Railway Oriented Programming

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red·head·s
SOFTWARE SOLUTIONS SUPPORT

PATRICK DRECHSLER

- Software Entwickler / Architekt
- Beruflich: C#
- Interessen:
  - Software Crafting
  - Domain-Driven-Design
  - Funktionale Programmierung

https://pixabay.com/users/Larisa-K-1107275/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=1635118

MEIN ZIEL

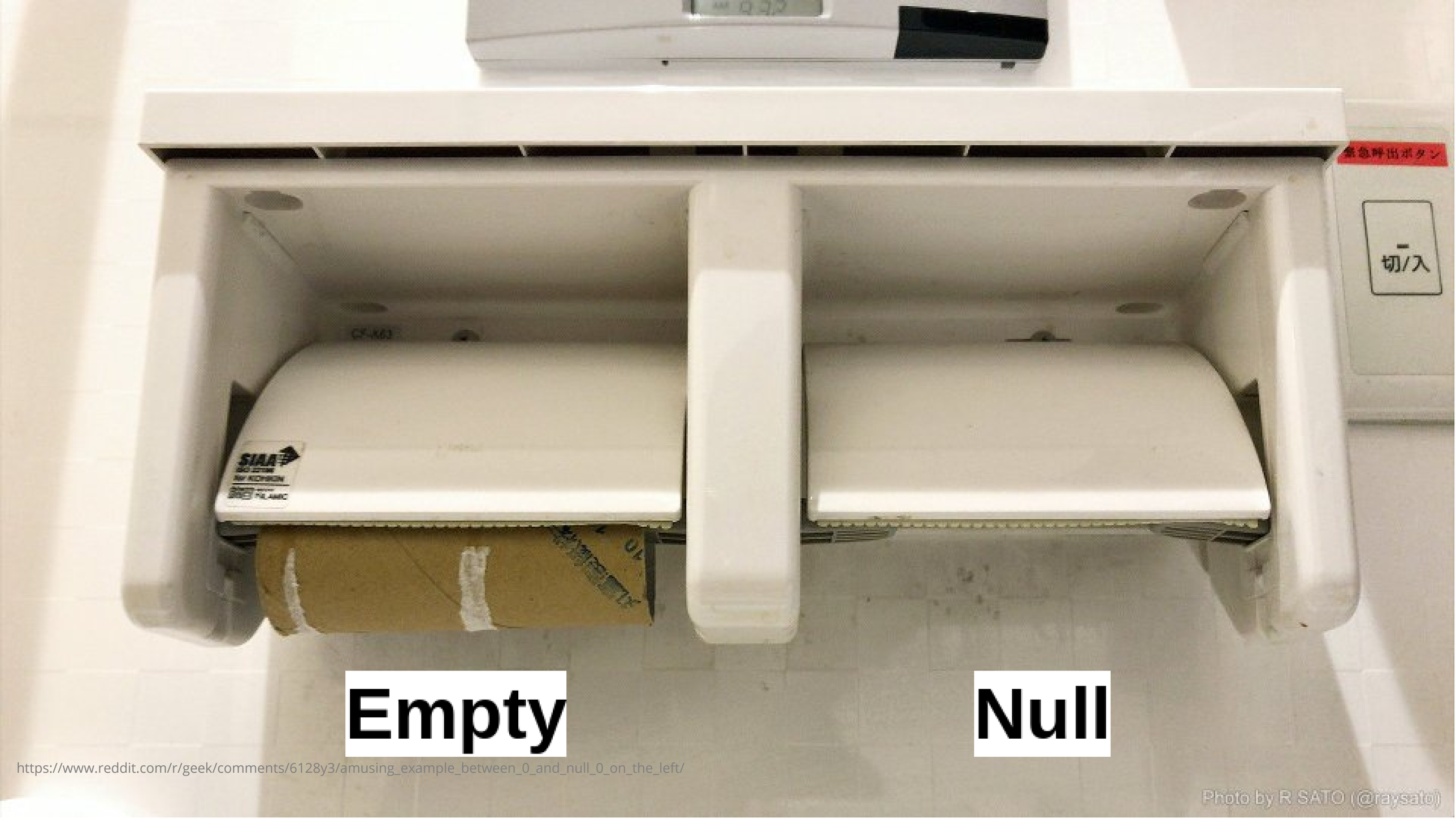
https://pixabay.com/users/Fotoworkshop4You-2995268/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=1555348

NULL IS A PAIN

```
public void Foo(string s)
{
    if (string.IsNullOrWhiteSpace(s))
    {
        // ...
    }
}
```

```
public void Foo(List<string> someStringCollection)
{
    if (someStringCollection ≠ null && someStringCollection.Any())
    {
        // ...
    }
}
```

```
public void Foo(Customer customer)
{
    if (customer?.Address?.ZipCode ≠ null)
    {
        // ..
    }
    else
    {
        // ..
    }
}
```


緊急呼出ボタン
切/入
Empty
Null
https://www.reddit.com/r/geek/comments/6128y3/amusing_example_between_0_and_null_0_on_the_left/
Photo by R SATO (@raysato)

ANTIPATTERN: PRIMITIVE OBSESSION

> *Like most other [code] smells, primitive obsessions are born in moments of weakness.* ***"Just a field for storing some data!"*** *the programmer said. Creating a primitive field is so much easier than* ***making a whole new class****, right?*

https://sourcemaking.com/refactoring/smells/primitive-obsession

Tony Hoare

From Wikipedia, the free encyclopedia

For the bicycle racer, see Tony Hoar.

