DerivingVia

or, How to Turn Hand-Written Instances into an Anti-Pattern

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St. Louis, MO

```haskell
newtype Pair = Pair (Int, Int)
```

```
newtype Pair = Pair (Int, Int)

instance Monoid Pair where
  mempty = Pair (0, 1)
  mappend (Pair x1 y1)
          (Pair x2 y2)
    = Pair (x1 + x2) (y1 * y2)
```

```haskell
newtype Pair = Pair (Int, Int)
  deriving Monoid
  via (Sum Int, Product Int)
```

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Use deriveVia #511

Merged **phadej** merged 2 commits into `master` from `derive-via` on Feb 15

Conversation 0 | Commits 2 | Checks 0 | Files changed 65 | +657 −1,048

phadej commented on Feb 13 **Member**

No description provided.

phadej added some commits on Feb 13

`Use deriveVia` ✗ `096ebe3`

`Remove GHC-8.0.2 job` ✗ `22e3a96`

Reviewers

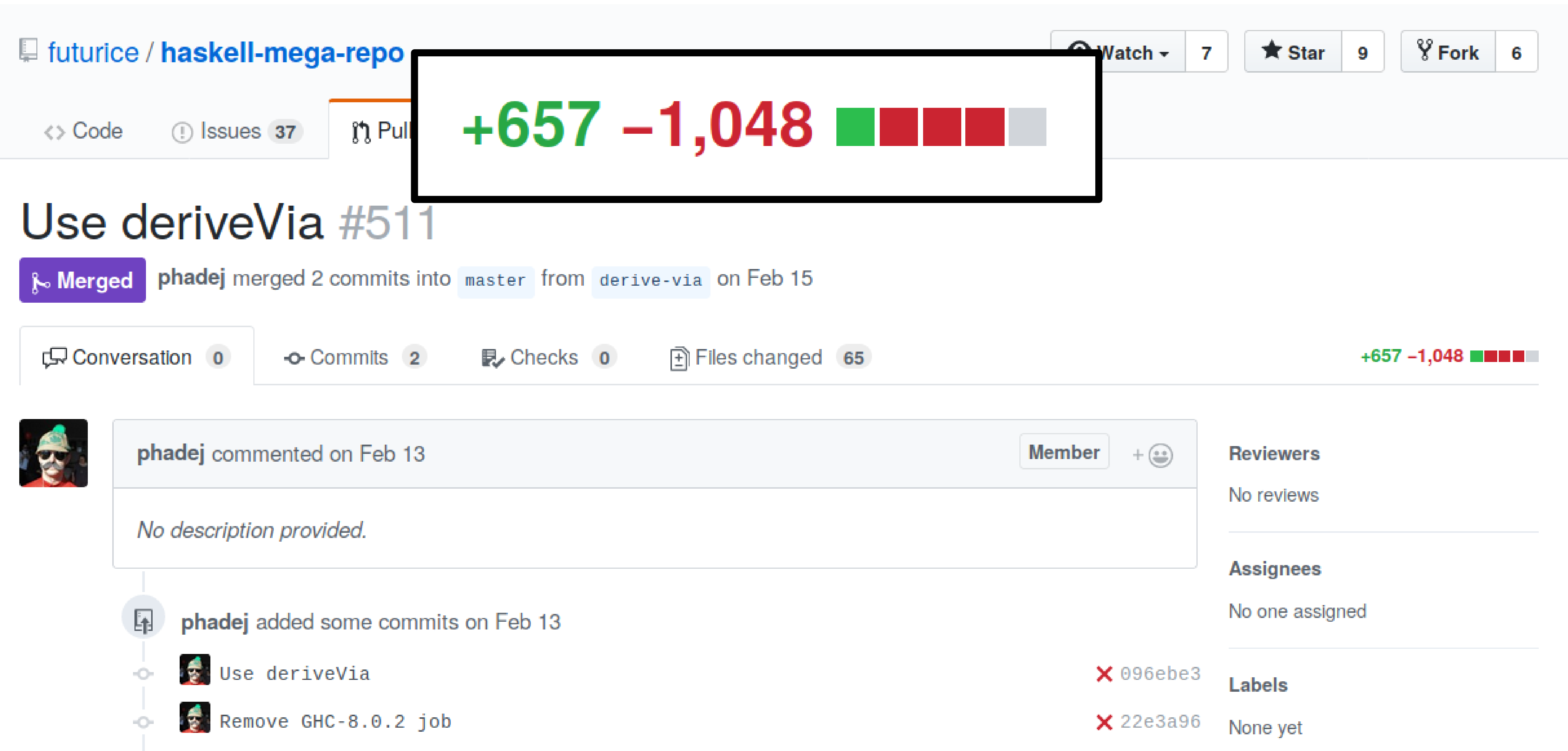
No reviews

Assignees

No one assigned

Labels

None yet


futurice / haskell-mega-repo
Watch 7
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Use deriveVia #511
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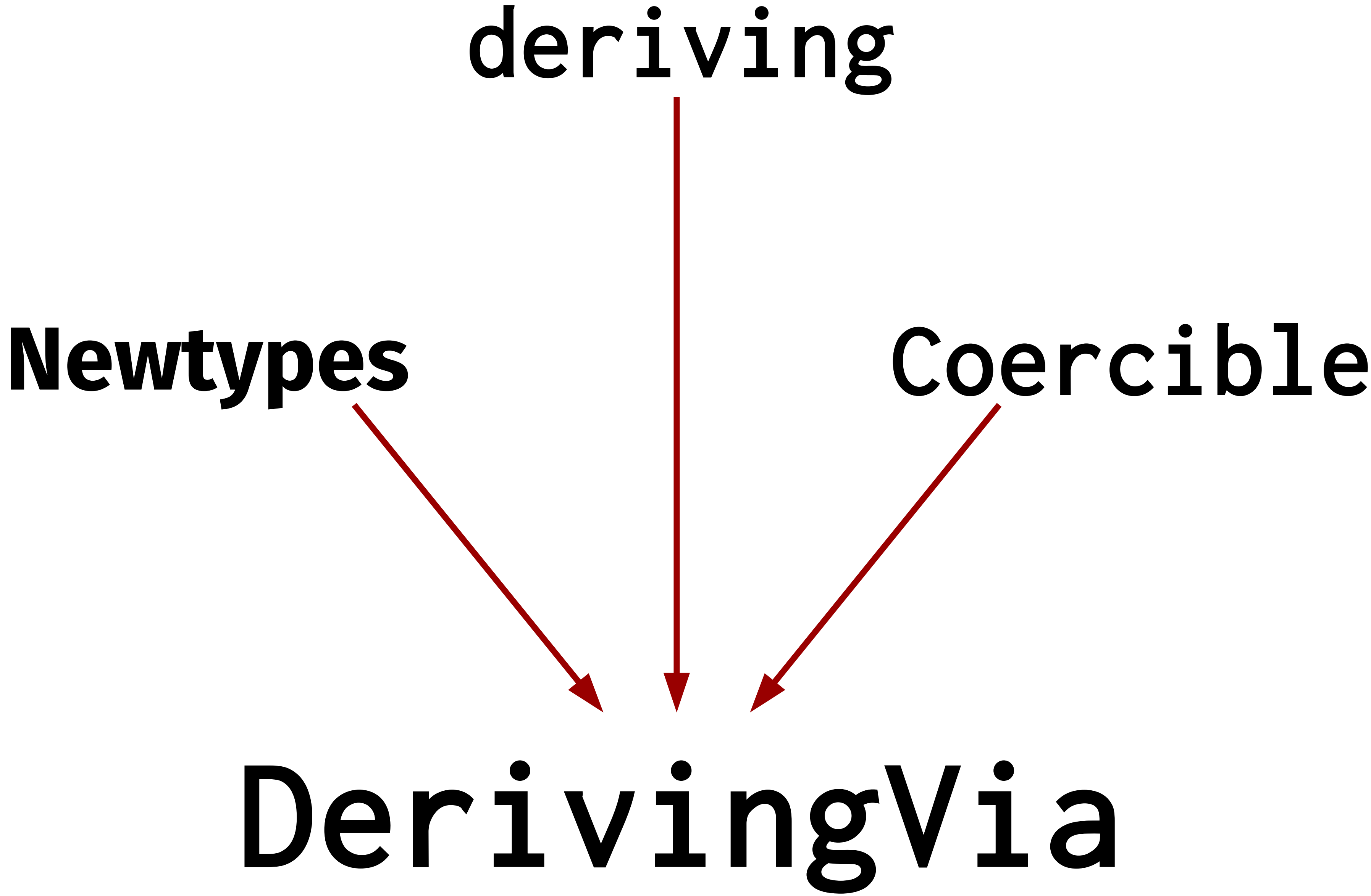
deriving
Newtypes
Coercible
DerivingVia

deriving

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```
deriving ( Eq, Ord, Read, Show, ... )
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{-# LANGUAGE DeriveDataTypeable #-}
{-# LANGUAGE DeriveGeneric #-}
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{-# LANGUAGE DerivingStrategies #-}
```

