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Generic Generic Programming

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Practical Aspects of Declarative Languages 2014

21 January 2014

Introduction

- Generic programming: an abstraction technique to reduce code duplication
  - Generic programs operate on "representation types"; a small set of types used to encode all other user-defined datatypes
  - Conversion functions mediate the isomorphism between a datatype and its generic representation

Introduction

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- Generic programming: an abstraction technique to reduce code duplication
  - Generic programs operate on "representation types"; a small set of types used to encode all other user-defined datatypes
  - Conversion functions mediate the isomorphism between a datatype and its generic representation
- Several generic programming libraries, specialised for different tasks, supporting different datatypes

2008: regular

$$
\begin{array}{l}
\textbf{class}\ \mathit{GEq}\ \phi\ \textbf{where} \\
\quad \mathit{geq} :: (\alpha \to \alpha \to \mathit{Bool}) \to \phi\ \alpha \to \phi\ \alpha \to \mathit{Bool}
\end{array}
$$

$$
\begin{array}{llllll}
\textbf{instance} & & \mathit{GEq}\ \mathit{Unit} & \textbf{where}\ \mathit{geq}\ _ & \mathit{Unit}\quad \mathit{Unit} & = \mathit{True} \\
\textbf{instance} & \mathit{Eq}\ \alpha \Rightarrow & \mathit{GEq}\ (\mathit{Arg}\ \alpha) & \textbf{where}\ \mathit{geq}\ _ & (\mathit{Arg}\ x)\ (\mathit{Arg}\ y) & = x \equiv y \\
\textbf{instance} & & \mathit{GEq}\ \mathit{Rec} & \textbf{where}\ \mathit{geq}\ \mathit{eqf} & (\mathit{Rec}\ x)\ (\mathit{Rec}\ y) & = \mathit{eqf}\ x\ y
\end{array}
$$

$$
\begin{array}{l}
\textbf{instance}\ (\mathit{GEq}\ \phi, \mathit{GEq}\ \psi) \Rightarrow \mathit{GEq}\ (\phi :+: \psi)\ \textbf{where} \\
\quad \mathit{geq}\ \mathit{eqf}\ (\mathit{Left}\ \ x)\ (\mathit{Left}\ \ y) = \mathit{geq}\ \mathit{eqf}\ x\ y \\
\quad \mathit{geq}\ \mathit{eqf}\ (\mathit{Right}\ x)\ (\mathit{Right}\ y) = \mathit{geq}\ \mathit{eqf}\ x\ y \\
\quad \mathit{geq}\ _\quad _ \qquad\qquad _ \qquad\qquad = \mathit{False}
\end{array}
$$

$$
\begin{array}{l}
\textbf{instance}\ (\mathit{GEq}\ \phi, \mathit{GEq}\ \psi) \Rightarrow \mathit{GEq}\ (\phi :\times: \psi)\ \textbf{where} \\
\quad \mathit{geq}\ \mathit{eqf}\ (x_1 :\times: y_1)\ (x_2 :\times: y_2) = \mathit{geq}\ \mathit{eqf}\ x_1\ x_2 \wedge \mathit{geq}\ \mathit{eqf}\ y_1\ y_2
\end{array}
$$

$$
\begin{array}{l}
\mathit{eq} :: (\mathit{Regular}\ \alpha, \mathit{GEq}\ (\mathit{Rep}\ \alpha)) \Rightarrow \alpha \to \alpha \to \mathit{Bool} \\
\mathit{eq}\ x\ y = \mathit{geq}\ \mathit{eq}\ (\mathit{from}\ x)\ (\mathit{from}\ y)
\end{array}
$$