Sir Charles Antony Richard Hoare FRS FREng[3] (born 11 January 1934),[4] is a British computer scientist. He developed the sorting algorithm quicksort in 1959/1960.[5] He also developed Hoare logic for verifying program correctness, and the formal language communicating sequential processes (CSP) to specify the interactions of concurrent processes (including the dining philosophers problem) and the inspiration for the occam programming language.[6][7][8][9][10][11]

Contents [hide]

Sir Tony Hoare

FRS FREng

Tony Hoare in 2011

Born	Charles Antony Richard Hoare 11 January 1934 (age 85) Colombo, British Ceylon
Residence	Cambridge

Tony Hoare

From Wikipedia, the free encyclopedia

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Sir Tony Hoare

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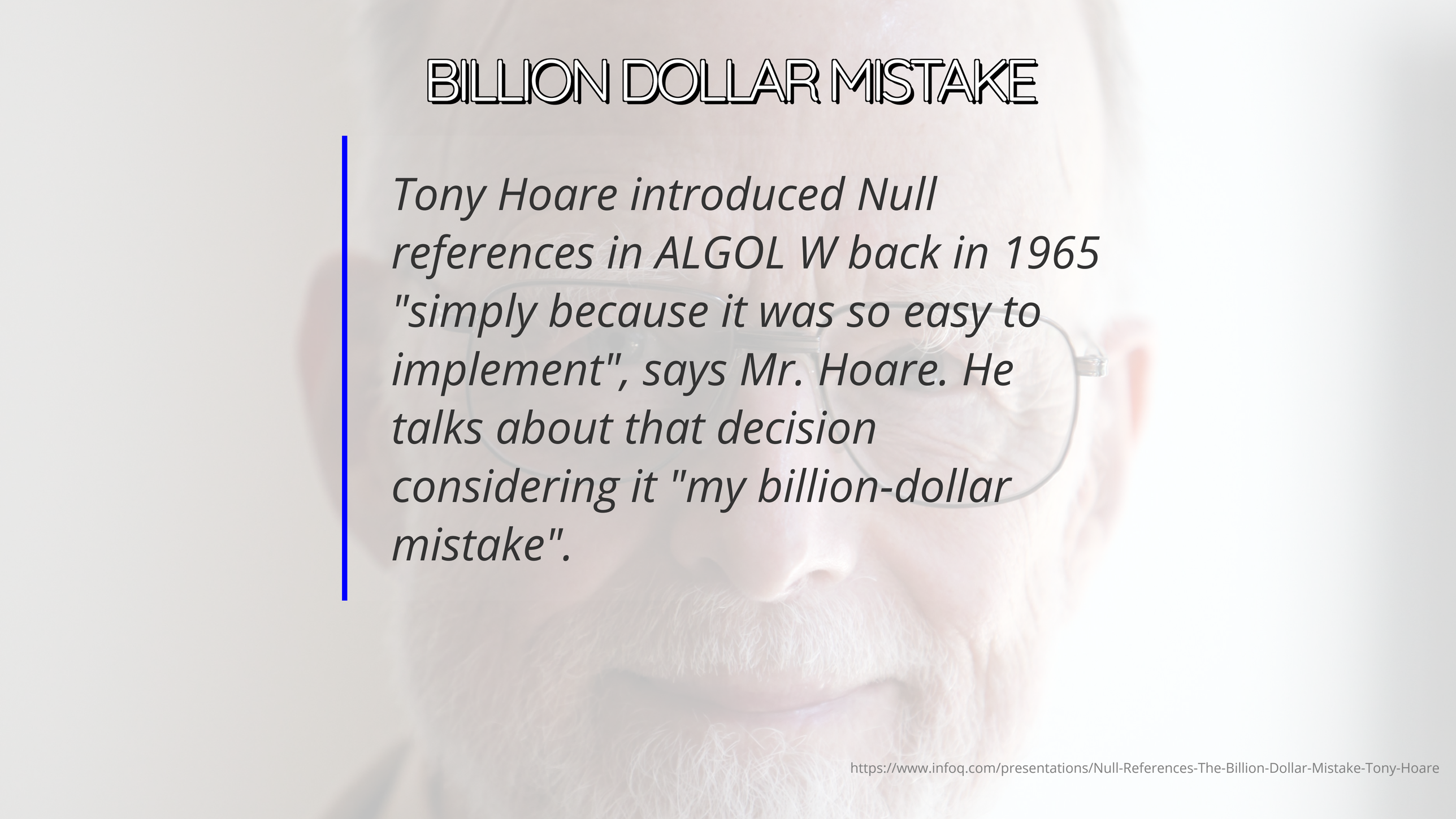
Residence	Cambridge

BILLION DOLLAR MISTAKE

Tony Hoare introduced Null references in ALGOL W back in 1965 "simply because it was so easy to implement", says Mr. Hoare. He talks about that decision considering it "my billion-dollar mistake".



https://www.infoq.com/presentations/Null-References-The-Billion-Dollar-Mistake-Tony-Hoare

House MD: Everybody lies!

