x^R) \to a_1\ \mathsf{to}\ (p_2\ y^R) \to (a_2\{y/x\})\ \mathsf{excluding}\ \Delta\ \mathsf{and}\ (\Delta', y)} \quad \textsc{Rename\_AppRel}$$

$$\frac{\mathsf{rename}\ p_1 \to a_1\ \mathsf{to}\ p_2 \to a_2\ \mathsf{excluding}\ \Delta\ \mathsf{and}\ \Delta'}{\mathsf{rename}\ (p_1\ \Box^-) \to a_1\ \mathsf{to}\ (p_2\ \Box^-) \to a_2\ \mathsf{excluding}\ \Delta\ \mathsf{and}\ \Delta'} \quad \textsc{Rename\_AppIrrel}$$

$$\frac{\mathsf{rename}\ p_1 \to a_1\ \mathsf{to}\ p_2 \to a_2\ \mathsf{excluding}\ \Delta\ \mathsf{and}\ \Delta'}{\mathsf{rename}\ (p_1[\bullet]) \to a_1\ \mathsf{to}\ (p_2[\bullet]) \to a_2\ \mathsf{excluding}\ \Delta\ \mathsf{and}\ \Delta'} \quad \textsc{Rename\_CApp}$$

$\boxed{\mathsf{match}\ a_1\ \mathsf{with}\ p \to b_1 \nrightarrow b_2}$ match and substitute

$$\frac{}{\mathsf{match}\ F\ \mathsf{with}\ F \to b \nrightarrow b} \quad \textsc{MatchSubst\_Const}$$

$$\frac{\mathsf{match}\ a_1\ \mathsf{with}\ p_1 \to b_1 \nrightarrow b_2}{\mathsf{match}\ (a_1\ a^R)\ \mathsf{with}\ (p_1\ x^R) \to b_1 \nrightarrow (b_2\{a/x\})} \quad \textsc{MatchSubst\_AppRelR}$$

$$\frac{\mathsf{match}\ a_1\ \mathsf{with}\ p_1 \to b_1 \not\leftrightarrow b_2}{\mathsf{match}\ (a_1\ \ a^-)\ \mathsf{with}\ (p_1\ \Box^-) \to b_1 \not\leftrightarrow b_2}\quad \textsc{MatchSubst\_AppIrrel}$$

$$\frac{\mathsf{match}\ a_1\ \mathsf{with}\ a_2 \to b_1 \not\leftrightarrow b_2}{\mathsf{match}\ (a_1[\bullet])\ \mathsf{with}\ (a_2[\bullet]) \to b_1 \not\leftrightarrow b_2}\quad \textsc{MatchSubst\_CApp}$$

$\boxed{\mathbf{uncurry}\, p = F@PA}$ Pattern data (head arguments)

$$\frac{}{\mathbf{uncurry}\, F = F@\mathbf{none}}\quad \textsc{PatData\_Head}$$

$$\frac{\mathbf{uncurry}\, p = F@PA}{\mathbf{uncurry}\,(p\ \ a^R) = F@\mathbf{Tm}\, R\, a, PA}\quad \textsc{PatData\_Rel}$$

$\boxed{\mathbf{pattern}\, p}$

$$\frac{}{\mathbf{pattern}\, F}\quad \textsc{Pattern\_Head}$$

$$\frac{\mathbf{pattern}\, p}{\mathbf{pattern}\,(p\ \ a^R)}\quad \textsc{Pattern\_Rel}$$

$$\frac{\mathbf{pattern}\, p}{\mathbf{pattern}\,(p\ \ a^-)}\quad \textsc{Pattern\_Irrel}$$

$$\frac{\mathbf{pattern}\, p}{\mathbf{pattern}\,(p[\gamma])}\quad \textsc{Pattern\_Co}$$

$\boxed{\mathbf{subpattern}\, p'\, p}$ Subpattern

$$\frac{\mathbf{pattern}\, p}{\mathbf{subpattern}\, p\, p}\quad \textsc{SubPat\_Refl}$$

$$\frac{\mathbf{subpattern}\, p'\, p}{\mathbf{subpattern}\, p'\,(p\ \ x^R)}\quad \textsc{SubPat\_Rel}$$

$$\frac{\mathbf{subpattern}\, p'\, p}{\mathbf{subpattern}\, p'\,(p\ \ \Box^-)}\quad \textsc{SubPat\_Irrel}$$

$$\frac{\mathbf{subpattern}\, p'\, p}{\mathbf{subpattern}\, p'\,(p[\bullet])}\quad \textsc{SubPat\_Co}$$

$\boxed{a \leftrightarrow p}$ term and pattern agree

$$\frac{}{F \leftrightarrow F}\quad \textsc{tm\_pattern\_agree\_Const}$$

$$\frac{a_1 \leftrightarrow p_1}{(a_1\ \ {a_2}^R) \leftrightarrow (p_1\ \ x^R)}\quad \textsc{tm\_pattern\_agree\_AppRelR}$$

$$\frac{a_1 \leftrightarrow p_1}{(a_1\ \ a^-) \leftrightarrow (p_1\ \ \Box^-)}\quad \textsc{tm\_pattern\_agree\_AppIrrel}$$

$$\frac{a_1 \leftrightarrow p_1}{(a_1[\bullet]) \leftrightarrow (p_1[\bullet])}\quad \textsc{tm\_pattern\_agree\_CApp}$$

$\boxed{a \sqsubseteq p}$ sub-pattern agrees with term

$$\frac{a \leftrightarrow p}{a \sqsubseteq p}\quad \textsc{tm\_subpattern\_agree\_Base}$$

$$\frac{a \sqsubseteq p}{a \sqsubseteq (p\ x^R)} \quad \textsc{tm\_subpattern\_agree\_AppRelR}$$

$$\frac{a \sqsubseteq p}{a \sqsubseteq (p\ \Box^-)} \quad \textsc{tm\_subpattern\_agree\_AppIrrel}$$

$$\frac{a \sqsubseteq p}{a \sqsubseteq (p[\bullet])} \quad \textsc{tm\_subpattern\_agree\_CAppp}$$

$\boxed{a \sqsupseteq p}$ sub-term agrees with pattern

$$\frac{a \leftrightarrow p}{a \sqsupseteq p} \quad \textsc{subtm\_pattern\_agree\_Base}$$

$$\frac{a \sqsupseteq p}{a\ a_2{}^\nu \sqsupseteq p} \quad \textsc{subtm\_pattern\_agree\_App}$$

$$\frac{a \sqsupseteq p}{a[\bullet] \sqsupseteq p} \quad \textsc{subtm\_pattern\_agree\_CAppp}$$

$\boxed{\mathsf{ValuePath}\ a \nrightarrow F}$ Type headed by constant (role-sensitive partial function used in value)

$$\frac{F :_{Rs}\ A \in \Sigma_0}{\mathsf{ValuePath}\ F \nrightarrow F} \quad \textsc{ValuePath\_AbsConst}$$

$$\frac{F :_{Rs}\ p \sim_{R_1} a : A \in \Sigma_0}{\mathsf{ValuePath}\ F \nrightarrow F} \quad \textsc{ValuePath\_Const}$$

$$\frac{\mathsf{ValuePath}\ a \nrightarrow F}{\mathsf{ValuePath}\ (a\ b'^\nu) \nrightarrow F} \quad \textsc{ValuePath\_App}$$

$$\frac{\mathsf{ValuePath}\ a \nrightarrow F}{\mathsf{ValuePath}\ (a[\bullet]) \nrightarrow F} \quad \textsc{ValuePath\_CApp}$$

