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

relflag, ρ	::=			relevance flag
	|	$+$		
	|	$-$		
	|	$app\_rho \nu$	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	
	|	$app\_role \nu$	S	
	|	(R)	S	
constraint, ϕ	::=			props
	|	$a \sim_{A/R} b$		
	|	(ϕ)	S	
	|	$\phi\{b/x\}$	S	
	|	$\|\phi\|$	S	
	|	$a \sim_R b$	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		
	|	$\square$		
	|	$\mathsf{case}_R\ a\ \mathsf{of}\ F \to b_1 \|\|_{\_} \to b_2$		
	|	K		
	|	**match** a **with** brs		
	|	**sub** R a		
	|	$a\{b/x\}$	S	
	|	$a\{\gamma/c\}$	S	
	|	$a\{b/x\}$	S	
	|	$a\{\gamma/c\}$	S	

	$\mid$	a	S	
	$\mid$	a	S	
	$\mid$	(a)	S	
	$\mid$	a	S	parsing precedence is hard
	$\mid$	$\lvert a \rvert_R$	S	
	$\mid$	$\mathbf{Int}$	S	
	$\mid$	$\mathbf{Bool}$	S	
	$\mid$	$\mathbf{Nat}$	S	
	$\mid$	$\mathbf{Vec}$	S	
	$\mid$	0	S	
	$\mid$	S	S	
	$\mid$	$\mathbf{True}$	S	
	$\mid$	$\mathbf{Fix}$	S	
	$\mid$	$\mathbf{Age}$	S	
	$\mid$	$a \to b$	S	
	$\mid$	$\phi \Rightarrow A$	S	
	$\mid$	$a\ \ b$	S	
	$\mid$	$\lambda x.a$	S	
	$\mid$	$\lambda x\!:\!A.a$	S	
	$\mid$	$\forall\, x : A \to B$	S	
	$\mid$	$\mathbf{if}\ \phi\ \mathbf{then}\ a\ \mathbf{else}\ b$	S	
brs	$::=$			case branches
	$\mid$	$\mathbf{none}$		
	$\mid$	$K \Rightarrow a; brs$		
	$\mid$	$brs\{a/x\}$	S	
	$\mid$	$brs\{\gamma/c\}$	S	
	$\mid$	(brs)	S	
$co,\ \gamma$	$::=$			explicit coercions
	$\mid$	$\bullet$		
	$\mid$	c		
	$\mid$	$\mathbf{red}\ a\ b$		
	$\mid$	$\mathbf{refl}\ a$		
	$\mid$	$(a \mid = \mid_{\gamma}\ b)$		
	$\mid$	$\mathbf{sym}\ \gamma$		
	$\mid$	$\gamma_1 ; \gamma_2$		
	$\mid$	$\mathbf{sub}\ \gamma$		
	$\mid$	$\Pi^{R,\rho} x\!:\!\gamma_1.\gamma_2$	bind x in γ_2	
	$\mid$	$\lambda^{R,\rho} x\!:\!\gamma_1.\gamma_2$	bind x in γ_2	
	$\mid$	$\gamma_1\ \ \gamma_2^{R,\rho}$		
	$\mid$	$\mathbf{piFst}\ \gamma$		
	$\mid$	$\mathbf{cpiFst}\ \gamma$		
	$\mid$	$\mathbf{isoSnd}\ \gamma$		
	$\mid$	$\gamma_1 @ \gamma_2$		
	$\mid$	$\forall c\!:\!\gamma_1.\gamma_3$	bind c in γ_3	