ERRORS ARE A PAIN

ARITHMETIC ERRORS

```
int Add(int a, int b) ⇒ a + b;

var i1 = int.MaxValue;
var i2 = 1;

var result = Add(i1, i2);
```

INFRASTRUCTURE ERRORS

```
Customer GetById(Guid id)
{
    return db.GetById(id);
}
```

- Offensichtliche Lüge!

IMHO

- using Exception-Handling as control flow is bad practice
  - (unless you are performance optimizing)

Anticipate Errors!

- Fehler im Workflow sind normal (nicht die Ausnahme)
- Fehler müssen auf Business-Ebene behandelt werden

House MD: Everybody lies!

BAD MODELS ARE A PAIN

...hier sind wir (als Software Entwickler) gefragt...

```
class Customer
{
    string FirstName { get; set; }
    string LastName { get; set; }
    string Email { get; set; }
}
```

VS

```
class Customer
{
    Name FirstName { get; set; }
    Name LastName { get; set; }
    Email Email { get; set; }
}

class Name { /* ... */ }
class Email { /* ... */ }
```

House MD: Everybody lies!

BAD USER STORIES...

Beispiel: User Anmeldung Website

- Validierung
- Speichern in DB
- Greating-Email verschicken

Verhalten der Applikation bei Fehlern

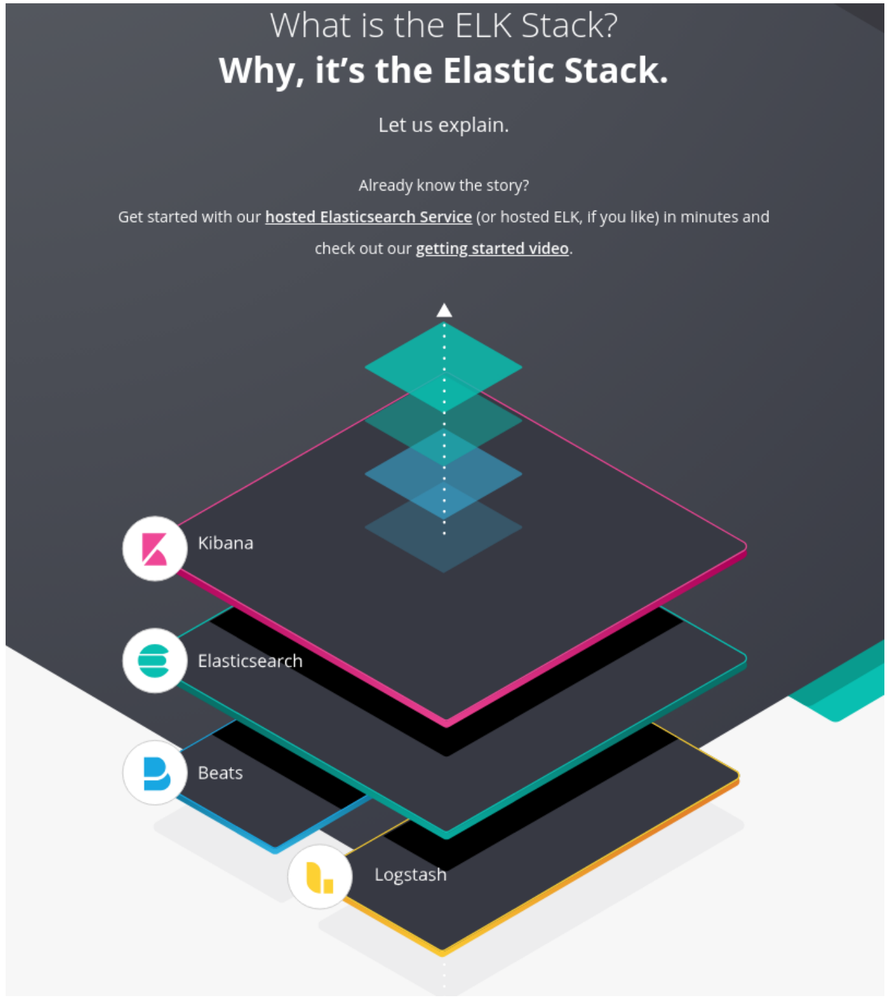
Fehler passieren und sollten beschrieben werden

House MD: Everybody lies!

LOG LIKE A PRO

ELK

- Elastic
- Logstash
- Kibana

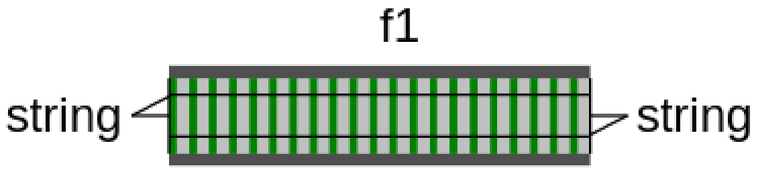


OPS

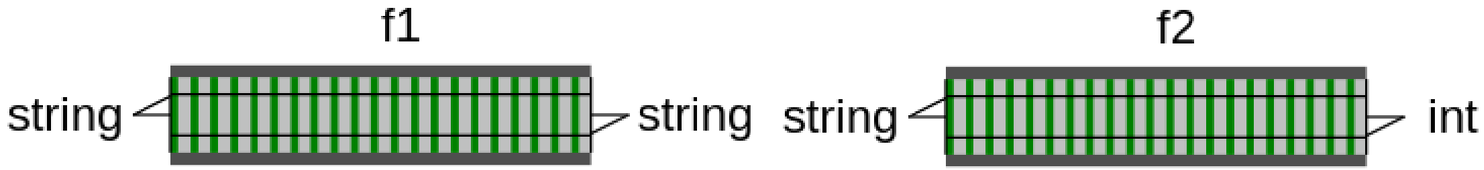
...will thank you

YOU PROMISED TRAINS... ?