$\boxed{\mathsf{CasePath}_R\ a \nrightarrow F}$ Type headed by constant (role-sensitive partial function used in case)

$$\frac{\begin{array}{l}\mathsf{ValuePath}\ a \nrightarrow F\\ F :_{Rs}\ A \in \Sigma_0\end{array}}{\mathsf{CasePath}_R\ a \nrightarrow F} \quad \textsc{CasePath\_AbsConst}$$

$$\frac{\begin{array}{l}\mathsf{ValuePath}\ a \nrightarrow F\\ F :_{Rs}\ p \sim_{R_1} b : A \in \Sigma_0\\ \neg(R_1 \leq R)\end{array}}{\mathsf{CasePath}_R\ a \nrightarrow F} \quad \textsc{CasePath\_Const}$$

$$\frac{\begin{array}{l}\mathsf{ValuePath}\ a \nrightarrow F\\ F :_{Rs}\ p \sim_{R_1} b : A \in \Sigma_0\\ \neg(a \sqsupseteq p)\end{array}}{\mathsf{CasePath}_R\ a \nrightarrow F} \quad \textsc{CasePath\_UnMatch}$$

$\boxed{\mathsf{apply\ args}\ a\ \mathsf{to}\ b \nrightarrow b'}$ apply arguments of a (headed by a constant) to b

$$\frac{}{\mathsf{apply\ args}\ F\ \mathsf{to}\ b \nrightarrow b} \quad \textsc{ApplyArgs\_Const}$$

$$\frac{\mathsf{apply\ args}\ a\ \mathsf{to}\ b \nrightarrow b'}{\mathsf{apply\ args}\ (a\ a'^R)\ \mathsf{to}\ b \nrightarrow (b'\ a'^+)} \quad \textsc{ApplyArgs\_AppRole}$$

$$\frac{\mathsf{apply\ args}\ a\ \mathsf{to}\ b \nrightarrow b'}{\mathsf{apply\ args}\ (a\ a'^\rho)\ \mathsf{to}\ b \nrightarrow (b'\ a'^\rho)} \quad \textsc{ApplyArgs\_AppRho}$$

$$\frac{\mathsf{apply\ args}\ a\ \mathsf{to}\ b \not\mapsto b'}{\mathsf{apply\ args}\ a[\bullet]\ \mathsf{to}\ b \not\mapsto b'[\bullet]} \quad \textsc{ApplyArgs\_CApp}$$

$\boxed{\mathsf{Value}_R\ A}$ values

$$\frac{}{\mathsf{Value}_R\ \star} \quad \textsc{Value\_Star}$$

$$\frac{}{\mathsf{Value}_R\ \Pi^\rho x\!:\!A \to B} \quad \textsc{Value\_Pi}$$

$$\frac{}{\mathsf{Value}_R\ \forall c\!:\!\phi.B} \quad \textsc{Value\_CPi}$$

$$\frac{}{\mathsf{Value}_R\ \lambda^+ x\!:\!A.a} \quad \textsc{Value\_AbsRel}$$

$$\frac{}{\mathsf{Value}_R\ \lambda^+ x.a} \quad \textsc{Value\_UAbsRel}$$

$$\frac{\mathsf{Value}_R\ a}{\mathsf{Value}_R\ \lambda^- x.a} \quad \textsc{Value\_UAbsIrrel}$$

$$\frac{}{\mathsf{Value}_R\ \Lambda c\!:\!\phi.a} \quad \textsc{Value\_CAbs}$$

$$\frac{}{\mathsf{Value}_R\ \Lambda c.a} \quad \textsc{Value\_UCAbs}$$

$$\frac{\mathsf{CasePath}_R\ a \not\mapsto F}{\mathsf{Value}_R\ a} \quad \textsc{Value\_Path}$$

$\boxed{\mathsf{ValueType}_R\ A}$ Types with head forms (erased language)

$$\frac{}{\mathsf{ValueType}_R\ \star} \quad \textsc{value\_type\_Star}$$

$$\frac{}{\mathsf{ValueType}_R\ \Pi^\rho x\!:\!A \to B} \quad \textsc{value\_type\_Pi}$$

$$\frac{}{\mathsf{ValueType}_R\ \forall c\!:\!\phi.B} \quad \textsc{value\_type\_CPi}$$

$$\frac{\mathsf{CasePath}_R\ a \not\mapsto F}{\mathsf{ValueType}_R\ a} \quad \textsc{value\_type\_ValuePath}$$

$\boxed{\mathsf{consistent}_R\ a\ b}$ (erased) types do not differ in their heads

$$\frac{}{\mathsf{consistent}_R\ \star\ \star} \quad \textsc{consistent\_a\_Star}$$

$$\frac{}{\mathsf{consistent}_{R'}\ (\Pi^\rho x_1\!:\!A_1 \to B_1)\ (\Pi^\rho x_2\!:\!A_2 \to B_2)} \quad \textsc{consistent\_a\_Pi}$$

$$\frac{}{\mathsf{consistent}_R\ (\forall c_1\!:\!\phi_1.A_1)\ (\forall c_2\!:\!\phi_2.A_2)} \quad \textsc{consistent\_a\_CPi}$$

$$\frac{\mathsf{CasePath}_R\ a_1 \not\mapsto F \quad \mathsf{CasePath}_R\ a_2 \not\mapsto F}{\mathsf{consistent}_R\ a_1\ a_2} \quad \textsc{consistent\_a\_CasePath}$$

$$\frac{\neg\mathsf{ValueType}_R\ b}{\mathsf{consistent}_R\ a\ b} \quad \textsc{consistent\_a\_Step\_R}$$

$$\frac{\neg\mathsf{ValueType}_R\ a}{\mathsf{consistent}_R\ a\ b} \quad \textsc{consistent\_a\_Step\_L}$$

$\boxed{\Omega \vDash a : R}$ Roleing judgment

$$\frac{uniq(\Omega)}{\Omega \vDash \Box : R} \quad \textsc{role\_a\_Bullet}$$

$$\frac{uniq(\Omega)}{\Omega \vDash \star : R} \quad \textsc{role\_a\_Star}$$

$$\frac{\begin{array}{l} uniq(\Omega) \\ x : R \in \Omega \\ R \leq R_1 \end{array}}{\Omega \vDash x : R_1} \quad \textsc{role\_a\_Var}$$

$$\frac{\Omega, x : \mathbf{Nom} \vDash a : R}{\Omega \vDash (\lambda^\rho x.a) : R} \quad \textsc{role\_a\_Abs}$$

$$\frac{\begin{array}{l} \Omega \vDash a : R \\ \Omega \vDash b : \mathbf{Nom} \end{array}}{\Omega \vDash (a\ b^\rho) : R} \quad \textsc{role\_a\_App}$$

$$\frac{\begin{array}{l} \Omega \vDash a : R \\ \Omega \vDash b : \mathbf{param}\, R_1\ R \end{array}}{\Omega \vDash a\ b^{R_1} : R} \quad \textsc{role\_a\_TApp}$$

$$\frac{\begin{array}{l} \Omega \vDash A : R \\ \Omega, x : \mathbf{Nom} \vDash B : R \end{array}}{\Omega \vDash (\Pi^\rho x\!:\!A \to B) : R} \quad \textsc{role\_a\_Pi}$$

$$\frac{\begin{array}{l} \Omega \vDash a : R_1 \\ \Omega \vDash b : R_1 \\ \Omega \vDash A : \mathbf{Rep} \\ \Omega \vDash B : R \end{array}}{\Omega \vDash (\forall c\!:\!a \sim_{R_1} b : A.B) : R} \quad \textsc{role\_a\_CPi}$$

$$\frac{\Omega \vDash b : R}{\Omega \vDash (\Lambda c.b) : R} \quad \textsc{role\_a\_CAbs}$$

$$\frac{\Omega \vDash a : R}{\Omega \vDash (a[\bullet]) : R} \quad \textsc{role\_a\_CApp}$$

$$\frac{\begin{array}{l} uniq(\Omega) \\ F :_{Rs}\ A \in \Sigma_0 \end{array}}{\Omega \vDash F : R} \quad \textsc{role\_a\_Const}$$

$$\frac{\begin{array}{l} uniq(\Omega) \\ F :_{Rs}\ p \sim_R a : A \in \Sigma_0 \end{array}}{\Omega \vDash F : R_1} \quad \textsc{role\_a\_Fam}$$

$$\frac{\begin{array}{l} \Omega \vDash a : \mathbf{Nom} \\ \Omega \vDash b_1 : R_1 \\ \Omega \vDash b_2 : R_1 \end{array}}{\Omega \vDash \mathsf{case}\ a\ \mathsf{of}\ F \to b_1 \| \_ \to b_2 : R_1} \quad \textsc{role\_a\_Pattern}$$

