Haskell for a New Decade

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Stephen 💖 Haskell

A community of people that think about the future, rather than just about the present.

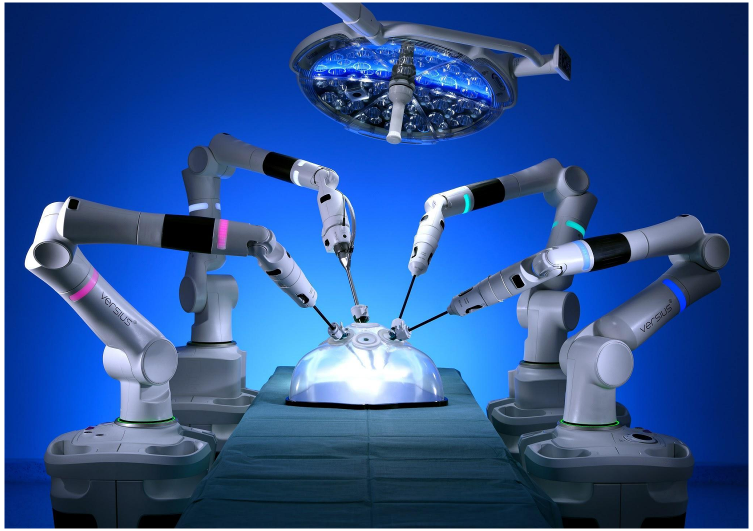
Software is Terrible and Getting Worse

- Late stage Moore's Law.
- End-user software is bloated, slow, insecure, and increasingly tied to a legacy stack our industry cannot afford to change.
- Software is only getting more expensive to write.
- We are forced to live with the bad decisions of the past forever.
- Our industry has gotten sloppy.
- Open source programming culture has changed. We sold out.
- Software is a pop culture.

Medicine in 1300
Software “engineering” in 2020

Medicine in 2020

A surgeon letting blood from a woman's arm. 18th (?) century. Wellcome Collection. CC BY4.0 https://wellcomecollection.org/works/e5jr3b89



Software is still at the blood-letting & leeching stage.

The Timescales of Progress

- Lambda calculus was discovered/invented in 1930.
- Second-order polymorphic lambda calculus was discovered by Girard in 1972.
- First GC appeared in 1959, didn't find mainstream adoption until 1992.
- Ideas that are in invented in functional languages find their way into other languages at about a 10-20 year lag.
- Proebsting's Law: Improvements to compiler technology double the performance of typical programs every 18 years.

Is it meaningful to ask if there is *progress* in programming languages? Or is our field merely a function of the fashions, whims, and tastes of our era.

Time scale of progress is slooooow!

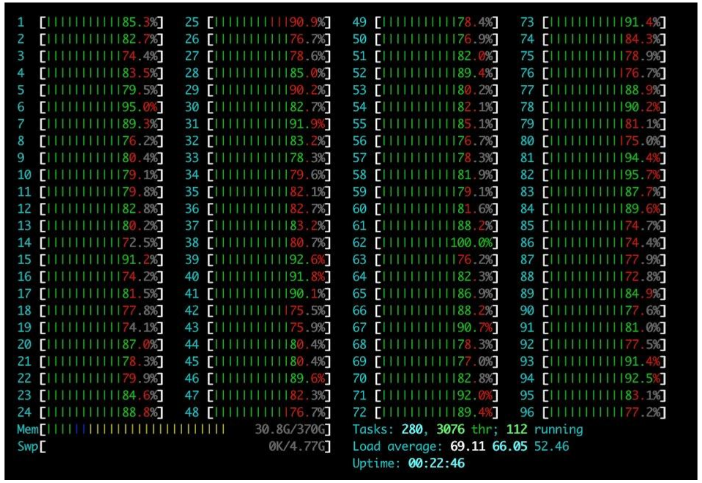
The Past

- 1989 - A very different time in software.
  - Berlin Wall fell
  - Apple Computer Macintosh SE/30 released
  - Intel 80486DX released
  - MS-DOS 4.01
  - Lotus Notes released
  - CERN "Information Management: A Proposal" (i.e. The Internet)
  - First Haskell language proposal.

Haskell is an OLD language!