SINGLE TRACK MODEL

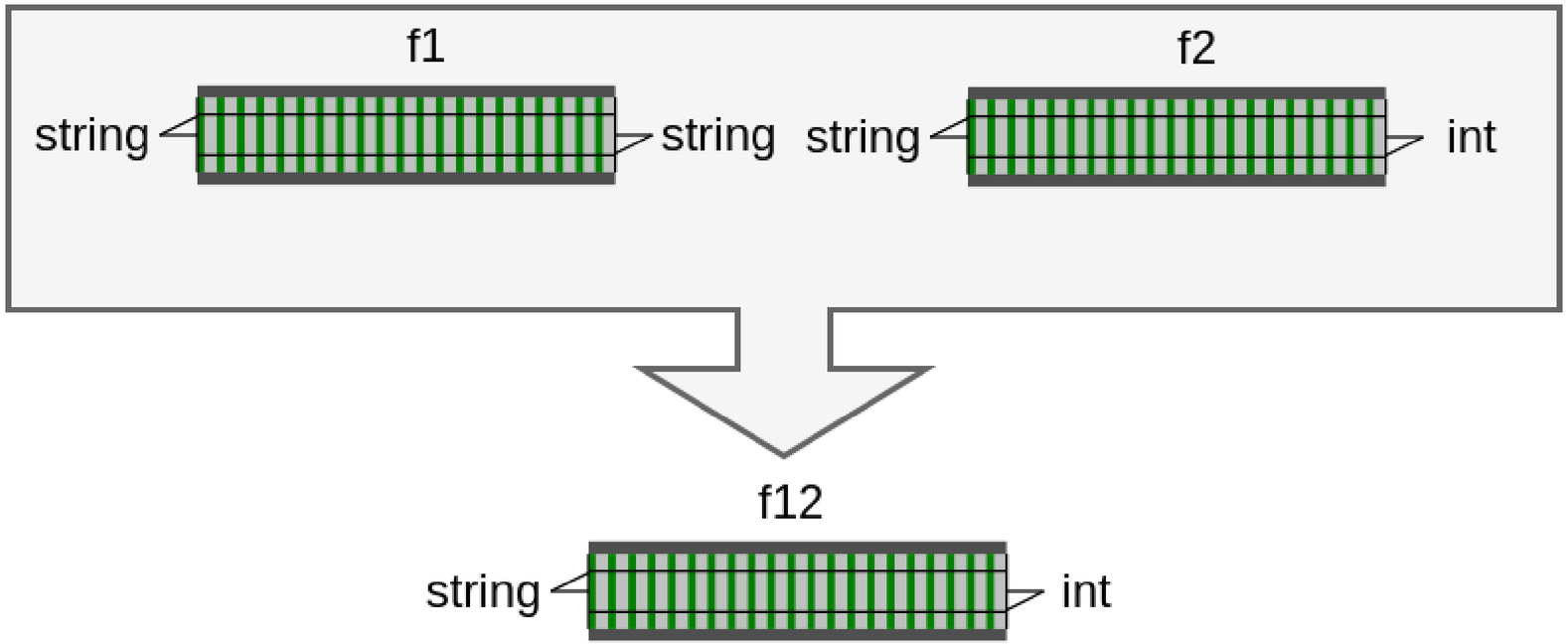



```
string f1(string input) ⇒ input.ToUpper();
var result = f1("abc");      // → "ABC"
```

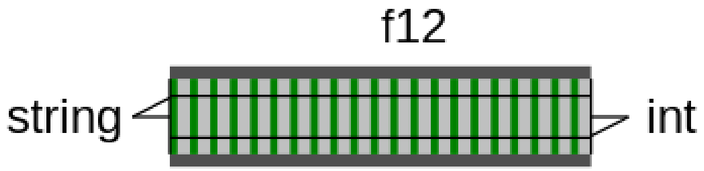



```
string f1(string input) ⇒ input.ToUpper();
int    f2(string input) ⇒ input.Length;

var r1 = f1("abc");
var r2 = f2(r1);   // → 3
```

