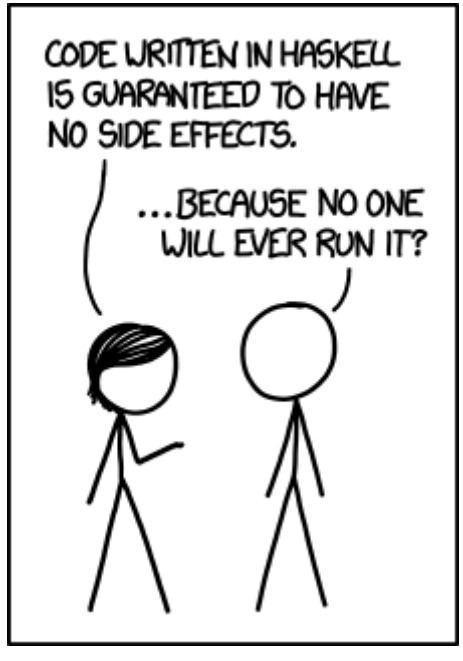
- share anything cool/fun/interesting
  (blog posts, new RFCs, funny bugs, open-source projects)
- <=5 minute slots
- max. 3-4 "talks"
- slides, no slides, anything goes
- (not intended for recruiting)

Functional Programming

for Pragmatic PHP Developers



PHP User Group Munich - 2017-09-27

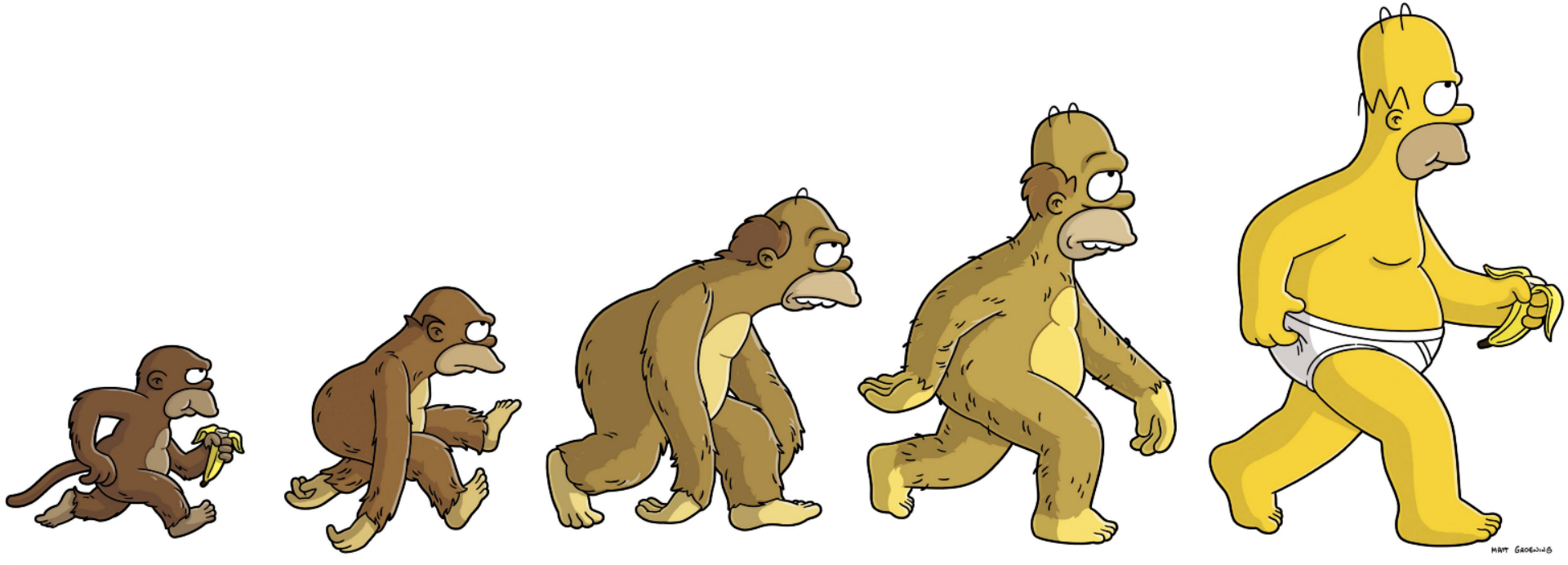
Michael Haeuslmann for TNG Technology Consulting GmbH / @michaelhaeu