2009: multirec

```
class GEq ρ φ where
  geq :: (∀ι.ρ ι → τ ι → τ ι → Bool) → ρ ι → φ τ ι → φ τ ι → Bool

instance          GEq ρ Unit      where geq _ _ Unit     Unit     = True
instance Eq α ⇒  GEq ρ (Arg α)   where geq _ _ (Arg x) (Arg y)  = x ≡ y
instance El ρ ι ⇒ GEq ρ (Rec ι)  where
  geq eqf _ (Rec   x) (Rec   y) = eqf proof x y
instance (GEq ρ φ, GEq ρ ψ) ⇒ GEq ρ (φ :+: ψ) where
  geq eqf p (Left  x) (Left  y) = geq eqf p x y
  geq eqf p (Right x) (Right y) = geq eqf p x y
  geq _   _ _         _         = False
instance (GEq ρ φ, GEq ρ ψ) ⇒ GEq ρ (φ :×: ψ) where
  geq eqf p (x1 :×: y1) (x2 :×: y2) = geq eqf p x1 x2 ∧ geq eqf p y1 y2
instance GEq ρ φ ⇒ GEq ρ (φ :▷: ι) where
  geq eq p (Tag x) (Tag y) = geq eq p x y

eq :: (Fam ρ, GEq ρ (Rep ρ)) ⇒ ρ ι → ι → ι → Bool
eq p x y = geq (λp (I0 x) (I0 y) → eq p x y) p (from p x) (from p y)
```

2010: generic-deriving

$$\textbf{class } \mathit{GEq}\ \phi \textbf{ where}$$
$$\quad \mathit{geq} :: \phi\ \alpha \to \phi\ \alpha \to \mathit{Bool}$$

$$\textbf{instance } \mathit{GEq}\ \mathit{Unit} \textbf{ where } \mathit{geq}\ \mathit{Unit}\ \mathit{Unit} = \mathit{True}$$
$$\textbf{instance } \mathit{Eq}\ \alpha \Rightarrow \mathit{GEq}\ (\mathit{Arg}\ \iota\ \alpha) \textbf{ where } \mathit{geq}\ (\mathit{Arg}\ x)\ (\mathit{Arg}\ y) = \mathit{geq}\ x\ y$$

$$\textbf{instance } (\mathit{GEq}\ \alpha, \mathit{GEq}\ \beta) \Rightarrow \mathit{GEq}\ (\alpha :+: \beta) \textbf{ where}$$
$$\quad \mathit{geq}\ (\mathit{Left}\ x)\ (\mathit{Left}\ y) = \mathit{geq}\ x\ y$$
$$\quad \mathit{geq}\ (\mathit{Right}\ x)\ (\mathit{Right}\ y) = \mathit{geq}\ x\ y$$
$$\quad \mathit{geq}\ _\ _ = \mathit{False}$$

$$\textbf{instance } (\mathit{GEq}\ \alpha, \mathit{GEq}\ \beta) \Rightarrow \mathit{GEq}\ (\alpha :\times: \beta) \textbf{ where}$$
$$\quad \mathit{geq}\ (x_1 :\times: y_1)\ (x_2 :\times: y_2) = \mathit{geq}\ x_1\ x_2 \wedge \mathit{geq}\ y_1\ y_2$$

$$\mathit{eq} :: (\mathit{Generic}\ \alpha, \mathit{GEq}\ (\mathit{Rep}\ \alpha)) \Rightarrow \alpha \to \alpha \to \mathit{Bool}$$
$$\mathit{eq}\ x\ y = \mathit{geq}\ (\mathit{from}\ x)\ (\mathit{from}\ y)$$

This is generic programming

- "Generic programming (...) makes it possible to write programs that solve a class of problems *once and for all*, instead of writing new code over and over again (...)" [Backhouse et al., 1999]
- "Generic programming techniques aim to *eliminate boilerplate* code." [Lämmel and Peyton Jones, 2003]
- "Generic programming has developed as a technique for increasing the amount and scale of *reuse* in code (...)" [Jeuring et al., 2009]
- "Generic programming (...) *reduces code duplication* and makes code more robust to changes (...)" (Haskell Wiki, 2013)

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. . . yet generic programmers keep writing boilerplate code!

Duplicated representations across different libraries

Representing lists in `regular`:

$$\textbf{instance}\ \mathit{Regular}\ [\alpha]\ \textbf{where}$$
$$\quad \mathit{Rep}\ [\alpha] = \mathit{Unit}\ {:+:}\ ((\mathit{Arg}\ \alpha)\ {:\times:}\ \mathit{Rec})$$
$$\quad \mathit{from}\ [\,] \qquad = \mathit{Left}\ \mathit{Unit}$$
$$\quad \mathit{from}\ (h : t) = \mathit{Right}\ (\mathit{Arg}\ h\ {:\times:}\ \mathit{Rec}\ t)$$
$$\quad \mathit{to}\ (\mathit{Left}\ \mathit{Unit}) \qquad\qquad\quad = [\,]$$
$$\quad \mathit{to}\ (\mathit{Right}\ (\mathit{Arg}\ h\ {:\times:}\ \mathit{Rec}\ t)) = h : t$$

