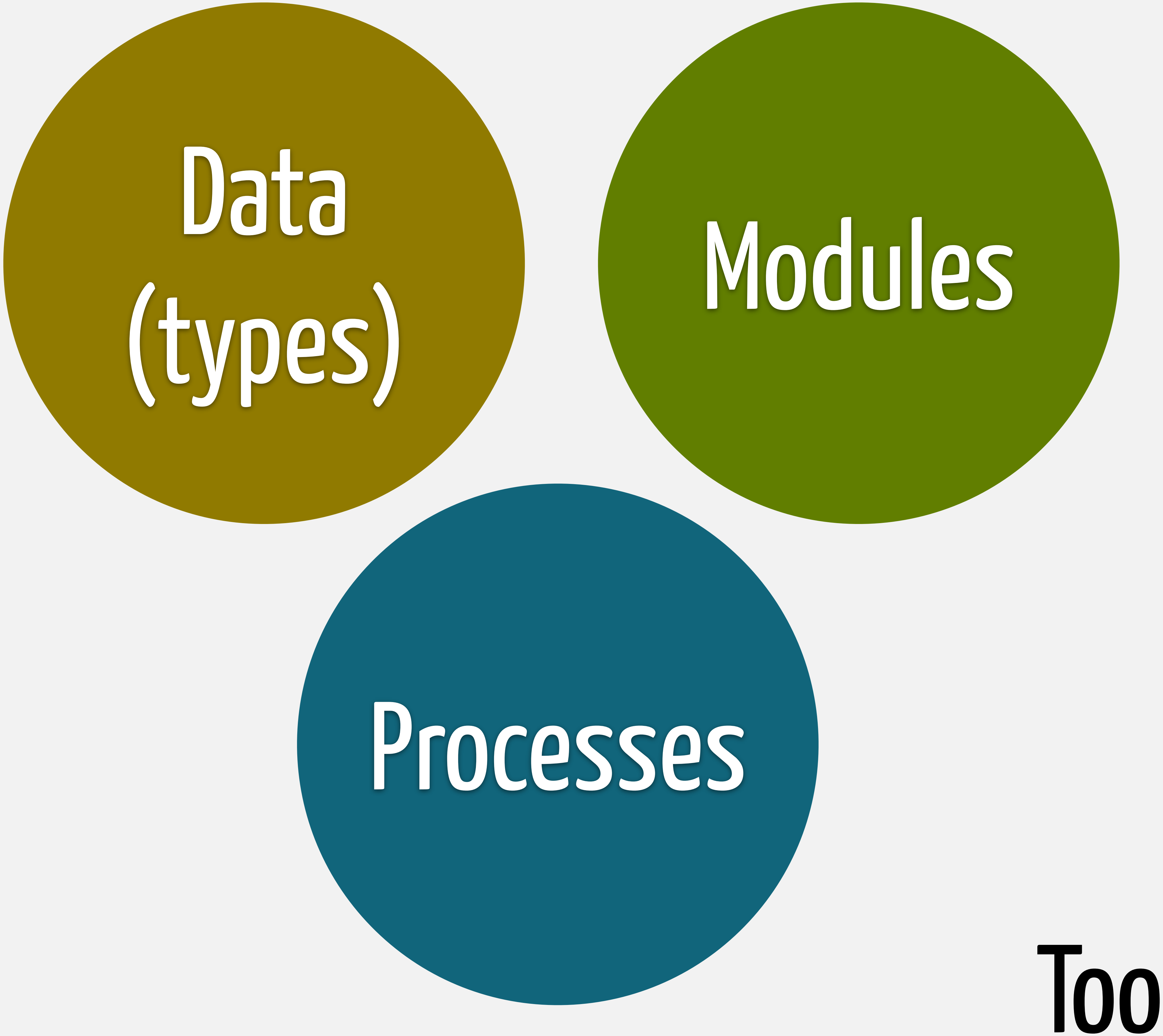
# elixir

@elixirlang / elixir-lang.org

# It is not about the syntax!



Data (types)