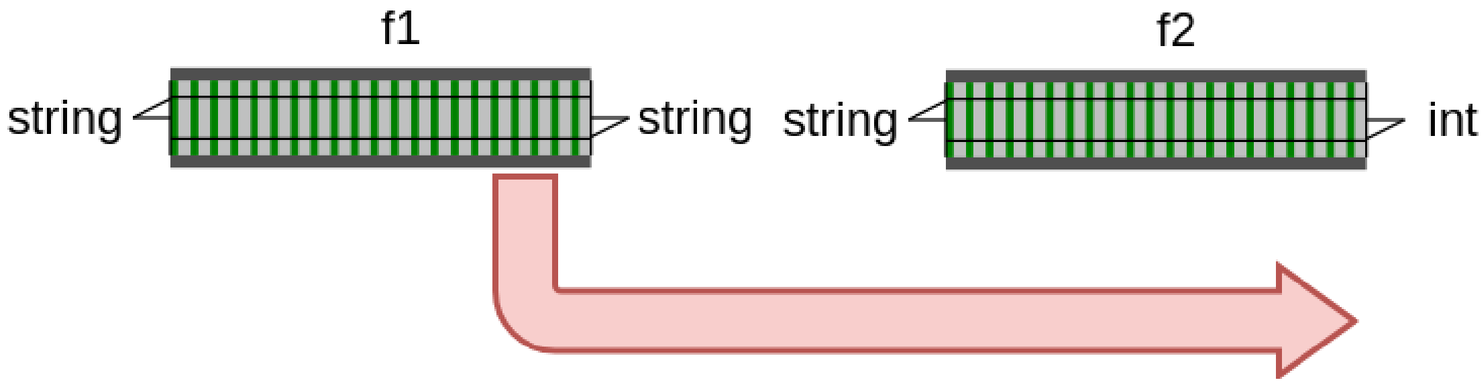
Composition



Composition



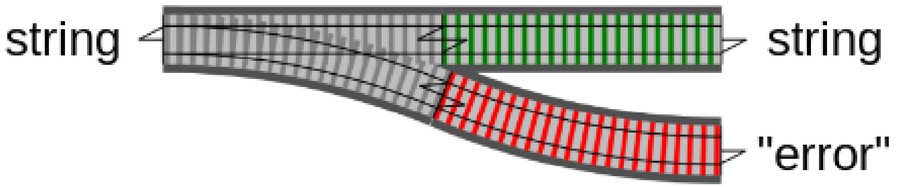

```
string f1 (string input) ⇒ input.ToUpper();
int    f2 (string input) ⇒ input.Length;

int    f12(string input) ⇒ f2(f1(input)); // "Composition"

var result = f12("abc");      // → 3
```

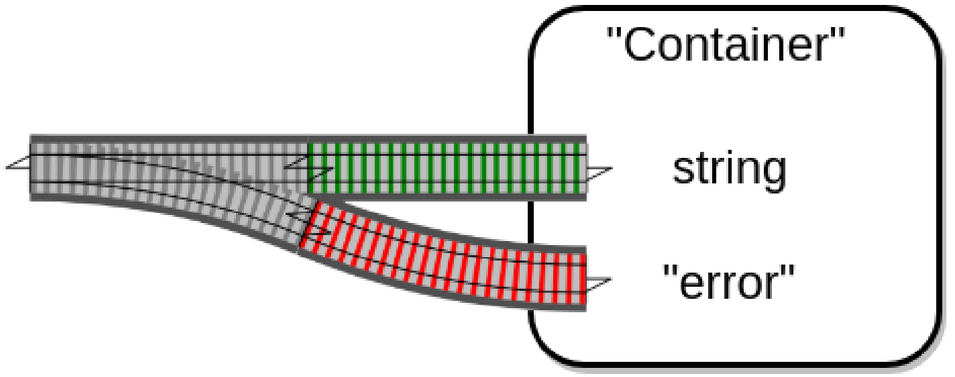


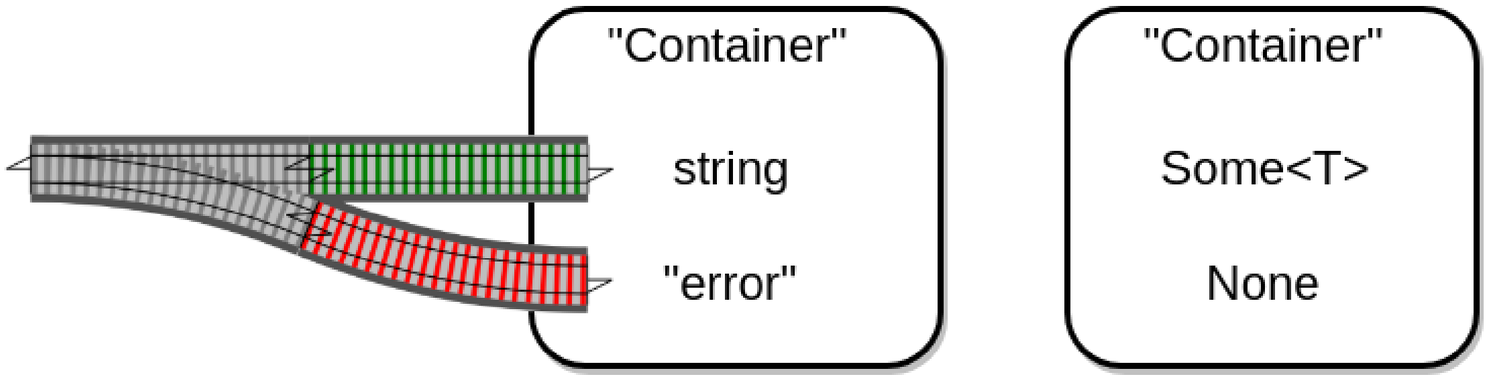
- `f1` kann fehlschlagen
- Komposition von `f1` und `f2` nicht möglich