```haskell
class Monoid a where
  mempty  :: a
  mappend :: a -> a -> a

class Applicative f where
  pure   :: a -> f a
  liftA2 :: (a -> b -> c) -> f a -> f b -> f c
```

```haskell
instance Monoid a
    => Monoid (IO a) where
  mempty  = pure   mempty
  mappend = liftA2 mappend
```

```haskell
instance Monoid a
    => Monoid (ST s a) where
  mempty  = pure   mempty
  mappend = liftA2 mappend
```

```haskell
instance Monoid b
    => Monoid (a -> b) where
  mempty  = pure   mempty
  mappend = liftA2 mappend
```

```haskell
instance (Monoid a, Monoid b)
    => Monoid (a, b) where
  mempty  = pure    mempty
  mappend = liftA2 mappend
```

```haskell
instance (Applicative f, Monoid a)
    => Monoid (f a) where
  mempty  = pure   mempty
  mappend = liftA2 mappend
```

```haskell
instance (Applicative f, Monoid a)
    => Monoid (f a) where
  mempty  = pure    mempty
  mappend = liftA2 mappend

instance Alternative f
    => Monoid (f a) where
  mempty  = empty
  mappend = (<|>)
```

```haskell
instance (Applicative f, Monoid a)
    => Monoid (f a) where
  mempty = pure mempty
  mappend = liftA2 mappend

instance Alternative f
    => Monoid (f a) where
  mempty = empty
  mappend = (<|>)
```

```haskell
newtype Ap f a = Ap { getAp :: f a }
```

```haskell
newtype Ap f a = Ap { getAp :: f a }

instance (Applicative f, Monoid a)
    => Monoid (Ap f a) where
  mempty = Ap (pure mempty)
  mappend (Ap fa) (Ap fb)
    = Ap (liftA2 mappend fa fb)
```

```haskell
instance Monoid a
    => Monoid (IO a) where
  mempty =    pure mempty
  mappend p1 p2
    = liftA2 mappend     p1    p2
```

```haskell
instance Monoid a
    => Monoid (IO a) where
  mempty = getAp (mempty :: Ap IO a)
  mappend p1 p2
    = getAp (mappend (Ap p1) (Ap p2)
                 :: Ap IO a)
```

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instance Monoid a
    => Monoid (IO a) where
  mempty = getAp (mempty :: Ap IO a)
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```

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data IO a = ...
  deriving Monoid via (Ap IO a)
```

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                          :: Ap IO a)