The Present

- 2020 - Some things have changed.
    - GHC 8.10.1
    - A stable industrial-strength compiler
    - Fast concurrent runtime
    - Build tooling
    - Extensible compiler plugins
    - Pseudo-dependent types
    - Improving editor integration
    - Thriving package ecosystem



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                                                    Uptime: 00:22:46
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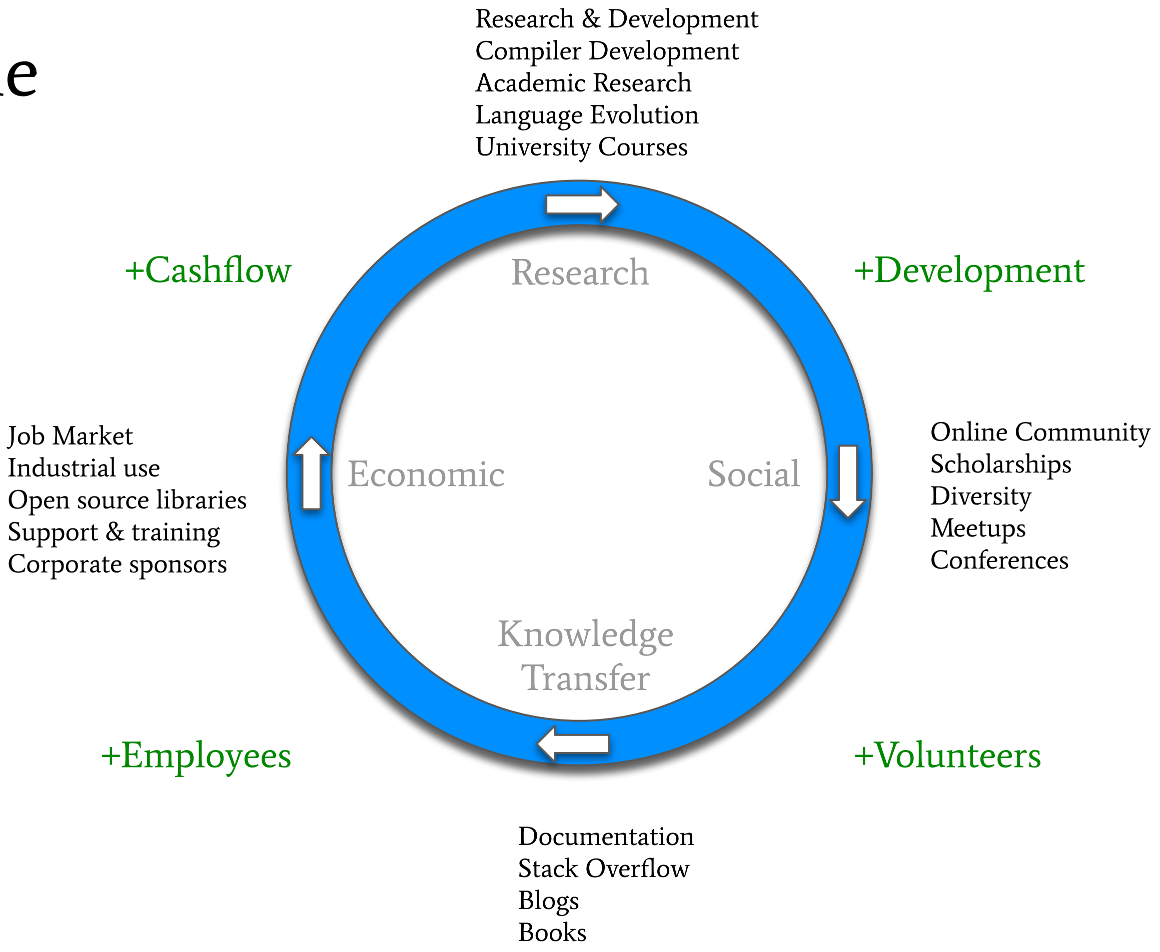
PL Economic Engine

A language community is an **economic engine.**

It's a fallacy to reduce all progress to a single spoke on the flywheel. There needs to be uniform torque!

Research alone won't move the wheel.
Community alone won't move the wheel

A PL community is a group of people who share in the success of common ideas.