$\boxed{(\rho = +) \vee (x \notin \mathsf{fv}\ A)}$ irrelevant argument check

$$\frac{}{(+ = +) \vee (x \notin \mathsf{fv}\ A)} \quad \textsc{Rho\_Rel}$$

$$\frac{x \notin \mathsf{fv} A}{(- = +) \vee (x \notin \mathsf{fv}\ A)} \quad \textsc{Rho\_IrrRel}$$

$\boxed{\Omega \vDash a \Rightarrow_R b}$ parallel reduction (implicit language)

$$\frac{\Omega \vDash a : R}{\Omega \vDash a \Rightarrow_R a} \quad \textsc{Par\_Refl}$$

$$\frac{\begin{array}{c}\Omega \vDash a \Rightarrow_R (\lambda^\rho x.a') \\ \Omega \vDash b \Rightarrow_{\mathbf{Nom}} b'\end{array}}{\Omega \vDash a\ b^\rho \Rightarrow_R a'\{b'/x\}} \quad \textsc{Par\_Beta}$$

$$\frac{\begin{array}{c}\Omega \vDash a \Rightarrow_R a' \\ \Omega \vDash b \Rightarrow_{(\mathbf{app\_role}\,\nu\,R)} b'\end{array}}{\Omega \vDash a\ b^\nu \Rightarrow_R a'\ b'^\nu} \quad \textsc{Par\_App}$$

$$\frac{\Omega \vDash a \Rightarrow_R (\Lambda c.a')}{\Omega \vDash a[\bullet] \Rightarrow_R a'\{\bullet/c\}} \quad \textsc{Par\_CBeta}$$

$$\frac{\Omega \vDash a \Rightarrow_R a'}{\Omega \vDash a[\bullet] \Rightarrow_R a'[\bullet]} \quad \textsc{Par\_CApp}$$

$$\frac{\Omega, x : \mathbf{Nom} \vDash a \Rightarrow_R a'}{\Omega \vDash \lambda^\rho x.a \Rightarrow_R \lambda^\rho x.a'} \quad \textsc{Par\_Abs}$$

$$\frac{\begin{array}{c}\Omega \vDash A \Rightarrow_R A' \\ \Omega, x : \mathbf{Nom} \vDash B \Rightarrow_R B'\end{array}}{\Omega \vDash \Pi^\rho x\!:\!A \to B \Rightarrow_R \Pi^\rho x\!:\!A' \to B'} \quad \textsc{Par\_Pi}$$

$$\frac{\Omega \vDash a \Rightarrow_R a'}{\Omega \vDash \Lambda c.a \Rightarrow_R \Lambda c.a'} \quad \textsc{Par\_CAbs}$$

$$\frac{\begin{array}{c}\Omega \vDash A \Rightarrow_{\mathbf{Rep}} A' \\ \Omega \vDash a \Rightarrow_{R_1} a' \\ \Omega \vDash b \Rightarrow_{R_1} b' \\ \Omega \vDash B \Rightarrow_R B'\end{array}}{\Omega \vDash \forall c\!:\!a \sim_{R_1} b : A.B \Rightarrow_R \forall c\!:\!a' \sim_{R_1} b' : A'.B'} \quad \textsc{Par\_CPi}$$

$$\frac{\begin{array}{l}F :_{Rs}\ F \sim_{R_1} b : A \in \Sigma_0 \\ R_1 \leq R \\ \mathit{uniq}(\Omega)\end{array}}{\Omega \vDash F \Rightarrow_R b} \quad \textsc{Par\_AxiomBase}$$

$$\frac{\begin{array}{l}F :_{Rs}\ p \sim_{R_1} b : A \in \Sigma_0 \\ a \sqsubseteq p \wedge \neg(a \leftrightarrow p) \\ \Omega \vDash a \Rightarrow_R a' \\ \Omega \vDash a_1 \Rightarrow_{(\mathbf{app\_role}\,\nu\,R)} a_1' \\ \textsf{rename } p \to b \textsf{ to } p' \to b' \textsf{ excluding } (\widetilde{\Omega}, \textsf{fv}p) \textsf{ and } \Delta' \\ \textsf{match } (a'\ {a_1'}^\nu) \textsf{ with } p' \to b' \nleftrightarrow a_2 \\ R_1 \leq R\end{array}}{\Omega \vDash a\ {a_1}^\nu \Rightarrow_R a_2} \quad \textsc{Par\_AxiomApp}$$

$$\frac{\begin{array}{l}F :_{Rs}\ p \sim_{R_1} b : A \in \Sigma_0 \\ a \sqsubseteq p \wedge \neg(a \leftrightarrow p) \\ \Omega \vDash a \Rightarrow_R a' \\ \textsf{rename } p \to b \textsf{ to } p' \to b' \textsf{ excluding } (\widetilde{\Omega}, \textsf{fv}p) \textsf{ and } \Delta' \\ \textsf{match } (a'[\bullet]) \textsf{ with } p' \to b' \nleftrightarrow a_2 \\ R_1 \leq R\end{array}}{\Omega \vDash a[\bullet] \Rightarrow_R a_2} \quad \textsc{Par\_AxiomCApp}$$

$$\frac{\Omega \vDash a \Rightarrow_{\mathbf{Nom}} a' \quad \Omega \vDash b_1 \Rightarrow_{R_0} b_1' \quad \Omega \vDash b_2 \Rightarrow_{R_0} b_2'}{\Omega \vDash (\mathsf{case}\ a\ \mathsf{of}\ F \to b_1 \| \_ \to b_2) \Rightarrow_{R_0} (\mathsf{case}\ a'\ \mathsf{of}\ F \to b_1' \| \_ \to b_2')} \quad \text{PAR\_PATTERN}$$

$$\frac{\Omega \vDash a \Rightarrow_{\mathbf{Nom}} a' \quad \Omega \vDash b_1 \Rightarrow_{R_0} b_1' \quad \Omega \vDash b_2 \Rightarrow_{R_0} b_2' \quad \mathbf{AppsPath}\,\mathbf{Nom}\, a' \not\leftrightarrow F\ \mathit{Apps} \quad \mathsf{apply\ args}\ a'\ \mathsf{to}\ b_1' \not\leftrightarrow b}{\Omega \vDash (\mathsf{case}\ a\ \mathsf{of}\ F \to b_1 \| \_ \to b_2) \Rightarrow_{R_0} b[\bullet]} \quad \text{PAR\_PATTERNTRUE}$$

$$\frac{\Omega \vDash a \Rightarrow_{\mathbf{Nom}} a' \quad \Omega \vDash b_1 \Rightarrow_{R_0} b_1' \quad \Omega \vDash b_2 \Rightarrow_{R_0} b_2' \quad \mathsf{Value}_{\mathbf{Nom}}\ a' \quad \neg(\mathbf{AppsPath}\,\mathbf{Nom}\, a' \not\leftrightarrow F\ \mathit{Apps})}{\Omega \vDash (\mathsf{case}\ a\ \mathsf{of}\ F \to b_1 \| \_ \to b_2) \Rightarrow_{R_0} b_2'} \quad \text{PAR\_PATTERNFALSE}$$

$\boxed{\Omega \vDash a \Rightarrow^*_R b}$ multistep parallel reduction

$$\frac{}{\Omega \vDash a \Rightarrow^*_R a} \quad \text{MP\_REFL}$$

$$\frac{\Omega \vDash a \Rightarrow_R b \quad \Omega \vDash b \Rightarrow^*_R a'}{\Omega \vDash a \Rightarrow^*_R a'} \quad \text{MP\_STEP}$$