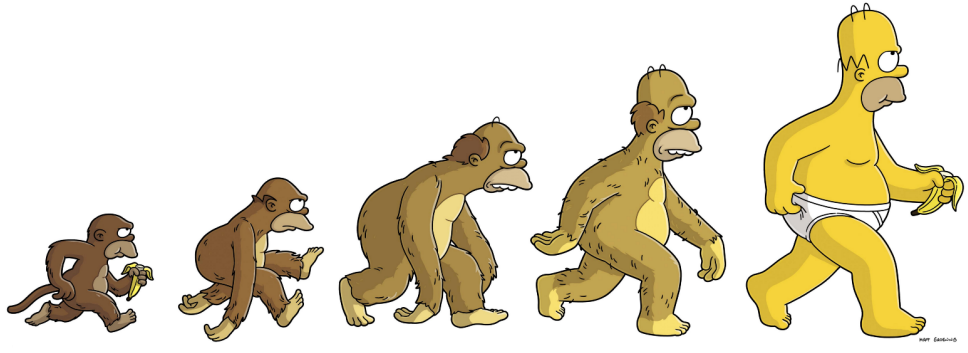
Disclaimer

I am not an expert at functional programming. These opinions are my own and do not reflect the opinions of proper functional programmers ;)

This talk is from a pragmatic developer for other pragmatic developers.

We want to get stuff done!


MACHINE
ASSEMBLY
PROCEDURAL
OBJECT ORIENTED
FUNCTIONAL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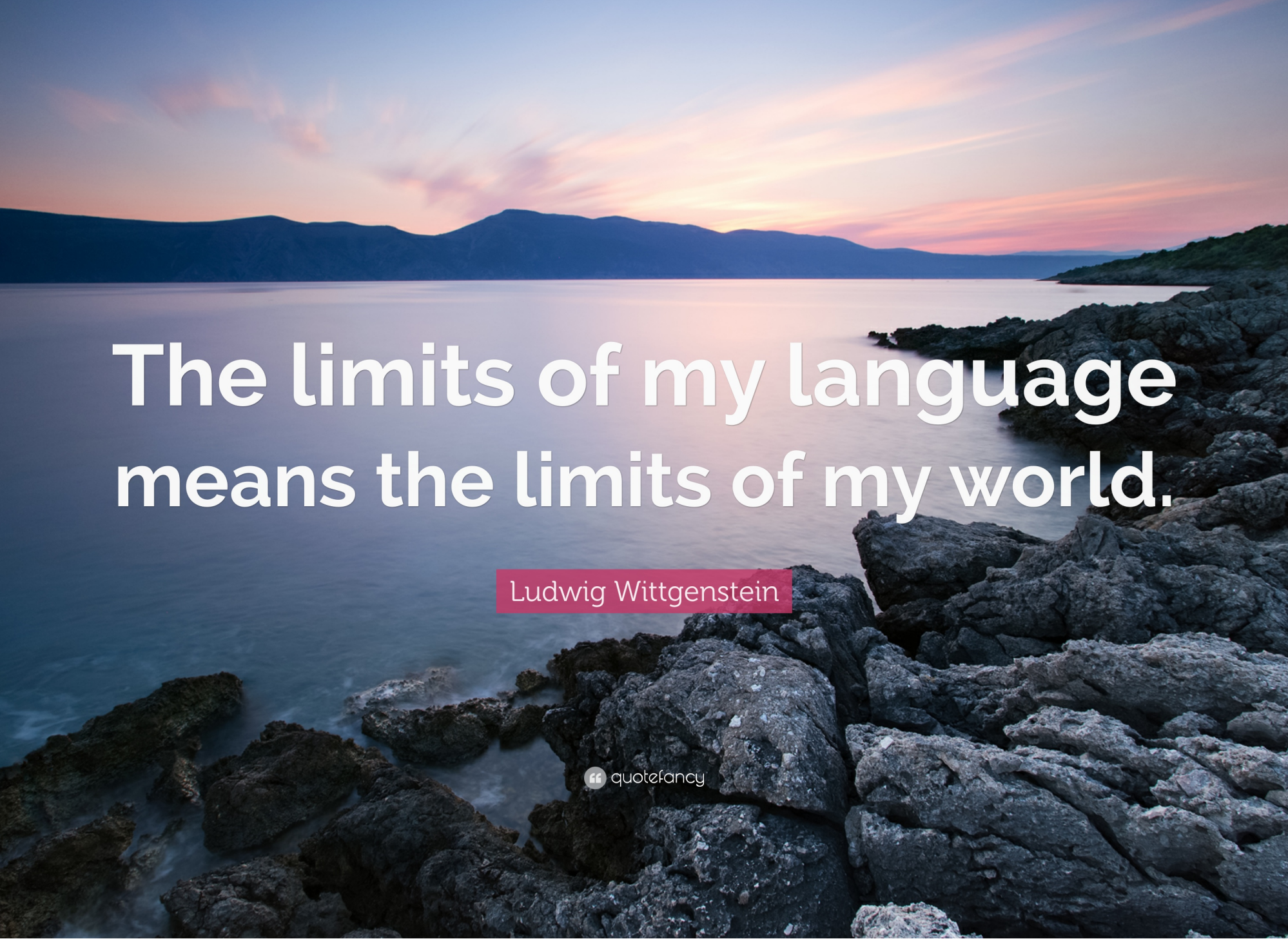

