Hazel PHI: 10-modules

June 29, 2021

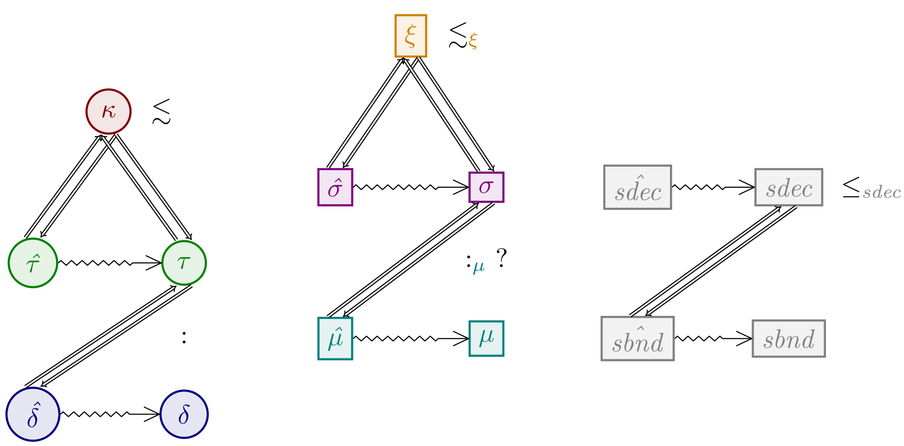
prerequisites

- Hazel PHI: 9-type-aliases-redux
  - github
  - current commit: 4410cd565ce717707e580e44f64868d3175fe2a6
- (optional) Hazel PHI: 1-labeled-tuples
  - github
  - current commit: 0a7d0b53ee7286d03ea3be13a7ac91a86f1c90b1

how to read

800000	kinds	D08000	signature kind
008000	types (constructors)	800080	signatures
000080	terms	008080	modules

notes



external typ/sig/mod syntax not written out yet (waiting for construction dust to settle); patterns not handled yet– will be left till end.

syntax

kind	κ	$::=$	$\mathtt{Type}$	kind of types
		$\mid$	$\mathtt{S}(\tau)$	singleton kind
		$\mid$	$\mathtt{KHole}$	kind hole
		$\mid$	$\Pi_{t::\kappa_1}.\kappa_2$	dependent function kind

