The Joy of Functional Programming

NICOLE RAUCH
softwareentwicklung &
entwicklungscoaching

Functional, isn't that a totally esoteric subject?!

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- ABN AMRO Amsterdam *Risk analysis in investment banking*
- AT&T *Network security: processing of internet abuse complaints*
- Bank of America Merril Lynch
  Backend data transformation and loading
- Barclays Capital Quantitative Analytics Group
  Mathematical modelling of equity derivatives
- Bluespec, Inc. *Modelling & verification of integrated circuits*
- Credit Suisse *Checking, manipulating and transforming spreadsheets*
- Deutsche Bank Equity Proprietary Trading, Directional Credit Trading *All its software infrastructure*
- Facebook *Internal tools*
- Factis Research, Freiburg *Mobile solutions (backend)*
- fortytools gmbh *web-based productivity tools - REST-backend*
- Functor AB, Stockholm *static analysis*

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- Galois, Inc *Security, information assurance and cryptography*
- Google *Internal projects*
- IMVU, Inc. *Social entertainment*
- JanRain *Network and web software*
- MITRE *Analysis of kryptographic protocols*
- New York Times *Image processing for the New York Fashion Week*
- NVIDIA *In-house tools*
- Parallel Scientific *High-availability cluster management system*
- Sankel Software *CAD/CAM, gaming and computer animation*
- Silk, Amsterdam *Filter and visualize large amounts of information*
- Skedge Me *Online scheduling platform*
- Standard Chartered *Wholesale banking business*
- Starling Software, Tokio *Commercial automated options trading system*
- Suite Solutions *Management of large sets of technical documentation*

(Quelle: `http://www.haskell.org/haskellwiki/Haskell_in_industry`)

Well-known functional languages

Scheme

Erlang

Clojure

ML

F#

Miranda

OCaml

Haskell

Lisp

Scala

Well-known functional languages

Scheme

Erlang

Clojure

ML

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Miranda

OCaml

Haskell

(Java 8)

Lisp

Scala

(JavaScript)

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Functions are „first order citizens“

Functions can be treated in the same way as strings or numbers

Functions are values

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Haskell:

```
times x y = x * y

timesVar = times

timesVar 3 5 == 15
```

Functions are function parameters

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JavaScript:

```
function times3(y) { return 3 * y; };

function apply(func, arg) { return func(arg); }

apply(times3, 5) === 15;
```

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function times3(y) { return 3 * y; };

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Haskell:

```
apply func arg = func arg

apply (\ x -> 3 * x) 5 == 15
```

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times x = (\y -> x * y)

times 3 5 == 15
```

Strange... ?!

JavaScript: Two different invocations

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function times(x, y) { return x * y; }
times(3, 5) === 15;

function times(x) { return function (y) { return x * y; }; }
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Haskell: Two identical invocations

```
times x y = x * y
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times x = (\y -> x * y)
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Currying! (also known as Schönfinkeling)

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but actually the following happens:

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Because functions always take exactly one argument

Useful for partial evaluation:

```
times x y = x * y

times3 = times 3

times3 5 == 15
```

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- What if I don't want to pass anything?

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- In real functional languages, functions always take exactly one argument!
- What if I don't want to pass anything?
- `Unit` to the rescue!
- `Unit` is a type with only one element
- In Haskell, this element is called `()`

Important library functions: filter

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Haskell:

