

Rust and Haskell

sitting in a tree



Lisa 'lislis' Passing

Lambda.World Cádiz 2018

\$ whoami

\$ whoami

Hi, I'm Lisa 🙋

\$ whoami

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Web dev, game jammer, wannabe digital artist, fp enthusiast, etc

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Co-organizer of ClojureBridge Berlin

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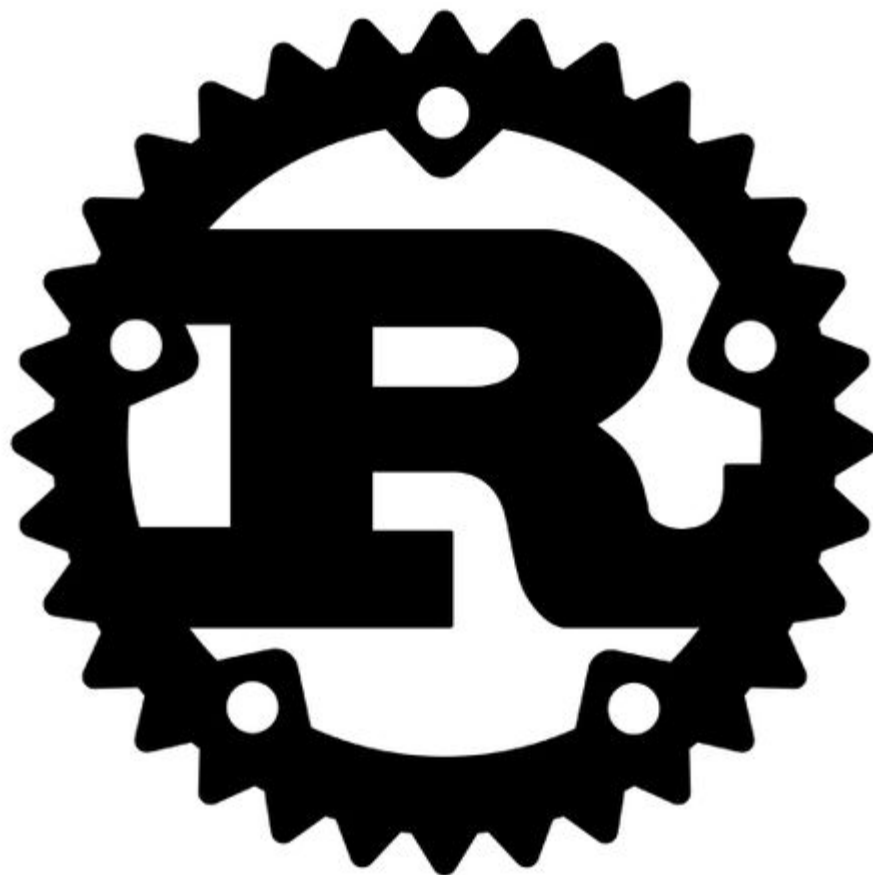
Hi, I'm Lisa 🙋

Web dev, game jammer, wannabe digital artist, fp enthusiast, etc

Co-organizer of ClojureBridge Berlin

I thought of a pun when writing the talk title, but decided the pun doesn't work when writing the talk

¬_ (ツ) _ /




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Rust is a systems programming language that runs blazingly fast, prevents segfaults, and guarantees thread safety.

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September 25, 2018

See [who's using Rust](#), and [read more about Rust in production](#).

Featuring

- zero-cost abstractions
- move semantics
- guaranteed memory safety
- threads without data races
- trait-based generics
- pattern matching
- type inference
- minimal runtime
- efficient C bindings

```
fn main() {
    let greetings = ["Hello", "Hola", "Bonjour",
                    "Ciao", "こんにちは", "안녕하세요",
                    "Cześć", "Olá", "Здравствуй",
                    "Chào bạn", "您好", "Hallo",
                    "Hej", "Ahoj", "سلام", "அவ்வை"];

    for (num, greeting) in greetings.iter().enumerate() {
        print!("{}", greeting);
        match num {
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```

Run

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Run

More examples



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More examples

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            _ => {},
        }
    }
}
```

Run

[More examples](#)

Let's see

Let's see

- type inference
- pattern matching
- trait-based generics
- zero-cost abstractions

Let's see

- type inference
- pattern matching
- trait-based generics
- zero-cost abstractions

Could make a pretty good fp talk 🤖

Type inference



*Did someone say **type inference**?*

Type inference in Haskell

Type inference in Haskell

```
doubleMe x = x * 2
```

Type inference in Haskell

```
doubleMe x = x * 2
```

```
doubleMe 8
```

```
16
```

Type inference in Haskell

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Haskell infers that this can only work with numbers.

