The HERMIT in the Tree

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- Alternative: GHC Core, the Glasgow Haskell Compiler's intermediate language

GHC Core

System F (polymorphic lambda calculus), extended with let-bindings, constructors and first-class proofs of type equality (coercions).

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```
type Prog = [Bind]

data Bind = NonRec Var Expr
          | Rec [(Var, Expr)]

data Expr = Var Var
          | Lit Literal
          | App Expr Expr
          | Lam Var Expr
          | Let Bind Expr
          | Case Expr [Alt]
          | Cast Expr Coercion
          | Type Type
          | Coercion Coercion

type Alt  = (Constructor, [Var], Expr)
```

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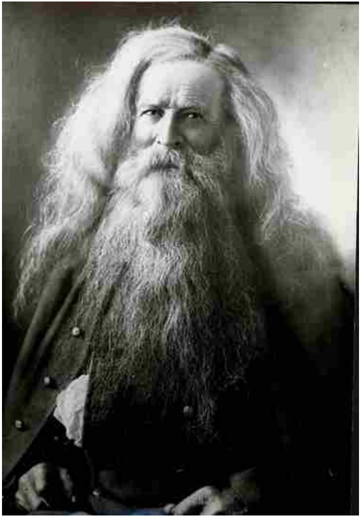
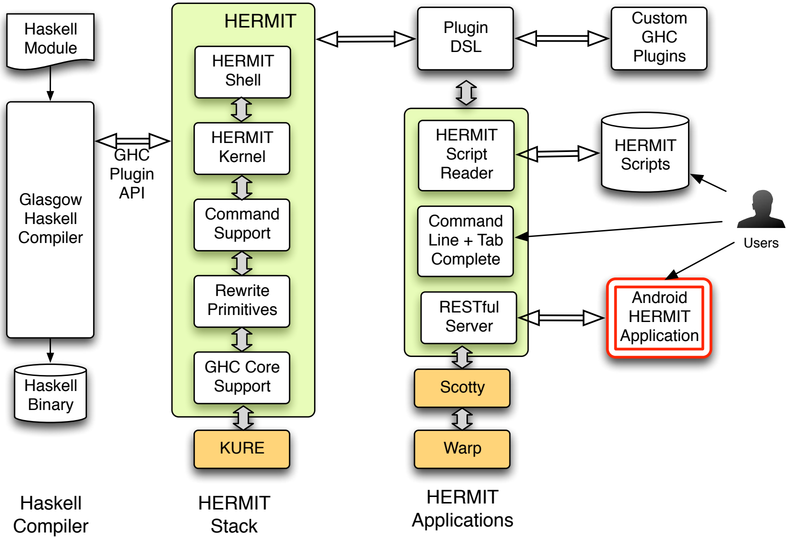
- Not to be confused with: The Kansas Hermit (1826–1909), also from Lawrence.



(image from http://www.angelfire.com/ks/larrycarter/LC/OldGuardCameron.html)

The HERMIT Project



Downloading and Running HERMIT

HERMIT requires GHC 7.6 or 7.8.

1. `cabal update`
2. `cabal install hermit`
3. `hermit Main.hs +MyModule1 +MyModule2`

The `hermit` command invokes GHC on `Main.hs`, and runs HERMIT on the specified modules.

Demo: Transforming Fibonacci

$$\textbf{data}\ \mathit{Nat} = \mathsf{Zero} \mid \mathsf{Succ}\ \mathit{Nat}$$

$$\begin{aligned}
&\mathit{fib} :: \mathit{Nat} \to \mathit{Nat}\\
&\mathit{fib}\ \mathsf{Zero} &&= \mathsf{Zero}\\
&\mathit{fib}\ (\mathsf{Succ}\ \mathsf{Zero}) &&= \mathsf{Succ}\ \mathsf{Zero}\\
&\mathit{fib}\ (\mathsf{Succ}\ (\mathsf{Succ}\ \mathsf{n})) &&= \mathit{fib}\ (\mathsf{Succ}\ \mathsf{n}) + \mathit{fib}\ \mathsf{n}
\end{aligned}$$

Demo: Transforming Fibonacci

```
data Nat = Zero | Succ Nat

fib :: Nat → Nat
fib Zero                = Zero
fib (Succ Zero)         = Succ Zero
fib (Succ (Succ n)) = fib (Succ n) + fib n


fib :: Nat → Nat
fib n = let work :: Nat → (Nat, Nat)
            work Zero       = (Zero, Succ Zero)
            work (Succ m) = let (x, y) = work m
                            in (y, x + y)
        in
            fst (work n)
```

HERMIT Commands

- Core-specific rewrites, e.g.
  - beta-reduce
  - eta-expand '*x*
  - inline
- Strategy combinators (from KURE), e.g.
  - any-td *r*
  - repeat *r*
  - innermost *r*
- Navigation, e.g.
  - binding-of '*foo*, occurrence-of '*x*
  - lam-body, app-arg, case-alt 2
- Version control, e.g.
  - log
  - back, step
  - save “myscript.hec”
- Presentation, e.g.
  - set-pp-type Show
  - set-pp ghc

Adding Transformations to HERMIT

Two main ways:

- Writing a HERMIT-extension Plugin
  - using KURE on the Core AST
  - full power of Haskell
  - easy to make mistakes
- Using GHC Rules
  - lightweight (can be included in the source code of the object program)
  - type checked by GHC
  - limited by the expressiveness of RULES

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  - HERMIT can be used to test/debug RULES

Summary

- HERMIT is a tool for interactively transforming GHC Core programs
- Currently very experimental
- Ongoing work: support for equational reasoning
- Publications describing HERMIT:
    - *The HERMIT in the Machine* [FGKS12] — HERMIT implementation
    - *The HERMIT in the Tree* [SFG13] — mechanising known transformations

  Publications using HERMIT to prototype new optimisations:
    - *The HERMIT in the Stream* [FHG14] — stream fusion
    - *Optimizing SYB is Easy!* [AFM14] — data-type–generic programming

References

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