

Functional programming, Seminar No. 1

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General words on Haskell and History

- The language is named after Haskell Curry, an American logician
- The first implementation: 1990
- The language standard: Haskell2010
- Default compiler: Glasgow Haskell compiler
- Haskell is a strongly-typed, polymorphic, and purely functional programming language

Lambda calculus and type theory. Incomplete and Utter History of Functional Programming

- At the end of the 1920-s, Alonzo Church proposed an alternative approach to the foundations of mathematics where the notion of a function is a primitive one. Informally, lambda-calculus is a formal system that describes abstract functions.

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- The first system of typed the lambda calculus is a hybrid from the lambda calculus and type theory developed by Bertrand Russell and Alfred North Whitehead in Principia Mathematica (1910-s).

Lambda calculus and type theory. Historical notes

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- Polymorphic type inference (Roger Hindley, Robin Milner and Luis Damas (1970-1980-s))
- ML: the very first language with polymorphic inferred type system (Robin Milner, 1973)
- The language Haskell appeared at the beginning of 1990-s. Haskell designed by Simon Peyton Jones, Philip Wadler, and others

Functional programming and its foundations

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- We have no assignment in imperative languages. Variables are nullary constant functions rather than boxes.
- We have no states (in a usual sense)
- We use recursion instead of loops
- Pattern-matching
- ...

What are types needed for?

According to Benjamin Pierce

A type system is a tractable syntactic method for proving the absence of certain program behaviours by classifying phrases according to the kinds of values they compute.

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Types in programming languages are about

- A partial specification
- Type preserving
- Type checking allows one to catch simple errors
- Type inference
- Etc

A landscape of typing from a bird's eye view

We may classify possible ways of typing as follows

- Static and dynamic typing
 - C, C++, Java, Haskell, etc
 - JavaScript, Ruby, PHP, etc
- Implicit and explicit typing
 - JavaScript, Ruby, PHP, etc
 - C++, Java, etc
- Inferred typing
 - Haskell, Standard ML, Ocaml, Idris, etc

Ecosystem

The Haskell Platform installation

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curl -sSL https://get.haskellstack.org/ | sh
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- Install ghc, stack, and cabal using Homebrew

Choose any way you prefer. All these ways are equivalent to each other.

- GHC is a default Haskell compiler.
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- GHC is developed under the GHC Steering committee control.
- Very roughly, compiling pipeline has the following form:
parsing \Rightarrow compile-time (type-checking mostly) \Rightarrow runtime
(program execution)

- GHCi is a Haskell interpreter based on GHC.
- One may run GHCi with the command `ghci`.
- You may play with GHCi as a calculator, arithmetic operators are usual
- You may also have a look at the GHCi chapter in the GHC User's Guide to get familiar with GHCi closer.

```
cylindricalalgebra@daniels-mbp ~ % ghci
GHCi, version 8.10.5: https://www.haskell.org/ghc/  :? for help
Loaded package environment from /Users/cylindricalalgebra/.ghc/x86_64-darwin-8.10.5/environments/default
Prelude> █
```

- Cabal is a system of library and dependency management
- A `.cabal` file describes the version of a package and its dependencies
- Cabal is also a packaging tool
- Cabal used to cause dependency hell, and it still does.

- Stack is a *mainstream* cross-platform build tool for Haskell projects
- Stack is about

- Stack is a *mainstream* cross-platform build tool for Haskell projects
- Stack is about
 - installation of required packages and the latest GHC (and their more concrete versions),
 - building, execution, and testing
 - creating an isolated location.
 - Builds are reproducible

Snapshots

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- A screenshot from Stackage:

News

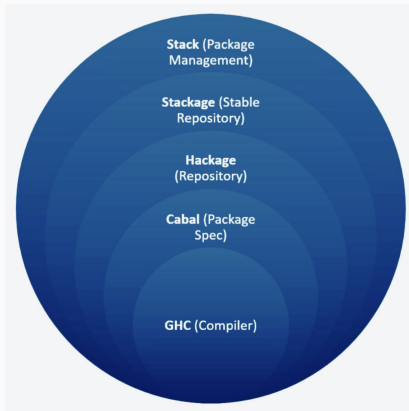
[Stackage nightly snapshots to switch to GHC 9.0.1](#), 3 months ago