Type inference in Haskell

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doubleMe x = x * 2
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Haskell infers that this can only work with numbers.

```
doubleMe "this is a trick!"
```

```
doubleMe []
```

Type inference in Haskell

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doubleMe x = x * 2
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doubleMe []
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```
ERROR!
```

Type inference in Haskell

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doubleMe x = x * 2
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doubleMe 8
```

```
16
```

Haskell infers that this can only work with numbers.

```
doubleMe "this is a trick!"
```

```
doubleMe []
```

```
ERROR!
```

We get an error for everything else.

Type inference in Haskell

This works with lists, too!

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```
doubleFirstOfList xs = head xs * 2
```

Type inference in Haskell

This works with lists, too!

```
doubleFirstOfList xs = head xs * 2
```

```
doubleFirstOfList [239, 3482, 23, 23]
```

Type inference in Haskell

This works with lists, too!

```
doubleFirstOfList xs = head xs * 2
```

```
doubleFirstOfList [239, 3482, 23, 23]
```

```
478
```

Type inference in Haskell

We don't have to annotate types,

but it's nice when we do.

Type inference in Haskell

We don't have to annotate types,

but it's nice when we do.

```
doubleFirstOfList' :: [Int] -> Int  
doubleFirstOfList' xs = head xs * 2
```



What about Rust?

Type inference in Rust

Type inference in Rust

- Types are inferred when possible

Type inference in Rust

- Types are inferred when possible

```
fn main() {  
    let elem = 5;  
  
    let doubleElem = elem * 2;  
  
    println!("{}", doubleElem);  
}
```

Type inference in Rust

- Types are inferred when possible

```
fn main() {  
    let elem = 5;  
  
    let doubleElem = elem * 2;  
  
    println!("{}", doubleElem);  
}
```

10

Type inference in Rust

```
fn main() {  
    let vector = vec![2, 16, 348];  
  
    let double_first_of_vec = vector[0] * 2;  
  
    println!("{}", double_first_of_vec);  
}
```

Type inference in Rust

```
fn main() {  
    let vector = vec![2, 16, 348];  
  
    let double_first_of_vec = vector[0] * 2;  
  
    println!("{}", double_first_of_vec);  
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```

4

Type inference in Rust

Function params and return values
have to always be annotated!

Type inference in Rust

Function params and return values
have to always be annotated!

```
fn double_first_of_vec(v:Vec<u32>) -> u32 {  
    v[0] * 2  
}  
  
fn main() {  
    let vector = vec![2, 16, 348];  
    println!("{}", double_first_of_vec(vector));  
}
```

Type inference in Rust

Function params and return values
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fn double_first_of_vec(v:Vec<u32>) -> u32 {  
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}  
  
fn main() {  
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```


Trait-based generics

What are generics in Rust?

What are generics in Rust?

An abstract stand-in for a concrete values

What are generics in Rust?

An abstract stand-in for a concrete values

```
fn first_and_last<T>(v: &Vec<T>) -> Vec<&T> {  
    vec![v.first().unwrap(),  
         v.iter().last().unwrap()]  
}
```

What are generics in Rust?

An abstract stand-in for a concrete values

```
fn first_and_last<T>(v: &Vec<T>) -> Vec<&T> {  
    vec![v.first().unwrap(),  
        v.iter().last().unwrap()]  
}
```

```
fn main() {  
    let nums = vec![2, 16, 348];  
    println!("{:?}", first_and_last(&nums));  
  
    let strings = vec!["Hello", "a", "foo", "World"];  
    println!("{:?}", first_and_last(&strings));  
}
```

What are generics in Rust?

An abstract stand-in for a concrete values

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fn first_and_last<T>(v: &Vec<T>) -> Vec<&T> {  
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    let strings = vec!["Hello", "a", "foo", "World"];  
    println!("{:?}", first_and_last(&strings));  
}
```

```
[2, 348]  
["Hello", "World"]
```



*Oh, did you mean **type variables**?*

Type variables in Haskell

Type variables in Haskell

```
firstAndLast :: [a] -> [a]  
firstAndLast xs = [head xs, last xs]
```

Type variables in Haskell