	$\mid$	$\lambda c\!:\!\gamma_1.\gamma_3@\gamma_4$	bind c in γ_3	
	$\mid$	$\gamma(\gamma_1, \gamma_2)$		
	$\mid$	$\gamma@(\gamma_1 \sim \gamma_2)$		
	$\mid$	$\gamma_1 \rhd_R \gamma_2$		
	$\mid$	$\gamma_1 \sim_A \gamma_2$		
	$\mid$	$\mathbf{conv}\ \phi_1 \sim_\gamma \phi_2$		
	$\mid$	$\mathbf{eta}\, a$		
	$\mid$	$\mathbf{left}\, \gamma\, \gamma'$		
	$\mid$	$\mathbf{right}\, \gamma\, \gamma'$		
	$\mid$	(γ)	S	
	$\mid$	γ	S	
	$\mid$	$\gamma\{a/x\}$	S	
role_context, Ω	::=			role$_c ontexts$
	$\mid$	$\varnothing$		
	$\mid$	$x : R$		
	$\mid$	$\Omega, x : R$		
	$\mid$	Ω, Ω'	M	
	$\mid$	Γ_{Nom}		
	$\mid$	(Ω)	M	
	$\mid$	Ω	M	
roles, Rs	::=			
	$\mid$	$\mathbf{nilR}$		
	$\mid$	R, Rs		
	$\mid$	$\mathbf{range}\, \Omega$	S	
sig_sort	::=			signature classifier
	$\mid$	$A@Rs$		
	$\mid$	$p \sim a : A/R@Rs$		
sort	::=			binding classifier
	$\mid$	$\mathbf{Tm}\, A$		
	$\mid$	$\mathbf{Co}\, \phi$		
context, Γ	::=			contexts
	$\mid$	$\varnothing$		
	$\mid$	$\Gamma, x : A$		
	$\mid$	$\Gamma, c : \phi$		
	$\mid$	$\Gamma\{b/x\}$	M	
	$\mid$	$\Gamma\{\gamma/c\}$	M	
	$\mid$	Γ, Γ'	M	
	$\mid$	$\lvert\Gamma\rvert$	M	
	$\mid$	(Γ)	M	
	$\mid$	Γ	M	
sig, Σ	::=			signatures

		$\vert$	$\emptyset$	
		$\vert$	$\Sigma \cup \{F : sig\_sort\}$	
		$\vert$	Σ_0	M
		$\vert$	Σ_1	M
		$\vert$	$\vert\Sigma\vert$	M
$available\_props,\ \Delta$	$::=$			
		$\vert$	$\emptyset$	
		$\vert$	Δ, c	
		$\vert$	$\widetilde{\Gamma}$	M
		$\vert$	(Δ)	M
$terminals$	$::=$			
		$\vert$	$\leftrightarrow$	
		$\vert$	$\Leftrightarrow$	
		$\vert$	$\longrightarrow$	
		$\vert$	min	
		$\vert$	$\equiv$	
		$\vert$	$\forall$	
		$\vert$	$\in$	
		$\vert$	$\not\in$	
		$\vert$	$\Leftarrow$	
		$\vert$	$\Rightarrow$	
		$\vert$	$\Rightarrow^*$	
		$\vert$	$\rightarrow$	
		$\vert$	Λ	
		$\vert$		
		$\vert$	$\Box$	
		$\vert$	$\vdash$	
		$\vert$	$\dashv$	
		$\vert$	$\models$	
		$\vert$	$\models$	
		$\vert$	$\neq$	
		$\vert$	$\triangleright$	
		$\vert$	ok	
		$\vert$	$\_$	
		$\vert$	$\leadsto$	
		$\vert$	$\leadsto^*$	
		$\vert$	$\leadsto$	
		$\vert$	$\emptyset$	
		$\vert$	$\circ$	
		$\vert$	fv	
		$\vert$	dom	
		$\vert$	$\sim$	
		$\vert$	$\asymp$	
		$\vert$	$\vert$	

	$\mid$	$\bullet$	
	$\mid$	**fst**	
	$\mid$	**snd**	
	$\mid$	**as**	
	$\mid$	$\mid \Rightarrow \mid$	
	$\mid$	$\vdash_{=}$	
	$\mid$	$\mathbf{refl_2}$	
	$\mid$	$++$	
	$\mid$	$\{$	
	$\mid$	$\}$	
formula, ψ	$::=$		
	$\mid$	*judgement*	
	$\mid$	$x : A \ \in \ \Gamma$	
	$\mid$	$x : R \ \in \ \Omega$	
	$\mid$	$c : \phi \ \in \ \Gamma$	
	$\mid$	$F : \mathit{sig\_sort} \ \in \ \Sigma$	
	$\mid$	$x \ \in \ \Delta$	
	$\mid$	$c \ \in \ \Delta$	
	$\mid$	$c\,\mathbf{not\,relevant} \ \in \ \gamma$	
	$\mid$	$x \ \notin \ \mathsf{fv}\, a$	
	$\mid$	$x \ \notin \ \mathsf{dom}\,\Gamma$	
	$\mid$	$\mathit{uniq}\,\Gamma$	
	$\mid$	$\mathit{uniq}(\Omega)$	
	$\mid$	$c \ \notin \ \mathsf{dom}\,\Gamma$	
	$\mid$	$T \ \notin \ \mathsf{dom}\,\Sigma$	
	$\mid$	$F \ \notin \ \mathsf{dom}\,\Sigma$	
	$\mid$	$R_1 = R_2$	
	$\mid$	$a = b$	
	$\mid$	$\phi_1 = \phi_2$	
	$\mid$	$\Gamma_1 = \Gamma_2$	
	$\mid$	$\gamma_1 = \gamma_2$	
	$\mid$	$\neg\psi$	
	$\mid$	$\psi_1 \wedge \psi_2$	
	$\mid$	$\psi_1 \vee \psi_2$	
	$\mid$	$\psi_1 \Rightarrow \psi_2$	
	$\mid$	(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
JPath	$::=$		
	$\mid$	$\mathsf{Path}\ a = F@Rs$	Type headed by constant (partial function)

