

Haskell Dynamic Tracing

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28th April, 2021

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Introduction

- Haskell is a [lazy](#) language

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- Delays evaluation of an expression until its value is needed

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snd :: (Int, Int) -> Int
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snd (x, y) = y
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foo :: Int
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foo = snd (complexComputation, 3)
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```
snd :: (Int, Int) -> Int
```

```
snd (x, y) = y
```

```
foo' :: Int
```

```
foo' = snd (error "oops!", 3)
```

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- Shares evaluated subexpressions

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```
let x = complexComputation  
in  f (x, x)
```


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Goals

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- Develop a [dynamic tracing](#) framework

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- Develop a [dynamic tracing](#) framework
- Tool capable of analysing real-world Haskell programs

- Interesting landscape – Haskell is heavily used in academia

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- Lack of empirical results despite extensive theoretical study
- Laziness has advantages as well as significant downsides

- Unnecessary laziness leads to [large memory overhead](#)

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- Some tools designed to avoid too much laziness (nothunks, BangPatterns)

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- Some tools designed to avoid too much laziness (nothunks, BangPatterns)
- Black-box problem: developers lack insight about the runtime state

- Compiler plugin for the [Glasgow Haskell Compiler](#)

Our solution

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- Transforms surface syntax of Haskell to add tracing calls

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- Compiler plugin for the [Glasgow Haskell Compiler](#)
- Transforms surface syntax of Haskell to add tracing calls
- Traces evaluation of function calls and function arguments

Our solution

```
qsort [] = []  
qsort (a:as) = qsort left ++ [a] ++ qsort right  
    where (left, right) = (filter (<=a) as, filter (>a) as)  
  
main = print $ qsort [1 + 8, 4, 0, 3, 1, 23, 11, 18]
```

Our solution

```
qsort (a : as) = let !call_number_1 = traceEntry "qsort"
                  in qsort left
                      ++ [(traceArg "qsort") "a" call_number_1 a]
                      ++ qsort right

where
(left, right) = let !call_number_2 = traceEntry "qsort"
                  in (filter
                      (<= (traceArg "qsort") "a" call_number_2 a)
                      (traceArg "qsort") "as" call_number_2 as,
                      filter
                      (> (traceArg "qsort") "a" call_number_2 a)
                      (traceArg "qsort") "as" call_number_2 as)
```

Our solution

Timestamp	Thread ID	Trace type	Function	Call ID	Argument	Closure
950778579	ThreadId 1	EntryTrace	qsort	1		
949631938	ThreadId 1	ArgTrace	qsort	1	as	constr
951867310	ThreadId 1	ArgTrace	qsort	1	a	thunk
952240416	ThreadId 1	EntryTrace	qsort	2		
952223429	ThreadId 1	ArgTrace	qsort	2	as	thunk
952269949	ThreadId 1	ArgTrace	qsort	2	a	constr
...						

- Compile-time [rewriting of programs](#) via a plugin for the Glasgow Haskell Compiler


Summary

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- Annotation with side-effecting tracing functions

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- Compile-time **rewriting of programs** via a plugin for the Glasgow Haskell Compiler
- Annotation with side-effecting tracing functions
- Compiled program records a trace of relevant events alongside regular output

Thank you for listening.

 Kvapil, Ondřej. *Haskell Dynamic Tracing*. Bachelor's thesis. Czech Technical University in Prague, Faculty of Information Technology, 2021.

<https://gitlab.fit.cvut.cz/kvapiond/bachelors-thesis>

<https://github.com/viluon/bachelors-thesis>