Representing lists in `generic-deriving`:

$$\textbf{instance}\ \mathit{Generic}\ [\alpha]\ \textbf{where}$$
$$\quad \mathit{Rep}\ [\alpha] = \mathit{Unit}\ {:+:}\ ((\mathit{Arg}\ P\ \alpha)\ {:\times:}\ (\mathit{Arg}\ (R\ S)\ [\alpha]))$$
$$\quad \mathit{from}\ [\,] \qquad = \mathit{Left}\ \ \mathit{Unit}$$
$$\quad \mathit{from}\ (h : t) = \mathit{Right}\ (\mathit{Arg}\ h\ {:\times:}\ \mathit{Arg}\ t)$$
$$\quad \mathit{to}\ (\mathit{Left}\ \ \mathit{Unit}) \qquad\qquad\quad = [\,]$$
$$\quad \mathit{to}\ (\mathit{Right}\ (\mathit{Arg}\ h\ {:\times:}\ \mathit{Arg}\ t)) = h : t$$

What should be possible

```
import Generics.Deriving          as GD
import Generics.Regular.Rewriting as R
import Generics.SYB.Schemes       as S
import Conversions ()

data Logic α = Var α | Logic α :∨: Logic α | Not (Logic α) | T | F
                 deriving (GD.Generic)
```

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data Logic α = Var α | Logic α :∨: Logic α | Not (Logic α) | T | F
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rewriting :: Logic Char
rewriting =
  let elim2Not = R.rule $ λx → Not (Not x) :⇝: x
  in R.bottomUp (R.rewrite elim2Not) $ T :∨: Not (Not (Var 'p'))
```

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size :: Int
size = S.everything (+) (const 1) $ Var 'p' :∨: Var 'q'
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size :: Int
size = S.everything (+) (const 1) $ Var 'p' :∨: Var 'q'

rename :: Logic String
rename = GD.gmap ('_':) $ T :∨: Var "p"
```
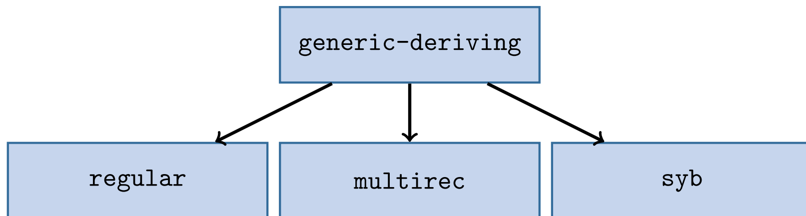

Why?

- Reduce code duplication across generic programming libraries - generic generic programming!
- Reduce code size for generic representations
- Libraries can be specialised, and need not provide general functionality
- No need to rely on Template Haskell for automatically generating representations

How?



We use `generic-deriving` (which has built-in GHC support) to derive conversions to the other libraries.

A closer look at generic-deriving: Universe

$$
\begin{array}{lll}
\textbf{kind}\ \mathit{Univ}_D = & \mathit{Univ}_D\ :+:_D\ \mathit{Univ}_D & \text{-- choice between constructors} \\
 \mid & \mathit{Univ}_D\ :\times:_D\ \mathit{Univ}_D & \text{-- multiple arguments} \\
 \mid & \mathit{Arg}_D\ \mathit{ArgType}\ \star & \text{-- arguments to constructors} \\
 \mid & \mathit{Unit}_D & \text{-- datatypes without constructors}
\end{array}
$$

$$
\begin{array}{ll}
\textbf{kind}\ \mathit{ArgType} = P \mid R\ \mathit{RecType} \mid U & \text{-- parameter, recursion, or unknown} \\
\textbf{kind}\ \mathit{RecType} = S \mid O & \text{-- self or other}
\end{array}
$$