JRoledPath	::=		
	|	$\mathsf{Path}_R\ a = F@Rs$	Type headed by constant (role-sensitive part
JPatCtx	::=		
	|	$\Omega; \Gamma \vDash p : A$	Contexts generated by a pattern (variables b
JMatchSubst	::=		
	|	$\mathsf{match}\ a_1\ \mathsf{with}\ p \to b_1 = b_2$	match and substitute
JApplyArgs	::=		
	|	$\mathsf{apply\ args}\ a\ \mathsf{to}\ b \mapsto b'$	apply arguments of a (headed by a constant
JValue	::=		
	|	$\mathsf{Value}_R\ A$	values
JValueType	::=		
	|	$\mathsf{ValueType}_R\ A$	Types with head forms (erased language)
Jconsistent	::=		
	|	$\mathsf{consistent}_R\ a\ b$	(erased) types do not differ in their heads
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	::=		
	|	$\vDash a > b/R$	primitive reductions on erased terms
	|	$\vDash a \leadsto b/R$	single-step head reduction for implicit langu
	|	$\vDash a \leadsto^* b/R$	multistep reduction
JBranchTyping	::=		
	|	$\Gamma \vDash \mathsf{case}_R\ a : A\ \mathsf{of}\ b : B \Rightarrow C \mid C'$	Branch Typing (aligning the types of case)
JFoldCtxType	::=		
	|	$\Gamma \vDash \mathsf{FoldCtxType}\ p : A = B$	Fold Context to Type
Jett	::=		
	|	$\Gamma \vDash \phi\ \mathsf{ok}$	Prop wellformedness
	|	$\Gamma \vDash a : A$	typing
	|	$\Gamma; \Delta \vDash \phi_1 \equiv \phi_2$	prop equality

	$\mid$	$\Gamma; \Delta \vDash a \equiv b : A / R$	definitional equality
	$\mid$	$\vDash \Gamma$	context wellformedness
Jsig	::=		
	$\mid$	$\vDash \Sigma$	signature wellformedness
judgement	::=		
	$\mid$	*JSubRole*	
	$\mid$	*JPath*	
	$\mid$	*JRoledPath*	
	$\mid$	*JPatCtx*	
	$\mid$	*JMatchSubst*	
	$\mid$	*JApplyArgs*	
	$\mid$	*JValue*	
	$\mid$	*JValueType*	
	$\mid$	*Jconsistent*	
	$\mid$	*Jroleing*	
	$\mid$	*JChk*	
	$\mid$	*Jpar*	
	$\mid$	*Jbeta*	
	$\mid$	*JBranchTyping*	
	$\mid$	*JFoldCtxType*	
	$\mid$	*Jett*	
	$\mid$	*Jsig*	
user_syntax	::=		
	$\mid$	*tmvar*	
	$\mid$	*covar*	
	$\mid$	*datacon*	
	$\mid$	*const*	
	$\mid$	*index*	
	$\mid$	*relflag*	
	$\mid$	*appflag*	
	$\mid$	*role*	
	$\mid$	*constraint*	
	$\mid$	*tm*	
	$\mid$	*brs*	
	$\mid$	*co*	
	$\mid$	*role_context*	
	$\mid$	*roles*	
	$\mid$	*sig_sort*	
	$\mid$	*sort*	
	$\mid$	*context*	
	$\mid$	*sig*	
	$\mid$	*available_props*	
	$\mid$	*terminals*	
	$\mid$	*formula*	

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

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

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

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

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

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

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

$$\frac{F : p \sim a : A/R_1@Rs \in \Sigma_0}{\mathsf{Path}\ F = F@Rs} \quad \textsc{Path\_Const}$$

$$\frac{\begin{array}{l} \mathsf{Path}\ a = F@R_1, Rs \\ \mathit{app\_role}\nu = R_1 \end{array}}{\mathsf{Path}\ (a\ b'^{\nu}) = F@Rs} \quad \textsc{Path\_App}$$

