Haskell Performance Measurements

what to do if laziness has bitten you (or you've eaten too much memory)

Bohdan Liesnikov

@phittacus

2018.04.22

Overview

Spoilers!

Overview

Spoilers!

This talk isn't an eye-opening one.

Overview

Spoilers!

This talk isn't an eye-opening one.

- there are profiling tools in haskell

Overview

Spoilers!

This talk isn't an eye-opening one.

- there are profiling tools in haskell
- they are actually usable

Overview

Spoilers!

This talk isn't an eye-opening one.

- there are profiling tools in haskell
- they are actually usable
- there is a couple of funny quirks and techniques along the way

Overview (like, a serious one)

- why do you need it?
  (isn't Haskell ponies and butterflies anyway?)
- time profiling
- memory profiling

Ponies and butterflies

Space leak

Ponies and butterflies

Space leak

- Not similar to memory leaks

Ponies and butterflies

Space leak

- Not similar to memory leaks
- “Space leak” simply means that we can do better

Ponies and butterflies

Space leak

- Not similar to memory leaks
- "Space leak" simply means that we can do better
- Classic example

```
let xs = [1..1000000::Integer]
in  sum xs * product xs
```

Optimizations

An interesting theme for all[1]of us[2]

---

[1]Functional Programming with Bananas, Lenses, Envelopes and Barbed Wire. 1991. E. Meijer, M. Fokkinga, R. Paterson [pdf]

[2]Blog posts by Don Stewart
https://donsbot.wordpress.com/tag/fusion/

Optimizations

An interesting theme for all[1]of us[2]

- Fusion

```
map f . map g → map (f . g)
```

[1]Functional Programming with Bananas, Lenses, Envelopes and Barbed Wire. 1991. E. Meijer, M. Fokkinga, R. Paterson [pdf]

[2]Blog posts by Don Stewart
https://donsbot.wordpress.com/tag/fusion/

Optimizations

An interesting theme for all[1]of us[2]

- Fusion

```
map f . map g → map (f . g)
```

- Strictness (in some arguments)

---

[1]Functional Programming with Bananas, Lenses, Envelopes and Barbed Wire. 1991. E. Meijer, M. Fokkinga, R. Paterson [pdf]

[2]Blog posts by Don Stewart
https://donsbot.wordpress.com/tag/fusion/

Optimizations

- Hylomorphism
  Catamorphism followed by anamorphism
  (fold then unfold)

Optimizations

- Hylomorphism
  Catamorphism followed by anamorphism
  (fold then unfold)
- Metamorphism
  Anamorphism followed by catamorphism
  (unfold then fold)

Optimizations

- Hylomorphism
  Catamorphism followed by anamorphism
  (fold then unfold)
- Metamorphism
  Anamorphism followed by catamorphism
  (unfold then fold)


Speed
PHEW! THIS SHOULD HELP-
Functional data structures
C FFI
Profiling
foldl'

Example

- takes three file names (initial, series of diffs and final)
- parses them
- checks if they are fine
- prints a verdict out

Example

- takes three file names (initial, series of diffs and final)
- parses them
- checks if they are fine
- prints a verdict out

initial:	diff:	final:

`me`
`you`
	`# 2018.04.22 13:00`
	`< me`
	`> them`
		`you`
		`them`

The simplest approach

- In ghci

```
*Main> :set +s
*Main> process $ Files { initial = "i.list"
                       , final   = "f.list"
                       , diff    = "d.list"}
this is a correct diff
(10.11 secs, 11,753,183,352 bytes)
```

  Not the same timing you would get in a real setting

The simplest approach

- Debug statements

```
import Debug.Trace (trace)
...
flip trace () $ "before" ++ show getCurrentTime
...
flip trace () $ "after"  ++ show getCurrentTime
```

  Meh

Compiling

You can't just profile it right away — we need to compile it properly beforehand

```
ghc-options:
  ...
  --enable-profiling # and/or --enable-library-profiling
  -fprof-auto
  -rtsopts
```