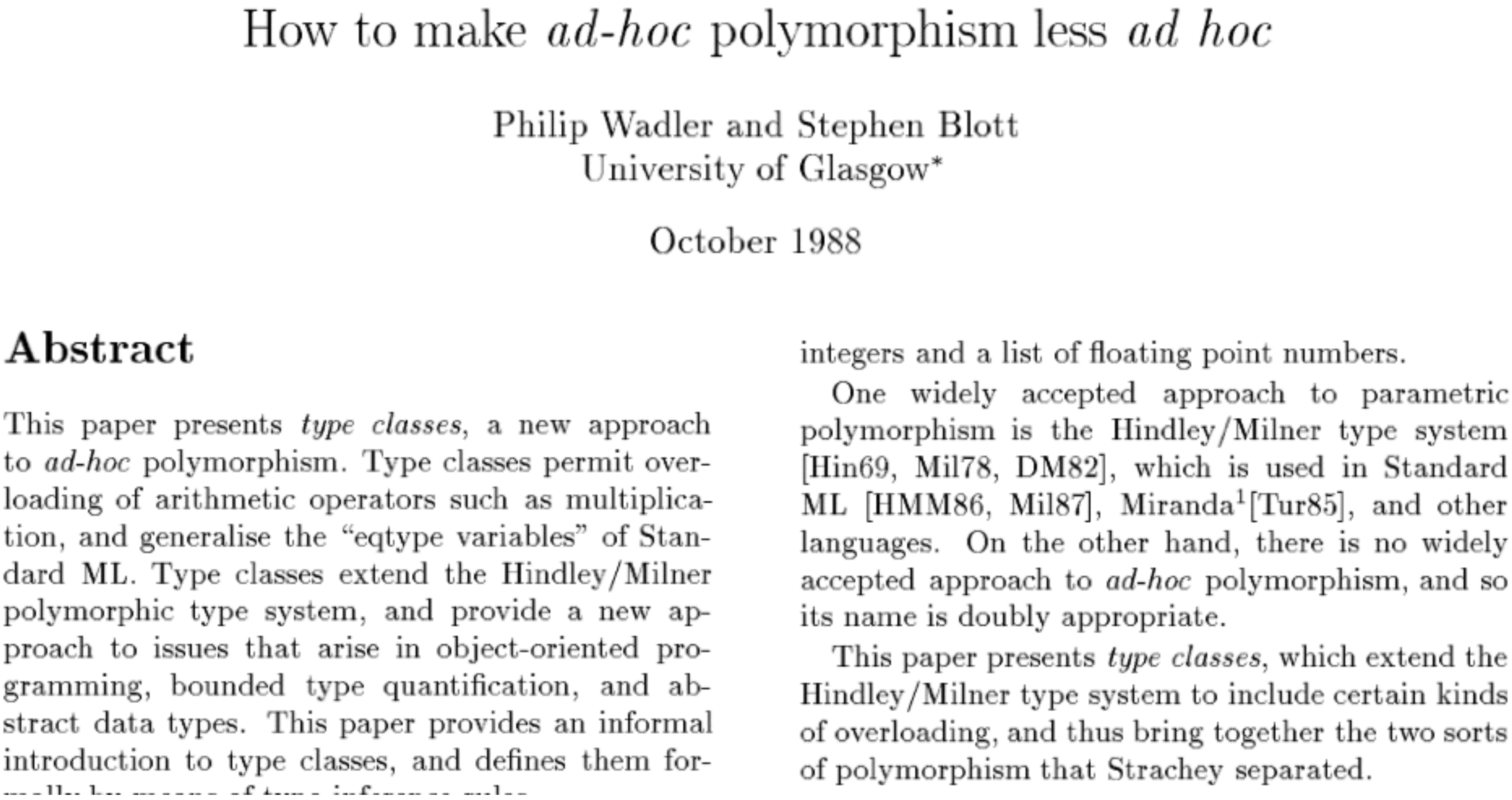
Modules

Processes

Tooling

# No custom data types

- Records aimed to add tagged tuples but the implementation backfired
- Maps are an improvement (imo) but do not officialise "tagging"



# How to make *ad-hoc* polymorphism less *ad hoc*

Philip Wadler and Stephen Blott
University of Glasgow[*]

October 1988

## Abstract

This paper presents *type classes*, a new approach to *ad-hoc* polymorphism. Type classes permit overloading of arithmetic operators such as multiplication, and generalise the "eqtype variables" of Standard ML. Type classes extend the Hindley/Milner polymorphic type system, and provide a new approach to issues that arise in object-oriented programming, bounded type quantification, and abstract data types. This paper provides an informal introduction to type classes, and defines them formally by means of type inference rules.

integers and a list of floating point numbers.

One widely accepted approach to parametric polymorphism is the Hindley/Milner type system [Hin69, Mil78, DM82], which is used in Standard ML [HMM86, Mil87], Miranda[1][Tur85], and other languages. On the other hand, there is no widely accepted approach to *ad-hoc* polymorphism, and so its name is doubly appropriate.

This paper presents *type classes*, which extend the Hindley/Milner type system to include certain kinds of overloading, and thus bring together the two sorts of polymorphism that Strachey separated.

# Collections

```
widgets.filter(b -> b.getColor() == RED)
       .mapToInt(b -> b.getWeight())
       .sum()
```

# Laziness in collections

```
widgets.stream()
       .filter(b -> b.getColor() == RED)
       .mapToInt(b -> b.getWeight())
       .sum()
```

# Elixir

# Goals

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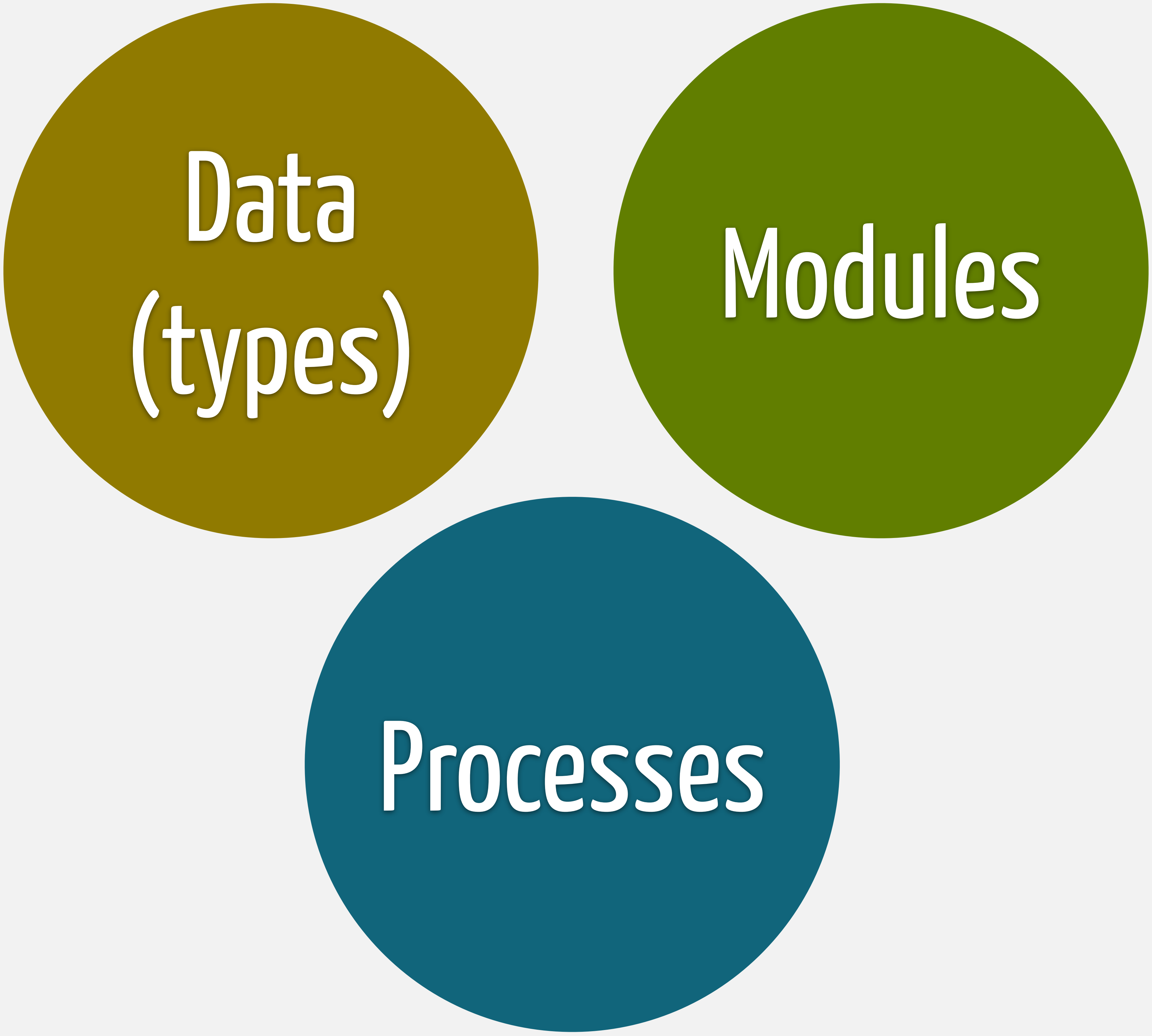
- Extensibility
- Productivity
- Compatibility