A closer look at generic-deriving: Interpretation

$$
\begin{array}{l}
\textbf{data}\ [\![\, \alpha :: \mathit{Univ}_D \,]\!]_D :: \star\ \textbf{where} \\
\quad \begin{array}{lll}
\mathit{Unit}_D & :: & [\![\, \mathit{Unit}_D \,]\!]_D \\
\mathit{Arg}_D & :: \alpha & \rightarrow [\![\, \mathit{Arg}_D\ \iota\ \alpha \,]\!]_D \\
\mathit{Left}_D & :: [\![\, \phi \,]\!]_D & \rightarrow [\![\, \phi\ :\!+\!:_D\ \psi \,]\!]_D \\
\mathit{Right}_D & :: [\![\, \psi \,]\!]_D & \rightarrow [\![\, \phi\ :\!+\!:_D\ \psi \,]\!]_D \\
:\!\times\!:_D & :: [\![\, \phi \,]\!]_D \rightarrow [\![\, \psi \,]\!]_D & \rightarrow [\![\, \phi\ :\!\times\!:_D\ \psi \,]\!]_D
\end{array}
\end{array}
$$

A closer look at `generic-deriving`: Datatype instantiation

$$
\begin{array}{l}
\textbf{class}\ \mathit{Generic}_D\ (\alpha :: \star)\ \textbf{where} \\
\quad \mathit{Rep}_D\ \alpha :: \mathit{Univ}_D \\
\quad \mathit{from}_D :: \alpha \to [\![\, \mathit{Rep}_D\ \alpha \,]\!]_D \\
\quad \mathit{to}_D \quad :: [\![\, \mathit{Rep}_D\ \alpha \,]\!]_D \to \alpha
\end{array}
$$

A closer look at `generic-deriving`: Datatype instantiation

$$
\begin{aligned}
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&\quad \mathit{Rep}_D\ \alpha :: \mathit{Univ}_D\\
&\quad \mathit{from}_D :: \alpha \to [\![\, \mathit{Rep}_D\ \alpha \,]\!]_D\\
&\quad \mathit{to}_D\ \ :: [\![\, \mathit{Rep}_D\ \alpha \,]\!]_D \to \alpha
\end{aligned}
$$

Example instance (lists):

$$
\begin{aligned}
&\textbf{instance}\ \mathit{Generic}\ [\,\alpha\,]\ \textbf{where}\\
&\quad \mathit{Rep}\ [\,\alpha\,] = \mathit{Unit}_D\ :\!+\!:_D\ ((\mathit{Arg}_D\ P\ \alpha)\ :\!\times\!:_D\ (\mathit{Arg}_D\ (R\ S)\ [\,\alpha\,]))\\
&\quad \mathit{from}\ [\,]\qquad = \mathit{Left}_D\ \mathit{Unit}_D\\
&\quad \mathit{from}\ (h : t) = \mathit{Right}_D\ (\mathit{Arg}_D\ h\ :\!\times\!:_D\ (\mathit{Arg}_D\ t))\\
&\quad \mathit{to}\ (\mathit{Left}_D\ \mathit{Unit}_D) = [\,]\\
&\quad \mathit{to}\ (\mathit{Right}_D\ (\mathit{Arg}_D\ h\ :\!\times\!:_D\ (\mathit{Arg}_D\ t))) = h : t
\end{aligned}
$$

Comparison with regular

$$\textbf{kind}\ \mathit{Univ}_R = \mathit{Unit}_R \mid \mathit{Rec}_R \mid \mathit{Arg}_R\ \star \\ \mid \mathit{Univ}_R\ :\!+\!:_R\ \mathit{Univ}_R \mid \mathit{Univ}_R\ :\!\times\!:_R\ \mathit{Univ}_R$$

Comparison with regular

$$\textbf{kind}\ \mathit{Univ}_R = \mathit{Unit}_R \mid \mathit{Rec}_R \mid \mathit{Arg}_R\ \star$$
$$\mid\ \mathit{Univ}_R\ :\!+\!:_R\ \mathit{Univ}_R \mid \mathit{Univ}_R\ :\!\times\!:_R\ \mathit{Univ}_R$$