Yes, this actually means recompiling libraries with profiling enabled

Simple approach

```
./dist/build/demo/demo +RTS
-sstderr
```

```
...
INIT    time    0.002s  (  0.001s elapsed)
MUT     time    0.343s  (  0.339s elapsed) <- doing useful things
GC      time    0.349s  (  0.346s elapsed) <- gc is gc
RP      time    0.000s  (  0.000s elapsed)
PROF    time    0.000s  (  0.000s elapsed)
EXIT    time    0.003s  (  0.004s elapsed)
Total   time    0.697s  (  0.690s elapsed)
...
Alloc rate    3,426,690,480 bytes per MUT second

Productivity  68.7% of total user, 68.8% of total elapsed
```

Stack traces and flame graphs

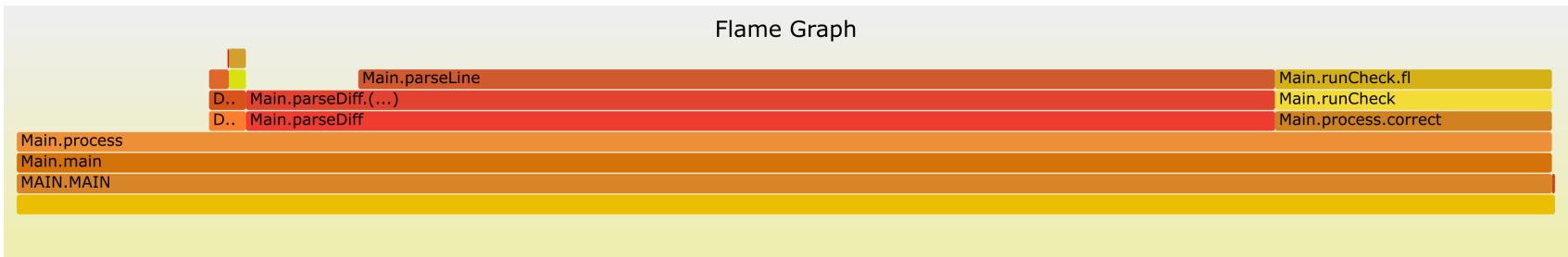
```
./dist/build/demo/demo +RTS -p
```

```
                                          1        2     3       4       5
                                                 individual   inherited
COST CENTRE          MODULE SRC no. entries  %time %alloc %time  %alloc
...
 parseDiff           Main   ... 419       1  0.0    0.0   39.6   66.9
  parseDiff.(...)    Main   ... 421       1  5.9    7.3   39.6   66.9
   parseLine         Main   ... 422  161080  26.7   59.6  33.7   59.6
...
```

1. entries — number of times this particular point in the call tree was entered
2. %time — percentage of the total run time of the program spent at this point
3. %alloc — percentage of the total memory allocations of the program made by this call
4. %time — percentage of the total run time of the program spent below this point in the call tree.
5. %alloc — percentage of the total memory allocations of the program made by this call and all of its sub-calls

Stack traces and flame graphs

- FlameGraph by Brendan Gregg
- ghc-prof-flamegraph by FP Complete



So good graphs, immedately runs faster

Cost centers

- Cost centres are just program annotations

  ```
  {-# SCC "name" #-} <expression>
  ```

- `-fprof-auto` automatically insert a cost centre annotation around every binding not marked INLINE in your program
- You are entirely free to add cost centre annotations yourself.

