Introduction to Vinyl

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Records in GHC 7.8

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```
data R = R { x :: X }
data R' = R' { x :: X } -- ^ Error
```

Structural Typing

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- Sharing field names and accessors
- Record types may be characterized *structurally*

Row Polymorphism

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$$\frac{x : \{foo : A; \vec{rs}\}}{f(x) : \{foo : A, bar : B; \vec{rs}\}}$$

Roll Your Own in Haskell

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  (:&) :: !t → !(Rec rs) → Rec ((s ::: t) ': rs)
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class s ∈ (rs :: [∗])
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class s ∈ (rs :: [∗])
class ss ⊆ (rs :: [∗]) where
  cast :: Rec rs → Rec ss
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(=:) : s ::: t → t → Rec '[s ::: t]
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lens : s ::: t ∈ rs ⇒ s ::: t → Lens' (Rec rs) t
```

Roll Your Own in Haskell

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```
f :: Rec ("foo" ::: A ': rs)
   → Rec ("bar" ::: B ': "foo" ::: A ': rs)
```

Universes à la Tarski

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$$\frac{\Gamma \vdash s : \mathcal{U}}{\Gamma \vdash El_{\mathcal{U}}(s) : \text{Type}}$$

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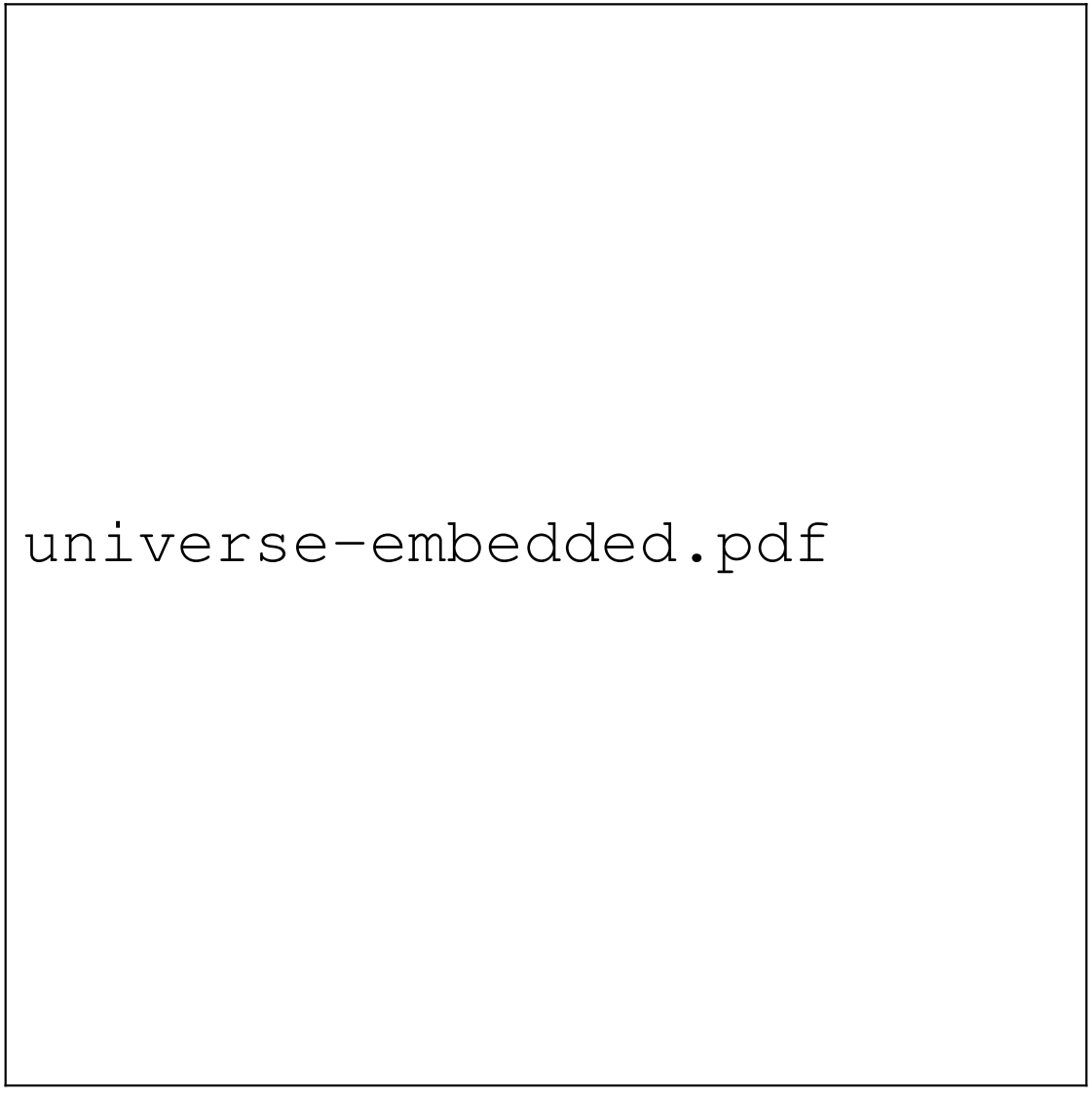

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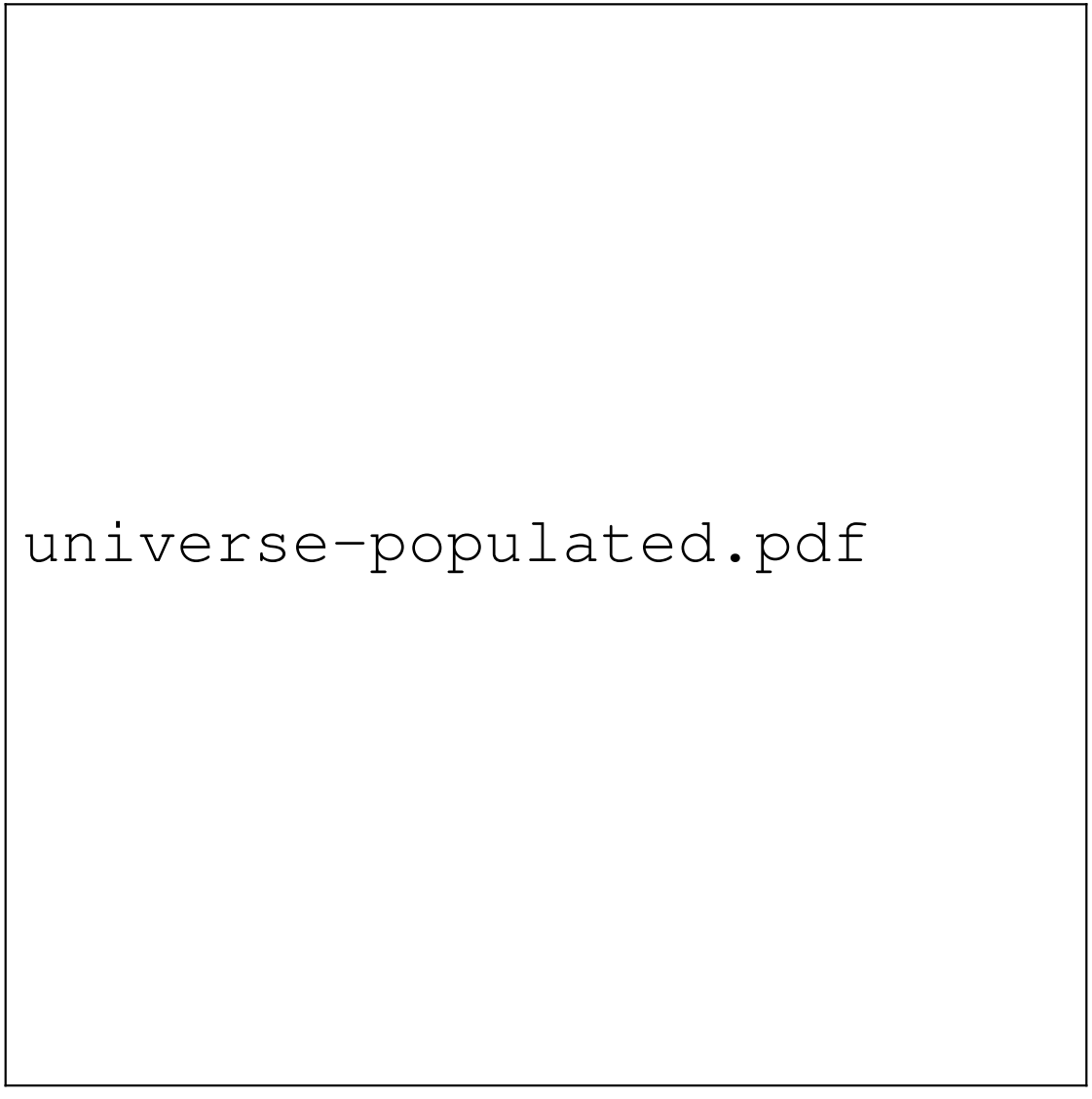

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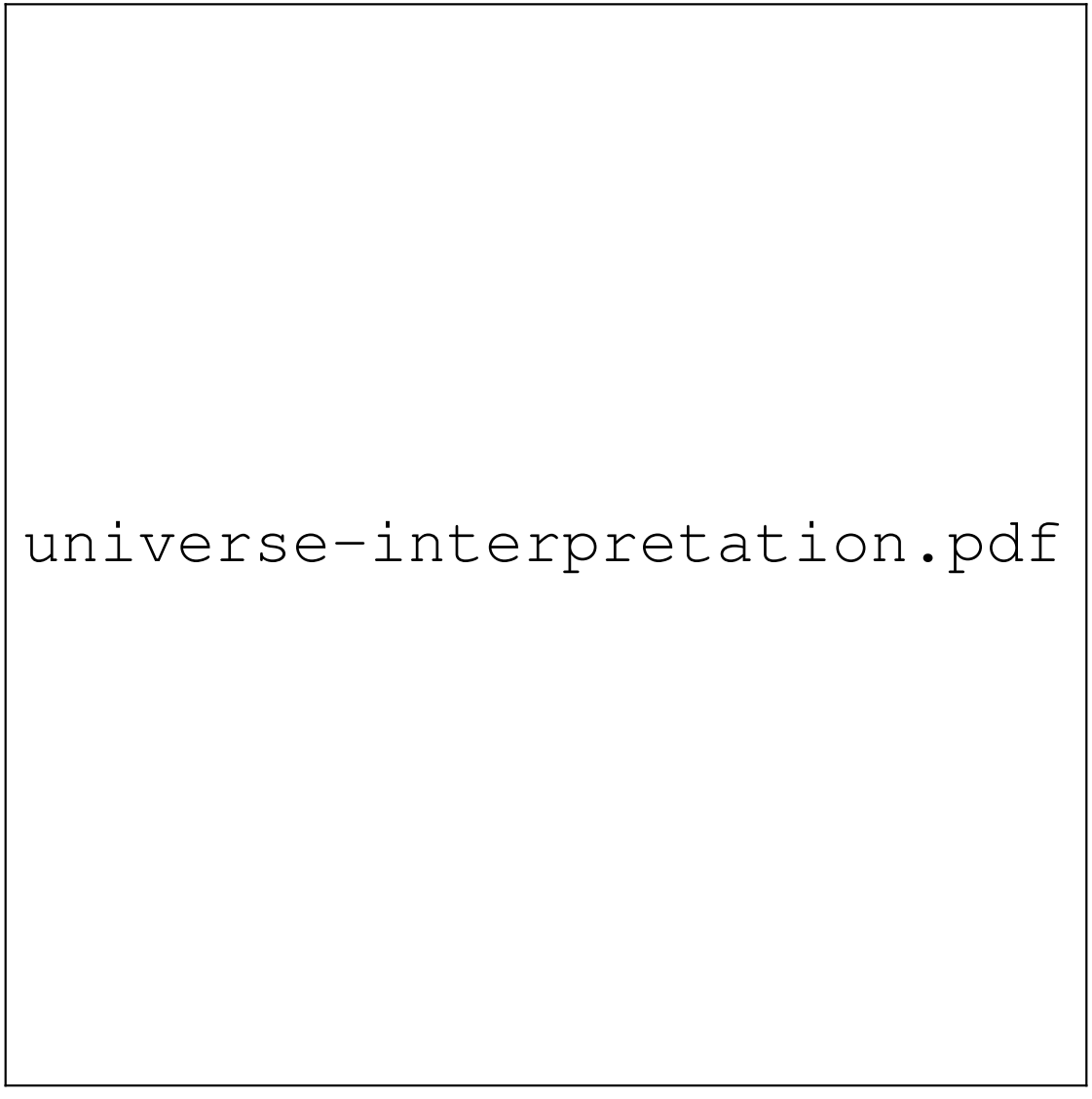

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data TyFun :: * → * → *
type family (f :: TyFun k l → *) $ (x :: k) :: l

data Rec :: (TyFun 𝒰 * → *) → [ 𝒰 ] → * where
  RNil :: Rec el𝒰 '[]
  (:&) :: !(el𝒰 $ r) → !(Rec el𝒰 rs) → Rec el𝒰 (r ': rs)
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data Id :: (TyFun k k) → ∗ where
type instance Id $ x = x

type HList rs = Rec Id rs

ex :: HList [ℤ, Bool, String]
ex = 34 :& True :& ”vinyl” :& RNil
```