# Extensibility

# Data type polymorphism



Data (types)

Modules

Processes

# Processes

```
Pid ! Message
```

“Any process that handles this message”

# Modules

```
Module:function()
```

“Any module that exports this function”

Data (types)

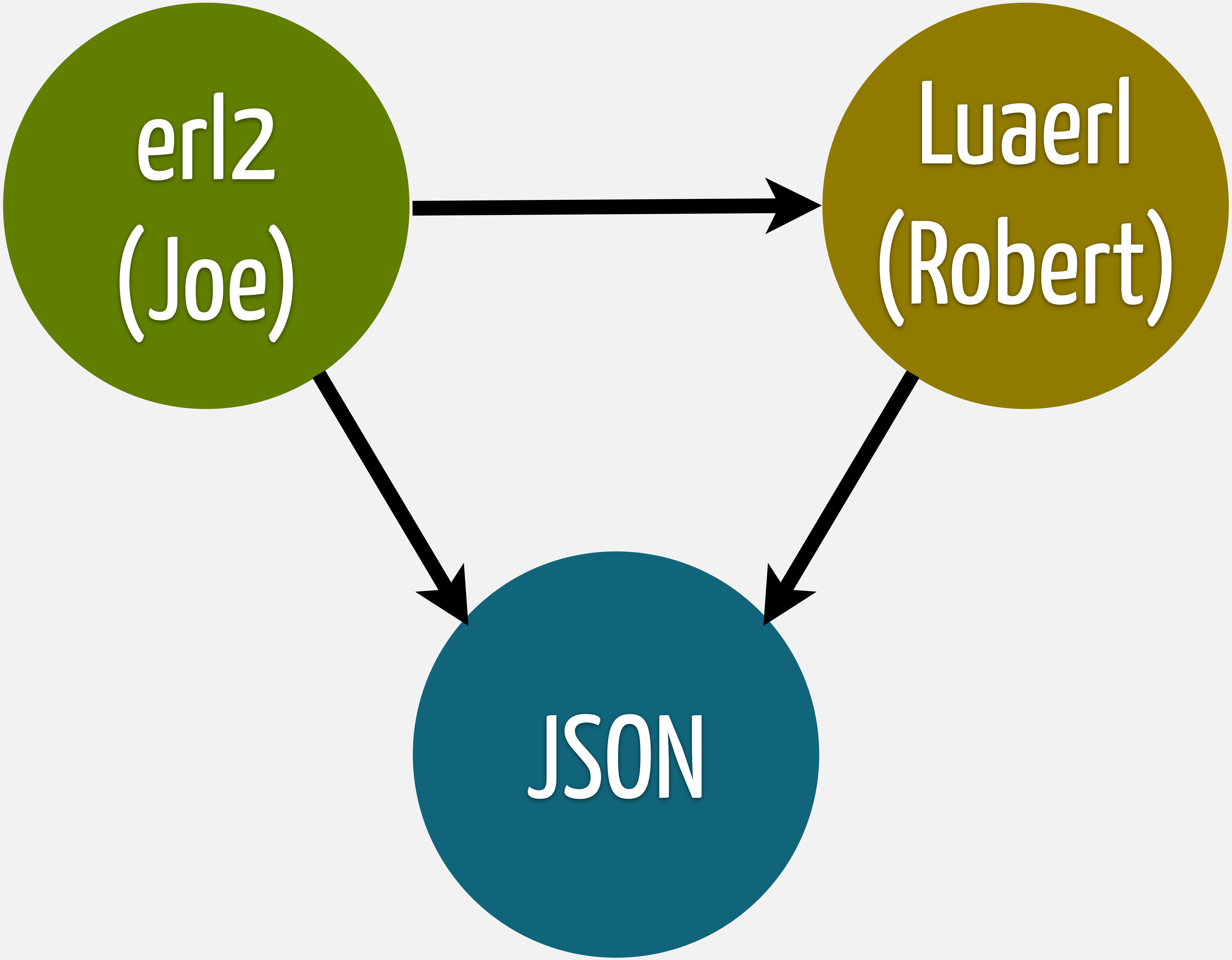
?????

“Any data type that does ????”

erlang

```
-module(json).

encode(Item) when is_list(Item) ->
  % ...
encode(Item) when is_binary(Item) ->
  % ...
encode(Item) when is_number(Item) ->
  % ...
```



erl2
(Joe)
Luaerl
(Robert)
JSON

erlang

```
-module(json).

encode(Item) when is_list(Item) ->
  % ...
encode(Item) when is_binary(Item) ->
  % ...
encode(Item) when is_number(Item) ->
  % ...
```

The data type is the one
that knows how to
convert itself to JSON

elixir

```
defprotocol JSON do
  def encode(item)
end

JSON.encode(item)
```

elixir

```
defimpl JSON, for: List do
  def encode(item) # ...
end

defimpl JSON, for: BitString do
  def encode(item) # ...
end

defimpl JSON, for: Number do
  def encode(item) # ...
end
```

I can write a JSON library that is **extensible** to **any** data type

Data
(types)

```
JSON.encode(data)
```

“Any data type that implements a protocol”

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# Enumerable Protocol

```
Enum.map [1,2,3], fn(x) ->
  x * 2
end
#=> [2,4,6]
```

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# Enumerable Protocol

```
Enum.map 1..5, fn(x) ->
  x * 2
end
#=> [2,4,6,8,10]
```

# Enumerable Protocol

- Based on Haskell Iteratees
- Works with in-memory collections and resources (like I/O, File, etc)

# Enumerable Protocol

```
# Uses raw & read_ahead
file = File.stream(path)
Enum.take(file, 5)
```

erlang

# Inspect Protocol

```
1> dict:from_list([{a,1}]).
{dict,1,16,16,8,80,48,
      {[],[],[],[],[],[],[],[],[],[],
       [],[],[],[],[],[]},
      {{[],
        [[a|1]],
        [],[],[],[],[],[],[],[],[],[],
        [],[],[],[]}}}
```