The limits of my language means the limits of my world.
Ludwig Wittgenstein
quotefancy

Why functional programming?

- Declarative vs. Imperative (what vs how?)
- More concise
- More generic and reusable
- ~~Mathematically proven~~
- ~~Parallel Programming~~

  ⇛ A different way of looking at problems

Declarative vs Imperative

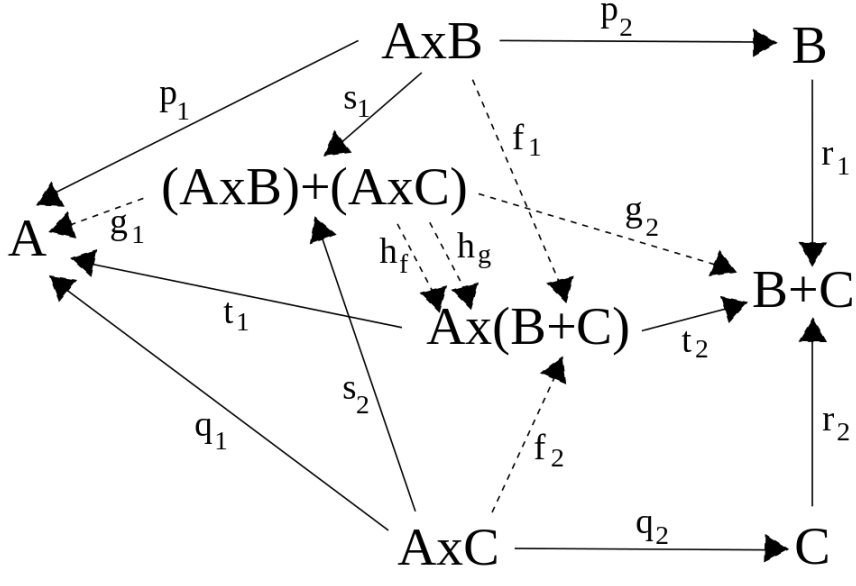
SQL is declarative,
we only say **what** we want,
and not **how**.

```
SELECT *
FROM users
WHERE age="42"
```

That doesn't mean we have to like SQL :)