$$
\begin{array}{lll}
\multicolumn{3}{l}{\textbf{data}\ [\![\,\alpha :: \mathit{Univ}_R\,]\!]_R\ (\tau :: \star)\ \textbf{where}} \\
\quad \mathit{Unit}_R & :: & [\![\,\mathit{Unit}_R\,]\!]_R\ \tau \\
\quad \mathit{Rec}_R & :: \tau & \to [\![\,\mathit{Rec}_R\,]\!]_R\ \tau \\
\quad \mathit{Arg}_R & :: \alpha & \to [\![\,\mathit{Arg}_R\ \alpha\,]\!]_R\ \tau \\
\quad \mathit{Left}_R & :: [\![\,\alpha\,]\!]_R\ \tau & \to [\![\,\alpha\ :\!+\!:_R\ \beta\,]\!]_R\ \tau \\
\quad \mathit{Right}_R & :: [\![\,\beta\,]\!]_R\ \tau & \to [\![\,\alpha\ :\!+\!:_R\ \beta\,]\!]_R\ \tau \\
\quad (:\!\times\!:_R) & :: [\![\,\alpha\,]\!]_R\ \tau \to [\![\,\beta\,]\!]_R\ \tau & \to [\![\,\alpha\ :\!\times\!:_R\ \beta\,]\!]_R\ \tau
\end{array}
$$

Comparison with regular

$$
\begin{aligned}
&\textbf{kind}\ \mathit{Univ}_R = \mathit{Unit}_R \mid \mathit{Rec}_R \mid \mathit{Arg}_R\ \star \\
&\qquad\qquad \mid \mathit{Univ}_R\ :\!+\!:_R\ \mathit{Univ}_R \mid \mathit{Univ}_R\ :\!\times\!:_R\ \mathit{Univ}_R
\end{aligned}
$$

$$
\begin{array}{lllll}
\multicolumn{5}{l}{\textbf{data}\ [\![\, \alpha :: \mathit{Univ}_R \,]\!]_R\ (\tau :: \star)\ \textbf{where}} \\
\quad \mathit{Unit}_R & :: & & & [\![\, \mathit{Unit}_R \,]\!]_R\ \tau \\
\quad \mathit{Rec}_R & :: & \tau & \rightarrow & [\![\, \mathit{Rec}_R \,]\!]_R\ \tau \\
\quad \mathit{Arg}_R & :: & \alpha & \rightarrow & [\![\, \mathit{Arg}_R\ \alpha \,]\!]_R\ \tau \\
\quad \mathit{Left}_R & :: & [\![\, \alpha \,]\!]_R\ \tau & \rightarrow & [\![\, \alpha\ :\!+\!:_R\ \beta \,]\!]_R\ \tau \\
\quad \mathit{Right}_R & :: & [\![\, \beta \,]\!]_R\ \tau & \rightarrow & [\![\, \alpha\ :\!+\!:_R\ \beta \,]\!]_R\ \tau \\
\quad (:\!\times\!:_R) & :: & [\![\, \alpha \,]\!]_R\ \tau \rightarrow [\![\, \beta \,]\!]_R\ \tau & \rightarrow & [\![\, \alpha\ :\!\times\!:_R\ \beta \,]\!]_R\ \tau
\end{array}
$$

$$
\begin{aligned}
&\textbf{class}\ \mathit{Regular}\ (\alpha :: \star)\ \textbf{where} \\
&\quad \mathit{Rep}\ \alpha :: \mathit{Univ}_R \\
&\quad \mathit{from}_R :: \alpha \rightarrow [\![\, \mathit{Rep}\ \alpha \,]\!]_R\ \alpha
\end{aligned}
$$

From `generic-deriving` to `regular`: types

Our conversion from `generic-deriving` to `regular` consists of two steps:

- A type function *ToRegular* to convert the type representations
- A value-level function *toRegular* to convert the value accordingly

From `generic-deriving` to `regular`: types

Our conversion from `generic-deriving` to `regular` consists of two steps:

- A type function *ToRegular* to convert the type representations
- A value-level function *toRegular* to convert the value accordingly

$$
\begin{array}{lcl}
\mathit{ToRegular}\ (\alpha :: \mathit{Univ}_D) :: \mathit{Univ}_R \\
\mathit{ToRegular}\ \mathit{Unit}_D & = & \mathit{Unit}_R \\
\mathit{ToRegular}\ (\alpha\ :+:_D\ \beta) & = & \mathit{ToRegular}\ \alpha\ :+:_R\ \mathit{ToRegular}\ \beta \\
\mathit{ToRegular}\ (\alpha\ :\times:_D\ \beta) & = & \mathit{ToRegular}\ \alpha\ :\times:_R\ \mathit{ToRegular}\ \beta \\
\mathit{ToRegular}\ (\mathit{Arg}_D\ (R\ S)\ \tau) & = & \mathit{Rec}_R \\
\mathit{ToRegular}\ (\mathit{Arg}_D\ (R\ O)\ \alpha) & = & \mathit{Arg}_R\ \alpha \\
\mathit{ToRegular}\ (\mathit{Arg}_D\ P\ \alpha) & = & \mathit{Arg}_R\ \alpha \\
\mathit{ToRegular}\ (\mathit{Arg}_D\ U\ \alpha) & = & \mathit{Arg}_R\ \alpha
\end{array}
$$

