

Introduction to Type-Level and Generic Programming in Haskell

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Datatype-generic programming

Express algorithms that make use of the structure of datatypes

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eqA :: A -> A -> Bool
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eq :: Generic a => a -> a -> Bool  
eq x y = geq (from x) (from y)
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In this tutorial: `generics-sop`.

Applications

- ▶ (De-)serialization
- ▶ Data generation
- ▶ Data traversals
- ▶ Data navigation
- ▶ ...

The generics-sop view on data, informally

Sample datatypes

```
data Maybe a    = Nothing | Just a
data Either a b = Left a  | Right b
data Group      = Group Char Bool Int
data Expr       = NumL Int
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                  | Add Expr Expr
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The plan

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- ▶ Choice between constructors modelled as an n -ary sum.
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$SOP \ (S \dots Z \ (I \ x_0 \ :* \dots \ :* \ I \ x_{n_i-1} \ :* \ Nil))$

Extensions, extensions

DataKinds
PolyKinds
ConstraintKinds
GADTs
TypeFamilies
MultiParamTypeClasses
FlexibleInstances
FlexibleContexts
UndecidableInstances
UndecidableSuperClasses
RankNTypes
DefaultSignatures
StandaloneDeriving
TypeOperators
ScopedTypeVariables

Overall plan

- ▶ Learn about n -ary products and n -ary sums.
- ▶ Example generic functions.
- ▶ Explain internals, discuss type-level programming features.
- ▶ More generic functions.
- ▶ Handling metadata.