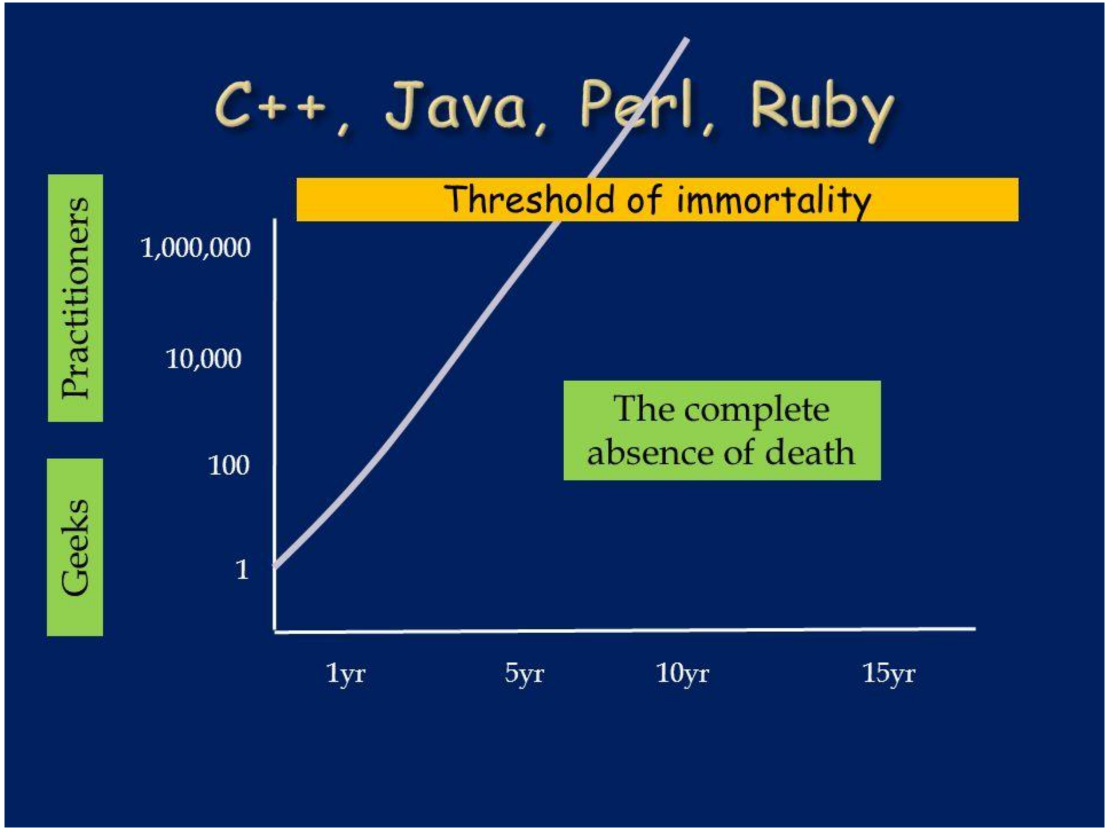


What if anything is Haskell good for?

- Compilers?
- Document preparation?
- Prototypes for papers?
- Proof assistants?
- Financial services?
- Static analysis?
- Crypto money laundering?

$\Big\}$ *Success?*

For a 30 year old language, it's very difficult to find many success stories!



Zombie Immortality

Time Lord Immortality

Complete absence of death has multiple readings

Future: Stagnation and Sclerosis

- The Standard ML fate.
- A curiosity left for students at university to study and then never use.
- The barrier to entry for GHC development remains impossibly high.
- The cartesian product of the semantics for all language extensions exceeds human cognitive capacity to maintain.
- Hackage ecosystem bitrots into an archive of abandonware.

Future: Steady State

- A small group of students learn Haskell at university. They leave university and go write Java in industry.
- Hobbyists at German meetups meet several times a year and talk about the latest functional pearl.
- The language is blacklisted as unfit for production at large companies because laziness is the boogeyman.
- Another dozen papers on building red-black trees with dependent types.
- We continue the debate about the word *monad* being renamed to “warm fuzzy thing” after every new monad tutorial is written.
- High turnover of small companies.

Future: Growth

What does success look like?

How do we do to get there?

A New Decade!

Open source development drastically outperforms the market.

Open source: open as in open door, not as in open bar.