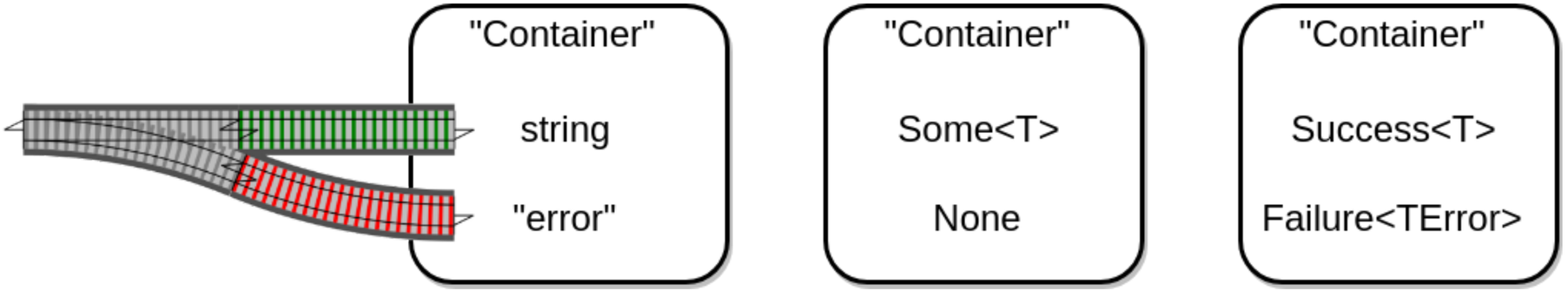
```
try {
    var resultF1 = f1(s);
    var resultF2 = f2(resultF1);
} catch {
    // ...
}
```

SINGLE TRACK WITH SWITCH


string
string
"error"


"Container"
string
"error"


"Container"
string
"error"
"Container"
Some<T>
None


"Container"
string
"error"
"Container"
Some<T>
None
"Container"
Success<T>
Failure<TError>

nennen wir `Container` besser `Result`

Funktionen, die fehlschlagen können, sollten `Result` zurückgeben

wie könnte eine `Result` Klasse aussehen?

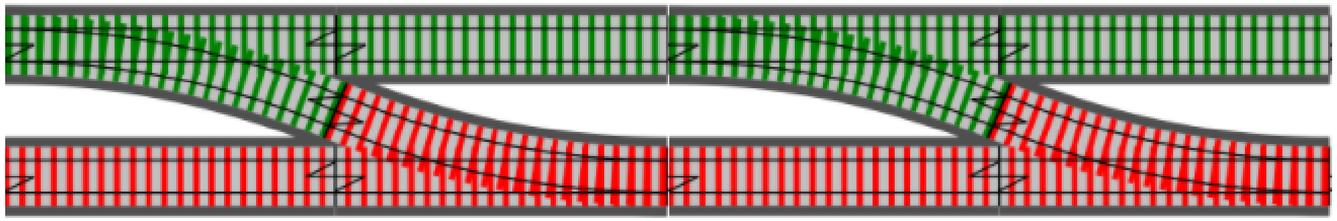
```
// Pseudo code (!)
class Result<TSuccess, TError>
{
    TSuccess Success { get; }
    TError Failure { get; }

    private Result(TSuccess success, TError error) {
        Success = success;
        Failure = error;
    }

    static Success(TSuccess success) ⇒ Result(success, null);

    static Failure(TError error) ⇒ Result(null, error);

    bool IsSuccess ⇒ Success ≠ null;
    bool IsFailure ⇒ !IsSuccess;
}
```

- `Result` muss eindeutigen Zustand haben...

Wie kann man Funktionen verketten?

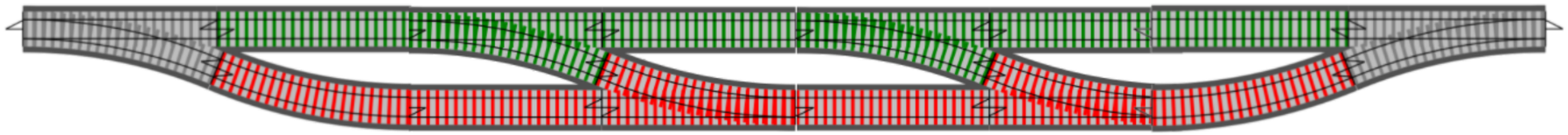
- `f1` gibt `Result` zurück
- `f2` kann `Result` nicht entgegennehmen!

ZIEL: TWO-TRACK MODEL



TWO-TRACK MODEL

MIT ANFANG UND ENDE



`Result` muss **Single-Input Funktion** entgegennehmen

Single-Input Funktion mit `Result` Rückgabewert hat folgende Signatur:

```
// Methode
Result<int, Error> f2(string input) { /* .. */ }

// Allgemein
Result<TSuccess, TError> f2(TInput input) { /* .. */ }
```

```
// Funktion
Func<string, Result<int, Error>> func2

// Allgemein
Func<TInput, Result<TSuccess, TError>> func2
```

Eine Funktionssignatur verhält sich zu einer Funktion wie ein Interface zu einer Klasse

```
Func<TInput, Result<TSuccess, TError>> func2
```

Das Lesen so einer Signatur benötigt anfangs etwas Übung...