HTyp	τ	::=	t	type variable
		|	bse	base type
		|	$\tau_1 \oplus \tau_2$	type binop
		|	$[\tau]$	list type
		|	$\lambda t{::}\kappa.\tau$	type function
		|	$\tau_1\ \tau_2$	type application
		|	$\{lab_1 \hookrightarrow \tau_1, \ldots\ lab_n \hookrightarrow \tau_n\}$	labelled product type (record)
		|	$\mu.lab$	module type projection
		|	$(\!\|\!)$	empty type hole
		|	$(\!\|\tau\|\!)$	nonempty type hole
base type	bse	::=	$\texttt{Int}$	
		|	$\texttt{Float}$	
		|	$\texttt{Bool}$	
HTyp BinOp	$\oplus$	::=	$\times$	
		|	$+$	
		|	$\rightarrow$	
external expression	$\hat{\delta}$	::=	...	
		|	x	
		|	$\texttt{signature}\ s = \hat{\sigma}\ \texttt{in}\ \hat{\delta}$	
		|	$\texttt{module}\ m = \hat{\mu}\ \texttt{in}\ \hat{\delta}$	
		|	$\texttt{module}\ m{:}_{\mu}s = \hat{\mu}\ \texttt{in}\ \hat{\delta}$	
		|	$\texttt{functor something} = \texttt{something in}\ \hat{\delta}$	
		|	$\hat{\mu}.lab$	module term projection
internal expression	δ	::=	...	
		|	x	
		|	$\texttt{signature}\ s = \sigma\ \texttt{in}\ \delta$	
		|	$\texttt{module}\ m{:}_{\mu}s = \mu\ \texttt{in}\ \delta$	
		|	$\texttt{functor something} = \texttt{something in}\ \delta$	
		|	$\mu.lab$	module term projection
signature kind	ξ	::=	$\texttt{SSigKind}(\sigma)$	
		|	$\texttt{SigKHole}$	
signature	σ	::=	s	signature variable
		|	$\{sdecs\}$	structure signature
		|	$\Pi_{m:_{\mu}\sigma_1}.\sigma_2$	functor signature
		|	$(\!\|\!)$	empty signature hole
		|	$(\!\|s\|\!)$	nonempty signature hole
module	μ	::=	m	module variable
		|	$\{sbnds\}$	structure
		|	$\lambda m{:}_{\mu}\sigma.\mu$	functor
		|	$\mu_1\ \mu_2$	functor application
		|	$\mu.lab$	submodule projection
		|	$(\!\|\!)$	empty module hole
		|	$(\!\|\mu\|\!)$	nonempty module hole
signature declarations	$sdecs$	::=	$\cdot$	
		|	$sdec, sdecs$	
signature declaration	$sdec$	::=	$\texttt{type}\ lab$	
		|	$\texttt{type}\ lab = \tau$	
		|	$\texttt{val}\ lab{:}\tau$	
		|	$\texttt{module}\ lab{:}_{\mu}\sigma$	
		|	$\texttt{functor}\ lab{:}_{\mu}\sigma$	
structure bindings	$sbnds$	::=	$\cdot$	
		|	$sbnd, sbnds$	
structure binding	$sbnd$	::=	$\texttt{type}\ t = \tau$	
		|	$\texttt{let}\ x{:}\tau = \delta$	
		|	$\texttt{module}\ m = \mu$	
		|	$\texttt{module}\ m{:}_{\mu}s = \mu$	

$| \quad \texttt{functor}\ m{:}_\mu s = \mu$

contexts

$\Delta, ?; \Gamma, x{:}\tau; \Phi, t{::}\kappa; \Xi, m{:}_\mu\sigma; \Psi, s{::}_\sigma\xi$

statics

scratch

$\boxed{\Delta; \Phi \vdash \kappa_1 \lesssim \kappa_2}$ κ_1 is a consistent subkind of κ_2

$$\texttt{KCSubsumption}\quad \frac{test}{test}$$

$\boxed{\Delta; \Phi; \Xi; \Psi \vdash \xi_1 \lesssim_\xi \xi_2}$ ξ_1 is a consistent sub signature kind of ξ_2

$$\texttt{nameMe}\quad \frac{\exists sdec_x \in sdecs_1 \ \textit{st}\ \Delta; \Phi; \Xi; \Psi \vdash \texttt{SSigKind}(\{sdec_x\}) \lesssim_\xi \texttt{SSigKind}(\{sdec_2\}) \quad \Delta; \Phi, \mathsf{type}(\Delta; \Phi; \Xi; \Psi, sdec_2); \Xi, \mathsf{submodule}(sdec_2); \Psi \vdash \{sdecs_1\} \lesssim_\xi \{sdecs_2\}}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{SSigKind}(\{sdec_{11}, sdec_{12}, sdecs_{13}\ \texttt{as}\ sdecs_1\}) \lesssim_\xi \texttt{SSigKind}(\{sdec_2, sdecs_2\})}$$

$$\texttt{single}\quad \frac{\Delta; \Phi; \Xi; \Psi \vdash sdec_1 \leq_{sdec} sdec_2}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{SSigKind}(\{sdec_1\}) \lesssim_\xi \texttt{SSigKind}(\{sdec_2\})}$$

$$\texttt{nil}\quad \frac{}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{SSigKind}(\{sdecs\}) \lesssim_\xi \texttt{SSigKind}(\{\cdot\})}$$

$$\texttt{varprop}\quad \frac{s{::}_\sigma\xi \in \Psi}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{SSigKind}(s) \lesssim_\xi \xi}$$