data IO a = ...
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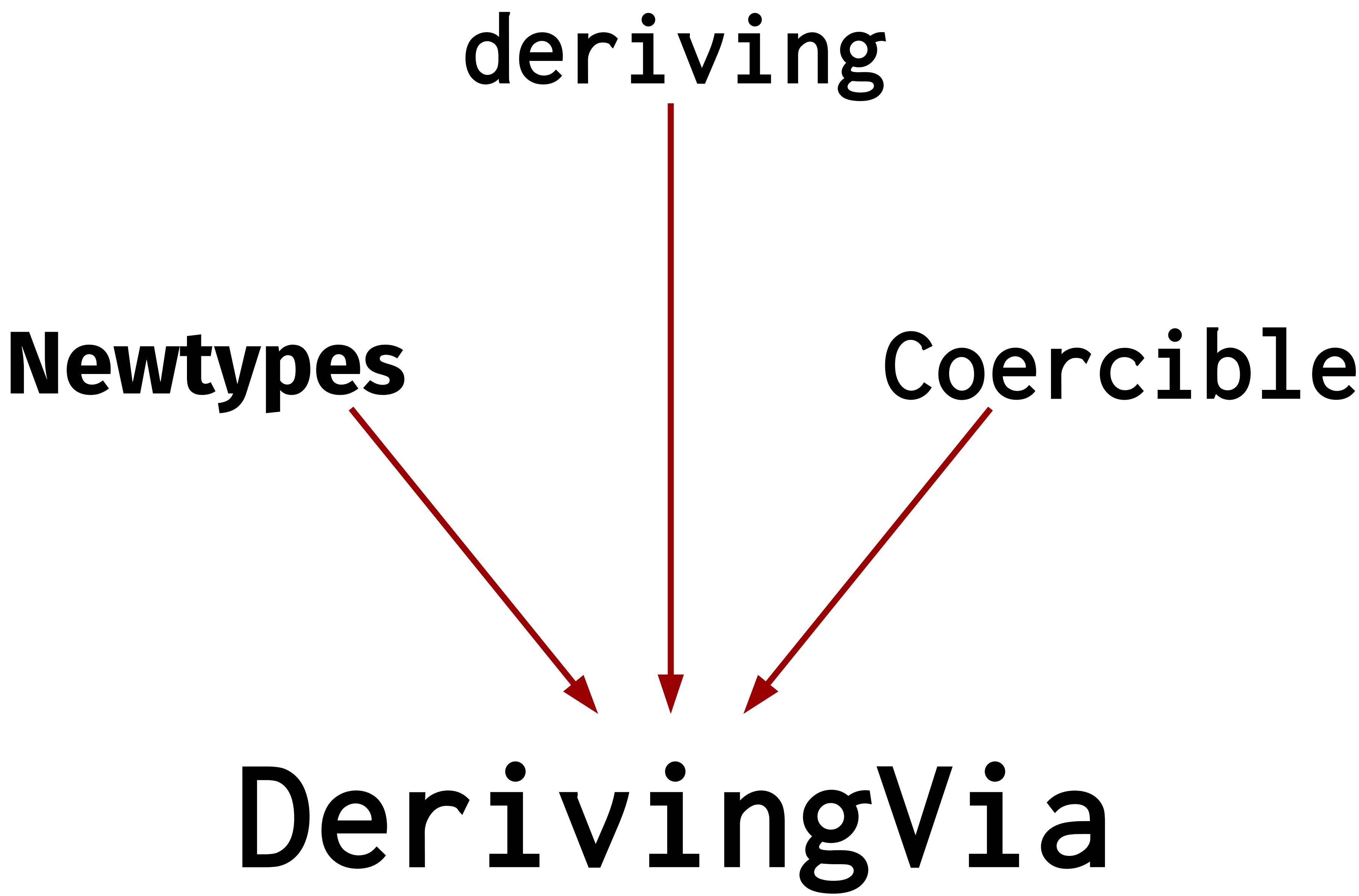
???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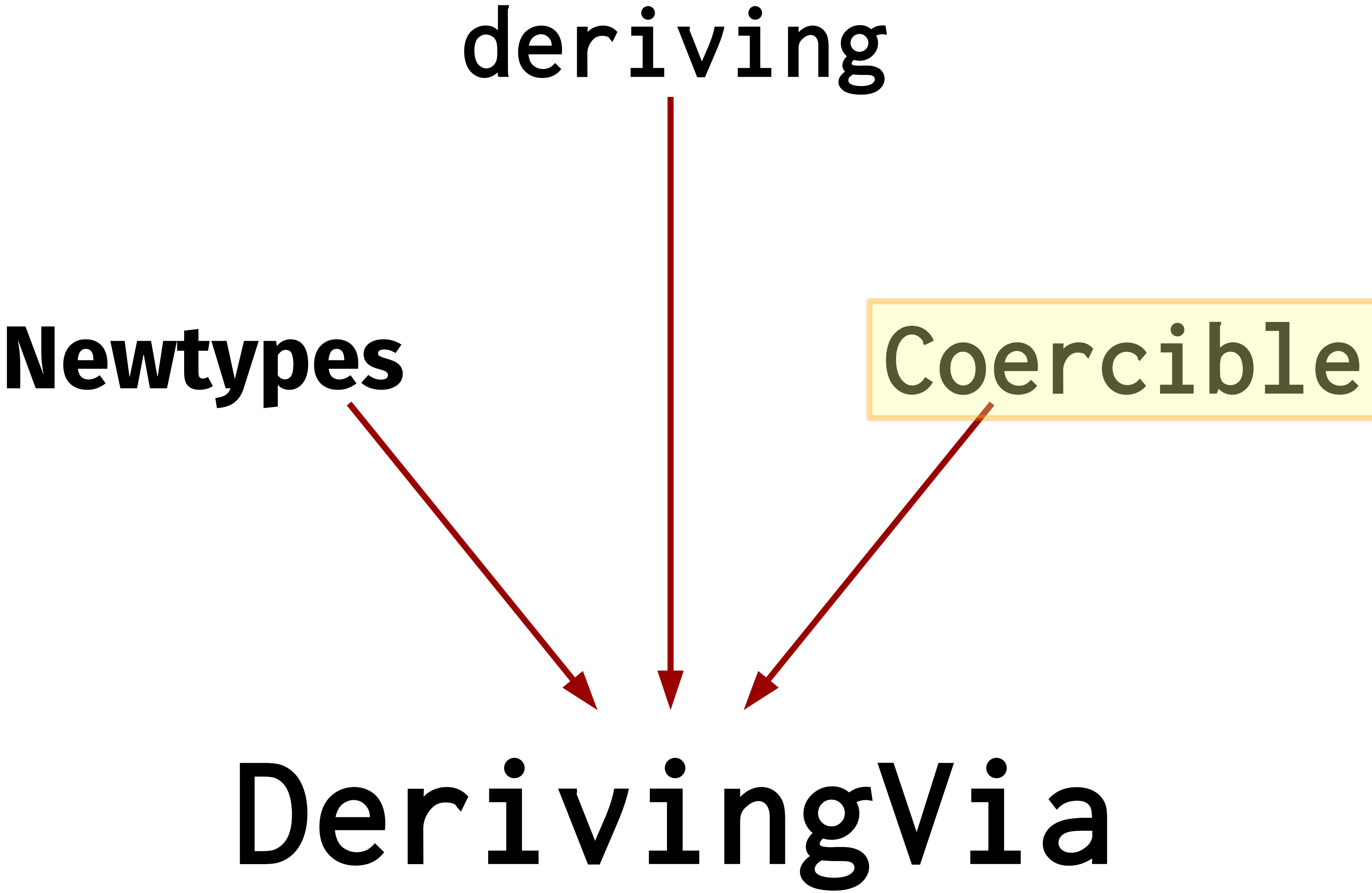
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Safe Zero-cost Coercions for Haskell