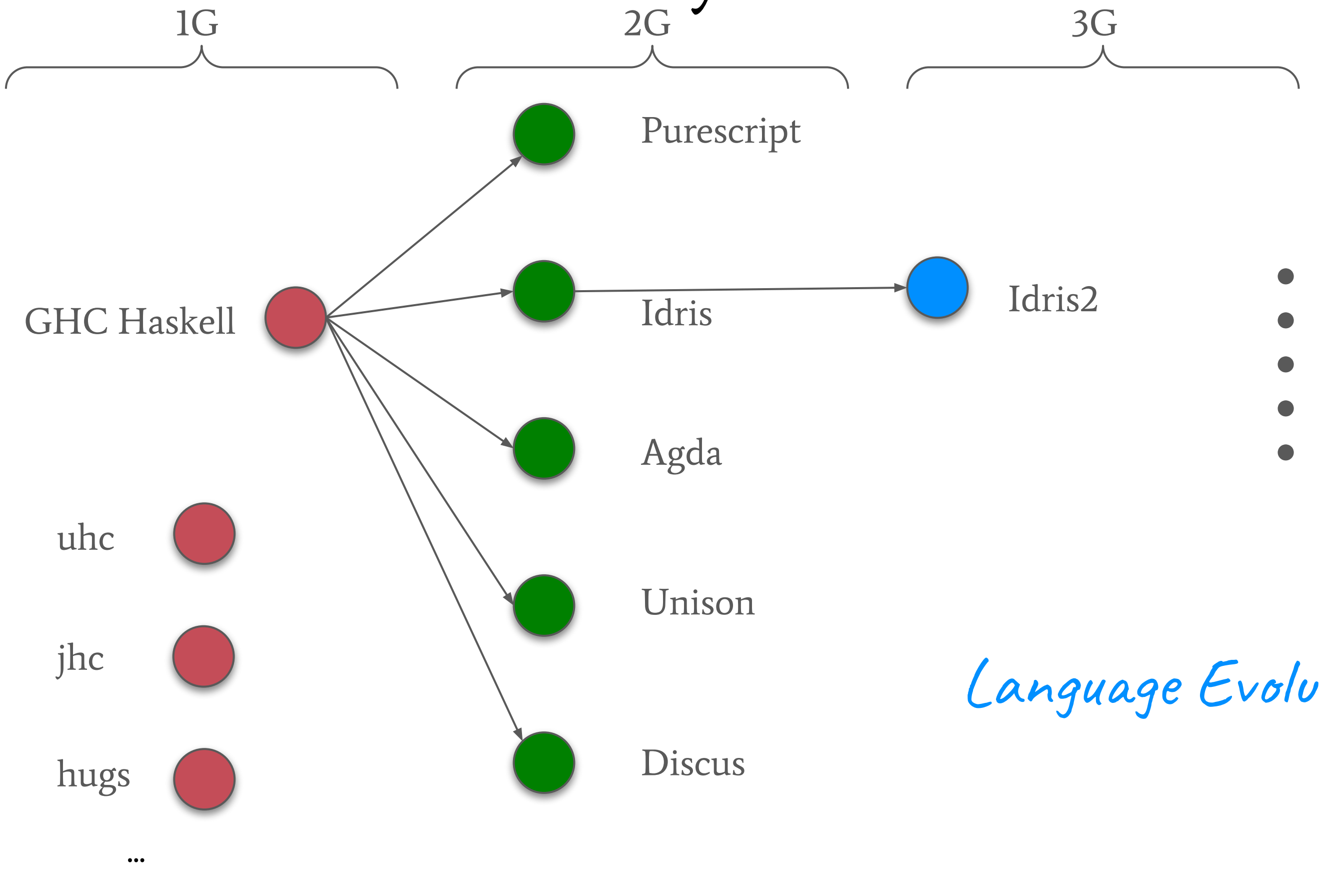
Leave the campground better than when you found it.

A new generation of FPers!

Ideas and trends that will carry the ecosystem into the future.

What Haskell open source should I work on?

The Haskell-like Family Tree



- Namespace records.
- Implicit Prelude.
- Numerical tower.
- Modules.
- Dependent core.

Language Evolution = Progress

Language Family

Is 2020 the decade of practical dependent types?

- We don’t know what we don’t know about the functional language design space.
- Most of the design space is unexplored.
- More compiler experiments are a **good** thing.
- All knowledge is derived from experience.
- Efficient backend code generation dominates the fate of functional languages.

Algebraic Effect Systems

- There are better models than MTL for effect handling.
  - https://hackage.haskell.org/package/polysemy
  - https://hackage.haskell.org/package/fused-effects
- Lots of optimisation and testing to do.
- Very few experiments programming with effects in the large.

```
example :: Members '[Trace, State Example, Error MyError] r => Sem r ()
example = do
  modify $ \s -> s {x = 1}
  trace "Logging message"
  throw MyError
```

GHC

- A **big** old quirky codebase.
- Everyone should build GHC from source at least once. https://ghc.dev
- Subscribe to ghc-devs. You will learn a lot about how the sausage gets made. https://mail.haskell.org/pipermail/ghc-devs/
- GHC development sustainability worries me a lot. I don't know how/if the language will continue in its current situation.
- GHC Haskell cannot remain *all things* to *all people* forever. The needs of different subsets of the community will eventually diverge under the current specification.