Space profiling

Not that easy with lazy evaluation and all the transformations [3]
All we can do — get some measurements from the beforementioned tools

[3] You can do that, just it isn't pleasant in any way

[4] Neil Mitchell Detecting Space Leaks. 2015
https://neilmitchell.blogspot.com/2015/09/detecting-space-leaks.html

Space profiling

Not that easy with lazy evaluation and all the transformations [3]
All we can do — get some measurements from the beforementioned tools
Or we can try to detect space leaks using a cute trick[4]

---

[3] You can do that, just it isn't pleasant in any way

[4] Neil Mitchell Detecting Space Leaks. 2015
https://neilmitchell.blogspot.com/2015/09/detecting-space-leaks.html

Space profiling

- Run the program with a specific stack size, `./demo +RTS -K100K` to run with a 100Kb stack.
- Increase/decrease the stack size until you have determined the minimum stack for which the program succeeds
- Reduce the stack by a small amount and rerun

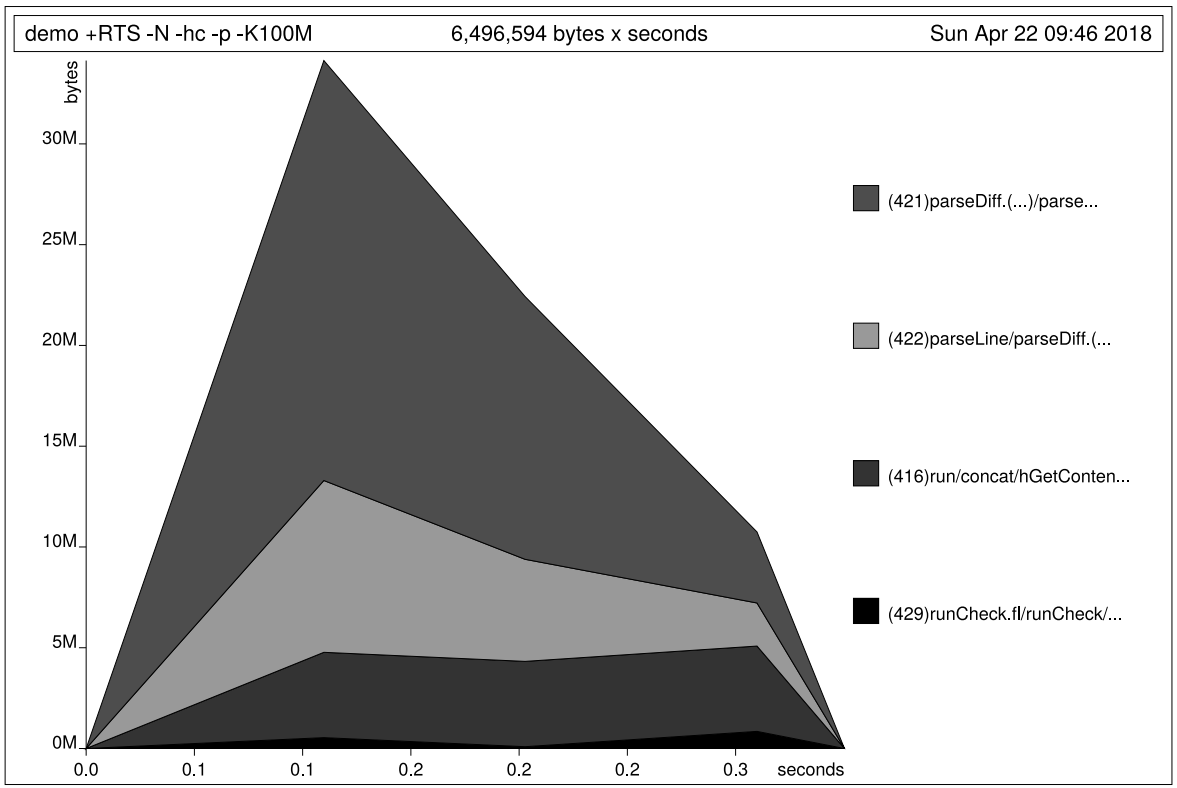
Space profiling

- The `-xc` run will print out the stack trace on every exception, look for the one which says stack overflow
- Attempt to fix the space leak, confirm by rerunning
- Repeat until the test works with a small stack, typically `-K1K`.

Space profiling can have nice graphs too!

add `-caf-all` to ghc-flags and then run as

```
./demo +RTS -hc -p -K100M
```



Questions?