```
firstAndLast :: [a] -> [a]  
firstAndLast xs = [head xs, last xs]
```

```
firstAndLast [45, 28, 645, 23]
```

```
[45, 23]
```

What are Traits in Rust?

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Traits define behaviour that Types can implement.

What are Traits in Rust?

Traits define behaviour that Types can implement.

Example `Display` Trait for user facing string output.



Trait Display

Required Methods

fmt

Implementations on Foreign Types

Utf8Lossy

TryFromSliceError

Implementors

std::fmt

Structs

Arguments

DebugList

DebugMap

DebugSet

DebugStruct

DebugTuple

Error

Formatter

← → ↺ 🏠

🔒 https://doc.rust-lang.org/std/fmt/trait.Display.html

🔍

Click or press 'S' to search, '?' for more options...

⚙️

Trait std::fmt::Display1.0.0[-][src]

[+] Show declaration

[-] Format trait for an empty format, {}.

Display is similar to Debug, but Display is for user-facing output, and so cannot be derived.
For more information on formatters, see [the module-level documentation](#).

Examples

Implementing Display on a type:

```
use std::fmt;

struct Point {
    x: i32,
    y: i32,
}

impl fmt::Display for Point {
    fn fmt(&self, f: &mut fmt::Formatter) -> fmt::Result {
        write!(f, "({}, {})", self.x, self.y)
    }
}

let origin = Point { x: 0, y: 0 };

println!("The origin is: {}", origin);
```

Run

Implementing **Display** on a type

Implementing **Display** on a type

```
use std::fmt;

struct Point {
    x: i32,
    y: i32
}
```


Implementing **Display** on a type

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Implementing **Display** on a type

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impl fmt::Display for Point {
    fn fmt(&self, f: &mut fmt::Formatter) -> fmt::Result {
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    }
}

let p = Point { x: 0, y: 0 };
println!("The point is: {}", p);
```

Implementing **Display** on a type

```
use std::fmt;

struct Point {
    x: i32,
    y: i32
}

impl fmt::Display for Point {
    fn fmt(&self, f: &mut fmt::Formatter) -> fmt::Result {
        write!(f, "({}, {})", self.x, self.y)
    }
}

let p = Point { x: 0, y: 0 };
println!("The point is: {}", p);
```

The point is: (0, 0)



*Sounds a lot like **type classes***

Type classes in Haskell

Type classes in Haskell

Let's look at the `Show` type class

Type classes in Haskell

Let's look at the **Show** type class

```
data Point = Point { x :: Int  
                    , y :: Int  
                    } deriving (Show)
```

Type classes in Haskell

Let's look at the **Show** type class

```
data Point = Point { x :: Int
                     , y :: Int
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```
let p1 = Point 2 3
```

```
show p1
```


Type classes in Haskell

Let's look at the `Show` type class

```
data Point = Point { x :: Int
                    , y :: Int
                    } deriving (Show)
```

```
let p1 = Point 2 3
```

```
show p1
```

```
Point {x = 2, y = 3}
```

Alternatively we can make a function

```
display :: Point -> String
display (Point {x=x, y=y}) = "The point is (" ++ show x ++
                             ", " ++ show y ++ ")"
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display (Point {x=x, y=y}) = "The point is (" ++ show x ++
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let p = Point 0 0
display p
```

Alternatively we can make a function

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display :: Point -> String
display (Point {x=x, y=y}) = "The point is (" ++ show x ++
                             ", " ++ show y ++ ")"
```

```
let p = Point 0 0
display p
```

```
The point is (0, 0)
```

Trait bounds!

Trait bounds!

Class constraints!

Trait bounds!

Class constraints!

```
// Rust

use std::fmt::Display;

fn shout_out<T: Display>(s: T) -> String {
    format!("{}", !!!!!!!!!, s)
}

fn main() {
    println!("{}", shout_out("Uuuuh"));
}
```

Trait bounds!

Class constraints!

```
// Rust

use std::fmt::Display;

fn shout_out<T: Display>(s: T) -> String {
    format!("{}", s)
}

fn main() {
    println!("{}", shout_out("Uuuuh"));
}
```

```
-- Haskell

shoutOut :: (Show a) => a -> String
shoutOut x = (show x) ++ "!!!!!!!!!!"

shoutOut "Yeah"
```


Pattern matching



*Did someone say **pattern matching**?*

Pattern matching in Haskell

Pattern matching in Haskell

```
data Shape = Circle Float Float Float | Rectangle Float Float Float Float
surface :: Shape -> Float
surface (Circle _ _ r) = pi * r ^ 2
surface (Rectangle x1 y1 x2 y2) = (abs $ x2 - x1)
                                   * (abs $ y2 - y1)
```

Pattern matching in Haskell