Latest releases per GHC version

- Stackage Nightly 2021-08-24 (ghc-9.0.1), today
- LTS 18.7 for ghc-8.10.6, published 4 days ago
- LTS 18.6 for ghc-8.10.4, published 4 days ago
- LTS 17.2 for ghc-8.10.3, published 7 months ago
- LTS 16.31 for ghc-8.8.4, published 7 months ago
- LTS 16.11 for ghc-8.8.3, published a year ago
- LTS 15.3 for ghc-8.8.2, published a year ago
- LTS 14.27 for ghc-8.6.5, published a year ago
- LTS 13.19 for ghc-8.6.4, published 2 years ago
- LTS 13.11 for ghc-8.6.3, published 2 years ago
- LTS 12.26 for ghc-8.4.4, published 3 years ago
- LTS 12.14 for ghc-8.4.3, published 3 years ago
- LTS 11.22 for ghc-8.2.2, published 3 years ago
- LTS 9.21 for ghc-8.0.2, published 4 years ago
- LTS 7.24 for ghc-8.0.1, published 4 years ago
- LTS 6.35 for ghc-7.10.3, published 4 years ago
- LTS 3.22 for ghc-7.10.2, published 6 years ago
- LTS 2.22 for ghc-7.8.4, published 6 years ago
- LTS 0.7 for ghc-7.8.3, published 7 years ago

Ecosystem encapsulation

The Haskell ecosystem encapsulation can be described as the sequence of the following inclusions:



Creating a Haskell project using Stack

- Figure out how to call your project and run the script `stack new <projectname>`
- You will see the following story after the command `tree .` in the project directory:

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- You will see the following story after the command `tree .` in the project directory:

```
cylindricalgebra@daniels-mbp my-first-project % tree .
```

```
.
├── ChangeLog.md
├── LICENSE
├── README.md
├── Setup.hs
├── app
│   └── Main.hs
├── my-first-project.cabal
├── package.yaml
├── src
│   └── Lib.hs
├── stack.yaml
├── test
│   └── Spec.hs
```

3 directories, 10 files

Let us discuss on how dependency files look like. First of all, we have a look the `stack.yaml` file:

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```
20 resolver:
21   url: https://raw.githubusercontent.com/commercialhaskell/stackage-snapshots/master/lts/18/7.yaml
22
23   # User packages to be built.
24   # Various formats can be used as shown in the example below.
25   #
26   # packages:
27   # - some-directory
28   # - https://example.com/foo/bar/baz-0.0.2.tar.gz
29   #   subdirs:
30   #     - auto-update
31   #     - wai
32   packages:
33     - .
34   # Dependency packages to be pulled from upstream that are not in the resolver.
35   # These entries can reference officially published versions as well as
36   # forks / in-progress versions pinned to a git hash. For example:
37   #
38   # extra-deps:
39   # - acme-missiles-0.3
40   # - git: https://github.com/commercialhaskell/stack.git
41   #   commit: e7b331f14bcffb8367cd58fbfc8b40ec7642100a
42   #
43   # extra-deps: []
44
45   # Override default flag values for local packages and extra-deps
46   # flags: {}
```

Cabal file

The `.cabal` file describes the relevant version of a project and its dependencies:

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```
1 cabal-version: 1.12
2
3 -- This file has been generated from package.yaml by hpack version 0.34.4.
4 --
5 -- see: https://github.com/sol/hpack
6
7 name:          my-first-project
8 version:       0.1.0.0
9 description:   Please see the README on GitHub at <https://github.com/githubuser/my-first-project#readme>
10 homepage:     https://github.com/githubuser/my-first-project#readme
11 bug-reports:  https://github.com/githubuser/my-first-project/issues
12 author:       Author name here
13 maintainer:   example@example.com
14 copyright:    2021 Author name here
15 license:      BSD3
16 license-file: LICENSE
17 build-type:   Simple
18 extra-source-files:
19     README.md
20     ChangeLog.md
21
22 source-repository head
23   type: git
24   location: https://github.com/githubuser/my-first-project
25
26 library
```