Validating Records

bob :: Rec $\mathrm{El}_{\mathcal{A}}$ [Name, Email Work]

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validateName :: **String** $\rightarrow$ **Either** Error **String**
validateEmail :: **String** $\rightarrow$ **Either** Error **String**
validatePhone :: [$\mathbb{N}$] $\rightarrow$ **Either** Error [$\mathbb{N}$]

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unnnnnhhh...

validateContact
:: Rec El$_{\mathcal{A}}$ [Name, Email Work]
$\rightarrow$ **Either** Error (Rec El$_{\mathcal{A}}$ [Name, Email Work])

Welp.

Effects inside records

data Rec :: (TyFun $\mathcal{U}$ $*$ $\rightarrow$ $*$) $\rightarrow$ [$\mathcal{U}$] $\rightarrow$ $*$ **where**
  RNil :: Rec el$_{\mathcal{U}}$ '[]
  (:&) :: !(el$_{\mathcal{U}}$ $ r) $\rightarrow$!(Rec el$_{\mathcal{U}}$ rs) $\rightarrow$ Rec el$_{\mathcal{U}}$ (r ': rs)

Effects inside records

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data Rec :: (TyFun 𝒰 ∗ → ∗) → (∗ → ∗) → [ 𝒰 ] → ∗ where
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Effects inside records

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(=:) : Applicative f ⇒ sing r → el_𝒰 $ r → Rec el_𝒰 f '[r]
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(⇚): sing r → f (el_𝒰 $ r) → Rec el_𝒰 f '[r]
k ⇚ x = x :& RNil
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Compositional Validation

type $\mathsf{Rec}_{\mathcal{A}} = \mathsf{Rec}\ \mathsf{El}_{\mathcal{A}}$

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bob :: $\text{Rec}_{\mathcal{A}}$ Identity [Name, Email Work]

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validateName :: $\text{Rec}_{\mathcal{A}}$ Validator '[Name]
validatePhone :: $\forall \ell$. $\text{Rec}_{\mathcal{A}}$ Validator '[Phone ℓ]
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type TotalContact =
  [Name, Email Home, Email Work
  , Phone Home, Phone Work]

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  , Phone Home, Phone Work]

validateContact :: $\text{Rec}_{\mathcal{A}}$ Validator TotalContact
validateContact = validateName
  $\oplus$ validateEmail
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rdist :: Applicative f $\Rightarrow$ $\text{Rec}_{\mathcal{U}}$ f rs $\rightarrow$ f ($\text{Rec}_{\mathcal{U}}$ Identity rs)

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validateContact :: $\text{Rec}_{\mathcal{A}}$ Validator TotalContact

bobValid :: $\text{Rec}_{\mathcal{A}}$ (**Either** Error) [Name, Email Work]

Compositional Validation

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newtype Lift o f g x = Lift { runLift :: f x `o` g x }
type Validator = Lift (→) Identity (Either Error)
(⊛) :: Rec_U (Lift (→) f g) rs → Rec_U f rs → Rec_U g rs
rdist :: Applicative f ⇒ Rec_U f rs → f (Rec_U Identity rs)

validateContact :: Rec_A Validator TotalContact

bobValid :: Rec_A (Either Error) [Name, Email Work]
bobValid = cast validateContact ⊛ bob
```

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validBob :: **Either** Error ($\mathrm{Rec}_{\mathcal{A}}$ Identity [Name, Email Work])

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```

Demonstration