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

$\boxed{\mathsf{Path}_R\ a = F@Rs}$ Type headed by constant (role-sensitive partial function)

$$\frac{F : A@Rs \in \Sigma_0}{\mathsf{Path}_R\ F = F@Rs} \quad \textsc{RoledPath\_AbsConst}$$

$$\frac{\begin{array}{l} F : p \sim a : A/R_1@Rs \in \Sigma_0 \\ \neg(R_1 \leq R) \end{array}}{\mathsf{Path}_R\ F = F@Rs} \quad \textsc{RoledPath\_Const}$$

$$\frac{\begin{array}{l} \mathsf{Path}_R\ a = F@R_1, Rs \\ \mathit{app\_role}\nu = R_1 \end{array}}{\mathsf{Path}_R\ (a\ b'^{\nu}) = F@Rs} \quad \textsc{RoledPath\_App}$$

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

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

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

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

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

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

$\boxed{\text{match } a_1 \text{ with } p \to b_1 = b_2}$ match and substitute

$$\frac{}{\text{match } F \text{ with } F \to b = b} \quad \text{MatchSubst\_Const}$$

$$\frac{\text{match } a_1 \text{ with } a_2 \to b_1 = b_2}{\text{match } (a_1\ a^{R'}) \text{ with } (a_2\ x^+) \to b_1 = (b_2\{a/x\})} \quad \text{MatchSubst\_AppRelR}$$

$$\frac{\text{match } a_1 \text{ with } a_2 \to b_1 = b_2}{\text{match } (a_1\ a^+) \text{ with } (a_2\ x^+) \to b_1 = (b_2\{a/x\})} \quad \text{MatchSubst\_AppRel}$$

$$\frac{\text{match } a_1 \text{ with } a_2 \to b_1 = b_2}{\text{match } (a_1\ \Box^-) \text{ with } (a_2\ x^-) \to b_1 = (b_2\{\Box/x\})} \quad \text{MatchSubst\_AppIrrel}$$

$$\frac{\text{match } a_1 \text{ with } a_2 \to b_1 = b_2}{\text{match } (a_1[\bullet]) \text{ with } (a_2[c]) \to b_1 = (b_2\{\bullet/c\})} \quad \text{MatchSubst\_CApp}$$

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

$$\frac{}{\text{apply args } F \text{ to } b \mapsto b} \quad \text{ApplyArgs\_Const}$$

$$\frac{\text{apply args } a \text{ to } b \mapsto b'}{\text{apply args } a\ a'^{\nu} \text{ to } b \mapsto b'\ a'^{(app\_rho \nu)}} \quad \text{ApplyArgs\_App}$$

$$\frac{\text{apply args } a \text{ to } b \mapsto b'}{\text{apply args } a[\gamma] \text{ to } b \mapsto b'[\gamma]} \quad \text{ApplyArgs\_CApp}$$

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

$$\frac{}{\text{Value}_R\ \star} \quad \text{Value\_Star}$$

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

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

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

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

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

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

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

$$\frac{\text{Path}_R\ a = F@Rs}{\text{Value}_R\ a} \quad \text{Value\_RolePath}$$

$$\frac{\begin{array}{c}\neg(\text{Path}_R\ a = F@Rs)\\ \text{Path}\ a = F@R', Rs'\end{array}}{\text{Value}_R\ a} \quad \text{Value\_Path}$$

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

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

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

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

$$\frac{\mathsf{Path}_R\ \ a = F@Rs}{\mathsf{ValueType}_R\ \ a}\quad\textsc{value\_type\_RoledPath}$$

$$\frac{\begin{array}{l}\neg(\mathsf{Path}_R\ \ a = F@Rs)\\ \mathsf{Path}\ \ a = F@R', Rs'\end{array}}{\mathsf{ValueType}_R\ \ a}\quad\textsc{value\_type\_Path}$$

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

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

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

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

$$\frac{\begin{array}{l}\mathsf{Path}_R\ \ a_1 = F@Rs\\ \mathsf{Path}_R\ \ a_2 = F@Rs\end{array}}{\mathsf{consistent}_R\ \ a_1\ \ a_2}\quad\textsc{consistent\_a\_RoledPath}$$

$$\frac{\begin{array}{l}\neg(\mathsf{Path}_R\ \ a = F@Rs')\\ \mathsf{Path}\ \ a_1 = F@R', Rs\\ \mathsf{Path}\ \ a_2 = F@R', Rs\end{array}}{\mathsf{consistent}_R\ \ a_1\ \ a_2}\quad\textsc{consistent\_a\_Path}$$