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Abstract

Generative type abstractions – present in Haskell, OCaml, and other languages – are useful concepts to help prevent programmer errors. They serve to create new types that are distinct at compile time but share a run-time representation with some base type. We present a new mechanism that allows for zero-cost conversions between generative type abstractions and their representations, even when such types are deeply nested. We prove type safety in the presence of these conversions and have implemented our work in GHC.

Categories and Subject Descriptors D.3.3 [*Programming Languages*]: Language Constructs and Features—abstract data types; F.3.3 [*Logics and Meanings of Programs*]: Studies of Program Constructs—Type structure

Keywords Haskell; Coercion; Type class; Newtype deriving

```
module Html( HTML, text, unMk, ... ) where
  newtype HTML = Mk String
  unMk :: HTML → String
  unMk (Mk s) = s
  text :: String → HTML
  text s = Mk (escapeSpecialCharacters s)
```

Figure 1. An abstraction for HTML values

String will not be accepted by a function expecting an HTML. The constructor Mk converts a String to an HTML (see function text), while using Mk in a pattern converts in the other direction (see function unMk). By exporting the type HTML, but not its data constructor, module Html ensures that the type HTML is *abstract* – clients cannot make arbitrary strings into HTML – and thereby prevent cross-site scripting attacks.

`Coercible`

Special constraint witnessing the fact that two types have the same **runtime representation**.