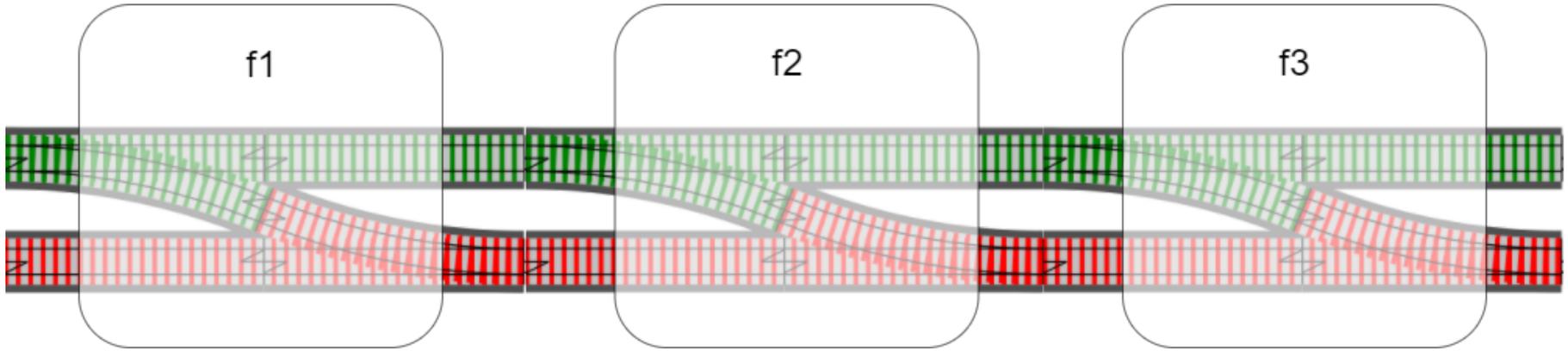
FP ARROW NOTATION

```
f1 :: string → string

f2 :: string → int

f12 :: (string → string) → int

f12' :: string → int
```

```
Func<string, string> f1

Func<string, int> f2

Func<Func<string, string>, int> f12

Func<string, int> f12'
```

ERGEBNISSE KOMBINIEREN

ERGEBNISSE KOMBINIEREN

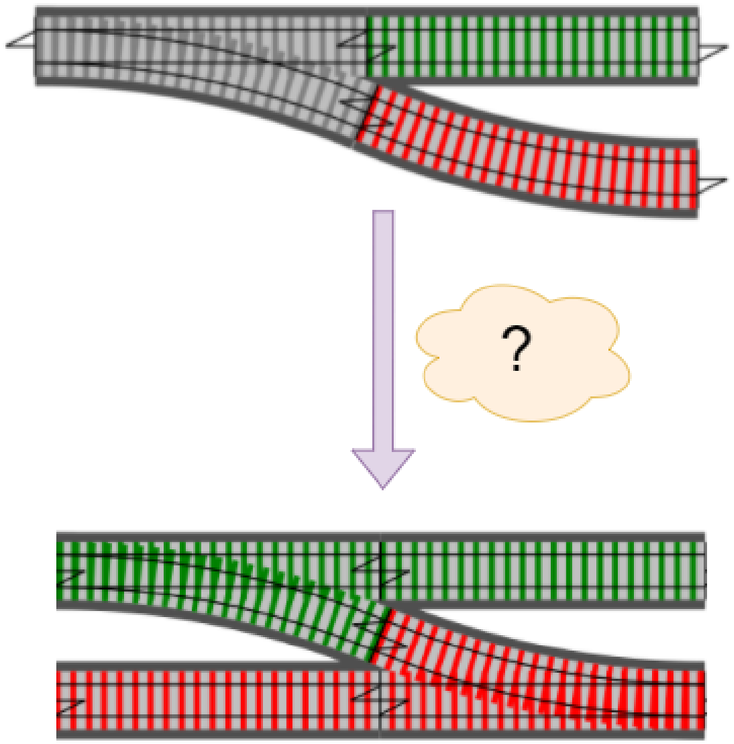


PROBLEM

Wir haben Funktionen mit

- Input: Single-Track
- Output: Two-Track

WIR BRAUCHEN EINEN "ADAPTER"

