

# Functional Programming in Haskell

$\lambda$

Narendra Joshi

February 6, 2015

# Outline

- Functional view of the world
- Haskell and its brief history
- Perks of being a Haskeller
- Logistics of the workshop

# The Enterprise of Education

*Education should prepare young people for jobs that do not yet exist, using technologies that have not been invented, to solve problems of which we are not yet aware.*

# Imperative World by Example

---

```
/* Adding numbers from 1 to 5, inclusive */
```

```
int acc = 0;
```

```
int i = 1;
```

```
while (i <= 5) {  
    acc = acc + i;  
    i = i + 1;  
}
```

---

Let's think about it for a while.

- What is the model of computation in our mind?
- What are the elements that make up that model?
- Is it all relevant to our problem of adding up a sequence of numbers?

# Functional World by Example

---

```
-- Sum up the *sequence* 1 to 5, inclusive  
sum [1..5]
```

```
-- Definition of the sum function
```

```
sum [] = 0
```

```
sum listOfNumbers = head listOfNumbers + sum (tail listOfNumbers)
```

---

Answers to previous questions for you:

- Computation by calculation. Not commands and their execution.
- Hides details of execution. Lets us have more time to think about the problem.

# What gives?

---

```
/* Adding numbers from 1 to 5, inclusive */
```

```
int acc = 0;
int i = 1;

while (i <= 5) {
    acc = acc + i;
    i = i + 1;
}
```

---

- Book-keeping of events in time.
- Details of the machine spill up to our mental model.

---

```
-- Sum up the *sequence* 1 to 5, inclusive
sum [1..5]
```

```
-- Definition of the sum function
sum [] = 0
sum (x:xs) = x + sum xs
```

---

- Nice clean functional abstraction.
- Order of events that happen is based on data dependencies.

# Yet Another Example

## Imperative Code

---

```
/* Find first 2 primes in the range [1000, 1000000] */
```

```
int count = 0;
int primes[2] = {0};

for (int i = 1000; i <= 1000000 && count < 2; ++i) {
    if (is_prime(i))
        primes[count++] = i;
}
```

---

## Functional Code

---

```
-- Filter primes in the range [1000, 1000000]
primesInRange = filter isPrime [1000..1000000]

-- Take 2 out of them
twoPrimesInRange = take 2 primesInRange
```

---

# Key Points to Notice

## Imperative Code

---

```
/* Find first 2 primes in the range [1000, 1000000] */
```

```
int count = 0;
int primes[2] = {0};

for (int i = 1000; i <= 1000000 && count < 2; ++i) {
    if (is_prime(i))
        primes[count++] = i;
}
```

---

- Filtering primes and collecting them intertwined. Looks more efficient.
- We lost modularity when the above two operations mixed, .i.e no separation of *generation* from *selection*.

## Functional Code

---

```
-- Filter primes in the range [1000, 1000000]
primesInRange = filter isPrime [1000..1000000]
```

```
-- Take 2 out of them
twoPrimesInRange = take 2 primesInRange
```

---

- First filter primes from the sequence. Then pick two out of them. Perfect!
- Is it less efficient? Are you checking primality for every number in the range?

*That's being lazy with style!*



# What's Haskell?

Haskell is

- **Purely Functional**

*You have definitions not assignments. No mutation.*

- **Lazy**

*If something doesn't need to be computed, it will never be.*

- **Higher Order**

*Functions are first-class people. Like values, they can be input to other functions.*

- **General Purpose**

*It's not specific to any domain, e.g. SQL or html.*

# A little bit of History

Credits: Simon Peyton Jones

Pure functional programming:  
recursion, pattern matching,  
comprehensions etc etc  
(ML, SASL, KRC, Hope, Id)

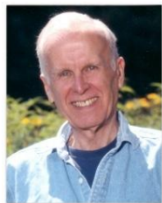
Lazy functional  
programming  
(Friedman, Wise,  
Henderson, Morris, Turner)

Lisp machines  
(Symbolics, LMI)

Lambda the Ultimate  
(Steele, Sussman)

SK combinators,  
graph reduction  
(Turner)

Dataflow architectures  
(Dennis, Arvind et al)



## Backus 1978

Can programming be  
liberated from the von  
Neumann style?