~~Mathematically proven~~

Category Theory

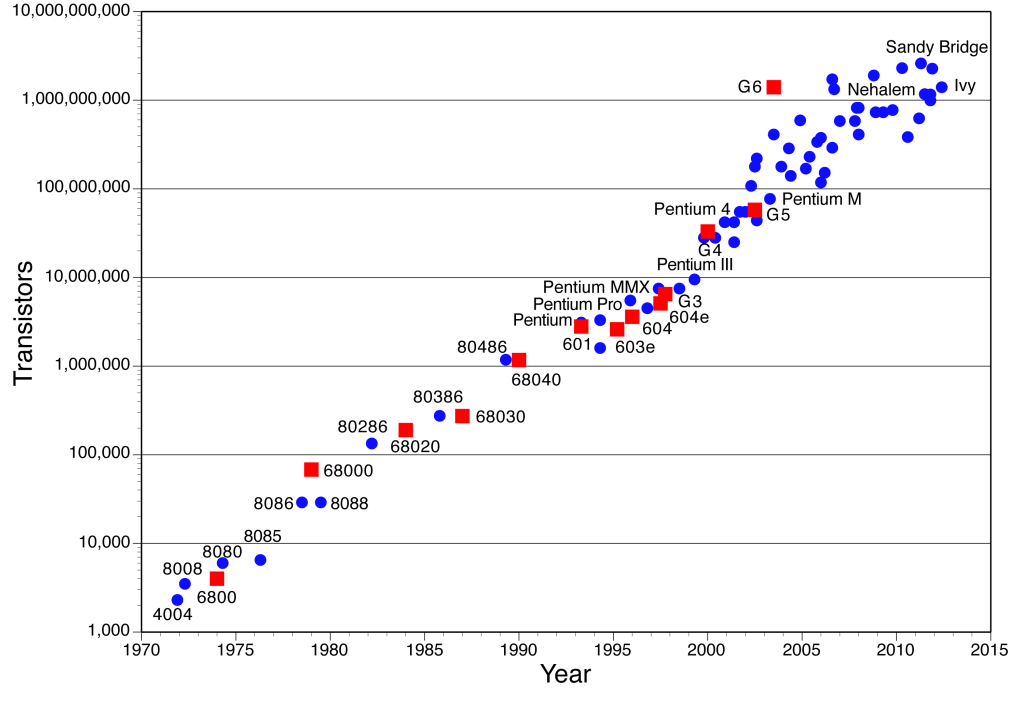


http://ism.uqam.ca/~ism/academics/category-theory-and-applications/

~~Parallel Programming~~

Moore's Law

Processor's aren't getting any faster, we can only expect to get more cores.