From generic-deriving to regular: values

$$
\begin{array}{l}
\textbf{class } \mathit{Convert}_R\ (\alpha :: \mathit{Univ}_D)\ \tau \textbf{ where}\\
\quad \mathit{toRegular} :: [\![\, \alpha \,]\!]_D\ \rho \to [\![\, \mathit{ToRegular}\ \alpha \,]\!]_R\ \tau\\
\\
\textbf{instance } \mathit{Convert}_R\ (\mathit{Arg}_D\ (R\ S)\ \tau)\ \tau \textbf{ where}\\
\quad \mathit{toRegular}\ (\mathit{Arg}_D\ x) = \mathit{Rec}_R\ x\\
\textbf{instance } \mathit{Convert}_R\ (\mathit{Arg}_D\ \gamma\ \tau)\ \rho \textbf{ where}\\
\quad \mathit{toRegular}\ (\mathit{Arg}_D\ x) = \mathit{Arg}_R\ x\\
\textbf{instance } (\mathit{Convert}_R\ \alpha\ \tau, \mathit{Convert}_R\ \beta\ \tau)\\
\qquad\qquad \Rightarrow \mathit{Convert}_R\ (\alpha :+:_D \beta)\ \tau \textbf{ where}\\
\quad \mathit{toRegular}\ (\mathit{Left}_D\ x) = \mathit{Left}_R\ (\mathit{toRegular}\ x)\\
\quad \mathit{toRegular}\ (\mathit{Right}_D\ x) = \mathit{Right}_R\ (\mathit{toRegular}\ x)\\
\textbf{instance } (\mathit{Convert}_R\ \alpha\ \tau, \mathit{Convert}_R\ \beta\ \tau)\\
\qquad\qquad \Rightarrow \mathit{Convert}_R\ (\alpha :\times:_D \beta)\ \tau \textbf{ where}\\
\quad \mathit{toRegular}\ (x :\times:_D y) = \mathit{toRegular}\ x :\times:_R \mathit{toRegular}\ y\\
\ldots
\end{array}
$$

From `generic-deriving` to `regular`: datatypes

It is here that we set the second parameter of $\mathit{Convert}_R$ to the type being converted (α):

$$\textbf{instance}\ (\mathit{Generic}_D\ \alpha, \mathit{Convert}_R\ (\mathit{Rep}_D\ \alpha)\ \alpha) \Rightarrow \mathit{Regular}\ \alpha\ \textbf{where}$$
$$\mathit{Rep}\ \alpha = \mathit{ToRegular}\ (\mathit{Rep}_D\ \alpha)$$
$$\mathit{from}_R\ x = \mathit{toRegular}\ (\mathit{from}_D\ x)$$

With this instance, functions defined in the `regular` library are now available to all `generic-deriving` supported datatypes.

The Spine view (syb)

Encoding syb via the Spine view:

$$
\begin{array}{l}
\textbf{data}\ \mathit{Spine} :: \star \rightarrow \star\ \textbf{where} \\
\quad \mathit{Con} :: \alpha \rightarrow \mathit{Spine}\ \alpha \\
\quad (:\diamond:) :: (\mathit{Data}\ \alpha) \Rightarrow \mathit{Spine}\ (\alpha \rightarrow \beta) \rightarrow \alpha \rightarrow \mathit{Spine}\ \beta
\end{array}
$$

$$
\begin{array}{l}
\textbf{class}\ (\mathit{Typeable}\ \alpha) \Rightarrow \mathit{Data}\ \alpha\ \textbf{where} \\
\quad \mathit{spine} :: \alpha \rightarrow \mathit{Spine}\ \alpha
\end{array}
$$

$$
\begin{array}{l}
\textbf{instance}\ (\mathit{Data}\ \alpha) \Rightarrow \mathit{Data}\ [\,\alpha\,]\ \textbf{where} \\
\quad \mathit{spine}\ [\,] \qquad\;\; = \mathit{Con}\ [\,] \\
\quad \mathit{spine}\ (h : t) = \mathit{Con}\ (:)\ :\diamond:\ h\ :\diamond:\ t
\end{array}
$$