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

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

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

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

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

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

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

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

$$\frac{\Omega \vDash a : R}{\Omega \vDash a\ \square^- : R}\quad\textsc{role\_a\_IApp}$$

$$\frac{\begin{array}{l}\Omega \vDash a : R \\ \mathsf{Path}\ a = F@R_1, Rs \\ \Omega \vDash b : R_1\end{array}}{\Omega \vDash a\ b^{R_1} : R} \quad \textsc{role\_a\_TApp}$$

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

$$\frac{\begin{array}{l}\Omega \vDash a : R_1 \\ \Omega \vDash b : R_1 \\ \Omega \vDash A : R_0 \\ \Omega \vDash B : R\end{array}}{\Omega \vDash (\forall c\!:\!a \sim_{A/R_1} b.B) : R} \quad \textsc{role\_a\_CPi}$$

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

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

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

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

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

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

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

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

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

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

$$\frac{\begin{array}{l}\Omega \vDash a \Rightarrow_R (\lambda^{\rho} x.a') \\ \Omega \vDash b \Rightarrow_{\mathit{app\_role}\,\nu} b'\end{array}}{\Omega \vDash a\ b^{\nu} \Rightarrow_R a'\{b'/x\}} \quad \textsc{Par\_Beta}$$

$$\frac{\begin{array}{l}\Omega \vDash a \Rightarrow_R a' \\ \Omega \vDash b \Rightarrow_{\mathit{app\_role}\,\nu} b'\end{array}}{\Omega \vDash a\ b^{\nu} \Rightarrow_R a'\ b'^{\nu}} \quad \textsc{Par\_App}$$

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

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

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

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

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

$$\frac{\begin{array}{l}\Omega \vDash A \Rightarrow_{R_0} A' \\ \Omega \vDash a \Rightarrow_{R_1} a' \\ \Omega \vDash b \Rightarrow_{R_1} b' \\ \Omega \vDash B \Rightarrow_R B'\end{array}}{\Omega \vDash \forall c\!:\!a \sim_{A/R_1} b.B \Rightarrow_R \forall c\!:\!a' \sim_{A'/R_1} b'.B'} \quad \textsc{Par\_CPi}$$

$$\frac{\begin{array}{l}F : p \sim b : A/R_1 @ Rs \in \Sigma_0 \\ \mathsf{match}\ a'\ \mathsf{with}\ p \to b = b' \\ R_1 \leq R \\ \mathit{uniq}(\Omega)\end{array}}{\Omega \vDash a \Rightarrow_R b'} \quad \textsc{Par\_Axiom}$$

$$\frac{\begin{array}{l}\Omega \vDash a \Rightarrow_R a' \\ \Omega \vDash b_1 \Rightarrow_{R_0} b_1' \\ \Omega \vDash b_2 \Rightarrow_{R_0} b_2'\end{array}}{\Omega \vDash (\mathsf{case}_R\ a\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2) \Rightarrow_{R_0} (\mathsf{case}_R\ a'\ \mathsf{of}\ F \to b_1' \|_{\_} \to b_2')} \quad \textsc{Par\_Pattern}$$

$$\frac{\begin{array}{l}\Omega \vDash a \Rightarrow_R a' \\ \Omega \vDash b_1 \Rightarrow_{R_0} b_1' \\ \mathsf{Path}_R\ a' = F @ Rs \\ \mathsf{apply\ args}\ a'\ \mathsf{to}\ b_1' \mapsto b\end{array}}{\Omega \vDash (\mathsf{case}_R\ a\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2) \Rightarrow_{R_0} b[\bullet]} \quad \textsc{Par\_PatternTrue}$$

$$\frac{\begin{array}{l}\Omega \vDash a \Rightarrow_R a' \\ \Omega \vDash b_2 \Rightarrow_{R_0} b_2' \\ \mathsf{Value}_R\ a' \\ \neg(\mathsf{Path}_R\ a' = F @ Rs)\end{array}}{\Omega \vDash (\mathsf{case}_R\ a\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2) \Rightarrow_{R_0} b_2'} \quad \textsc{Par\_PatternFalse}$$

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

$$\frac{}{\Omega \vDash a \Rightarrow_R^* a} \quad \textsc{MP\_Refl}$$

$$\frac{\begin{array}{l}\Omega \vDash a \Rightarrow_R b \\ \Omega \vDash b \Rightarrow_R^* a'\end{array}}{\Omega \vDash a \Rightarrow_R^* a'} \quad \textsc{MP\_Step}$$