# Inspect Protocol

```
iex> HashDict.new(a: 1)
#HashDict<[a: 1]>
```

# Productivity

# Mix + Hex + Docs

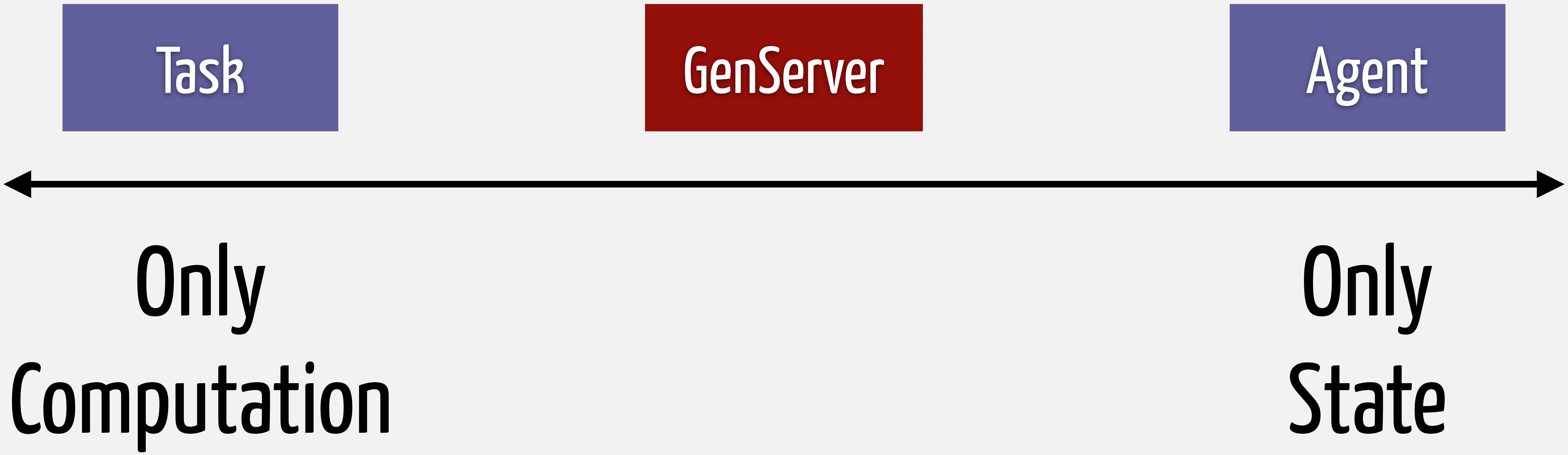
```
$ mix new foo
$ cd foo
$ mix test
$ mix hex.publish
$ mix hex.docs
```

# Compatibility

# OTP & Elixir

- GenServer (plus Task and Agents)
- GenEvent

# GenServer



Task

GenServer

Agent

Only
Computation

Only
State

# Task

- Task.start_link/3 is similar to proc_lib:spawn_link/3

# async / await

```
Top = self(),
Ref = make_ref(),

Pid = spawn_link(fun ->
  Top ! {Ref, …}
end),

receive
  {Ref, Value} -> Value
end
```

# async / await

```
task = Task.async(&calculate_x/0)
# Do something else
Task.await(task)
```

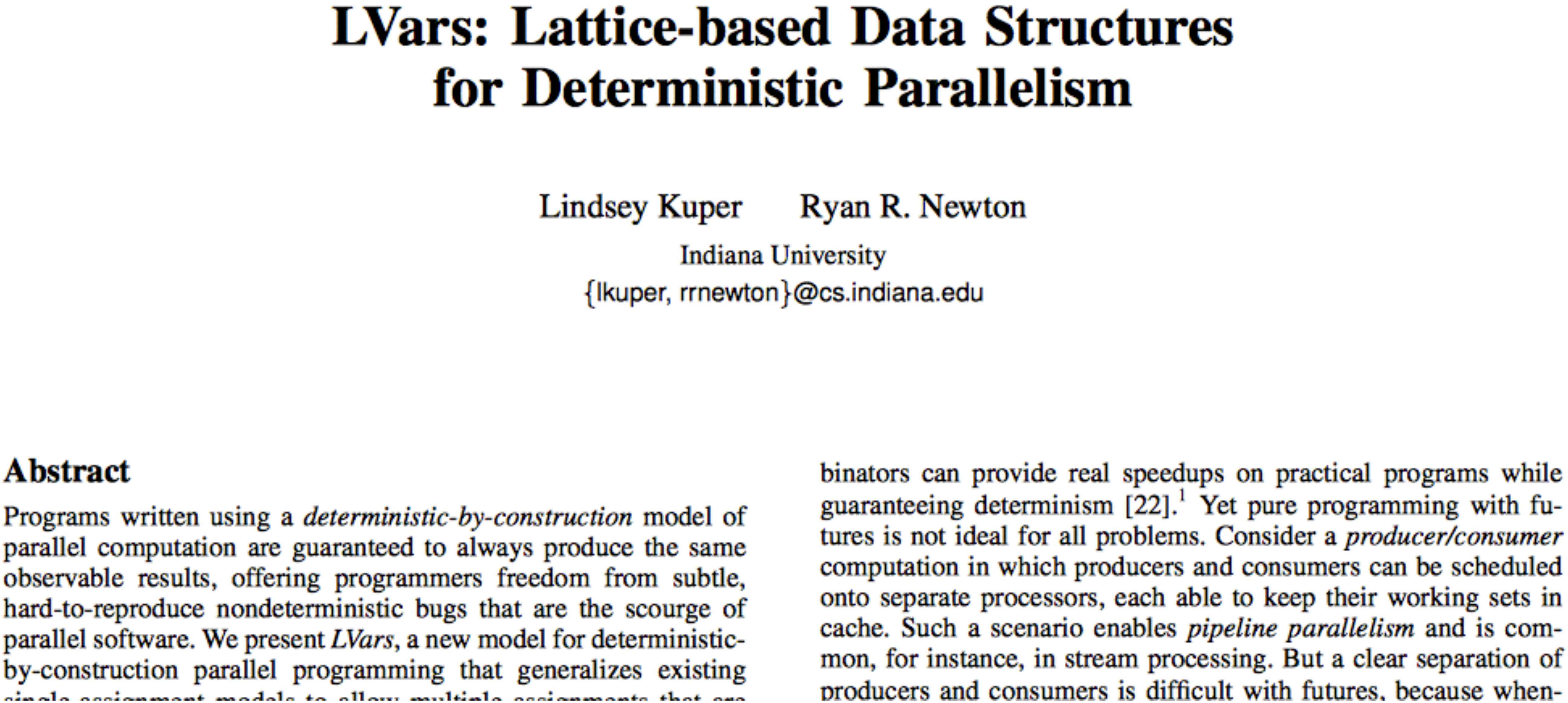
# Distributed Tasks

```
# In the remote node
Task.Supervisor.start_link(name: :tasks_sup)

# In the client
Task.Supervisor.async(
  {:tasks_sup, :remote@local},
  &calculate_x/0)
```