$$\texttt{nameMe?delete?}\quad \frac{\sigma_1 \neq s \qquad \Delta; \Phi; \Xi; \Psi \vdash \sigma_1 \Leftarrow \texttt{SSigKind}(\sigma_2)}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{SSigKind}(\sigma_1) \lesssim_\xi \texttt{SSigKind}(\sigma_2)}$$

$$\texttt{funct}\quad \frac{\Delta; \Phi; \Xi; \Psi \vdash \texttt{SSigKind}(\sigma_{21}) \lesssim_\xi \texttt{SSigKind}(\sigma_{11}) \qquad \Delta; \Phi; \Xi, m{:}_\mu\sigma_{11}; \Psi \vdash \texttt{SSigKind}(\sigma_{12}) \lesssim_\xi \texttt{SSigKind}(\sigma_{22})}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{SSigKind}(\Pi_{m{:}_\mu\sigma_{11}}.\sigma_{12}) \lesssim_\xi \texttt{SSigKind}(\Pi_{m{:}_\mu\sigma_{21}}.\sigma_{22})}$$

$$\texttt{holes}\quad \frac{\Delta; \Phi; \Xi; \Psi \vdash (\!|\!)^{\mathtt{u}} \Leftarrow \xi}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{SSigKind}((\!|\!)^{\mathtt{u}}) \lesssim_\xi \xi}$$

$$\texttt{neholes}\quad \frac{\Delta; \Phi; \Xi; \Psi \vdash (\!|\mathsf{s}|\!)^{\mathtt{u}} \Leftarrow \xi}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{SSigKind}((\!|\mathsf{s}|\!)^{\mathtt{u}}) \lesssim_\xi \xi}$$

$$\texttt{CSubSigKindHoleL}\quad \frac{}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{SigKHole} \lesssim_\xi \xi}$$

$$\texttt{CSubSigKindHoleR}\quad \frac{}{\Delta; \Phi; \Xi; \Psi \vdash \xi \lesssim_\xi \texttt{SigKHole}}$$

$\boxed{\Delta; \Phi; \Xi; \Psi \vdash \sigma \Rightarrow \xi}$ σ synthesizes signature kind ξ

$$\texttt{SynSigKndVar}\quad \frac{s{::}_\sigma\xi \in \Psi}{\Delta; \Phi; \Xi; \Psi \vdash s \Rightarrow \texttt{SSigKind}(s)}$$

$$\texttt{SynSigKndVarFail}\quad \frac{s \notin \mathsf{dom}(\Psi)}{\Delta; \Phi; \Xi; \Psi \vdash s \Rightarrow \texttt{SigKHole}}$$

$$\frac{\{sdecs\}\ well formed?}{\vdash \{sdecs\} \Rightarrow \texttt{SSigKind}(\{sdecs\})}$$

$$\frac{\Delta; \Phi; \Xi, m{:}_\mu\sigma_1; \Psi \vdash \sigma_2 \Rightarrow \xi}{\Delta; \Phi; \Xi; \Psi \vdash \Pi_{m{:}_\mu\sigma_1}.\sigma_2 \Rightarrow \texttt{SSigKind}(\Pi_{m{:}_\mu\sigma_1}.\sigma_2)}$$

$$\texttt{SynSigKndSigHole}\quad \frac{u{::}_\sigma\xi \in \Delta}{\Delta; \Phi; \Xi; \Psi \vdash (\!|\!)^{\mathtt{u}} \Rightarrow \xi}$$

$$\texttt{SynSigKndSigHole}\quad \frac{u{::}_\sigma\xi \in \Delta \qquad \Delta; \Phi; \Xi; \Psi \vdash s \Rightarrow \xi_1}{\Delta; \Phi; \Xi; \Psi \vdash (\!|s|\!)^{\mathtt{u}} \Rightarrow \xi}$$