From generic-deriving to syb

Representing generic-deriving types as a Spine:

$$
\begin{array}{l}
\textbf{class}\ \mathit{Converts}_S\ (\alpha :: \mathit{Univ}_D)\ \textbf{where} \\
\quad \mathit{toSpine} :: [\![\, \alpha \,]\!]_D \rightarrow \mathit{Spine}\ ([\![\, \alpha \,]\!]_D)
\end{array}
$$

$$
\begin{array}{l}
\textbf{instance}\ \mathit{Converts}_S\ \mathit{Unit}_D\ \textbf{where}\ \mathit{toSpine}\ \mathit{Unit}_D = \mathit{Con}\ \mathit{Unit}_D \\
\textbf{instance}\ (\mathit{Converts}_S\ \alpha, \mathit{Converts}_S\ \beta) \Rightarrow \mathit{Converts}_S\ (\alpha\ :+:_D\ \beta)\ \textbf{where} \\
\quad \mathit{toSpine}\ (\mathit{Left}_D\ \ x) = \mathit{fmap}\ \mathit{Left}_D\ \ (\mathit{toSpine}\ x) \\
\quad \mathit{toSpine}\ (\mathit{Right}_D\ x) = \mathit{fmap}\ \mathit{Right}_D\ (\mathit{toSpine}\ x) \\
\textbf{instance}\ (\mathit{Data}\ \alpha) \Rightarrow \mathit{Converts}_S\ (\mathit{Arg}_D\ \iota\ \alpha)\ \textbf{where} \\
\quad \mathit{toSpine}\ (\mathit{Arg}_D\ x) = \mathit{Con}\ \mathit{Arg}_D\ :\diamond:\ x
\end{array}
$$

$$
\begin{array}{l}
\textbf{instance}\ (\mathit{Generic}_D\ \alpha, \mathit{Converts}_S\ (\mathit{Rep}_D\ \alpha), \mathit{Typeable}\ \alpha) \\
\quad \Rightarrow \mathit{Data}\ \alpha\ \textbf{where} \\
\quad \mathit{spine} = \mathit{fmap}\ \mathit{to}_D \circ \mathit{toSpine} \circ \mathit{from}_D
\end{array}
$$

Further reading

In the paper we also have a conversion from `generic-deriving` to `multirec`.

Full code (compiling with GHC 7.6.2) available at `http://dreixel.net/research/code/ggp.zip`.

Future work

- What is the performance penalty imposed by the conversions?
- Can we optimise it using "known techniques"?
- Which other libraries can we convert to?

Conclusion

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We have:

- Recognised the existence of code duplication across generic programming libraries
- Eliminated this duplication by defining conversions between approaches
- Proposed a new approach to the development of generic programming, libraries, focusing on how to relate them to existing approaches, rather than reimplementing everything from scratch

Conclusion

We have:

- Recognised the existence of code duplication across generic programming libraries
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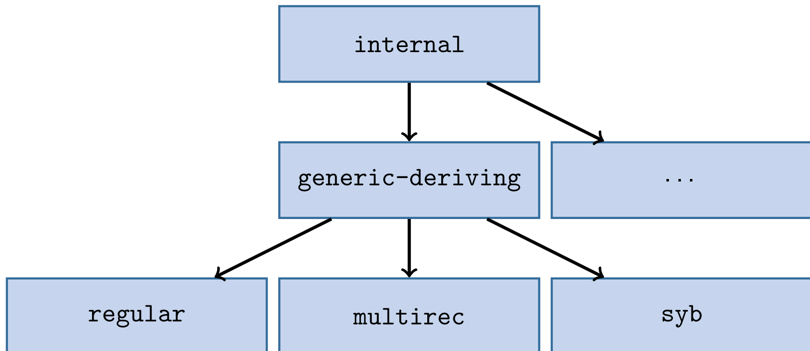
Thank you for your time!

How?



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