```
data Shape = Circle Float Float Float | Rectangle Float Float Float Float
surface :: Shape -> Float
surface (Circle _ _ r) = pi * r ^ 2
surface (Rectangle x1 y1 x2 y2) = (abs $ x2 - x1)
                                   * (abs $ y2 - y1)
```

```
surface $ Circle 10 10 10
```

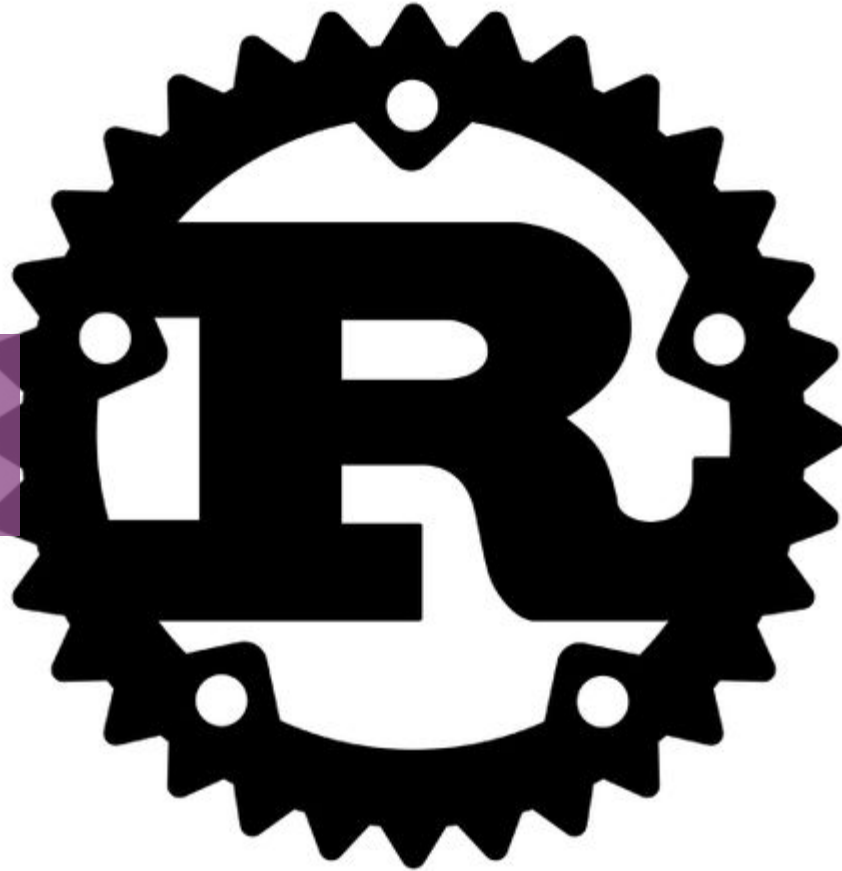
Pattern matching in Haskell

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data Shape = Circle Float Float Float | Rectangle Float Float Float Float  
  
surface :: Shape -> Float  
surface (Circle _ _ r) = pi * r ^ 2  
surface (Rectangle x1 y1 x2 y2) = (abs $ x2 - x1)  
                                   * (abs $ y2 - y1)
```

```
surface $ Circle 10 10 10
```

```
314.15927
```

And in Rust?



Pattern matching in Rust

Pattern matching in Rust

```
use std::f32::consts::PI;

struct Circle(f32, f32, f32);
struct Rectangle(f32, f32, f32, f32);

enum Shape {
    Circle(f32, f32, f32),
    Rectangle(f32, f32, f32, f32)
}
```

Pattern matching in Rust

```
use std::f32::consts::PI;

struct Circle(f32, f32, f32);
struct Rectangle(f32, f32, f32, f32);

enum Shape {
    Circle(f32, f32, f32),
    Rectangle(f32, f32, f32, f32)
}

fn surface(s: Shape) -> f32 {
    match s {
        Shape::Circle(_, _, r) => ( PI * r.powf(2.0) ),
        Shape::Rectangle(x1, y1, x2, y2) => {
            (x2 - x1).abs() * (y2 - y1).abs()
        },
    }
}
```

Pattern matching in Rust

```
fn main() {  
    let circle = Shape::Circle(10.0, 10.0, 10.0);  
    println!("{:?}", surface(circle));  
}
```

Pattern matching in Rust

```
fn main() {  
    let circle = Shape::Circle(10.0, 10.0, 10.0);  
    println!("{:?}", surface(circle));  
}
```