$\boxed{\Delta; \Phi; \Xi; \Psi \vdash \sigma \Leftarrow \xi}$ σ analyzes against signature kind ξ

$$\texttt{Sub}\quad \frac{\Delta; \Phi; \Xi; \Psi \vdash \sigma \Rightarrow \xi_1 \qquad \Delta; \Phi; \Xi; \Psi \vdash \xi_1 \lesssim_\xi \xi}{\Delta; \Phi; \Xi; \Psi \vdash \sigma \Leftarrow \xi}$$

$\boxed{\Delta; \Phi; \Xi; \Psi \vdash \mathit{sdec_1} \leq_{sdec} \mathit{sdec_2}}$ $\mathit{sdec_1}$ is a subsdec of $\mathit{sdec_2}$

singleType

$$\frac{}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{type}\ \mathit{lab} = \tau \leq_{sdec} \texttt{type}\ \mathit{lab}}$$

singleType2

$$\frac{\Delta; \Phi; \Xi; \Psi \vdash \tau_1 \equiv \tau_2}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{type}\ \mathit{lab} = \tau_1 \leq_{sdec} \texttt{type}\ \mathit{lab} = \tau_2}$$

singleType3

$$\frac{}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{type}\ \mathit{lab} \leq_{sdec} \texttt{type}\ \mathit{lab}}$$

singleVa

$$\frac{\Delta; \Phi; \Xi; \Psi \vdash \tau_1 \equiv \tau_2}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{val}\ \mathit{lab}{:}\tau_1 \leq_{sdec} \texttt{val}\ \mathit{lab}{:}\tau_2}$$

singleMod

$$\frac{\Delta; \Phi; \Xi; \Psi \vdash \sigma_1 \Leftarrow \texttt{SSigKind}(\sigma_2)}{\Delta; \Phi; \Xi; \Psi \vdash \texttt{module}\ \mathit{lab}{:}_{\mu}\sigma_1 \leq_{sdec} \texttt{module}\ \mathit{lab}{:}_{\mu}\sigma_2}$$

elab

$\boxed{\Gamma; \Phi; \Xi \vdash \hat{\delta} \Rightarrow \tau \rightsquigarrow \delta \dashv \Delta}$ $\hat{\delta}$ synthesizes type τ and elaborates to δ with hole context Δ

...

SynElabLetMod

$$\frac{\Gamma; \Phi; \Xi \vdash \hat{\mu} \Rightarrow \sigma \rightsquigarrow \mu \dashv \Delta_1 \qquad \Gamma; \Phi; \Xi, m{:}_{\mu}\sigma \vdash \hat{\delta} \Rightarrow \tau \rightsquigarrow \delta \dashv \Delta_2}{\Gamma; \Phi; \Xi \vdash \texttt{module}\ m = \hat{\mu}\ \texttt{in}\ \hat{\delta} \Rightarrow \tau \rightsquigarrow \texttt{module}\ m = \mu\ \texttt{in}\ \delta \dashv \Delta_1 \cup \Delta_2}$$

SynElabLetModAnn

$$\frac{\Phi; \Xi \vdash \hat{\sigma} \Rightarrow \xi \rightsquigarrow \sigma \dashv \Delta_1 \qquad \Gamma; \Phi; \Xi \vdash \hat{\mu} \Leftarrow \sigma \rightsquigarrow \mu \dashv \Delta_2 \qquad \Gamma; \Phi; \Xi, m{:}_{\mu}\sigma \vdash \hat{\delta} \Rightarrow \tau \rightsquigarrow \delta \dashv \Delta_3}{\Gamma; \Phi; \Xi \vdash \texttt{module}\ m{:}_{\mu}\hat{\sigma} = \hat{\mu}\ \texttt{in}\ \hat{\delta} \Rightarrow \tau \rightsquigarrow \texttt{module}\ m{:}_{\mu}\sigma = \mu\ \texttt{in}\ \delta \dashv \Delta_1 \cup \Delta_2 \cup \Delta_3}$$