Compiler Performance

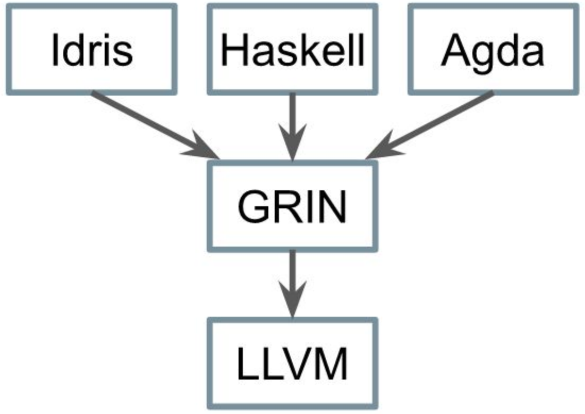
- On its current trajectory GHC may cross threshold of being almost unusably slow for large industrial codebases.
- Majority of compilation time is in the simplifier. All the big wins in GHC compile-times are to be had in optimising the simplifier.
- Compilation allocates a **lot** of memory.
- Shouldn't need to allocate u-6tb1.metal instances with TBs of RAM just to compile a project.

Pending crisis for industrial users?

GRIN

- A whole-program optimization framework for multiple functional languages.
- A compiler back-end for lazy and strict functional languages.
- Retargetable and reusable functional compilation framework based on LLVM for functional languages.

https://github.com/grin-compiler/grin
https://github.com/grin-compiler/ghc-grin
https://github.com/grin-compiler/ghc-wpc