$\boxed{\Omega \vDash a \Leftrightarrow_R b}$ parallel reduction to a common term

$$\frac{\Omega \vDash a_1 \Rightarrow^*_R b \quad \Omega \vDash a_2 \Rightarrow^*_R b}{\Omega \vDash a_1 \Leftrightarrow_R a_2} \quad \text{JOIN}$$

$\boxed{\vDash a >_R b}$ primitive reductions on erased terms

$$\frac{\mathsf{Value}_{R_1}\ (\lambda^\rho x.v)}{\vDash (\lambda^\rho x.v)\ b^\rho >_{R_1} v\{b/x\}} \quad \text{BETA\_APPABS}$$

$$\frac{}{\vDash (\Lambda c.a')[\bullet] >_R a'\{\bullet/c\}} \quad \text{BETA\_CAPPCABS}$$

$$\frac{F :_{Rs}\ p \sim_{R_1} b : A \in \Sigma_0 \quad \mathsf{rename}\ p \to b\ \mathsf{to}\ p_1 \to b_1\ \mathsf{excluding}\ (\mathsf{fv}a, \mathsf{fv}p)\ \mathsf{and}\ \Delta' \quad \mathsf{match}\ a\ \mathsf{with}\ p_1 \to b_1 \not\leftrightarrow b' \quad R_1 \leq R}{\vDash a >_R b'} \quad \text{BETA\_AXIOM}$$

$$\frac{\mathbf{AppsPath}\,\mathbf{Nom}\, a \not\leftrightarrow F\ \mathit{Apps} \quad \mathsf{apply\ args}\ a\ \mathsf{to}\ b_1 \not\leftrightarrow b_1'}{\vDash \mathsf{case}\ a\ \mathsf{of}\ F \to b_1 \| \_ \to b_2 >_{R_0} b_1'[\bullet]} \quad \text{BETA\_PATTERNTRUE}$$

$$\frac{\mathsf{Value}_{\mathbf{Nom}}\ a \quad \neg(\mathbf{AppsPath}\,\mathbf{Nom}\, a \not\leftrightarrow F\ \mathit{Apps})}{\vDash \mathsf{case}\ a\ \mathsf{of}\ F \to b_1 \| \_ \to b_2 >_{R_0} b_2} \quad \text{BETA\_PATTERNFALSE}$$

$\boxed{\vDash a \leadsto_R b}$ single-step head reduction for implicit language

$$\frac{\vDash a \leadsto_{R_1} a'}{\vDash \lambda^{-} x.a \leadsto_{R_1} \lambda^{-} x.a'} \quad \text{E\_AbsTerm}$$

$$\frac{\vDash a \leadsto_{R_1} a'}{\vDash a\ b^{\nu} \leadsto_{R_1} a'\ b^{\nu}} \quad \text{E\_AppLeft}$$

$$\frac{\vDash a \leadsto_{R} a'}{\vDash a[\bullet] \leadsto_{R} a'[\bullet]} \quad \text{E\_CAppLeft}$$

$$\frac{\vDash a \leadsto_{\mathbf{Nom}} a'}{\vDash \mathsf{case}\ a\ \mathsf{of}\ F \to b_1 \| \_ \to b_2 \leadsto_{R_0} \mathsf{case}\ a'\ \mathsf{of}\ F \to b_1 \| \_ \to b_2} \quad \text{E\_Pattern}$$

$$\frac{\vDash a >_{R} b}{\vDash a \leadsto_{R} b} \quad \text{E\_Prim}$$

$\boxed{\vDash a \leadsto^{*} b/R}$ multistep reduction

$$\frac{}{\vDash a \leadsto^{*} a/R} \quad \text{Equal}$$

$$\frac{\begin{array}{l}\vDash a \leadsto_{R} b \\ \vDash b \leadsto^{*} a'/R\end{array}}{\vDash a \leadsto^{*} a'/R} \quad \text{Step}$$

$\boxed{\Gamma \vDash \mathsf{case}\ a : A\ \mathsf{of}\ b : B \Rightarrow C \mid C'}$ Branch Typing (aligning the types of case)

$$\frac{\begin{array}{l}\mathit{uniq}\ \Gamma \\ \mathtt{lc\_tm}\ C\end{array}}{\Gamma \vDash \mathsf{case}\ a : A\ \mathsf{of}\ b : A \Rightarrow \forall c{:}(a \sim_{\mathbf{Nom}} \mathbf{apply}\ b\ \mathit{pattern\_args} : A).C \mid C} \quad \text{BranchTyping\_Base}$$

$$\frac{\Gamma, x : A \vDash \mathsf{case}\ a : A_1\ \mathsf{of}\ b : B \Rightarrow C \mid C'}{\Gamma \vDash \mathsf{case}\ a : A_1\ \mathsf{of}\ b : \Pi^{+} x{:}A \to B \Rightarrow \Pi^{+} x{:}A \to C \mid C'} \quad \text{BranchTyping\_PiRole}$$

$$\frac{\Gamma, x : A \vDash \mathsf{case}\ a : A_1\ \mathsf{of}\ b : B \Rightarrow C \mid C'}{\Gamma \vDash \mathsf{case}\ a : A_1\ \mathsf{of}\ b : \Pi^{+} x{:}A \to B \Rightarrow \Pi^{+} x{:}A \to C \mid C'} \quad \text{BranchTyping\_PiRel}$$

$$\frac{\Gamma, x : A \vDash \mathsf{case}\ a : A_1\ \mathsf{of}\ b : B \Rightarrow C \mid C'}{\Gamma \vDash \mathsf{case}\ a : A_1\ \mathsf{of}\ b : \Pi^{-} x{:}A \to B \Rightarrow \Pi^{-} x{:}A \to C \mid C'} \quad \text{BranchTyping\_PiIrrel}$$

$$\frac{\Gamma, c : \phi \vDash \mathsf{case}\ a : A\ \mathsf{of}\ b : B \Rightarrow C \mid C'}{\Gamma \vDash \mathsf{case}\ a : A\ \mathsf{of}\ b : \forall c{:}\phi.B \Rightarrow \forall c{:}\phi.C \mid C'} \quad \text{BranchTyping\_CPi}$$

$\boxed{\Gamma \vDash \phi\ \ \mathsf{ok}}$ Prop wellformedness

$$\frac{\begin{array}{l}\Gamma \vDash a : A \\ \Gamma \vDash b : A \\ \Gamma \vDash A : \star\end{array}}{\Gamma \vDash a \sim_{R} b : A\ \ \mathsf{ok}} \quad \text{E\_Wff}$$

$\boxed{\Gamma \vDash a : A}$ typing

$$\frac{\vDash \Gamma}{\Gamma \vDash \star : \star} \quad \text{E\_Star}$$

$$\frac{\begin{array}{l}\vDash \Gamma \\ x : A \in \Gamma\end{array}}{\Gamma \vDash x : A} \quad \text{E\_Var}$$

$$\frac{\Gamma, x : A \vDash B : \star \qquad \Gamma \vDash A : \star}{\Gamma \vDash \Pi^\rho x\!:\!A \to B : \star} \quad \text{E\_Pi}$$

$$\frac{\Gamma, x : A \vDash a : B \qquad \Gamma \vDash A : \star \qquad (\rho = +) \lor (x \notin \mathsf{fv}\ a)}{\Gamma \vDash \lambda^\rho x.a : (\Pi^\rho x\!:\!A \to B)} \quad \text{E\_Abs}$$

$$\frac{\Gamma \vDash b : \Pi^+ x\!:\!A \to B \qquad \Gamma \vDash a : A}{\Gamma \vDash b\ \ a^+ : B\{a/x\}} \quad \text{E\_App}$$

$$\frac{\Gamma \vDash b : \Pi^+ x\!:\!A \to B \qquad \Gamma \vDash a : A \qquad \mathsf{RolePath}\ \ b = F@R, Rs}{\Gamma \vDash b\ \ a^R : B\{a/x\}} \quad \text{E\_TApp}$$