# Agent

```elixir
agent = Agent.start_link(&initial_state/0)
Agent.update(agent, &increment/1)
Agent.get(agent, &identity/1)
```



# LVars: Lattice-based Data Structures for Deterministic Parallelism

Lindsey Kuper Ryan R. Newton
Indiana University
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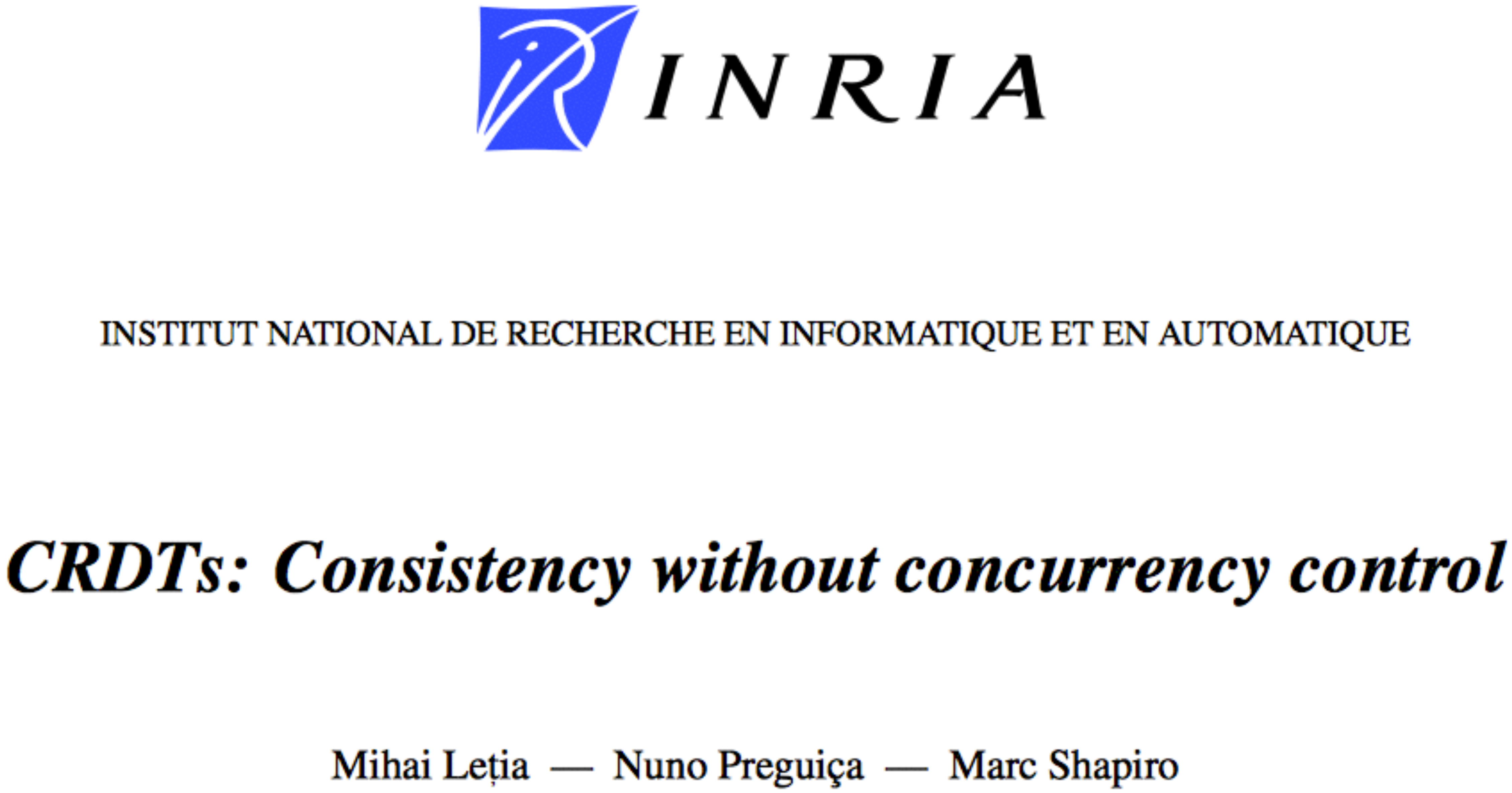
## Abstract

Programs written using a *deterministic-by-construction* model of parallel computation are guaranteed to always produce the same observable results, offering programmers freedom from subtle, hard-to-reproduce nondeterministic bugs that are the scourge of parallel software. We present *LVars*, a new model for deterministic-by-construction parallel programming that generalizes existing single-assignment models to allow multiple assignments that are

binators can provide real speedups on practical programs while guaranteeing determinism [22].[1] Yet pure programming with futures is not ideal for all problems. Consider a *producer/consumer* computation in which producers and consumers can be scheduled onto separate processors, each able to keep their working sets in cache. Such a scenario enables *pipeline parallelism* and is common, for instance, in stream processing. But a clear separation of producers and consumers is difficult with futures, because when-

# Agent.Lattices

- A set of agents/operations guaranteed to deterministic for parallelism?



INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

# *CRDTs: Consistency without concurrency control*

Mihai Leția — Nuno Preguiça — Marc Shapiro

# Agent.CRDT

- A set of agents/operations guaranteed to replicatable across nodes?

