Hazel PHI: 10-modules

June 17, 2021

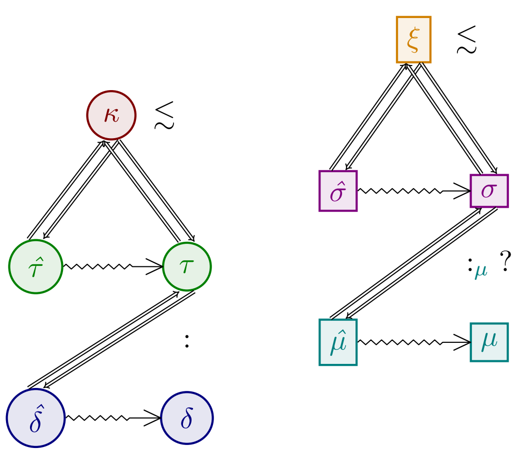
prerequisites

- 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	temperment
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	::=	$\texttt{Type}$	kind of types
		|	$\texttt{S}(\tau)$	singleton kind
		|	$\texttt{KHole}$	kind hole
		|	$\Pi_{t::\kappa_1}.\kappa_2$	dependent function kind

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

structure bindings	$sbnds$	::=	$\cdot$
		|	$sbnd, sbnds$
structure binding	$sbnd$	::=	$\texttt{type}\ t = \tau$
		|	$\texttt{let}\ x{:}\tau = \delta$
		|	$\texttt{module}\ m = \mu$
		|	$\texttt{module}\ m{:}_{\mu} s = \mu$
		|	$\texttt{functor}\ m{:}_{\mu} s = \mu$

contexts

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

statics

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

KCSubsumption

$$\frac{test}{test}$$

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

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

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

...

SynElabModTypPrj

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

$\boxed{\Phi; \Xi \vdash \hat{\tau} \Leftarrow \kappa \rightsquigarrow \tau \dashv \Delta}$ $\hat{\tau}$ 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

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

SynElabConsStruct

$$\frac{\Gamma;\Phi;\Xi \vdash \hat{sbnd} \Rightarrow sdec \rightsquigarrow sbnd \dashv \Delta_1 \qquad \Gamma, \mathsf{val}(sdec);\Phi, \mathsf{type}(sdec);\Xi, \mathsf{submodule}(sdec) \vdash \{\hat{sbnds}\} \Rightarrow \{sdecs\} \rightsquigarrow \{sbnds\} \dashv \Delta_2}{\Gamma;\Phi;\Xi \vdash \{\hat{sbnd}, \hat{sbnds}\} \Rightarrow \{sdec, sdecs\} \rightsquigarrow \{sbnd, sbnds\} \dashv \Delta_1 \cup \Delta_2}$$

SynElabNilStruct

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

SynElabEmptyModHole

$$\frac{}{\Gamma;\Phi;\Xi \vdash \llparenthesis\rrparenthesis^{u} \Rightarrow \llparenthesis\rrparenthesis \rightsquigarrow \llparenthesis\rrparenthesis^{u} \dashv u{:}_{\mu}\llparenthesis\rrparenthesis}$$

SynElabNonemptyModHole

$$\frac{}{\Gamma;\Phi;\Xi \vdash \llparenthesis m \rrparenthesis^{u} \Rightarrow \llparenthesis\rrparenthesis \rightsquigarrow \llparenthesis m \rrparenthesis^{u} \dashv u{:}_{\mu}\llparenthesis\rrparenthesis}$$

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

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

SynElabValSbnd

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

SynElabModSbnd

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

SynElabModAnnSbnd

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

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

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

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

`misc`

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

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

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