$$\frac{\Gamma \vDash b : \Pi^- x\!:\!A \to B \qquad \Gamma \vDash a : A}{\Gamma \vDash b\ \Box^- : B\{a/x\}} \quad \text{E\_IApp}$$

$$\frac{\Gamma \vDash a : A \qquad \Gamma; \widetilde{\Gamma} \vDash A \equiv B : \star/\mathbf{Rep} \qquad \Gamma \vDash B : \star}{\Gamma \vDash a : B} \quad \text{E\_Conv}$$

$$\frac{\Gamma, c : \phi \vDash B : \star \qquad \Gamma \vDash \phi\ \ \mathsf{ok}}{\Gamma \vDash \forall c\!:\!\phi.B : \star} \quad \text{E\_CPi}$$

$$\frac{\Gamma, c : \phi \vDash a : B \qquad \Gamma \vDash \phi\ \ \mathsf{ok}}{\Gamma \vDash \Lambda c.a : \forall c\!:\!\phi.B} \quad \text{E\_CAbs}$$

$$\frac{\Gamma \vDash a_1 : \forall c\!:\!(a \sim_R b : A).B_1 \qquad \Gamma; \widetilde{\Gamma} \vDash a \equiv b : A/R}{\Gamma \vDash a_1[\bullet] : B_1\{\bullet/c\}} \quad \text{E\_CApp}$$

$$\frac{\vDash \Gamma \qquad F :_{Rs}\ \ A\ \in\ \Sigma_0 \qquad \varnothing \vDash A : \star}{\Gamma \vDash F : A} \quad \text{E\_Const}$$

$$\frac{\vDash \Gamma \qquad F :_{Rs}\ \ p \sim_{R_1}\ a : A\ \in\ \Sigma_0 \qquad \varnothing \vDash A : \star}{\Gamma \vDash F : A} \quad \text{E\_Fam}$$

$$\frac{\begin{array}{l}\Gamma \vDash a : A \\ \Gamma \vDash b_1 : B \\ \Gamma \vDash b_2 : C \\ \Gamma \vDash \mathsf{case}\ a : A\ \mathsf{of}\ F : A_1 \Rightarrow B \mid C \\ \Gamma \vDash F : A_1 \\ \mathbf{Sat}\ F\ Apps\end{array}}{\Gamma \vDash \mathsf{case}\ \ a\ \ \mathsf{of}\ \ F \to b_1 \|_{\_} \to b_2 : C} \quad \text{E\_Case}$$

$\boxed{\Gamma; \Delta \vDash \phi_1 \equiv \phi_2}$ prop equality

$$\frac{\begin{array}{c}\Gamma; \Delta \vDash A_1 \equiv A_2 : A/R \\ \Gamma; \Delta \vDash B_1 \equiv B_2 : A/R\end{array}}{\Gamma; \Delta \vDash A_1 \sim_R B_1 : A \equiv A_2 \sim_R B_2 : A} \quad \text{E\_PropCong}$$

$$\frac{\begin{array}{c}\Gamma; \Delta \vDash A \equiv B : \star/R_0 \\ \Gamma \vDash A_1 \sim_R A_2 : A \ \mathsf{ok} \\ \Gamma \vDash A_1 \sim_R A_2 : B \ \mathsf{ok}\end{array}}{\Gamma; \Delta \vDash A_1 \sim_R A_2 : A \equiv A_1 \sim_R A_2 : B} \quad \text{E\_IsoConv}$$

$$\frac{\Gamma; \Delta \vDash \forall c\!:\!(a_1 \sim_{R_1} a_2 : A).B_1 \equiv \forall c\!:\!(b_1 \sim_{R_2} b_2 : B).B_2 : \star/R'}{\Gamma; \Delta \vDash a_1 \sim_{R_1} a_2 : A \equiv b_1 \sim_{R_2} b_2 : B} \quad \text{E\_CPiFst}$$

$\boxed{\Gamma; \Delta \vDash a \equiv b : A/R}$ definitional equality

$$\frac{\begin{array}{l}\vDash \Gamma \\ c : (a \sim_R b : A) \in \Gamma \\ c \in \Delta\end{array}}{\Gamma; \Delta \vDash a \equiv b : A/R} \quad \text{E\_Assn}$$

$$\frac{\Gamma \vDash a : A}{\Gamma; \Delta \vDash a \equiv a : A/R} \quad \text{E\_Refl}$$

$$\frac{\Gamma; \Delta \vDash b \equiv a : A/R}{\Gamma; \Delta \vDash a \equiv b : A/R} \quad \text{E\_Sym}$$

$$\frac{\begin{array}{c}\Gamma; \Delta \vDash a \equiv a_1 : A/R \\ \Gamma; \Delta \vDash a_1 \equiv b : A/R\end{array}}{\Gamma; \Delta \vDash a \equiv b : A/R} \quad \text{E\_Trans}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash a \equiv b : A/R_1 \\ R_1 \leq R_2\end{array}}{\Gamma; \Delta \vDash a \equiv b : A/R_2} \quad \text{E\_Sub}$$

$$\frac{\begin{array}{l}\Gamma \vDash a_1 : B \\ \Gamma \vDash a_2 : B \\ \vDash a_1 >_R a_2\end{array}}{\Gamma; \Delta \vDash a_1 \equiv a_2 : B/R} \quad \text{E\_Beta}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash A_1 \equiv A_2 : \star/R' \\ \Gamma, x : A_1; \Delta \vDash B_1 \equiv B_2 : \star/R' \\ \Gamma \vDash A_1 : \star \\ \Gamma \vDash \Pi^\rho x\!:\!A_1 \to B_1 : \star \\ \Gamma \vDash \Pi^\rho x\!:\!A_2 \to B_2 : \star\end{array}}{\Gamma; \Delta \vDash (\Pi^\rho x\!:\!A_1 \to B_1) \equiv (\Pi^\rho x\!:\!A_2 \to B_2) : \star/R'} \quad \text{E\_PiCong}$$

$$\frac{\begin{array}{l}\Gamma, x : A_1; \Delta \vDash b_1 \equiv b_2 : B/R' \\ \Gamma \vDash A_1 : \star \\ (\rho = +) \vee (x \notin \mathsf{fv}\ b_1) \\ (\rho = +) \vee (x \notin \mathsf{fv}\ b_2)\end{array}}{\Gamma; \Delta \vDash (\lambda^\rho x.b_1) \equiv (\lambda^\rho x.b_2) : (\Pi^\rho x\!:\!A_1 \to B)/R'} \quad \text{E\_AbsCong}$$

$$\frac{\begin{array}{c}\Gamma; \Delta \vDash a_1 \equiv b_1 : (\Pi^+ x\!:\!A \to B)/R' \\ \Gamma; \Delta \vDash a_2 \equiv b_2 : A/\mathbf{Nom}\end{array}}{\Gamma; \Delta \vDash a_1\ {a_2}^+ \equiv b_1\ {b_2}^+ : (B\{a_2/x\})/R'} \quad \text{E\_AppCong}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash a_1 \equiv b_1 : (\Pi^{+} x\!:\!A \to B)/R' \\ \Gamma; \Delta \vDash a_2 \equiv b_2 : A/\mathbf{param}\, R\, R' \\ \mathsf{RolePath}\ a_1 = F@R, Rs \\ \mathsf{RolePath}\ b_1 = F'@R, Rs' \\ \Gamma \vDash b_1\ \ {b_2}^{R} : B\{a_2/x\}\end{array}}{\Gamma; \Delta \vDash a_1\ \ {a_2}^{R} \equiv b_1\ \ {b_2}^{R} : (B\{a_2/x\})/R'} \quad \textsc{E\_TAppCong}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash a_1 \equiv b_1 : (\Pi^{-} x\!:\!A \to B)/R' \\ \Gamma \vDash a : A\end{array}}{\Gamma; \Delta \vDash a_1\ \Box^{-} \equiv b_1\ \Box^{-} : (B\{a/x\})/R'} \quad \textsc{E\_IAppCong}$$