# Parallelism

# Parallelism

- Laziness
- Pipeline parallelism
- Data parallelism

# Collections

```
widgets
|> Enum.filter(fn b -> b[:color] == RED end)
|> Enum.map(fn b -> b[:weight] end)
|> Enum.take(5)
```

# Streams / Laziness

```
widgets
|> Stream.filter(fn b -> b[:color] == RED end)
|> Stream.map(fn b -> b[:weight] end)
|> Stream.take(5)
|> Enum.to_list()
```

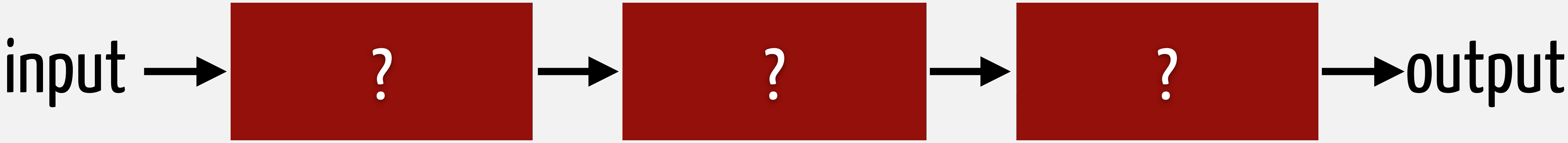
# Pipeline Parallelism

```
widgets
|> Stream.filter(fn b -> b[:color] == RED end)
|> Stream.map(fn b -> b[:weight] end)
|> Stream.take(5)
|> Stream.async()
|> Enum.to_list()
```

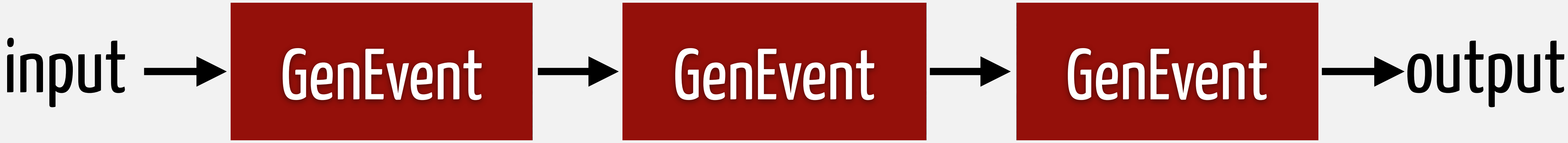
# Pipeline Parallelism

```
data
|> …
|> Stream.async()
|> …
|> Stream.async()
|> …
|> Stream.async()
|> …
|> Enum.to_list()
```

# Pipeline Parallelism



# Pipeline Parallelism

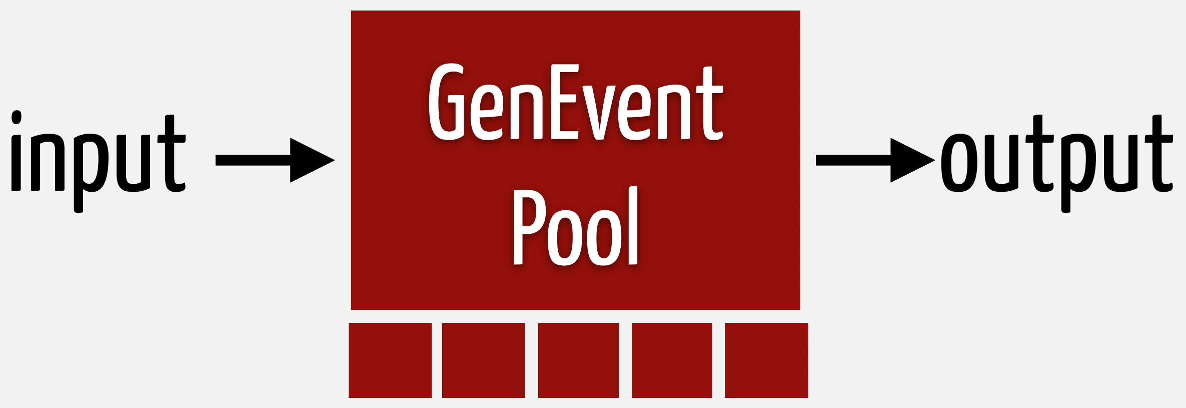


input → GenEvent → GenEvent → GenEvent → output

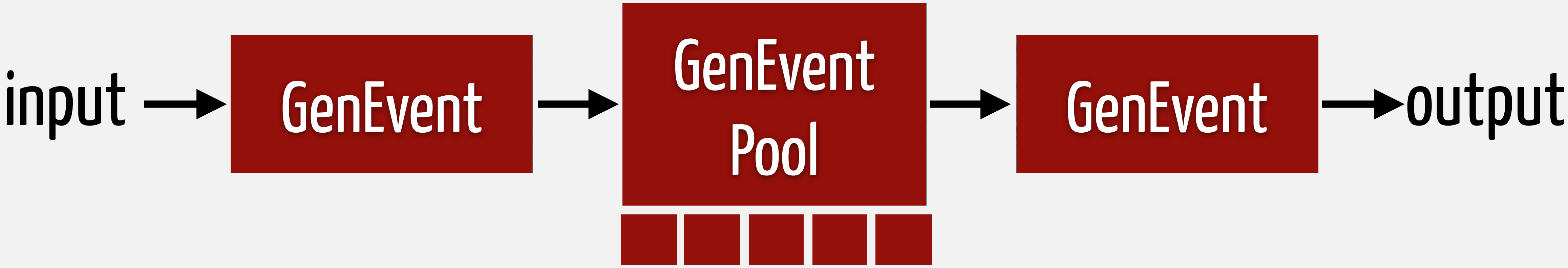
# Data Parallelism

- Stream.farm(data, ...)
- Stream.pmap(data, ...)
- Stream.chunked_pmap(data, ...)