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

$$\frac{\begin{array}{l}\Omega \vDash a_1 \Rightarrow_R^* b \\ \Omega \vDash a_2 \Rightarrow_R^* b\end{array}}{\Omega \vDash a_1 \Leftrightarrow_R a_2} \quad \textsc{join}$$

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

$$\frac{\mathsf{Value}_{R_1}\ (\lambda^\rho x.v)}{\vDash (\lambda^\rho x.v)\ b^\nu > v\{b/x\}/R_1}\ \textsc{Beta\_AppAbs}$$

$$\frac{}{\vDash (\Lambda c.a')[\bullet] > a'\{\bullet/c\}/R}\ \textsc{Beta\_CAppCAbs}$$

$$\frac{\begin{array}{l} F : p \sim b : A/R_1 @ Rs \in \Sigma_0 \\ \mathsf{match}\ a\ \mathsf{with}\ p \to b = b' \\ R_1 \leq R \end{array}}{\vDash a > b'/R}\ \textsc{Beta\_Axiom}$$

$$\frac{\begin{array}{l} \mathsf{Path}_R\ a = F @ Rs \\ \mathsf{apply\ args}\ a\ \mathsf{to}\ b_1 \mapsto b_1' \end{array}}{\vDash \mathsf{case}_R\ a\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2 > b_1'[\bullet]/R_0}\ \textsc{Beta\_PatternTrue}$$

$$\frac{\begin{array}{l} \mathsf{Value}_R\ a \\ \neg(\mathsf{Path}_R\ a = F @ Rs) \end{array}}{\vDash \mathsf{case}_R\ a\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2 > b_2/R_0}\ \textsc{Beta\_PatternFalse}$$

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

$$\frac{\vDash a \rightsquigarrow a'/R_1}{\vDash \lambda^- x.a \rightsquigarrow \lambda^- x.a'/R_1}\ \textsc{E\_AbsTerm}$$

$$\frac{\vDash a \rightsquigarrow a'/R_1}{\vDash a\ b^\nu \rightsquigarrow a'\ b^\nu/R_1}\ \textsc{E\_AppLeft}$$

$$\frac{\vDash a \rightsquigarrow a'/R}{\vDash a[\bullet] \rightsquigarrow a'[\bullet]/R}\ \textsc{E\_CAppLeft}$$

$$\frac{\vDash a \rightsquigarrow a'/R}{\vDash \mathsf{case}_R\ a\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2 \rightsquigarrow \mathsf{case}_R\ a'\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2/R_0}\ \textsc{E\_Pattern}$$

$$\frac{\vDash a > b/R}{\vDash a \rightsquigarrow b/R}\ \textsc{E\_Prim}$$

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

$$\frac{}{\vDash a \rightsquigarrow^* a/R}\ \textsc{Equal}$$

$$\frac{\begin{array}{l} \vDash a \rightsquigarrow b/R \\ \vDash b \rightsquigarrow^* a'/R \end{array}}{\vDash a \rightsquigarrow^* a'/R}\ \textsc{Step}$$

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

$$\frac{\begin{array}{c} \mathit{uniq}\ \Gamma \\ \mathtt{lc\_tm}\ C \end{array}}{\Gamma \vDash \mathsf{case}_R\ a : A\ \mathsf{of}\ b : A \Rightarrow \forall c{:}(a \sim_{A/R} b).C \mid C}\ \textsc{BranchTyping\_Base}$$

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

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

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

$\boxed{\Gamma \vDash \mathsf{FoldCtxType}\ p : A = B}$ Fold Context to Type

$$\frac{}{\varnothing \vDash \mathsf{FoldCtxType}\ F : A = A} \quad \textsc{FoldCtxType\_Base}$$

$$\frac{\begin{array}{l}\Gamma, x : A_1 \vDash \mathsf{FoldCtxType}\ p : A = B_1 \\ B\{x/y\} = B_1\end{array}}{\Gamma, x : A_1 \vDash \mathsf{FoldCtxType}\ p\ x^+ : A = \Pi^+ y{:}A_1 \to B} \quad \textsc{FoldCtxType\_PiRel}$$

$$\frac{\begin{array}{l}\Gamma \vDash \mathsf{FoldCtxType}\ p : A = B_1 \\ B\{x/y\} = B_1\end{array}}{\Gamma, x : A_1 \vDash \mathsf{FoldCtxType}\ p\ \Box^- : A = \Pi^- y{:}A_1 \to B} \quad \textsc{FoldCtxType\_PiIrrel}$$

$$\frac{\begin{array}{l}\Gamma \vDash \mathsf{FoldCtxType}\ p : A = B_1 \\ B\{c/c_1\} = B_1\end{array}}{\Gamma, c : \phi \vDash \mathsf{FoldCtxType}\ p[\bullet] : A = \forall c_1{:}\phi.B} \quad \textsc{FoldCtxType\_CPi}$$