John Backus Dec 1924 - Mar 2007

# A little bit of History

Credits: Simon Peyton Jones

## Haskell 98



### Haskell 98

- Stable
- Documented
- Consistent across implementations
- Useful for teaching, books

Haskell  
development

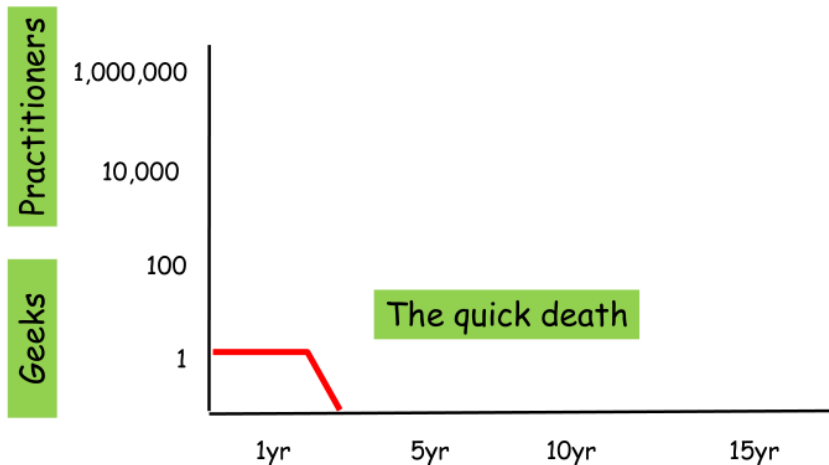
### Haskell + extensions

- Dynamic, exciting
- Unstable, undocumented, implementations vary...



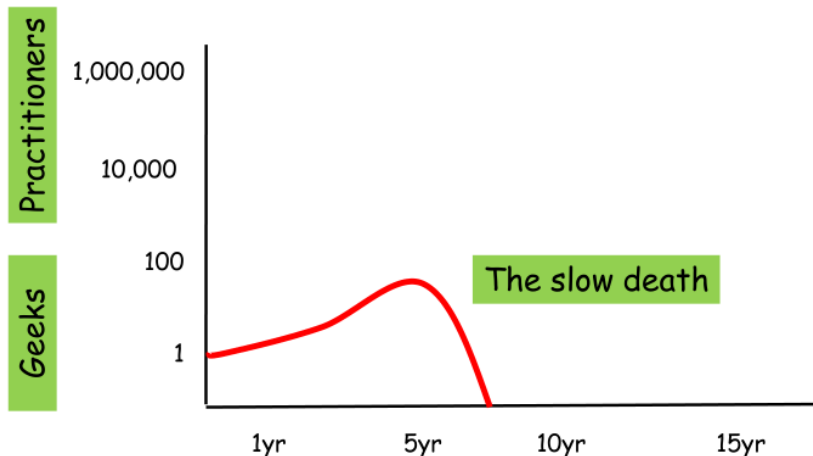
# History of Research Languages

Credits: Simon Peyton Jones



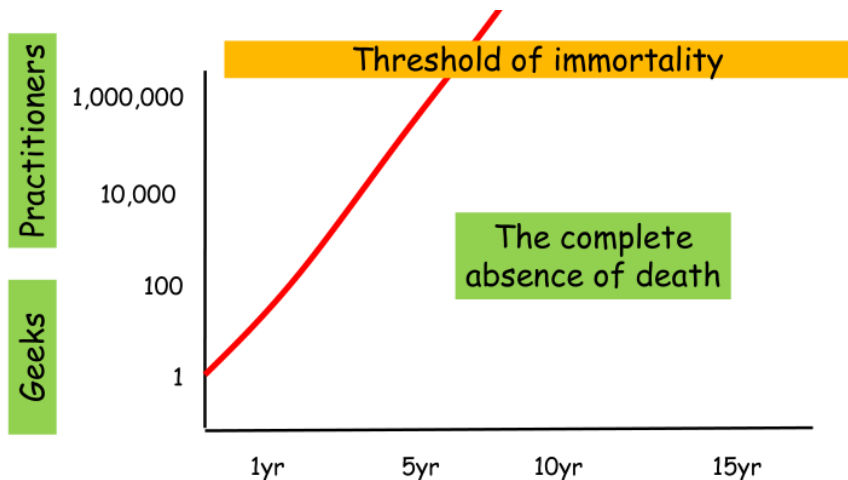
# Successful Research Languages

Credits: Simon Peyton Jones



# C++/Java/Perl/Ruby

Credits: Simon Peyton Jones



# Where's Haskell?

Credits: Simon Peyton Jones