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Driving force: newtypes

```
newtype Age = MkAge Int
```

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```
newtype Age = MkAge Int

instance Coercible Age Int
instance Coercible Int Age
```

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Special constraint witnessing the fact that two types have the same **runtime representation**.

Driving force: newtypes

```
newtype Age = MkAge Int

instance Coercible (Age -> Bool) (Int -> Bool)
instance Coercible (Int -> Bool) (Age -> Bool)
```

```haskell
coerce :: Coercible a b => a -> b
```

```
coerce :: Coercible a b => a -> b
unsafeCoerce            :: a -> b
```

coerce :: Coercible a b => a -> b

```haskell
newtype Age = MkAge Int

succInt :: Int -> Int
succInt i = i + 1

succAge :: Age -> Age
succAge (MkAge i) = Age (succInt i)
```

```haskell
coerce :: Coercible a b => a -> b
```

```haskell
newtype Age = MkAge Int

succInt :: Int -> Int
succInt i = i + 1

succAge :: Age -> Age
succAge = coerce succInt
```

```haskell
data IO a = ...
  deriving Monoid via (Ap IO a)
```

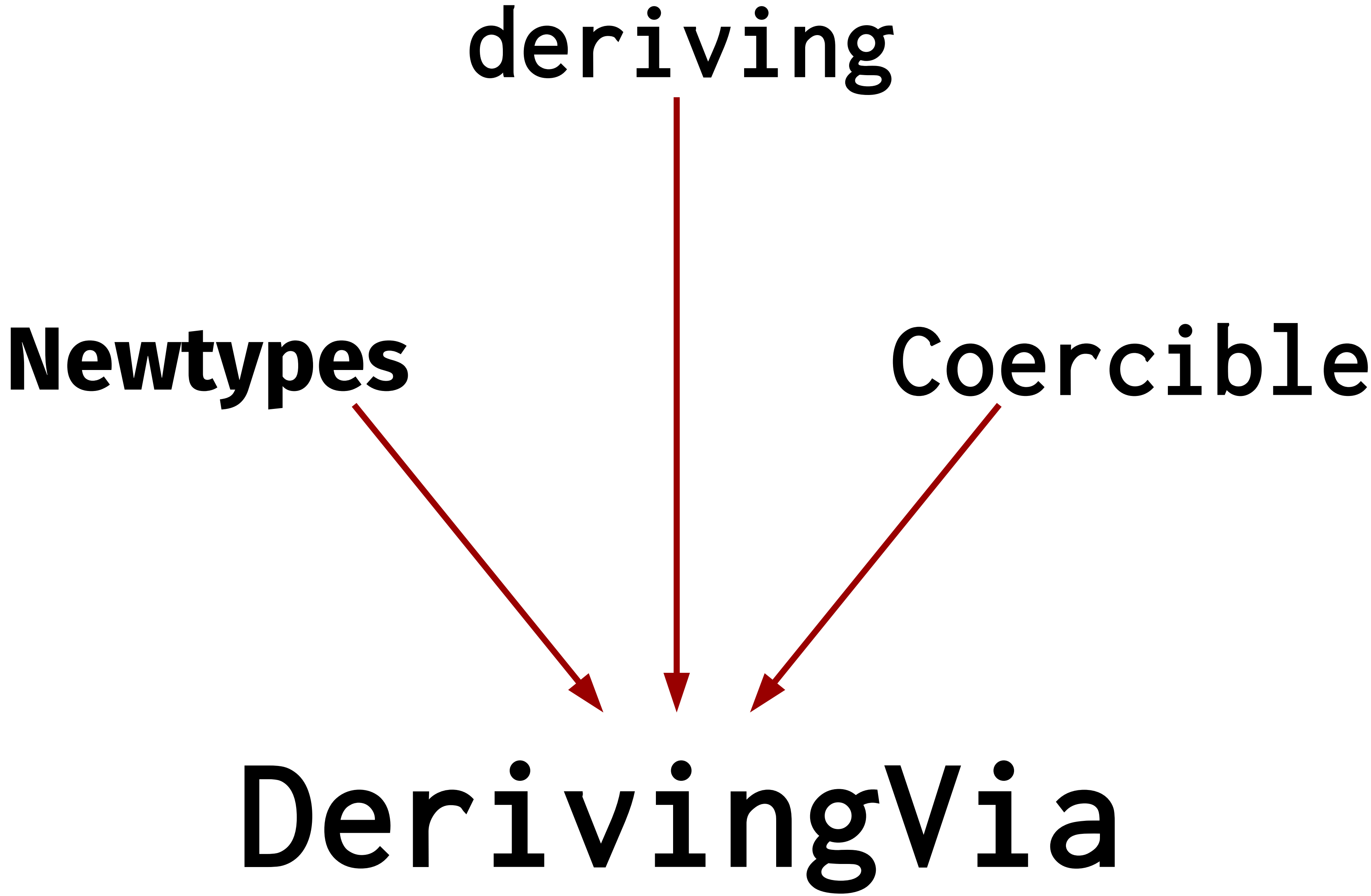
```haskell
data IO a = ...
  deriving Monoid via (Ap IO a)

instance Monoid a => Monoid (IO a) where
  mempty  = coerce (mempty  :: Ap IO a)
  mappend = coerce (mappend :: Ap IO a
                            -> Ap IO a
                            -> Ap IO a)
```