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filter (\x -> x `mod` 2 == 0) [1,2,3,4] == [2,4]
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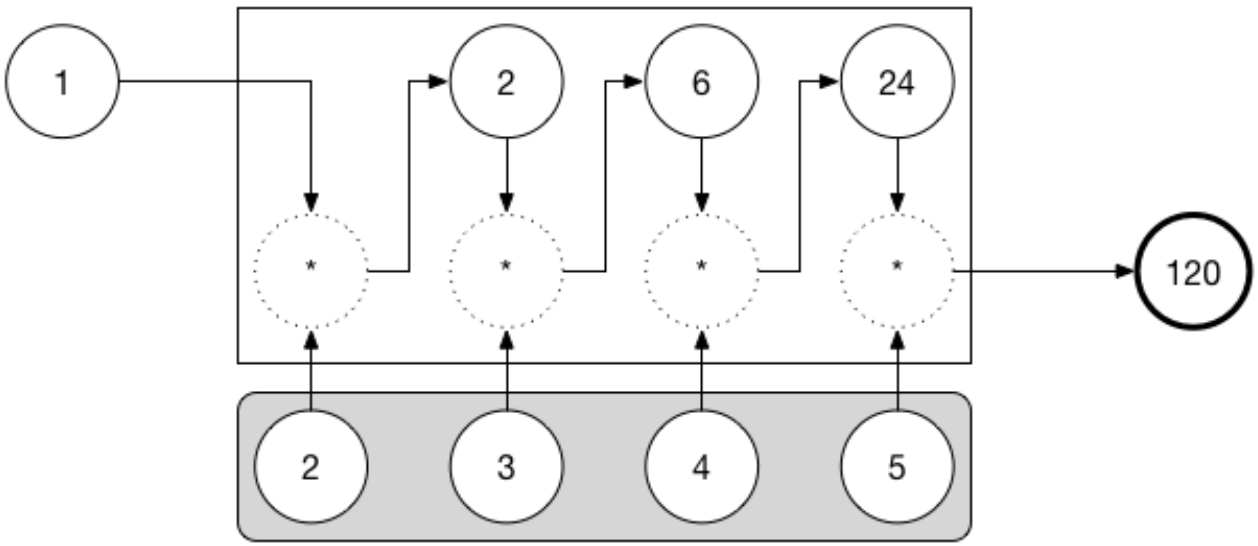
- Takes a collection, a function and an initial value
- Merges initial value and first collection entry using the function
- Merges the result and the next collection entry
- Continues for all collection entries, yielding a single result

Important library functions: fold

- fold or reduce or inject

JavaScript:

```
_.foldl( [2, 3, 4, 5], function (x, y) { return x * y; }, 1 ) === 120
```



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_.foldl( [2, 3, 4, 5], function (x, y) { return x * y; }, 1 ) === 120
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Haskell:

```
foldl   (*) 1 [2,3,4,5] == 120
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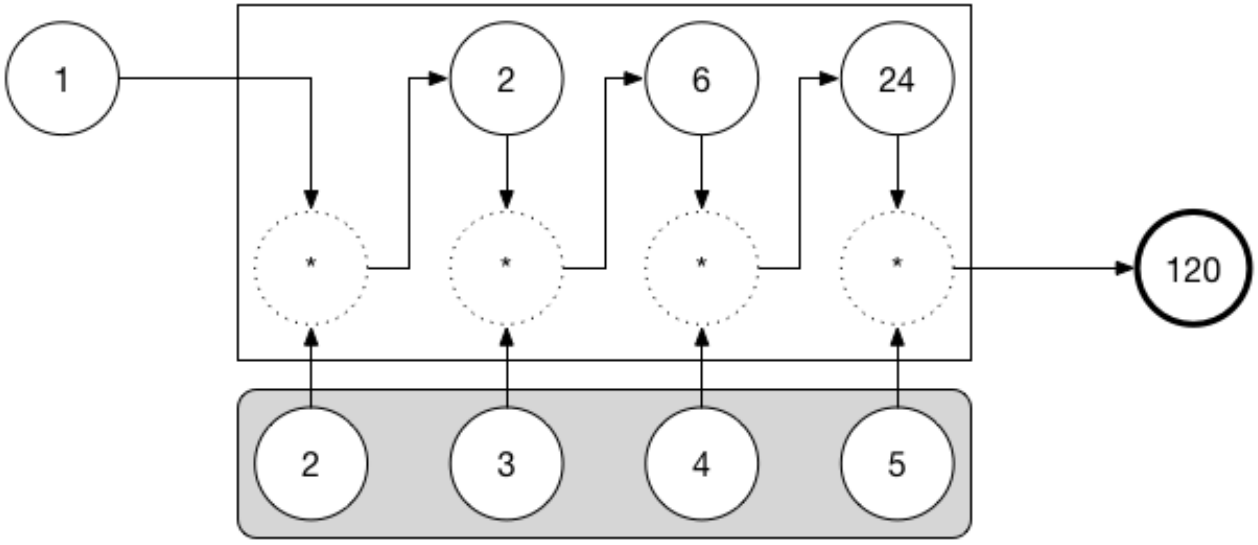

Type inference

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(*) :: Num a => a -> a -> a

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```

Compile error for:

