

# Rebooting Supercompilation for Haskell

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# Rebooting Supercompilation for Haskell - Talk outline

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- Overview of how it works.
- "But where's my supercompiler for Haskell?" My preliminary work and research goals.

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  - Evaluate programs in compile-time, while making the most out of known inputs and definitions.
    - Definitions of used functions.
    - Statically known arguments of functions.
    - When branching, propagate learned information through branches and make use of that information while compiling branches. (case expressions)

# Supercompilation: An overview

- The paper that describes the idea in English: "The Concept of a Supercompiler" Turchin [1986].
- High-level idea: (contd)
  - Evaluate programs in compile-time, while making the most out of known inputs and definitions.
    - Most of the time the goal is to generate more efficient programs.  
(but see Klyuchnikov and Romanenko [2010] for a different use of supercompilation)

# Supercompilation in the context of Haskell

- Why is it interesting?
- In a sense, it's the "ultimate" optimization. ("-O99")
- This optimizes in the sense that:  
If we have a programs  $\mathcal{P}_1$  and  $\mathcal{P}_2$ , and  
 $\mathcal{P}_1 \Downarrow v$  in  $N$  steps and  
 $\mathcal{P}_2 \Downarrow v$  in  $M$  steps,  
we consider  $\mathcal{P}_2$  optimized if  $M < N$ .
- An approximation, but works well in practice.

# Supercompilation in the context of Haskell

- It generalizes:
  - Deforestation(Wadler [1988])
  - Partial evaluation
  - Call-pattern specialization(Peyton Jones [2007])
  - Ad-hoc optimizations via rewrite rules, e.g. shortcut fusion (Gill et al. [1993]) or library-specific rewrite rules
  - "Optimizing SYB is Easy!" (Adams et al. [2014]) and "Optimizing Generics is Easy!" (Magalhães et al. [2010]) style "domain-specific" partial evaluators
  - Function specialization(SPECIALIZE pragmas)
  - ... and many more

# Current state-of-the-art

- Bolingbroke [2013] shows some great potential:
  - Up to  $-95.1\%$  runtime improvement.
  - Up to  $-100.0\%$  allocation improvement.
- But it also suffers from problems that are inherent to supercompilation:
  - "We do not attempt to supercompile the full Nofib suite because the other Nofib benchmarks are considerably more complicated and generally suffer from extremely long supercompilation times."  
(Jonsson [201?] focuses on compilation performance, and reports  $<3$  seconds for all the small programs from Nofib)
  - Up to  $+132002.0\%$  in compile time.
  - Up to  $+188.9\%$  in generated code size.

# How it works? An overview

Bolingbroke [2013] laid out a great framework for supercompiling Haskell:

- **Driving:** Take steps according to operational semantics. Some additional steps like case-of-case transformation (Jones and Santos [1998]).



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- **Matching:** Evaluating open terms lead to loops. Matcher tried to detect loops, returns information about how to refer to this new loop.
- **Termination checking:** Because perfect matcher is not possible, and some programs just loop.

## How it works? An overview

```
mapOfMap f g = (.) (map f) (map g)
```

```
h1 f g a = map f (map g a)
```

```
h2 f g a =  
  (\f lst -> case lst of  
    []      -> []  
    h : t   -> f h : map f t) f (map g a)
```

```
h3 f g a =  
  case (map g a) of  
    []      -> []  
    h : t   -> f h : map f t
```

## How it works? An overview

```
h3 f g a =  
  case (map g a) of  
    []      -> []  
    h : t -> f h : map f t
```

```
h4 f g a =  
  case (case a of  
    []      -> []  
    h1 : t1 -> g h1 : map g t1) of  
    []      -> []  
    h0 : t0 -> f h0 : map f t0
```

## How it works? An overview

```
h4 f g a =  
  case (case a of  
    []      -> []  
    h1 : t1 -> g h1 : map g t1) of  
    []      -> []  
    h0 : t0 -> f h0 : map f t0
```

Case-of-case transformation: (Jones and Santos [1998])

```
h5 f g a =  
  case a of  
    [] -> case [] of  
      []      -> []  
      h0 : t0 -> f h0 : map f t0  
    h1 : t1 ->  
      case (g h1 : map g t1) of  
        []      -> []  
        h0 : t0 -> f h0 : map f t0
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  case a of  
    [] -> case [] of  
            [] -> []  
            h0 : t0 -> f h0 : map f t0  
    h1 : t1 ->  
      case (g h1 : map g t1) of  
        [] -> []  
        h0 : t0 -> f h0 : map f t0
```

```
h6 f g a =  
  case a of  
    [] -> []  
    h : t -> f (g h) : map f (map g t)
```

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h6 f g a =  
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```

---

map f (map g t)

Looks similar to:

```
h1 f g a = map f (map g a)
```

## How it works? An overview

At this point splitter tell us there's a loop.

```
h7 f g a =  
  case a of  
    []      -> []  
    h : t -> f (g h) : h7 f g t
```

Supercompiled version doesn't generate intermediate list.

## Another example, growing arguments

```
reverse_acc []      acc = acc
reverse_acc (h : t) acc = reverse_acc t (h : acc)
goal lst = reverse_acc (reverse_acc lst []) []

h0 lst = reverse_acc (reverse_acc lst []) []
...
h5 lst = case lst of
  []      -> []
  h1 : t1 -> case (reverse_acc t1 (h1 : [])) of
    []      -> []
    h0 : t0 -> reverse_acc t0 (h0 : [])
...
h_ lst = ... reverse_acc t1 (h1 : []) ...
...
h_ lst = ... reverse_acc t2 (h2 : h1 : []) ...
...
```

## Another example, growing arguments

What to do after stopping is completely different story.

Generalization

Rollback

Other/new ideas?

# Problems with supercompilation operations

Each operation has hard problems to solve.

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But we still don't have a working implementation.

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- I'm rebooting the supercompiler!
- The goal here is to distribute it as a package, downloadable from Hackage.
- Then the research will follow.

# Problems

# Thanks!

Github: [osa1/sc-plugin](#)

IRC: [osa1](#)

Email me your slow programs: [oagacan@indiana.edu](mailto:oagacan@indiana.edu)



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