```haskell
data IO a = ...
  deriving Monoid via (Ap IO a)

instance Monoid a => Monoid (IO a) where
  mempty  = coerce (mempty  :: Ap IO a)
  mappend = coerce (mappend :: Ap IO a
                            -> Ap IO a
                            -> Ap IO a)
```

Typechecks since `IO a` and `Ap IO a` have the same runtime representation!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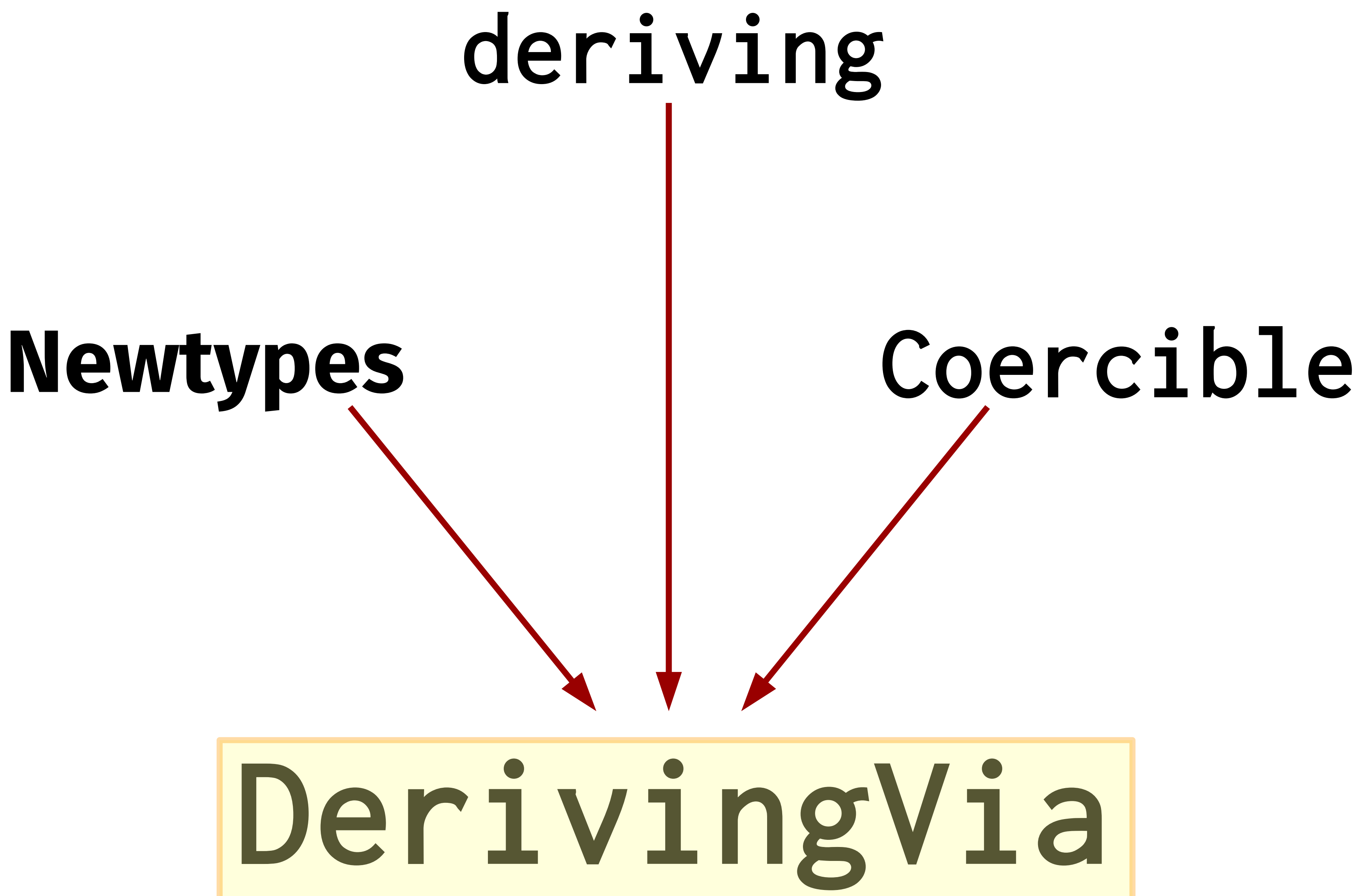
deriving
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`DerivingVia` is generalized `GeneralizedNewtypeDeriving`

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```
newtype Age = MkAge Int
  deriving newtype Num

==>

instance Num Age where
  (+) = coerce ((+) :: Int -> Int -> Int)
  ...
```