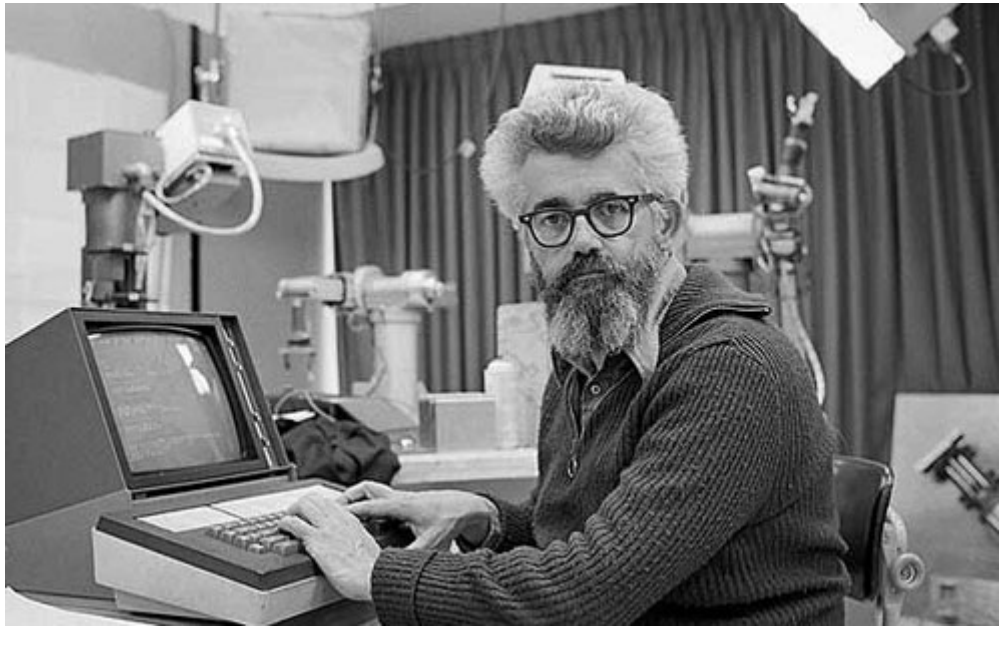



Functional Programming
is not a Hype

1958 - LISP

First functional language

```
(defun factorial (n &optional (acc 1))
   (if (= n 0) acc
       (factorial (- n 1) (* acc n))))
```



1962 - Simula

First object-oriented language

```
Simulation Begin
   Class FittingRoom; Begin
      Ref (Head) door;
      Boolean inUse;
      Procedure request; Begin
         If inUse Then Begin
             Wait (door);
             door.First.Out;
         End;
         inUse:= True;
      End;
      Procedure leave; Begin
         inUse:= False;
         Activate door.First;
      End;
      door:- New Head;
   End;

   Integer u;
   Ref (FittingRoom) fittingRoom1;

   fittingRoom1:- New FittingRoom;
   Hold (100);
End;
```

1980 - C++

C-with-classes

```
#include <iostream>

using namespace std;

class Box {
   public:
      double length;   // Length of a box
      double breadth;  // Breadth of a box
      double height;   // Height of a box
};
```

1984 - Common Lisp

- modern Lisp dialect
- still too many brackets

1990 - Haskell

Purely functional and lazy

```
factorial n
   | n < 2     = 1
   | otherwise = n * factorial (n - 1)
```

1995 - JavaScript

Not functional, but functions always have been first-class citizens

```
class PseudoOO {
    method() {
        return
            `I won't return what you
               think I should.`;
    }
}

const tax = R.curry((tax, price) => {
  if (!_.isNumber(price)) return Left(new Error());

  return  Right(price + (tax * price));
});
```

1995 - Java

"Modern" OO, support for a more functional style since Java 8

```
List<String> myList =
    Arrays.asList("a1", "a2", "b1", "c2", "c1");

myList
    .stream()
    .filter(s -> s.startsWith("c"))
    .map(String::toUpperCase)
    .sorted()
    .forEach(System.out::println);

// C1
// C2
```

2003 - Scala

Modern Java with many functional features

```
class Point(
    val x: Double, val y: Double,
    addToGrid: Boolean = false
) {
    // ...
}

val a = List(1, 2, 3, 4, 5)
val b = a.map(x => x * x)
val c = b.reduce((x, y) => x + y)
```

2005 - F#

Microsoft's answer to Scala

```
type Person(name : string, age : int) =
    member x.Name = name
    member x.Age = age
```

2007 - Clojure

- Lisp with objects
- now runs on the JVM
- still too many brackets

```
(def bit-bucket-writer
  (proxy [java.io.Writer] []
    (write [buf] nil)
    (close []    nil)
    (flush []    nil)))
```

1995 - PHP

- 4.0 - `array_map`, `array_filter`, `array_reduce`
- < 5 - procedural, painful, "C as a scripting language with convenience functions"
- 5.4 - lambdas and closures, callable
- 5.5 - generators
- 5.6 - varargs
- 7.0 - anonymous classes, scalar return types, direct call
- 7.2 - `Closure::fromCallable`
- 7.3 - ??? Fat arrow functions, pipes, short closures

Arrow functions

- concise
- easier to use
- automatic binding of scope to closure

```
array_map( fn($x) => $x * 2, [1, 2, 3] );
```

by Levi Morrison, Bob Weinand

Status: Under Discussion

Pipe Operator (Hack)