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

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

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

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

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

$$\frac{\begin{array}{l}\Gamma, x : A \vDash B : \star \\ \Gamma \vDash A : \star\end{array}}{\Gamma \vDash \Pi^\rho x{:}A \to B : \star} \quad \textsc{E\_Pi}$$

$$\frac{\begin{array}{l}\Gamma, x : A \vDash a : B \\ \Gamma \vDash A : \star \\ (\rho = +) \vee (x \notin \mathsf{fv}\ a)\end{array}}{\Gamma \vDash \lambda^\rho x.a : (\Pi^\rho x{:}A \to B)} \quad \textsc{E\_Abs}$$

$$\frac{\begin{array}{l}\Gamma \vDash b : \Pi^+ x{:}A \to B \\ \Gamma \vDash a : A\end{array}}{\Gamma \vDash b\ a^+ : B\{a/x\}} \quad \textsc{E\_App}$$

$$\frac{\begin{array}{l}\Gamma \vDash b : \Pi^+ x{:}A \to B \\ \Gamma \vDash a : A\end{array}}{\Gamma \vDash b\ a^R : B\{a/x\}} \quad \textsc{E\_TApp}$$

$$\frac{\begin{array}{l}\Gamma \vDash b : \Pi^- x{:}A \to B \\ \Gamma \vDash a : A\end{array}}{\Gamma \vDash b\ \Box^- : B\{a/x\}} \quad \textsc{E\_IApp}$$

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

$$\frac{\begin{array}{l}\Gamma, c : \phi \vDash B : \star \\ \Gamma \vDash \phi \ \mathsf{ok}\end{array}}{\Gamma \vDash \forall c{:}\phi.B : \star} \quad \text{E\_CPi}$$

$$\frac{\begin{array}{l}\Gamma, c : \phi \vDash a : B \\ \Gamma \vDash \phi \ \mathsf{ok}\end{array}}{\Gamma \vDash \Lambda c.a : \forall c{:}\phi.B} \quad \text{E\_CAbs}$$

$$\frac{\begin{array}{l}\Gamma \vDash a_1 : \forall c{:}(a \sim_{A/R} b).B_1 \\ \Gamma; \widetilde{\Gamma} \vDash a \equiv b : A/R\end{array}}{\Gamma \vDash a_1[\bullet] : B_1\{\bullet/c\}} \quad \text{E\_CApp}$$

$$\frac{\begin{array}{l}\vDash \Gamma \\ F : A@Rs \in \Sigma_0 \\ \varnothing \vDash A : \star\end{array}}{\Gamma \vDash F : A} \quad \text{E\_Const}$$

$$\frac{\begin{array}{l}\vDash \Gamma \\ F : p \sim a : A/R_1@Rs \in \Sigma_0 \\ \varnothing \vDash A : \star \\ \Omega; \Gamma' \vDash p : A \\ \Gamma' \vDash \mathsf{FoldCtxType}\ p : A = A'\end{array}}{\Gamma \vDash F : A'} \quad \text{E\_Fam}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\frac{\begin{array}{l}\Gamma; \Delta \vDash a \equiv a' : A/R \\ \Gamma; \Delta \vDash b_1 \equiv b_1' : B/R_0 \\ \Gamma; \Delta \vDash b_2 \equiv b_2' : B/R_0\end{array}}{\Gamma; \Delta \vDash \mathsf{case}_R\ a\ \mathsf{of}\ F \to b_1 \|_{\_} \to b_2 \equiv \mathsf{case}_R\ a'\ \mathsf{of}\ F \to b_1' \|_{\_} \to b_2' : B/R_0} \quad \text{E\_PatCong}$$