The `package.yaml` is used to generate the `.cabal` file automatically:

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```
1 name: my-first-project
2 version: 0.1.0.0
3 github: "githubuser/my-first-project"
4 license: BSD3
5 author: "Author name here"
6 maintainer: "example@example.com"
7 copyright: "2021 Author name here"
8
9 extra-source-files:
10 - README.md
11 - ChangeLog.md
12
13 # Metadata used when publishing your package
14 # synopsis: Short description of your package
15 # category: Web
16
17 # To avoid duplicated efforts in documentation and dealing with the
18 # complications of embedding Haddock markup inside cabal files, it is
19 # common to point users to the README.md file.
20 description: Please see the README on GitHub at <https://github.com/githubuser/my-first-project#readme>
21
22 dependencies:
23 - base >= 4.7 && < 5
24
25 library:
26   source-dirs: src
```

Building and running a project

The basic commands:

- `stack build`
- `stack run`
- `stack exec`
- `stack ghci`
- `stack clean`
- `stack test`

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The roles of all these commands follow from their quite self-explanatory names.

Hackage

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singletons: Basic singleton types and definitions

[BSD3, dependent-types, library] [Propose Tags]

`singletons` contains the basic types and definitions needed to support dependently typed programming techniques in Haskell. This library was originally presented in *Dependently Typed Programming with Singletons*, published at the Haskell Symposium, 2012.

(<https://cs.brynmawr.edu/~rae/papers/2012/singletons/paper.pdf>)

`singletons` is intended to be a small, foundational library on which other projects can build. As such, `singletons` has a minimal dependency footprint and supports GHCs dating back to GHC 8.0. For more information, consult the `singletons` [README](#).

You may also be interested in the following related libraries:

- The `singletons-th` library defines Template Haskell functionality that allows *promotion* of term-level functions to type-level equivalents and *singling* functions to dependently typed equivalents.
- The `singletons-base` library uses `singletons-th` to define promoted and singled functions from the `base` library, including the `Prelude`.

[\[Skip to Readme\]](#)

[Build](#) [Install](#) [Documentation](#) [Available](#)

Modules

[Index] [Quick Jump]

Data

Data.Singletons
Data.Singletons.Decide
Data.Singletons.ShowSigma
Data.Singletons.Sigma

Versions [RSS] [faq]

0.8, 0.8.1, 0.8.2, 0.8.3, 0.8.4, 0.8.5, 0.8.6, 0.9.0, 0.9.1, 0.9.2,
0.9.3, 0.10.0, 1.0, 1.1, 1.1.1, 1.1.2, 1.1.2.1, 2.0, 2.0.0.1, 2.0.0.2,
2.0.1, 2.1, 2.2, 2.3, 2.3.1, 2.4, 2.4.1, 2.5, 2.5.1, 2.6, 2.7, **3.0**

Change log

[CHANGES.md](#)

Dependencies

base (≥4.9 & <4.16) [details]

License

BSD-3-Clause

Author

Richard Eisenberg <rae@cs.brynmawr.edu>, Jan Stolarek
<jan.stolarek@p.lodz.pl>

Maintainer

Ryan Scott <ryan.glscott@gmail.com>

Category

Dependent Types

Home page

<http://www.github.com/goldfrere/singletons>

Bug tracker

<https://github.com/goldfrere/singletons/issues>

Source repo

this: git clone
<https://github.com/goldfrere/singletons.git> (tag v3.0)
(singletons)
head: git clone <https://github.com/goldfrere/singletons.git>