Before:

```
$ret =
  array_merge(
    $ret,
    getFileArg(
      array_map(
        function ($x) use ($arg) { return $arg . '/' . $x; },
        array_filter(
          scandir($arg),
          function ($x) { return $x !== '.' && $x !== '..'); }
        )
      )
    )
  );
```

by Sara Golemon

Status: Under Discussion

Pipe Operator (Hack)

After:

```
$ret = scandir($arg)
  |> array_filter($$, function($x) { return $x !== '.' && $x != '..'; })
  |> array_map(function ($x) use ($arg) { return $arg . '/' . $x; }, $$)
  |> getFileArg($$)
  |> array_merge($ret, $$);
```

by Sara Golemon

Status: Under Discussion

Short Closures

Before:

```
$action = CustomerController::class . '::delete';
```

After:

```
$action = {CustomerController::delete};

// which is a simplification for
$action = Closure::fromCallable('CustomerController::delete');
```

by Michał Brzuchalski

Status: Draft

externals.io

#externals

Opening PHP's #internals to the outside.

Search with algolia

Search...

2 **[VOTE] JSON_THROW_ON_ERROR**
21 hours ago Andrea Faulds 2

0 **[RFC] [Discussion] Implement SQLite "openBlob" feature in PDO**
16 hours ago BohwaZ/PHP

0 **PHP extension - Saxon/C**
4 days ago O'Neil Delpratt 9

Core principles of functional programming

- Functions as first-class citizens
- Pure functions (i.e. no side-effects)
- Higher order functions
- Immutability
- Stateless
- Currying and composition

Functions as first-class citizens

- Functions can be passed as arguments
- Functions can be returned from other functions
- Functions can be assigned to variables

```
$times = function ($x) {
    return function ($y) use ($x) {
        return $x * $y;
    };
};
$times(7)(6); // 42
```

Pure functions

(i.e. no side-effects)

The output of a function, depends only on the input arguments.

```
function getUsers($db) {
    return $db->query('SELECT * FROM users');
}

public function getUsers() {
    return $this->db->query('SELECT * FROM users');
}
```

You wanted a banana but what you got was a gorilla holding the banana and the entire jungle.
- Joe Armstrong, Creator of Erlang

Stateless

- the more state, the harder to test
- more reasons to change
- unpredictable when state is shared and mutable
- (hard to parallelize)

```
function bumpCounter() {
    static $counter = 0;
    ++$counter;
    echo $counter;
}
bumpCounter(); // 1
bumpCounter(); // 2
```

Immutability

- the hardest thing when debugging is to figure out where a variable went wrong
- encourages pure functions (you always want to return something)
- allows checking for references instead of inner state

```
class Counter{
    private $counter = 0;

    public function increment() {
        $clone = clone $this;
        ++$clone->counter;
        return $clone;
    }

    public function __toString() { /** ... */}
}
$c1 = (new Counter)->increment();
$c2 = $c1->increment();
echo "$c1 < $c2"; // 1 < 2
```

Higher-order functions

- functions which receive other functions as arguments
- and/or return a function

```
$xs = [4, 5, 1, 2, 3];
usort($xs, function ($x, $y) {
    return $x <=> $y;
});
```

Currying and composition

Describing addition in "Hindley-Milner Form" (Haskell):

```
add :: a → b → c
```

- Add is a function which takes an `a`
- ... and returns a function which takes a `b` ...
- ... and returns a `c`.

So why not simply

```
add(int $a, int $b) : int
```
?

Let's say we want an increment function

We could do it the normal way:

```
function increment($x) {
    return $x + 1;
}
```

But we already have everything we need:

```
$increment = add(1);
```

Another one:

```
map :: (a → b) → [a] → [b]
```

Every function takes only one argument.

- Map is a function which takes an function ...
- ... which maps an `a` to a `b` ...
- ... and returns a function which takes a list of `a` ...
- ... and returns a list of `b`.

Examples of functional style

- Route definition in micro frameworks
- Promises
- Filter, map, reduce

Filter, map, reduce

- array array_filter (array $array [, callable $callback [, int $flag = 0]])
- array array_map (callable $callback , array $array1 [, array $...])
- mixed array_reduce (array $array , callable $callback [, mixed $initial = NULL])
- bool array_walk (array &$array , callable $callback [, mixed $userdata = NULL])
- array array_udiff (array $array1 , array $array2 [, array $ ...], callable $value_compare_func)
- ...