# Data Parallelism


input → GenEvent Pool → output

# Parallelism



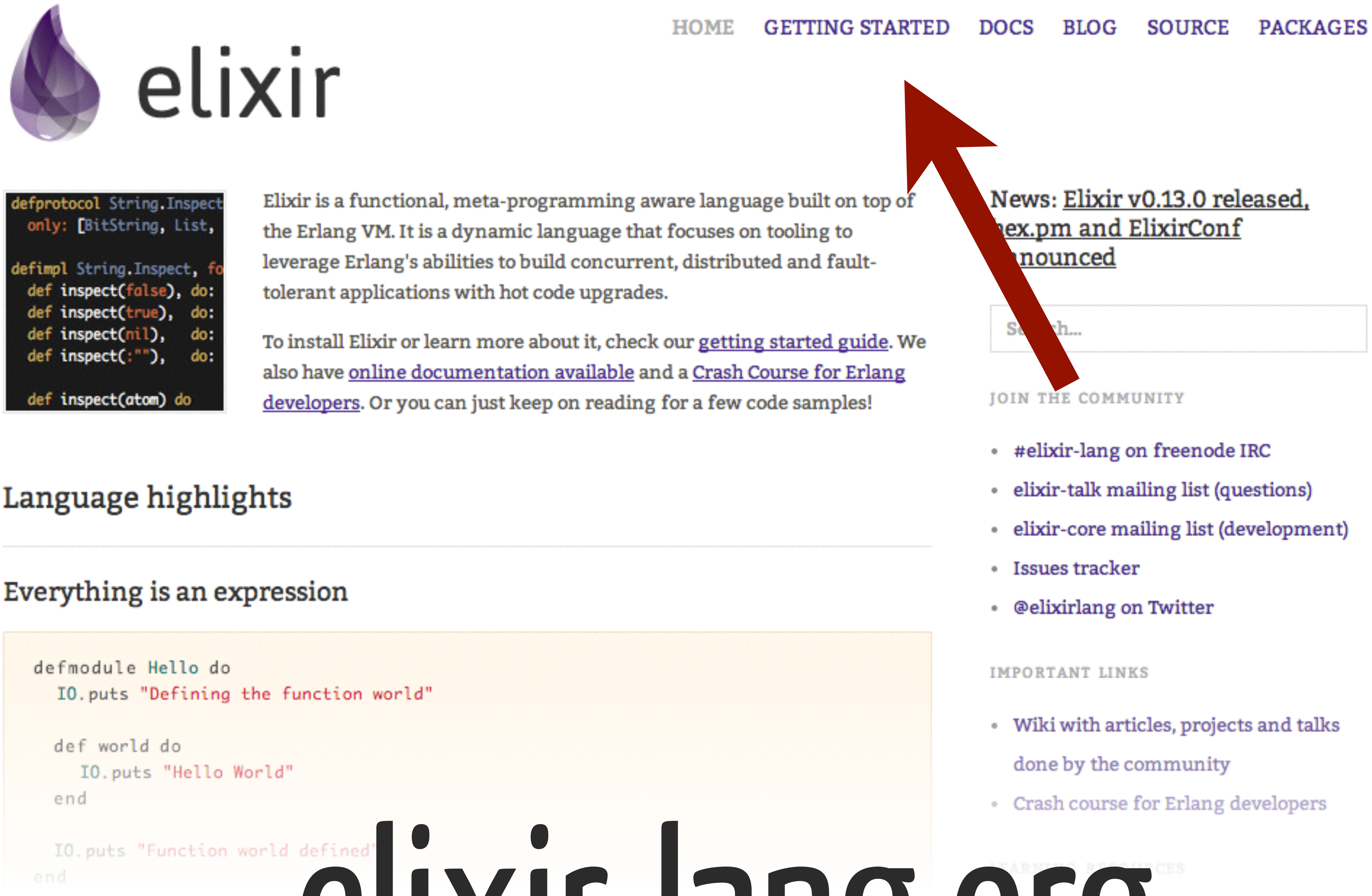
# VM + OTP

# Many interesting challenges

- What is the most efficient way of doing polymorphic dispatch?
- The most effective technique for implementing inline caches?

# Many interesting challenges

- How to provide pipeline parallelism with back pressure efficiently?
- Which strategies are relevant for data parallelism?



```
defprotocol String.Inspect
  only: [BitString, List,

defimpl String.Inspect, fo
  def inspect(false), do:
  def inspect(true),  do:
  def inspect(nil),   do:
  def inspect(:""),   do:

  def inspect(atom) do
```

Elixir is a functional, meta-programming aware language built on top of the Erlang VM. It is a dynamic language that focuses on tooling to leverage Erlang's abilities to build concurrent, distributed and fault-tolerant applications with hot code upgrades.

To install Elixir or learn more about it, check our getting started guide. We also have online documentation available and a Crash Course for Erlang developers. Or you can just keep on reading for a few code samples!

News: Elixir v0.13.0 released, hex.pm and ElixirConf announced

JOIN THE COMMUNITY

- #elixir-lang on freenode IRC
- elixir-talk mailing list (questions)
- elixir-core mailing list (development)
- Issues tracker
- @elixirlang on Twitter

IMPORTANT LINKS

- Wiki with articles, projects and talks done by the community
- Crash course for Erlang developers

LEARNING RESOURCES

## Language highlights

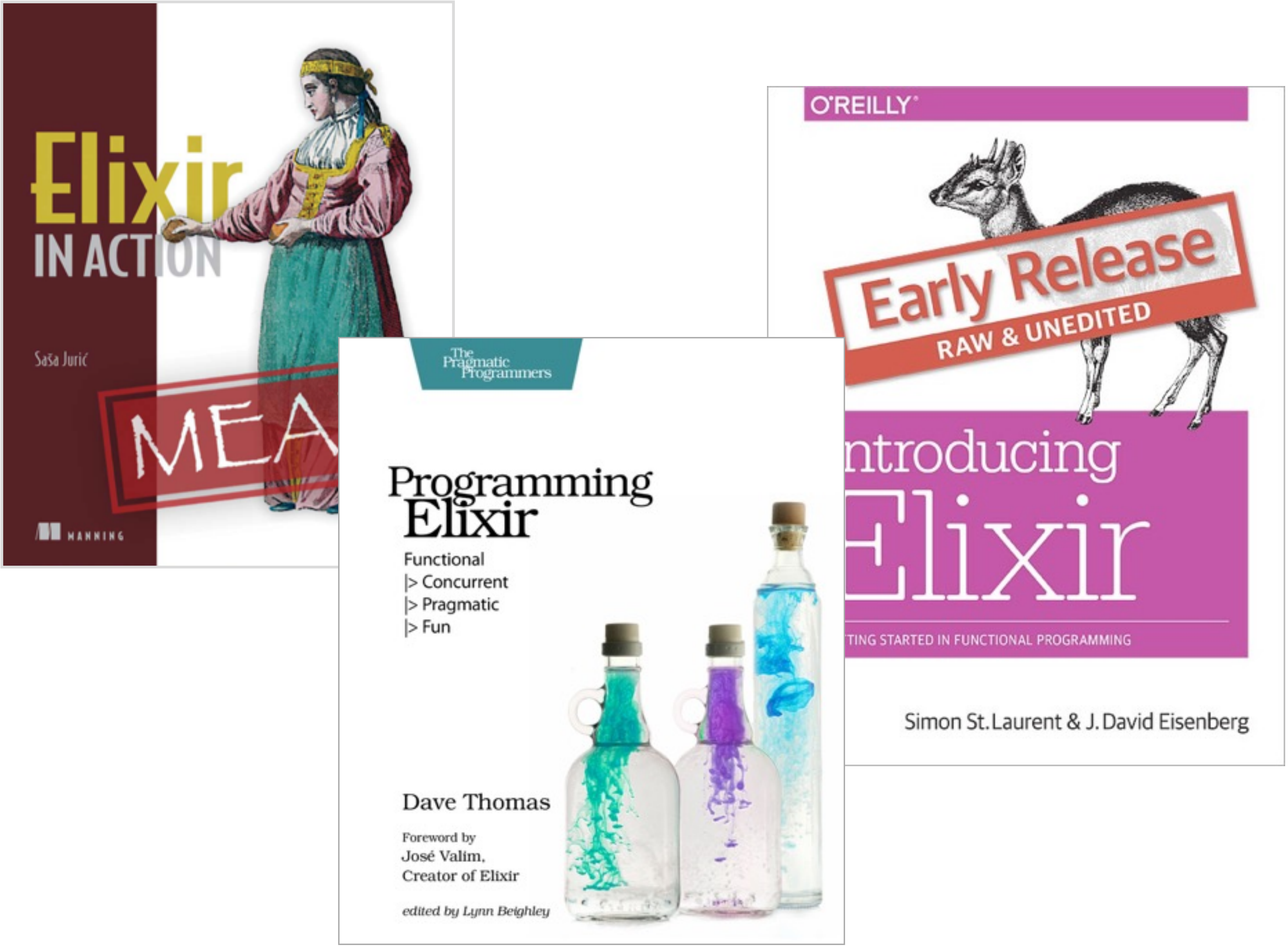
### Everything is an expression

```
defmodule Hello do
  IO.puts "Defining the function world"

  def world do
    IO.puts "Hello World"
  end

  IO.puts "Function world defined"
end
```