SynElabModTermPrj

$$\frac{\Gamma; \Phi; \Xi \vdash \hat{\mu} \Rightarrow \sigma \rightsquigarrow \mu \dashv \Delta \qquad \Phi; \Xi \vdash \sigma \Rightarrow \xi}{\Gamma; \Phi; \Xi \vdash \hat{\mu}.\mathit{lab} \Rightarrow \tau \rightsquigarrow \mu.\mathit{lab} \dashv \Delta}$$

$\boxed{\Phi; \Xi \vdash \hat{\tau} \Rightarrow \kappa \rightsquigarrow \tau \dashv \Delta}$ $\hat{\tau}$ synthesizes kind κ and elaborates to τ with hole context Δ

...

SynElabModTypPrj

$$\frac{\Phi; \Xi \vdash m \Rightarrow \sigma \rightsquigarrow m \dashv \Delta \qquad \mathit{something}\sigma\kappa}{\Phi; \Xi \vdash m.\mathit{lab} \Rightarrow \kappa \rightsquigarrow m.\mathit{lab} \dashv \Delta}$$

$\boxed{\Phi; \Xi \vdash \hat{\tau} \Leftarrow \kappa \rightsquigarrow \tau \dashv \Delta}$ $\hat{\tau}$ analyzes against kind κ and elaborates to τ with hole context Δ

$\boxed{\Gamma; \Phi; \Xi \vdash \hat{\mu} \Rightarrow \sigma \rightsquigarrow \mu \dashv \Delta}$ $\hat{\mu}$ synthesizes signature σ and elaborates to μ with hole context Δ

SynElabModVar

$$\frac{m{:}_{\mu}\sigma \in \Xi}{\Gamma; \Phi; \Xi \vdash m \Rightarrow \sigma \rightsquigarrow m \dashv \cdot}$$

SynElabModVarFail

$$\frac{m \notin \mathsf{dom}(\Xi)}{\Gamma; \Phi; \Xi \vdash m \Rightarrow (\!|\!|\!) \rightsquigarrow (\!|m|\!)^{\mathtt{u}} \dashv u{:}_{\mu}(\!|\!|\!)}$$

SynElabConsStruct

$$\frac{\begin{array}{c}\Gamma; \Phi; \Xi \vdash \widehat{\mathit{sbnd}} \Rightarrow \mathit{sdec} \rightsquigarrow \mathit{sbnd} \dashv \Delta_1 \\ \Gamma, \mathsf{val}(\mathit{sdec}); \Phi, \mathsf{type}(\Delta_1; \Phi; \Xi; \Psi, \mathit{sdec}); \Xi, \mathsf{submodule}(\mathit{sdec}) \vdash \{\widehat{\mathit{sbnds}}\} \Rightarrow \{\mathit{sdecs}\} \rightsquigarrow \{\mathit{sbnds}\} \dashv \Delta_2\end{array}}{\Gamma; \Phi; \Xi \vdash \{\widehat{\mathit{sbnd}}, \widehat{\mathit{sbnds}}\} \Rightarrow \{\mathit{sdec}, \mathit{sdecs}\} \rightsquigarrow \{\mathit{sbnd}, \mathit{sbnds}\} \dashv \Delta_1 \cup \Delta_2}$$

SynElabNilStruct

$$\frac{}{\Gamma; \Phi; \Xi \vdash \{\cdot\} \Rightarrow \{\cdot\} \rightsquigarrow \{\cdot\} \dashv \cdot}$$

SynElabEmptyModHole

$$\frac{}{\Gamma; \Phi; \Xi \vdash (\!|\!|\!)^{\mathtt{u}} \Rightarrow (\!|\!|\!) \rightsquigarrow (\!|\!|\!)^{\mathtt{u}} \dashv u{:}_{\mu}(\!|\!|\!)}$$