-b master(singletons)

Uploaded

by [ryanglscott](#) at 2021-03-12T17:18:32Z

Hoogle is a sort of Haskell search engine. Webpage:
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set:stackage
Search

Packages

- is:exact
- is:module
- base
- Cabal
- hedghog
- semigroupoids
- comonad
- rio
- numeric-prelude
- relude
- universum
- foundation
- basement
- clash-prelude
- dimensional
- ghc
- ghc-lib-parser

fmap

fmap :: Functor f => (a -> b) -> f a -> f b
 base Prelude Control.Monad.Control.Monad.Instances.Data.Functor.GHC.Base, Cabal Distribution.Compat.Prelude.Internal, hedghog Hedghog.Internal.Prelude, semigroupoids Data.Functor.Apply.Data.Functor.Bind, comonad Control.Comonad, rio RIO.Prelude, numeric-prelude NumericPrelude NumericPrelude.Base, relude Relude.Functor.Reexport, universum Universum.Functor.Reexport, foundation Foundation, basement Basement.Compat.Base.Basement.Imports, clash-prelude Clash.Haskell.Prelude, dimensional Numeric.Units.Dimensional.Prelude, ghc GhcPrelude, ghc-lib-parser GHC.Prelude, rebase Rebase.Prelude, nri-prelude NriPrelude, massiv-test Test.Massiv.Utils, numhask NumHask.Prelude, stack Stack.Prelude, mixed-types-num Numeric.MixedTypes.PreludeHiding, loc Data.Loc.Internal.Prelude, faktory Faktory.Prelude, hledger-web Hledger.Web.Import, tonalude Tonalude, zio ZIO.Trans

Using ApplicativeDo: 'fmap f as' can be understood as the do expression

fmap :: Functor f => (a -> b) -> f a -> f b
 base-compat Control.Monad.Compat.Data.Functor.Compat.Prelude.Compat, protolude Protolude Protolude.Functor, base-prelude BasePrelude, basic-prelude CorePrelude, base-compat-batteries Control.Monad.Compat.Data.Functor.Compat, prelude-compat Prelude2010, llvm-hs-pure LLVM.Prelude LLVM.Prelude, xmonad-contrib XMonad.Config.Prime, LambdaHack Game.LambdaHack.Core.Prelude Game.LambdaHack.Core.Prelude, can-i-haz Control.Monad.Except.CoHas Control.Monad.Reader.Has, yesod-paginator Yesod.Paginator.Prelude

fmap :: Functor f => a -> b -> f a -> f b
 classy-prelude ClassyPrelude, control-monad-free Control.Monad.Free, distribution-opensuse OpenSuse.Prelude OpenSuse.Prelude

fmap :: Functor f => (a <=> b) -> f a -> f b
 invertible Control.Invertible.Functor.Data.Invertible.Prelude

20/23

Hackage Search

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Hackage Search

[Expand All](#) [Collapse All](#)

[Query Examples](#) [Regex Syntax Reference](#)

Q `CmpSymbol`

AspectAG-0.6.0.0

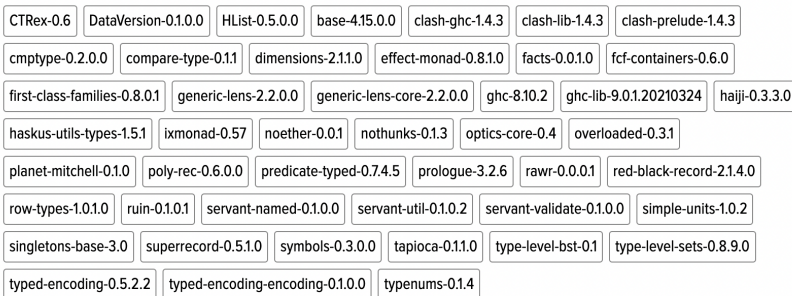
src/Language/Grammars/AspectAG/RecordInstances.hs

```
43
44 type instance Cmp ('Att a _) ('Att b _) =
45   CmpSymbol a b
46
47 type instance Cmp ('Prd a _) ('Prd b _) =
48   CmpSymbol a b
49
50 type instance Cmp ('Chi a _ _) ('Chi b _ _) =
51   CmpSymbol a b
52
53
```

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Search completed (161 matches across 47 packages)

Summary

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1. General aspects of GHC and GHCi
2. The Haskell Platform installation
3. Dependency management using Stack and Cabal
4. In other words, the Haskell ecosystem in a nutshell

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On the next seminar, we will discuss:

1. The basic Haskell syntax
2. The underlying aspects of the Haskell type system
3. Functions and lambdas
4. Immutability and laziness