$$\frac{\Gamma; \Delta \vDash \Pi^{\rho} x\!:\!A_1 \to B_1 \equiv \Pi^{\rho} x\!:\!A_2 \to B_2 : \star/R'}{\Gamma; \Delta \vDash A_1 \equiv A_2 : \star/R'} \quad \textsc{E\_PiFst}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash \Pi^{\rho} x\!:\!A_1 \to B_1 \equiv \Pi^{\rho} x\!:\!A_2 \to B_2 : \star/R' \\ \Gamma; \Delta \vDash a_1 \equiv a_2 : A_1/\mathbf{Nom}\end{array}}{\Gamma; \Delta \vDash B_1\{a_1/x\} \equiv B_2\{a_2/x\} : \star/R'} \quad \textsc{E\_PiSnd}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash a_1 \sim_R b_1 : A_1 \equiv a_2 \sim_R b_2 : A_2 \\ \Gamma, c : a_1 \sim_R b_1 : A_1; \Delta \vDash A \equiv B : \star/R' \\ \Gamma \vDash a_1 \sim_R b_1 : A_1\ \ \mathsf{ok} \\ \Gamma \vDash \forall c\!:\!a_1 \sim_R b_1 : A_1.A : \star \\ \Gamma \vDash \forall c\!:\!a_2 \sim_R b_2 : A_2.B : \star\end{array}}{\Gamma; \Delta \vDash \forall c\!:\!a_1 \sim_R b_1 : A_1.A \equiv \forall c\!:\!a_2 \sim_R b_2 : A_2.B : \star/R'} \quad \textsc{E\_CPiCong}$$

$$\frac{\begin{array}{l}\Gamma, c : \phi_1; \Delta \vDash a \equiv b : B/R \\ \Gamma \vDash \phi_1\ \ \mathsf{ok}\end{array}}{\Gamma; \Delta \vDash (\Lambda c.a) \equiv (\Lambda c.b) : \forall c\!:\!\phi_1.B/R} \quad \textsc{E\_CAbsCong}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash a_1 \equiv b_1 : (\forall c\!:\!(a \sim_R b : A).B)/R' \\ \Gamma; \widetilde{\Gamma} \vDash a \equiv b : A/\mathbf{param}\, R\, R'\end{array}}{\Gamma; \Delta \vDash a_1[\bullet] \equiv b_1[\bullet] : (B\{\bullet/c\})/R'} \quad \textsc{E\_CAppCong}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash \forall c\!:\!(a_1 \sim_R a_2 : A).B_1 \equiv \forall c\!:\!(a_1' \sim_{R'} a_2' : A').B_2 : \star/R_0 \\ \Gamma; \widetilde{\Gamma} \vDash a_1 \equiv a_2 : A/\mathbf{param}\, R\, R_0 \\ \Gamma; \widetilde{\Gamma} \vDash a_1' \equiv a_2' : A'/\mathbf{param}\, R'\, R_0\end{array}}{\Gamma; \Delta \vDash B_1\{\bullet/c\} \equiv B_2\{\bullet/c\} : \star/R_0} \quad \textsc{E\_CPiSnd}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash a \equiv b : A/R \\ \Gamma; \Delta \vDash a \sim_R b : A \equiv a' \sim_{R'} b' : A'\end{array}}{\Gamma; \Delta \vDash a' \equiv b' : A'/R'} \quad \textsc{E\_Cast}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash a \equiv b : A/R \\ \Gamma; \widetilde{\Gamma} \vDash A \equiv B : \star/\mathbf{Rep} \\ \Gamma \vDash B : \star\end{array}}{\Gamma; \Delta \vDash a \equiv b : B/R} \quad \textsc{E\_EqConv}$$

$$\frac{\Gamma; \Delta \vDash a \sim_{R_1} b : A \equiv a' \sim_{R_1} b' : A'}{\Gamma; \Delta \vDash A \equiv A' : \star/\mathbf{Rep}} \quad \textsc{E\_IsoSnd}$$

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash a \equiv a' : A/\mathbf{Nom} \\ \Gamma; \Delta \vDash b_1 \equiv b_1' : B/R_0 \\ \Gamma; \Delta \vDash b_2 \equiv b_2' : C/R_0 \\ \Gamma \vDash \mathsf{case}\ a : A\ \mathsf{of}\ F : A_1 \Rightarrow B \mid C \\ \Gamma \vDash \mathsf{case}\ a' : A\ \mathsf{of}\ F : A_1 \Rightarrow B \mid C \\ \mathbf{Sat}\ F\ Apps \\ \Gamma \vDash F : A_1\end{array}}{\Gamma; \Delta \vDash \mathsf{case}\ a\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2 \equiv \mathsf{case}\ a'\ \mathsf{of}\ F \to b_1' \|_{\_} \to b_2' : C/R_0} \quad \textsc{E\_PatCong}$$

$$\frac{\begin{array}{l}\mathsf{ValuePath}\ a \not\mapsto F\\ \mathsf{ValuePath}\ a' \not\mapsto F\\ \Gamma \vDash a : \Pi^{+} x\!:\!A \to B\\ \Gamma \vDash b : A\\ \Gamma \vDash a' : \Pi^{+} x\!:\!A \to B\\ \Gamma \vDash b' : A\\ \Gamma; \Delta \vDash a\ \ b^{R_1} \equiv a'\ \ b'^{R_1} : B\{b/x\}/R'\\ \Gamma; \widetilde{\Gamma} \vDash B\{b/x\} \equiv B\{b'/x\} : \star/\mathbf{Rep}\end{array}}{\Gamma; \Delta \vDash a \equiv a' : \Pi^{+} x\!:\!A \to B/R'} \quad \textsc{E\_LeftRel}$$

$$\frac{\begin{array}{l}\mathsf{ValuePath}\ a \not\mapsto F\\ \mathsf{ValuePath}\ a' \not\mapsto F\\ \Gamma \vDash a : \Pi^{-} x\!:\!A \to B\\ \Gamma \vDash b : A\\ \Gamma \vDash a' : \Pi^{-} x\!:\!A \to B\\ \Gamma \vDash b' : A\\ \Gamma; \Delta \vDash a\ \square^{-} \equiv a'\ \square^{-} : B\{b/x\}/R'\\ \Gamma; \widetilde{\Gamma} \vDash B\{b/x\} \equiv B\{b'/x\} : \star/\mathbf{Rep}\end{array}}{\Gamma; \Delta \vDash a \equiv a' : \Pi^{-} x\!:\!A \to B/R'} \quad \textsc{E\_LeftIrrel}$$

$$\frac{\begin{array}{l}\mathsf{ValuePath}\ a \not\mapsto F\\ \mathsf{ValuePath}\ a' \not\mapsto F\\ \Gamma \vDash a : \Pi^{+} x\!:\!A \to B\\ \Gamma \vDash b : A\\ \Gamma \vDash a' : \Pi^{+} x\!:\!A \to B\\ \Gamma \vDash b' : A\\ \Gamma; \Delta \vDash a\ \ b^{R_1} \equiv a'\ \ b'^{R_1} : B\{b/x\}/R'\\ \Gamma; \widetilde{\Gamma} \vDash B\{b/x\} \equiv B\{b'/x\} : \star/\mathbf{Rep}\end{array}}{\Gamma; \Delta \vDash b \equiv b' : A/\mathbf{param}\, R_1\, R'} \quad \textsc{E\_Right}$$

$$\frac{\begin{array}{l}\mathsf{ValuePath}\ a \not\mapsto F\\ \mathsf{ValuePath}\ a' \not\mapsto F\\ \Gamma \vDash a : \forall c\!:\!(a_1 \sim_{R_1} a_2 : A).B\\ \Gamma \vDash a' : \forall c\!:\!(a_1 \sim_{R_1} a_2 : A).B\\ \Gamma; \widetilde{\Gamma} \vDash a_1 \equiv a_2 : A/\mathbf{param}\, R_1\, R'\\ \Gamma; \Delta \vDash a[\bullet] \equiv a'[\bullet] : B\{\bullet/c\}/R'\end{array}}{\Gamma; \Delta \vDash a \equiv a' : \forall c\!:\!(a_1 \sim_{R_1} a_2 : A).B/R'} \quad \textsc{E\_CLeft}$$