Type-safe ”iteration”

```php
foreach ($xs as $x) {
    /** @var Object $x */
    $x->sideEffect();
}

array_walk($xs, function (Object $x) {
    $x->sideEffect();
});

each($xs, fn($x) => $x->sideEffect());
```

Route definition in micro frameworks

```
$app = new App();
$app->get(
    'customers',
    function (RequestInterface $request, ResponseInterface $response) : ResponseInterface {
        return $response;
    }
);
```

Promises

- Async promises (e.g. from ReactPHP) use functional concepts
- Wrap side-effects
- higher order functions for result handling
- map, reduce etc. for results
- not lazy

(see continuation monad)

reactphp / promise

```php
$deferred = new React\Promise\Deferred();
$deferred->promise()
    ->then(function ($x) {
        return $x + 1;
    })
    ->then(function ($x) {
        throw new \Exception($x + 1);
    })
    ->otherwise(function (\Exception $x) {
        return $x->getMessage() + 1;
    })
    ->then(function ($x) {
        echo 'Mixed ' . $x;
    });
$deferred->resolve(1);
```

Functional PHP libraries

- functional-php
  - small functions for everyday use
  - use what you need
  - not invasive
- php-functional
  - more complicated functional features
  - low coverage (~60%)
  - interesting implementation of various monads
- https://preprocess.io/
  - not a library
  - pre-processor (duh!)
  - makes functional programming more enjoyable

functional-php

```php
function filter($collection, callable $callback) : array {}

function map($collection, callable $callback) : array {}

function reduce_left($collection, callable $callback, $initial = null) : array {}

function reduce_right($collection, callable $callback, $initial = null) : array {}

function each($collection, callable $callback) : null {}

// ...
```

functional-php

by Lars Strojny (@lstrojny)

Imperative:

```
foreach ($xs as $x) {
    if ($x % 2 === 0) {
        return true;
    }
}
return false;
```

Declarative:

```
Functional\some($xs, function ($x) {
    return $x % 2 === 0;
});
```

Let's take this further

A curried mod function

```
function mod($mod) {
    return function ($x) use ($mod) {
        return $x % $mod;
    };
}
some($xs, mod(2));
```

Or: if our operators were functions

```
$even = curry('%')(2);    // operators as functions RFC pending
some($xs, $even);
```

Pre.

(https://github.com/preprocess)

(https://twitter.com/assertchris)

code.pre | code.php | output

```
1 <?php
2
3
```

Drawbacks

•

Performance ...

- Premature optimization is the root of all evil
- copy on write helps
- don't worry about collections with less than 10000 entries

Lessons learned

- Functional concepts can help us write better OO code
- Pure functions and immutability will safe you from debugging
- Higher order functions and composition help simplify complex OO patterns
- Libraries provide common functions (functional-php)
- Document your callables using HMF (Hindley-Milner Form)

Thank you! Any Questions?

Become vocal about functional programming in PHP.

Sources

- https://github.com/lstrojny/functional-php
- https://github.com/widmogrod/php-functional
- https://www.slideshare.net/boerdedavid/being-functional-in-php
- "Functional Programming in PHP" by Simon Holywell

Figures

- Haskell Comic https://xkcd.com/1312/
- Lightning Talks https://www.meetup.com/ReactJS-B
- Wittgenstein https://quotefancy.com/quote/100807 means-the-limits-of-my-world
- McCarthy http://history-computer.com/ModernCon
- Stroustrup http://www.stroustrup.com/Bjarne.jpg
- Gorilla http://media.tumblr.com/97691c212d7d07c2b640
- Simpsons https://medium.com/@cscalfani/so-you-w 1f15e387e536
- Moore's Law http://www.overclock.net/t/1542835/ 7nm-chips/30
- Category Theory http://ism.uqam.ca/~ism/academic