314.15927

Zero-cost abstractions



*Using higher level concepts
at no additional performance cost!*

Higher order functions in Haskell

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Like map

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Like map

```
map (+3) [1, 5, 3, 1, 6]
```

Higher order functions in Haskell

Like map

```
map (+3) [1, 5, 3, 1, 6]
```

```
[4, 8, 6, 4, 9]
```

Higher order functions in Haskell

Like map

```
map (+3) [1, 5, 3, 1, 6]
```

```
[4, 8, 6, 4, 9]
```

or filter

Higher order functions in Haskell

Like map

```
map (+3) [1, 5, 3, 1, 6]
```

```
[4, 8, 6, 4, 9]
```

or filter

```
filter (>3) [1, 5, 3, 2, 1, 6, 4, 3, 2, 1]
```

Higher order functions in Haskell

Like map

```
map (+3) [1, 5, 3, 1, 6]
```

```
[4, 8, 6, 4, 9]
```

or filter

```
filter (>3) [1, 5, 3, 2, 1, 6, 4, 3, 2, 1]
```

```
[5, 6, 4]
```



What about Rust?

About functions in Rust (pt 1)

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Function declarations in Rust are statements.

Function calls are expressions.

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Statements cannot be evaluated and therefore
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Expressions can be.

About functions in Rust (pt 2)

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A function's name becomes part of its type,
therefore two functions with the same signature are still different.

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A function's name becomes part of its type,
therefore two functions with the same signature are still different.

Dynamically creating functions
and passing or returning them is
not (easily) possible because types need to be annotated beforehand.



Wait, no higher order functions in Rust?



Closures in Rust

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Closures are anonymous functions that can capture their environment.

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Every closure has its own type but implements one of the traits `Fn`, `FnMut`, `FnOnce`. This can be used with trait bounds when defining structs that hold closures.

Using closures with **Iterators**

Using closures with Iterators

```
fn main() {  
    let vmap: Vec<i32> = vec![1, 5, 3, 1, 6]  
        .into_iter()  
        .map(|x| x + 3)  
        .collect();  
}
```

Using closures with Iterators

```
fn main() {  
    let vmap: Vec<i32> = vec![1, 5, 3, 1, 6]  
        .into_iter()  
        .map(|x| x + 3)  
        .collect();  
  
    let vfilter: Vec<i32> = vec![1, 5, 3, 2, 1, 6, 4, 3, 2, 1]  
        .into_iter()  
        .filter(|x| x > &3)  
        .collect();  
  
    println!("{:?}", vmap);  
    println!("{:?}", vfilter);  
}
```

Using closures with Iterators

```
fn main() {  
    let vmap: Vec<i32> = vec![1, 5, 3, 1, 6]  
        .into_iter()  
        .map(|x| x + 3)  
        .collect();  
  
    let vfilter: Vec<i32> = vec![1, 5, 3, 2, 1, 6, 4, 3, 2, 1]  
        .into_iter()  
        .filter(|x| x > &3)  
        .collect();  
  
    println!("{:?}", vmap);  
    println!("{:?}", vfilter);  
}
```

```
[4, 8, 6, 4, 9]  
[5, 6, 4]
```




Zero-cost abstractions

*Using higher level concepts
at no additional performance cost!*

phew

phew

That was a lot.

Rust and Haskell

Rust and Haskell

Rust is not a functional language,
but it has learned a lot of good things
from Haskell and the functional world.

More nice things!

More nice things!

- [Rust REPL RFC](#)

More nice things!

- Rust REPL RFC
- Generic associated types RFC

(formerly known as
associated type constructors)

← Konferenz in Cadiz + [Profile]

Do you know that there is a way to emulate HKT in Rust?
JUL 26, 11:07 PM

What is hkt?
JUL 26, 11:09 PM

[Profile] ~Jose
Higher kinded types
JUL 26, 11:09 PM

Fucntional folk love that
JUL 26, 11:10 PM

In Rust you can do it via ATC (associated type constructors) but not many people know that
JUL 26, 11:11 PM

It's a "hack" anyways but works
JUL 26, 11:12 PM

Ah, I didn't know that
JUL 26, 11:32 PM

120 / 121

Thank you!

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🐘 lislis@toot.cat

👤 <https://github.com/lislis>

🗄 <https://lislis.de/talks/lambda-world-2018/>

Resources

- [The Rust Programming Language](#)
- [Rust by Example](#)
- [Learn you a Haskell](#)