SynElabNonemptyModHole

$$\frac{}{\Gamma; \Phi; \Xi \vdash (\!|m|\!)^{\mathtt{u}} \Rightarrow (\!|\!|\!) \rightsquigarrow (\!|m|\!)^{\mathtt{u}} \dashv u{:}_{\mu}(\!|\!|\!)}$$

functor stuff

$\boxed{\Gamma; \Phi; \Xi \vdash \hat{\mu} \Leftarrow \sigma \rightsquigarrow \mu \dashv \Delta}$ $\hat{\mu}$ analyzes against signature σ and elaborates to μ with hole context Δ

AnaElabModSubsumption

$$\frac{\Gamma; \Phi; \Xi \vdash \hat{\mu} \Rightarrow \sigma \rightsquigarrow \mu \dashv \Delta}{\Gamma; \Phi; \Xi \vdash \hat{\mu} \Leftarrow \sigma \rightsquigarrow \mu \dashv \Delta}$$

$\boxed{\Gamma;\Phi;\Xi \vdash \hat{sbnd} \;\Rightarrow\; sdec \rightsquigarrow sbnd \dashv \Delta}$ $\hat{sbnd}$ synthesizes declaration $sdec$ and elaborates to $sbnd$ with hole context Δ

SynElabTypeSbnd

$$\frac{\Phi;\Xi \vdash \hat{\tau} \;\Rightarrow\; \kappa \rightsquigarrow \tau \dashv \Delta}{\Gamma;\Phi;\Xi \vdash \texttt{type}\ t = \hat{\tau} \;\Rightarrow\; \texttt{type}\ t = \tau \rightsquigarrow \texttt{type}\ t = \tau \dashv \Delta}$$

SynElabValSbnd

$$\frac{\Phi;\Xi \vdash \hat{\tau} \;\Rightarrow\; \kappa \rightsquigarrow \tau \dashv \Delta_1 \qquad \Gamma;\Phi;\Xi \vdash \hat{\delta} \;\Leftarrow\; \tau \rightsquigarrow \delta \dashv \Delta_2}{\Gamma;\Phi;\Xi \vdash \texttt{let}\ x{:}\hat{\tau} = \hat{\delta} \;\Rightarrow\; \texttt{val}\ x{:}\tau \rightsquigarrow \texttt{let}\ x{:}\tau = \delta \dashv \Delta_1 \cup \Delta_2}$$

SynElabModSbnd

$$\frac{\Gamma;\Phi;\Xi \vdash \hat{\mu} \;\Rightarrow\; \sigma \rightsquigarrow \mu \dashv \Delta}{\Gamma;\Phi;\Xi \vdash \texttt{module}\ m = \hat{\mu} \;\Rightarrow\; \texttt{module}\ m{:}_{\mu}\sigma \rightsquigarrow \texttt{module}\ m{:}_{\mu}\sigma = \mu \dashv \Delta}$$

SynElabModAnnSbnd

$$\frac{\Phi;\Xi \vdash \hat{\sigma} \;\Rightarrow\; \xi \rightsquigarrow \sigma_1 \dashv \Delta_1 \qquad \Gamma;\Phi;\Xi \vdash \hat{\mu} \;\Rightarrow\; \sigma_2 \rightsquigarrow \mu \dashv \Delta_2 \qquad \Phi;\Xi;\Psi \vdash \sigma_2 \;\Leftarrow\; \xi}{\Gamma;\Phi;\Xi \vdash \texttt{module}\ m{:}_{\mu}\hat{\sigma} = \hat{\mu} \;\Rightarrow\; \texttt{module}\ m{:}_{\mu}\sigma_1 \rightsquigarrow \texttt{module}\ m{:}_{\mu}\sigma_1 = \mu \dashv \Delta_1 \cup \Delta_2}$$