$\boxed{\vDash \Gamma}$ context wellformedness

$$\frac{}{\vDash \varnothing} \quad \textsc{E\_Empty}$$

$$\frac{\begin{array}{l}\vDash \Gamma\\ \Gamma \vDash A : \star\\ x \notin \widetilde{\Gamma}\end{array}}{\vDash \Gamma, x : A} \quad \textsc{E\_ConsTm}$$

$$\frac{\begin{array}{l}\vDash \Gamma\\ \Gamma \vDash \phi\ \ \mathsf{ok}\\ c \notin \widetilde{\Gamma}\end{array}}{\vDash \Gamma, c : \phi} \quad \textsc{E\_ConsCo}$$

$\boxed{\vDash \Sigma}$ signature wellformedness

$$\frac{}{\vDash \varnothing} \quad \textsc{Sig\_Empty}$$

$$\frac{\begin{array}{l}\vDash \Sigma \\ \varnothing \vDash A : \star \\ F \notin \mathsf{dom}\,\Sigma\end{array}}{\vDash \Sigma \cup \{F :_{Rs} \ A\}} \quad \textsc{Sig\_ConsConst}$$

$$\frac{\begin{array}{l}\vDash \Sigma \\ F \notin \mathsf{dom}\,\Sigma \\ \varnothing \vDash A : \star \\ \Omega;\Gamma \vDash p :_F B \Rightarrow A \\ \Gamma \vDash a : B \\ \Omega \vDash a : R\end{array}}{\vDash \Sigma \cup \{F :_{\mathbf{range}} \ \Omega\ p \sim_R a : A\}} \quad \textsc{Sig\_ConsAx}$$

$\boxed{Rs_1 \Leftarrow Rs_2}$

$$\frac{}{\cdot \Leftarrow \cdot} \quad \textsc{R\_Nil}$$

$$\frac{\begin{array}{c}R_2 \leq R_1 \\ Rs_1 \Leftarrow Rs_2\end{array}}{R_1, Rs_1 \Leftarrow R_2, Rs_2} \quad \textsc{R\_Cons}$$

$\boxed{\Sigma_1 \Leftarrow \Sigma_2}$

$$\frac{\Sigma_1 \Leftarrow \Sigma_2}{\Sigma_1 \Leftarrow \Sigma_2 \cup \{F : \mathit{sig\_sort}\}} \quad \textsc{S\_Forget}$$

$$\frac{\begin{array}{c}\Sigma_1 \Leftarrow \Sigma_2 \\ Rs_1 \Leftarrow Rs_2\end{array}}{\Sigma_1 \cup \{F :_{Rs_1} \ A\} \Leftarrow \Sigma_2 \cup \{F :_{Rs_2} \ p \sim_R a : A\}} \quad \textsc{S\_Hide}$$

$$\frac{\begin{array}{c}\Sigma_1 \Leftarrow \Sigma_2 \\ Rs_1 \Leftarrow Rs_2\end{array}}{\Sigma_1 \cup \{F :_{Rs_1} \ A\} \Leftarrow \Sigma_2 \cup \{F :_{Rs_2} \ A\}} \quad \textsc{S\_WeakenConst}$$

$$\frac{\begin{array}{c}\Sigma_1 \Leftarrow \Sigma_2 \\ Rs_1 \Leftarrow Rs_2\end{array}}{\Sigma_1 \cup \{F :_{Rs_1} \ p' \sim_R a : A\} \Leftarrow \Sigma_2 \cup \{F :_{Rs_2} \ p \sim_R a : A\}} \quad \textsc{S\_WeakenAxiom}$$

$$\frac{}{\varnothing \Leftarrow \varnothing} \quad \textsc{S\_Empty}$$

$$\frac{\Sigma_1 \Leftarrow \Sigma_2}{\Sigma_1 \cup \{F : \mathit{sig\_sort}\} \Leftarrow \Sigma_2 \cup \{F : \mathit{sig\_sort}\}} \quad \textsc{S\_Same}$$

$\boxed{\Gamma \vDash_{\mathsf{src}} a : A}$ source typing

$$\frac{\vDash \Gamma}{\Gamma \vDash_{\mathsf{src}} \star : \star} \quad \textsc{S\_Star}$$

$$\frac{\begin{array}{l}\vDash \Gamma \\ x : A \in \Gamma\end{array}}{\Gamma \vDash_{\mathsf{src}} x : A} \quad \textsc{S\_Var}$$

$$\frac{\Gamma \vDash_{\mathsf{src}} A : \star \quad \Gamma \vDash_{\mathsf{src}} A \rightsquigarrow A' : \star \quad \Gamma, x : A' \vDash_{\mathsf{src}} B : \star}{\Gamma \vDash_{\mathsf{src}} (\Pi^{\rho} x{:}A \to B) : \star} \quad \text{S\_Pi}$$

$$\frac{\Gamma, x : A \vDash_{\mathsf{src}} a : B}{\Gamma \vDash_{\mathsf{src}} \lambda x.a : (\Pi^{+} x{:}A \to B)} \quad \text{S\_Abs}$$

$$\frac{\Gamma, x : A \vDash_{\mathsf{src}} a : B}{\Gamma \vDash_{\mathsf{src}} a : (\Pi^{-} x{:}A \to B)} \quad \text{S\_IAbs}$$

$$\frac{\Gamma \vDash_{\mathsf{src}} a : A \quad \Gamma; \widetilde{\Gamma} \vDash A \equiv B : \star/\mathbf{Nom}}{\Gamma \vDash_{\mathsf{src}} a : B} \quad \text{S\_Conv}$$

$$\frac{\Gamma \vDash_{\mathsf{src}} a : A \quad \Gamma; \widetilde{\Gamma} \vDash A \equiv B : \star/\mathbf{Rep}}{\Gamma \vDash_{\mathsf{src}} \mathbf{coerce}\, a : B} \quad \text{S\_Coerce}$$

$$\frac{\Gamma \vDash_{\mathsf{src}} b : \Pi^{+} x{:}A \to B \quad \Gamma \vDash_{\mathsf{src}} a \rightsquigarrow a' : A}{\Gamma \vDash_{\mathsf{src}} b \ a : B\{a'/x\}} \quad \text{S\_App}$$

$$\frac{\Gamma \vDash_{\mathsf{src}} b : \Pi^{-} x{:}A \to B \quad \Gamma \vDash a' : A}{\Gamma \vDash_{\mathsf{src}} b : B\{a'/x\}} \quad \text{S\_IApp}$$

$$\frac{\Gamma \vDash_{\mathsf{src}} \phi \rightsquigarrow \phi' \ \mathsf{ok} \quad \Gamma, c : \phi' \vDash_{\mathsf{src}} B : \star}{\Gamma \vDash_{\mathsf{src}} \forall c{:}\phi.B : \star} \quad \text{S\_CPi}$$

$$\frac{\Gamma, c : \phi' \vDash_{\mathsf{src}} a : B}{\Gamma \vDash_{\mathsf{src}} a : \forall c{:}\phi.B} \quad \text{S\_CAbs}$$

$$\frac{\Gamma \vDash_{\mathsf{src}} a_1 : \forall c{:}(a \sim_R b : A).B_1 \quad \Gamma; \widetilde{\Gamma} \vDash a \equiv b : A/R}{\Gamma \vDash_{\mathsf{src}} a_1 : B_1\{\bullet/c\}} \quad \text{S\_CApp}$$

$$\frac{\vDash \Gamma \quad F :_{Rs} \ A \in \Sigma_0}{\Gamma \vDash_{\mathsf{src}} F : A} \quad \text{S\_Const}$$

$$\frac{\vDash \Gamma}{\Gamma \vDash_{\mathsf{src}} F : A} \quad \text{S\_Fam}$$

$$\frac{\Gamma \vDash_{\mathsf{src}} a : A \quad \Gamma \vDash_{\mathsf{src}} b_1' : B \quad \Gamma \vDash_{\mathsf{src}} b_2' : C}{\Gamma \vDash_{\mathsf{src}} \mathsf{case}\ a\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2 : C} \quad \text{S\_Case}$$