# elixir-lang.org



Elixir
IN ACTION

Saša Jurić

MEA

MANNING

The Pragmatic Programmers

Programming Elixir

Functional
|> Concurrent
|> Pragmatic
|> Fun

Dave Thomas

Foreword by
José Valim,
Creator of Elixir

*edited by Lynn Beighley*

O'REILLY

Early Release
RAW & UNEDITED

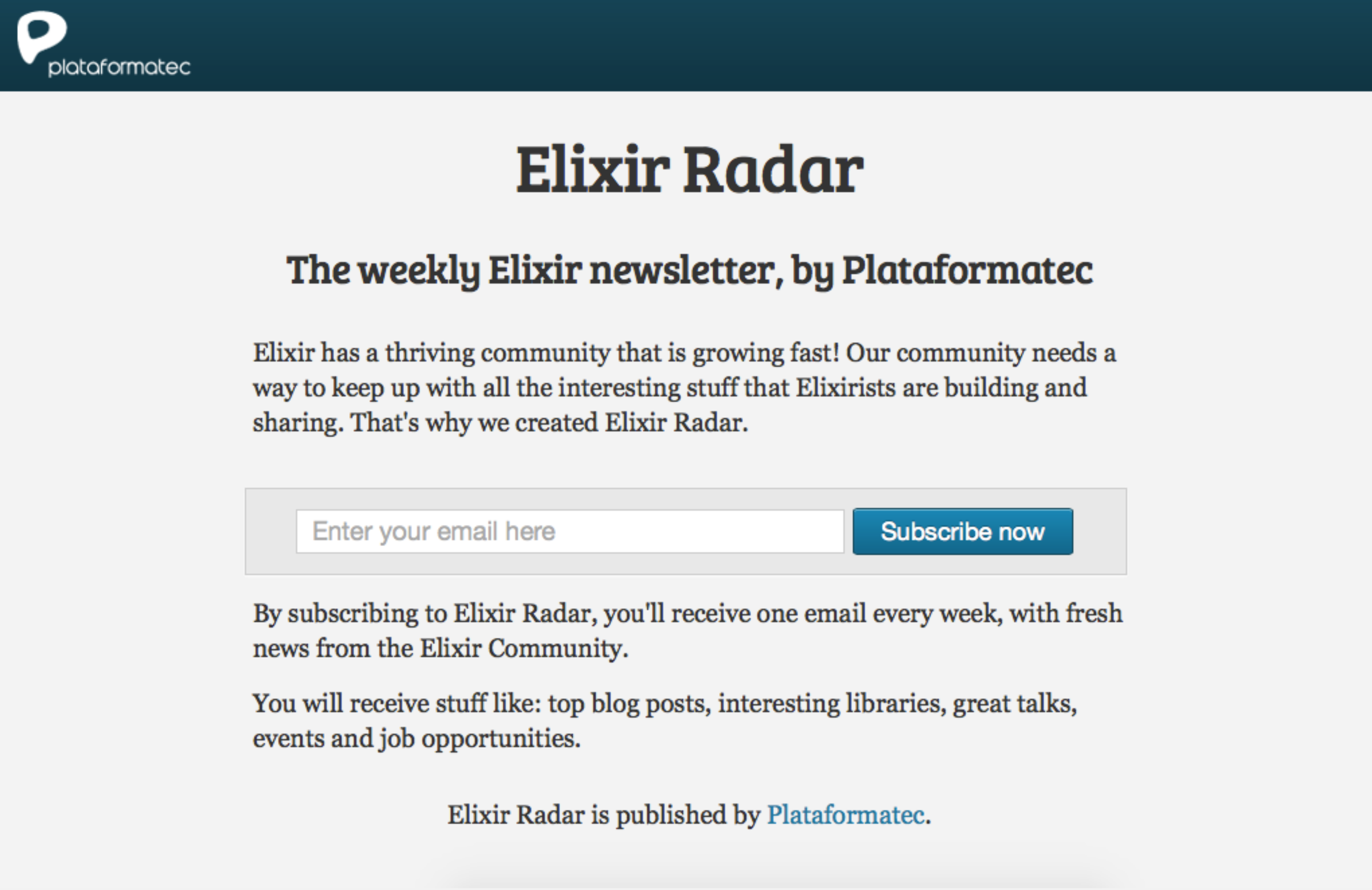
ntroducing Elixir

TING STARTED IN FUNCTIONAL PROGRAMMING

Simon St.Laurent & J. David Eisenberg

plataformatec

consulting and software engineering



# Elixir Radar

## The weekly Elixir newsletter, by Plataformatec

Elixir has a thriving community that is growing fast! Our community needs a way to keep up with all the interesting stuff that Elixirists are building and sharing. That's why we created Elixir Radar.

By subscribing to Elixir Radar, you'll receive one email every week, with fresh news from the Elixir Community.

You will receive stuff like: top blog posts, interesting libraries, great talks, events and job opportunities.

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