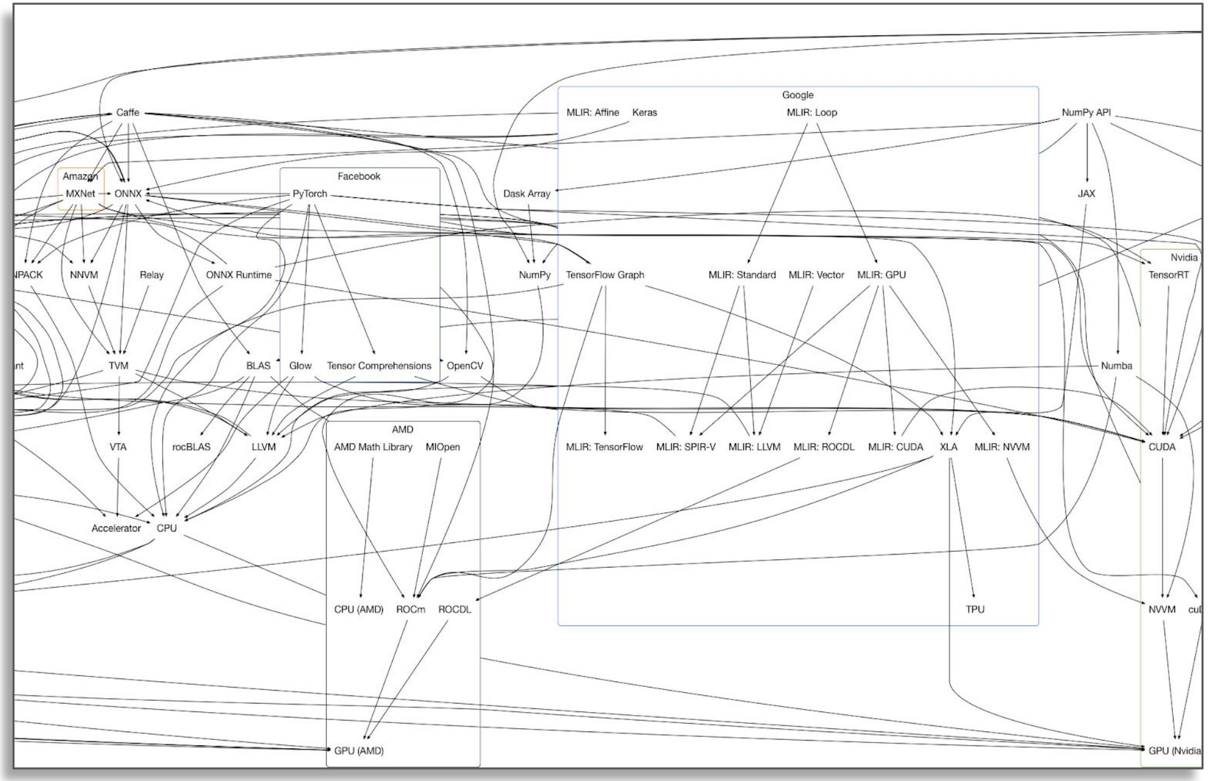
Editor Tooling

- ghcup is markedly improved.
- Cabal > 3.0 is markedly improved.
- Linking directly against the GHC & Cabal APIs used to a nightmare.
- https://hackage.haskell.org/package/hie-bios
- https://hackage.haskell.org/package/ghc-lib
- Early work on Language Server (hls)
- HIE Files

```
if impl(ghc >= 8.10)
   ghc-options:       -fwrite-ide-info
                      -hiedir=.hie
```

Machine Learning can learn from ML

- The Python ML ecosystem is reinventing functional compilers on top of Python for graph compilers.
  - JAX
  - Swift for TensorFlow
  - Torchscript
- There is a place for existing FP to enter this ecosystem with the interface being shared intermediate representations.
- MLIR (https://mlir.llvm.org)
- hasktorch/hasktorch
- google-research/dex-lang



Source: https://github.com/OpenTensors/ecosystem/blob/master/graph.png

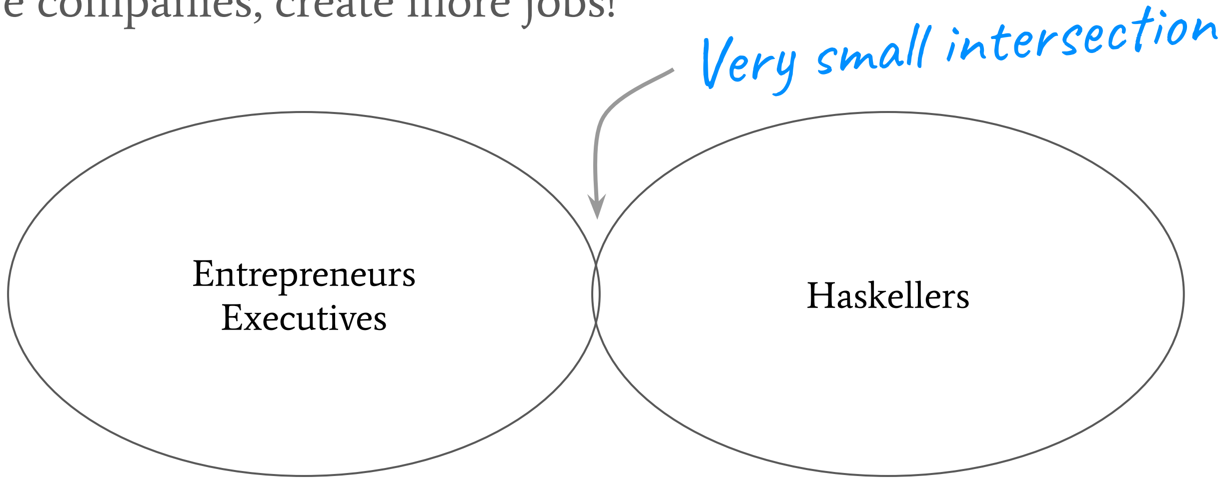
Computational Integrity Proofs

- Niche branch of computer science research being actively developed.
- Non-interactive zero-knowledge proofs (zkSNARKs)
- Small and computationally efficient zero-knowledge proofs of arbitrary computations.
- Currently quite computationally expensive proof construction, will become viable for large scale computation mid-decade at the current rate.
- A complete Haskell framework for circuit construction evaluation: https://github.com/adjoint-io/zkp

My company maintains these libraries.

Industry

- There is effectively no Haskell job market.
- The perception of Haskell in industry at large is not good.
- Large corporates are generally too risk averse.
- Early companies and SMEs.
- Start more companies, create more jobs!



Haskell 2030

Programming communities always like to believe our best days are ahead of us and our worst days behind us. But it's the **now** that's the issue and always has been.

Never accept the status quo in programming.

Dream of a better future in 2030.

Start building that future today.

🚀

Thank You

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https://gist.github.com/sdiehl/5e0e25d4a35d25abd3408d542ccfdf45