$\boxed{\Gamma \vDash_{\mathsf{src}} a \rightsquigarrow a' : A}$ source translation

$$\frac{\vDash \Gamma}{\Gamma \vDash_{\mathsf{src}} \star \rightsquigarrow \star : \star} \quad \text{ST\_Star}$$

$$\frac{\vDash \Gamma \quad x : A \in \Gamma}{\Gamma \vDash_{\mathsf{src}} x \rightsquigarrow x : A} \quad \text{ST\_Var}$$

$$\frac{\begin{array}{c}\Gamma \vDash_{\mathsf{src}} A \rightsquigarrow A' : \star \\ \Gamma, x : A' \vDash_{\mathsf{src}} B \rightsquigarrow B' : \star\end{array}}{\Gamma \vDash_{\mathsf{src}} (\Pi^{\rho} x\!:\!A \to B) \rightsquigarrow (\Pi^{\rho} x\!:\!A' \to B') : \star} \quad \text{ST\_PI}$$

$$\frac{\Gamma, x : A \vDash_{\mathsf{src}} a \rightsquigarrow a' : B}{\Gamma \vDash_{\mathsf{src}} \lambda x.a \rightsquigarrow \lambda^{+} x.a' : (\Pi^{+} x\!:\!A \to B)} \quad \text{ST\_ABS}$$

$$\frac{\begin{array}{l}\Gamma, x : A \vDash_{\mathsf{src}} a \rightsquigarrow a' : B \\ x \notin \mathsf{fv}\, a\end{array}}{\Gamma \vDash_{\mathsf{src}} a \rightsquigarrow \lambda^{-} x.a : (\Pi^{-} x\!:\!A \to B)} \quad \text{ST\_IABS}$$

$$\frac{\begin{array}{l}\Gamma \vDash_{\mathsf{src}} b \rightsquigarrow b' : \Pi^{+} x\!:\!A \to B \\ \Gamma \vDash_{\mathsf{src}} a \rightsquigarrow a' : A\end{array}}{\Gamma \vDash_{\mathsf{src}} b\ a \rightsquigarrow b'\ a'^{+} : B\{a'/x\}} \quad \text{ST\_APP}$$

$$\frac{\begin{array}{l}\Gamma \vDash_{\mathsf{src}} b \rightsquigarrow b' : \Pi^{+} x\!:\!A \to B \\ \Gamma \vDash_{\mathsf{src}} a \rightsquigarrow a' : A \\ \mathsf{RolePath}\ b = F@R, Rs\end{array}}{\Gamma \vDash_{\mathsf{src}} b\ a \rightsquigarrow b'\ a'^{R} : B\{a/x\}} \quad \text{ST\_TAPP}$$

$$\frac{\begin{array}{l}\Gamma \vDash_{\mathsf{src}} b \rightsquigarrow b' : \Pi^{-} x\!:\!A \to B \\ \Gamma \vDash a : A\end{array}}{\Gamma \vDash_{\mathsf{src}} b \rightsquigarrow b'\ \square^{-} : B\{a/x\}} \quad \text{ST\_IAPP}$$

$$\frac{\begin{array}{l}\Gamma \vDash_{\mathsf{src}} a \rightsquigarrow a' : A \\ \Gamma; \widetilde{\Gamma} \vDash A \equiv B : \star/\mathbf{Nom}\end{array}}{\Gamma \vDash_{\mathsf{src}} a \rightsquigarrow a' : B} \quad \text{ST\_CONV}$$

$$\frac{\begin{array}{l}\Gamma \vDash_{\mathsf{src}} a \rightsquigarrow a' : A \\ \Gamma; \widetilde{\Gamma} \vDash A \equiv B : \star/\mathbf{Rep}\end{array}}{\Gamma \vDash_{\mathsf{src}} \mathbf{coerce}\, a \rightsquigarrow a' : B} \quad \text{ST\_COERCE}$$

$$\frac{\begin{array}{l}\Gamma \vDash_{\mathsf{src}} \phi \rightsquigarrow \phi'\ \mathsf{ok} \\ \Gamma, c : \phi' \vDash_{\mathsf{src}} B \rightsquigarrow B' : \star\end{array}}{\Gamma \vDash_{\mathsf{src}} \forall c\!:\!\phi.B \rightsquigarrow \forall c\!:\!\phi.B' : \star} \quad \text{ST\_CPI}$$

$$\frac{\Gamma, c : \phi \vDash_{\mathsf{src}} a \rightsquigarrow a' : B}{\Gamma \vDash_{\mathsf{src}} a \rightsquigarrow \Lambda c.a' : \forall c\!:\!\phi.B} \quad \text{ST\_CABS}$$

$$\frac{\begin{array}{l}\Gamma \vDash_{\mathsf{src}} a_1 \rightsquigarrow a_1' : \forall c\!:\!(a \sim_R b : A).B_1 \\ \Gamma; \widetilde{\Gamma} \vDash a \equiv b : A/R\end{array}}{\Gamma \vDash_{\mathsf{src}} a_1 \rightsquigarrow a_1'[\bullet] : B_1\{\bullet/c\}} \quad \text{ST\_CAPP}$$

$$\frac{\begin{array}{l}\vDash \Gamma \\ F :_{Rs}\ A \in \Sigma_0\end{array}}{\Gamma \vDash_{\mathsf{src}} F \rightsquigarrow F : A} \quad \text{ST\_CONST}$$

$$\frac{\vDash \Gamma}{\Gamma \vDash_{\mathsf{src}} F \rightsquigarrow F : A} \quad \text{ST\_FAM}$$

$$\frac{\begin{array}{l}\Gamma \vDash_{\mathsf{src}} a \rightsquigarrow a' : A \\ \Gamma \vDash_{\mathsf{src}} b_1 \rightsquigarrow b_1' : B \\ \Gamma \vDash_{\mathsf{src}} b_2 \rightsquigarrow b_2' : C\end{array}}{\Gamma \vDash_{\mathsf{src}} \mathsf{case}\ a\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2 \rightsquigarrow \mathsf{case}\ a'\ \mathsf{of}\ F \to b_1' \|_{\_} \to b_2' : C} \quad \text{ST\_CASE}$$

$\boxed{\Gamma \vDash_{\mathsf{src}} \phi \rightsquigarrow \phi'\ \mathsf{ok}}$ Prop wellformedness

$$\frac{\Gamma \vDash_{\mathsf{src}} a \leadsto a' : A \qquad \Gamma \vDash_{\mathsf{src}} b \leadsto b' : A}{\Gamma \vDash_{\mathsf{src}} (a \sim_{\mathbf{Nom}} b : A) \leadsto (a' \sim_{\mathbf{Nom}} b' : A)\ \mathsf{ok}} \quad \text{S\_WFF}$$

$\boxed{\Gamma \vdash \phi\ \mathsf{ok}}$ prop wellformedness

$\boxed{\Gamma \vdash a : A/R}$ typing

$\boxed{\Gamma; \Delta \vdash \gamma : \phi_1 \sim \phi_2}$ coercion between props

$\boxed{\Gamma; \Delta \vdash \gamma : A \sim_R B}$ coercion between types

$\boxed{\vdash \Gamma}$ context wellformedness

$\boxed{\Gamma \vdash a \leadsto b/R}$ single-step, weak head reduction to values for annotated language

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Definition rules:        222 good    0 bad
Definition rule clauses: 607 good    0 bad
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