```
foldl   (*) "x" [2,3,4,5]

No instance for (Num [Char]) arising from a use of `*'
Possible fix: add an instance declaration for (Num [Char])
```

A simple calculation

$$sum = \sum_{i=1}^{10} i^2$$

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int sum = 0;
for(int i = 1; i <= 10; i++) {
  sum = sum + i * i;
}
```

Excursion: Clean Code

Single Responsibility Principle

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var sequence = _.range(1, 11);
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var square = function (i) { return i * i; };
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```
var squaredSequence = _.map(sequence, square)
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- Calculating the sum of two numbers

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var add = function (s1, s2) { return s1 + s2; };
```

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```

- Calculating the sum of all squares

```
var sum = _.reduce(squaredSequence, add);
```

Combining the components

JavaScript:

```
var square = function (i) { return i * i; };
var add = function (s1, s2) { return s1 + s2; };
```

```
_.reduce(_.map(_.range(1, 11), square), add) === 385;
```

Combining the components

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var square = function (i) { return i * i; };
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_.reduce(_.map(_.range(1, 11), square), add) === 385;
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_(1).range(11).map(square).reduce(add) === 385;
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Haskell:

```
foldl   (+) 0 (map (\x -> x*x) [1..10]) == 385
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foldl   (+) 0 (map (\x -> x*x) [1..10]) == 385
```

or

```
(>.>) x f = f x
[1..10] >.> map (\x -> x*x) >.> foldl (+) 0 == 385
```

Phew!

OK, everybody take a deep breath :-)

Pattern Matching

Fibonacci-Function „naïve“:

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Fibonacci-Function with Pattern Matching:

```
fib 0 = 0
fib 1 = 1
fib x = fib (x-1) + fib (x-2)
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Algebraic Datatypes

Binary tree:

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data Tree =
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     | Leaf Int
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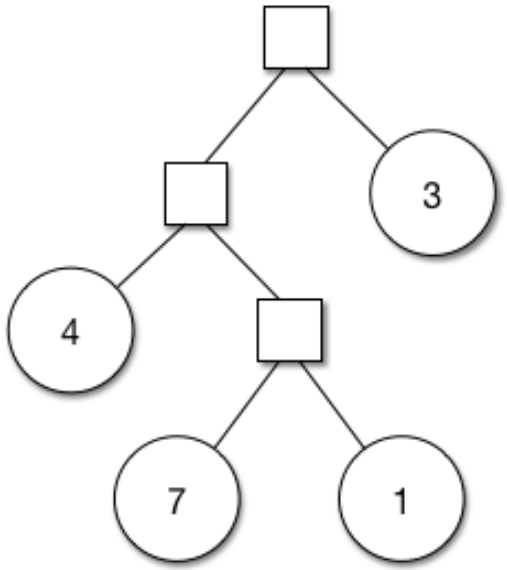

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```
treeSum myTree == 15
```

Bottom line

- Functional programming is more common than you may have expected
- Some of it can be integrated into non-functional coding
- Many languages have functional aspects or additional modules

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References:

- Functional JS-Library: `http://ramdajs.com`
- Haskell: `http://www.haskell.org`

Thank you very much!

Code & slides on GitHub:

`https://github.com`
`/NicoleRauch/FunctionalProgrammingForBeginners`

Nicole Rauch

E-Mail `info@nicole-rauch.de`

Twitter `@NicoleRauch`

Web `http://www.nicole-rauch.de`