$$\frac{\begin{array}{l}\mathsf{Path}_{R'}\ a = F@R, Rs \\ \mathsf{Path}_{R'}\ a' = F@R, Rs \\ \Gamma \vDash a : \Pi^+ x{:}A \to B \\ \Gamma \vDash b : A \\ \Gamma \vDash a' : \Pi^+ x{:}A \to B \\ \Gamma \vDash b' : A \\ \Gamma; \Delta \vDash a\ b^{R_1} \equiv a'\ b'^{R_1} : B\{b/x\}/R' \\ \Gamma; \widetilde{\Gamma} \vDash B\{b/x\} \equiv B\{b'/x\} : \star/R'\end{array}}{\Gamma; \Delta \vDash a \equiv a' : \Pi^+ x{:}A \to B/R'} \quad \text{E\_LeftRel}$$

$$\frac{\begin{array}{l}\mathsf{Path}_{R'}\ a = F@R, Rs \\ \mathsf{Path}_{R'}\ a' = F@R, Rs \\ \Gamma \vDash a : \Pi^- x{:}A \to B \\ \Gamma \vDash b : A \\ \Gamma \vDash a' : \Pi^- x{:}A \to B \\ \Gamma \vDash b' : A \\ \Gamma; \Delta \vDash a\ \Box^- \equiv a'\ \Box^- : B\{b/x\}/R' \\ \Gamma; \widetilde{\Gamma} \vDash B\{b/x\} \equiv B\{b'/x\} : \star/R_0\end{array}}{\Gamma; \Delta \vDash a \equiv a' : \Pi^- x{:}A \to B/R'} \quad \text{E\_LeftIrrel}$$

$$\frac{\begin{array}{l}\mathsf{Path}_{R'}\ a = F@R, Rs\\ \mathsf{Path}_{R'}\ a' = F@R, Rs\\ \Gamma \vDash a : \Pi^{+}x\!:\!A \to B\\ \Gamma \vDash b : A\\ \Gamma \vDash a' : \Pi^{+}x\!:\!A \to B\\ \Gamma \vDash b' : A\\ \Gamma; \Delta \vDash a\ b^{+} \equiv a'\ b'^{+} : B\{b/x\}/R'\\ \Gamma; \widetilde{\Gamma} \vDash B\{b/x\} \equiv B\{b'/x\} : \star/R_0\end{array}}{\Gamma; \Delta \vDash b \equiv b' : A/\mathbf{param}\, R_1\, R'} \quad \text{E\_RIGHT}$$

$$\frac{\begin{array}{l}\mathsf{Path}_{R'}\ a = F@R, Rs\\ \mathsf{Path}_{R'}\ a' = F@R, Rs\\ \Gamma \vDash a : \forall c\!:\!(a_1 \sim_{A/R_1} a_2).B\\ \Gamma \vDash a' : \forall c\!:\!(a_1 \sim_{A/R_1} a_2).B\\ \Gamma; \widetilde{\Gamma} \vDash a_1 \equiv a_2 : A/R'\\ \Gamma; \Delta \vDash a[\bullet] \equiv a'[\bullet] : B\{\bullet/c\}/R'\end{array}}{\Gamma; \Delta \vDash a \equiv a' : \forall c\!:\!(a_1 \sim_{A/R_1} a_2).B/R'} \quad \text{E\_CLEFT}$$

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

$$\frac{}{\vDash \varnothing} \quad \text{E\_EMPTY}$$

$$\frac{\begin{array}{l}\vDash \Gamma\\ \Gamma \vDash A : \star\\ x \notin \mathsf{dom}\,\Gamma\end{array}}{\vDash \Gamma, x : A} \quad \text{E\_CONSTM}$$

$$\frac{\begin{array}{l}\vDash \Gamma\\ \Gamma \vDash \phi\ \ \mathsf{ok}\\ c \notin \mathsf{dom}\,\Gamma\end{array}}{\vDash \Gamma, c : \phi} \quad \text{E\_CONSCO}$$

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

$$\frac{}{\vDash \varnothing} \quad \text{SIG\_EMPTY}$$

$$\frac{\begin{array}{l}\vDash \Sigma\\ \varnothing \vDash A : \star\\ F \notin \mathsf{dom}\,\Sigma\end{array}}{\vDash \Sigma \cup \{F : A@Rs\}} \quad \text{SIG\_CONSCONST}$$

$$\frac{\begin{array}{l}\vDash \Sigma\\ F \notin \mathsf{dom}\,\Sigma\\ \Omega; \Gamma \vDash p : A\\ \Gamma \vDash a : A\\ \Omega \vDash a : \mathbf{Rep}\end{array}}{\vDash \Sigma \cup \{F : p \sim a : A/R@\mathbf{range}\,\Omega\}} \quad \text{SIG\_CONSAX}$$

```
Definition rules:        147 good    0 bad
Definition rule clauses: 413 good    0 bad
```