`DerivingVia` is generalized `GeneralizedNewtypeDeriving`

```
newtype Age = MkAge Int
  deriving Num via Int

==>

instance Num Age where
  (+) = coerce ((+) :: Int -> Int -> Int)
  ...
```

`DerivingVia` **improves** `DefaultSignatures`

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```
class Pretty a where
  pPrint :: a -> Doc
```

DerivingVia improves DefaultSignatures

```
class Pretty a where
  pPrint :: a -> Doc
  default pPrint
         :: Show a
         => a -> Doc
  pPrint = text . show
```

DerivingVia **improves** DefaultSignatures

```
class Pretty a where
  pPrint :: a -> Doc
  default pPrint
         :: Show a
         => a -> Doc
  pPrint = text . show

data Foo deriving (Show)
instance Pretty Foo
```

DerivingVia improves DefaultSignatures

```
class Pretty a where
  pPrint :: a -> Doc
  default pPrint
          :: (Generic a, GPretty (Rep a))
          => a -> Doc
  pPrint = genericPPrint

data Foo deriving (Generic)
instance Pretty Foo
```

DerivingVia improves DefaultSignatures

```
class Pretty a where
  pPrint :: a -> Doc
  default pPrint
          :: ???
          => a -> Doc
  pPrint = -- Which is the One True Default?

data Foo deriving (Show, Generic)
instance Pretty Foo
```

DerivingVia **improves** DefaultSignatures

```
class Pretty a where
  pPrint :: a -> Doc
  default pPrint
          ???
          a -> Doc
  pPrint = -- Which is the One True Default?

data Foo deriving (Show, Generic)
instance Pretty Foo
```

`DerivingVia` **improves** `DefaultSignatures`

```
newtype ShowPPrint    a = ShowPPrint    a
newtype GenericPPrint a = GenericPPrint a
```

`DerivingVia` improves `DefaultSignatures`

```haskell
newtype ShowPPrint    a = ShowPPrint    a
newtype GenericPPrint a = GenericPPrint a

instance Show a
  => Pretty (ShowPPrint a) where
  pPrint (ShowPPrint x) = text (show x)
instance Generic a
  => Pretty (GenericPPrint a) where
  pPrint (GenericPPrint x) = genericPPrint x
```

DerivingVia **improves** DefaultSignatures

```
data Foo
  deriving (Show, Generic)
```

DerivingVia **improves** DefaultSignatures

```
data Foo
  deriving (Show, Generic)
  deriving Pretty via (ShowPPrint Foo)
```

DerivingVia **improves** DefaultSignatures

```haskell
data Foo
  deriving (Show, Generic)
  -- deriving Pretty via (ShowPPrint Foo)
  deriving Pretty via (GenericPPrint Foo)
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DerivingVia **improves** DefaultSignatures

```haskell
data Foo
  deriving (Show, Generic)
  deriving Pretty via (ShowPPrint Foo)
  -- deriving Pretty via (GenericPPrint Foo)
```

In the paper...

- Derive `via` things that aren't inter-`Coercible` (using datatype-generic programming)

- Interaction with `StandaloneDeriving`, associated type families, `MultiParamTypeClasses`, etc.

- `DerivingVia` as a way to derive asymptotically faster code

- `DerivingVia` as a technique for making it easier to retrofit superclass constraints

```
data Slides
  deriving Conclusion
  via WrapUp Slides
```

- Simple extension, but with powerful consequences
- Compositional, configurable, cheap, and cheerful
- Encourages code reuse and codifying patterns into named ideas that others can refer to
- Leverages existing technology in GHC

Debuts in GHC 8.6!