$\boxed{\Gamma;\Phi;\Xi \vdash \hat{sbnd} \;\Leftarrow\; sdec \rightsquigarrow sbnd \dashv \Delta}$ $\hat{sbnd}$ analyzes against declaration $sdec$ and elaborates to $sbnd$ with hole context Δ

subsump

$$\frac{\Gamma;\Phi;\Xi;l\Psi \vdash \hat{sbnd} \;\Rightarrow\; sdec_1 \rightsquigarrow sbnd \dashv \Delta \qquad \Delta;\Phi;\Xi;\Psi \vdash sdec_1 \leq_{sdec} sdec}{\Gamma;\Phi;\Xi;\Psi \vdash \hat{sbnd} \;\Leftarrow\; sdec \rightsquigarrow sbnd \dashv \Delta}$$

$\boxed{\Gamma;\Phi;\Xi;\Psi \vdash \hat{sdec} \rightsquigarrow sdec \dashv \Delta}$ $\hat{sdec}$ elaborates to $sdec$ with hole context Δ

opq

$$\frac{}{\Gamma;\Phi;\Xi;\Psi \vdash \texttt{type}\ lab \rightsquigarrow \texttt{type}\ lab \dashv \cdot}$$

trn

$$\frac{\Gamma;\Phi;\Xi;\Psi \vdash \hat{\tau} \;\Rightarrow\; \kappa \rightsquigarrow \tau \dashv \Delta}{\Gamma;\Phi;\Xi;\Psi \vdash \texttt{type}\ lab = \hat{\tau} \rightsquigarrow \texttt{type}\ lab = \tau \dashv \Delta}$$

val

$$\frac{\Gamma;\Phi;\Xi;\Psi \vdash \hat{\tau} \;\Rightarrow\; \kappa \rightsquigarrow \tau \dashv \Delta}{\Gamma;\Phi;\Xi;\Psi \vdash \texttt{val}\ lab{:}\hat{\tau} \rightsquigarrow \texttt{val}\ lab{:}\tau \dashv \Delta}$$

mod

$$\frac{\Gamma;\Phi;\Xi;\Psi \vdash \hat{\sigma} \;\Rightarrow\; \xi \rightsquigarrow \sigma \dashv \Delta}{\Gamma;\Phi;\Xi;\Psi \vdash \texttt{module}\ lab{:}_{\mu}\hat{\sigma} \rightsquigarrow \texttt{module}\ lab{:}_{\mu}\sigma \dashv \Delta}$$

`we're going to need HOFunctors so we don't need to preclude users from typing a functor into a module and vice versa`

$\boxed{\Phi;\Xi;\Psi \vdash \hat{\sigma} \;\Rightarrow\; \xi \rightsquigarrow \sigma \dashv \Delta}$ $\hat{\sigma}$ synthesizes signature kind ξ and elaborates to σ with hole context Δ

SynSigEmptyHole

$$\frac{}{\Phi;\Xi;\Psi \vdash (\!|\,|\!)^{u} \;\Rightarrow\; \texttt{SigKHole} \rightsquigarrow (\!|\,|\!)^{u} \dashv u{::}_{\sigma}\texttt{SigKHole}}$$

SynSigNonEmptyHole

$\boxed{\Phi;\Xi \vdash \hat{\sigma} \;\Leftarrow\; \xi \rightsquigarrow \sigma \dashv \Delta}$ $\hat{\sigma}$ analyzes against signature kind ξ and elaborates to σ with hole context Δ

misc

$$\mathsf{val}(sdec) = \begin{cases} lab{:}\tau & sdec = \texttt{val}\ lab{:}\tau \\ \cdot & \text{otherwise} \end{cases}$$

$$\mathsf{type}(cntxts, sdec) = \begin{cases} lab{::}\texttt{Type} & sdec = \texttt{type}\ lab \\ lab{::}\kappa & sdec = \texttt{type}\ lab = \tau \\ & \text{where } cntxts \vdash \tau \;\Rightarrow\; \kappa \\ \cdot & \text{otherwise} \end{cases}$$

$$\mathsf{submodule}(sdec) = \begin{cases} lab{:}_{\mu}\sigma & sdec = \texttt{module}\ lab{:}_{\mu}\sigma \\ \cdot & \text{otherwise} \end{cases}$$