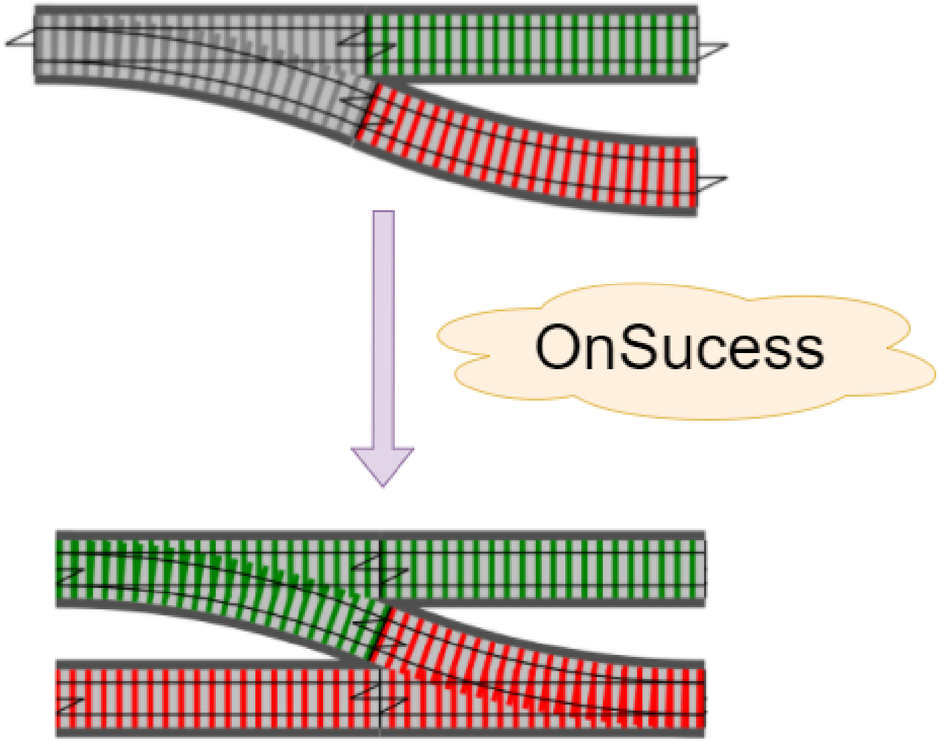


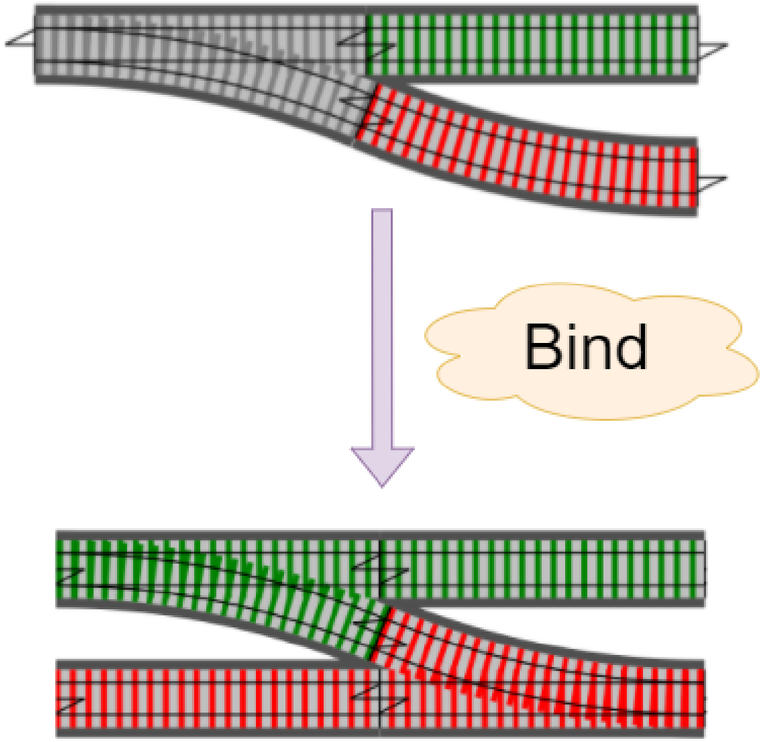
"Adapter" muss in die `Result` Klasse eingebaut sein

- kein Hexenwerk
- es gibt fertige NuGet Pakete
- "zu Fuß"

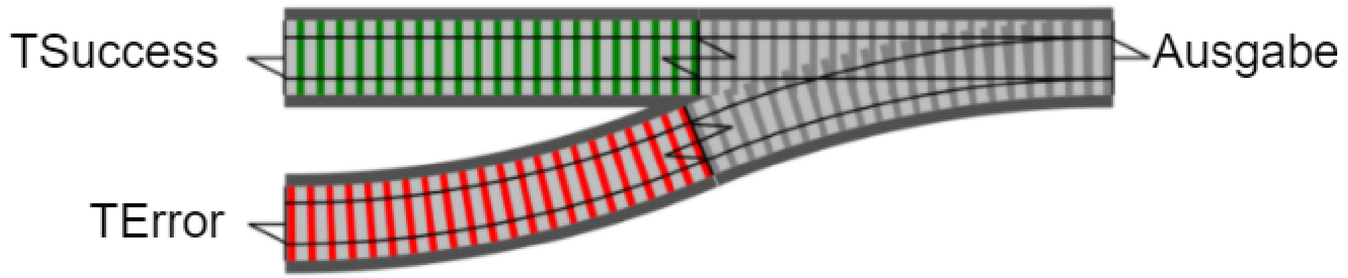
"zu Fuß"

```
static class ResultExtensions
{
    static Result<TSuccess2, TError> OnSuccess   //⟵ FP-Jargon: "Bind"
        (this Result<TSuccess, TError> result,
        Func<TSuccess, Result<TSuccess2, TError>> func)
    {
        if (result.IsSuccess)
            return func(result.Success) // auspacken (!) und func geben

        return result.Failure;
    }
})
```


OnSucess


Bind

ERGEBNIS AUSGEBEN



ERGEBNIS AUSGEBEN

```
static class ResultExtensions
{
    static K OnBoth<T, K>   //⟵ FP-Jargon: "Pattern Matching"
        (this Result<T> result, Func<Result<T>, K> func)
    {
        return func(result);
    }
})
```

C# RAILWAY LIBRARIES

- CSharpFunctionalExtensions
  - https://github.com/vkhorikov/CSharpFunctionalExtensions
- LaYumba
  - https://github.com/la-yumba/functional-csharp-code
- Language-Ext
  - https://github.com/louthy/language-ext

Video:

Scott Wlaschin ("Mr. F#") on Monads

(2min)

Wenn man verstanden hat, was eine Monade ist, verliert man die Fähigkeit zu erklären, was eine Monade ist.

(Monaden-Paradoxon)

F#

RECORD TYPE

```
type Request = {name:string; email:string}
```

- Immutable by default
- Equality by value

F#

RESULT

```
type Result<'T,'TError> =
    | Ok of ResultValue:'T
    | Error of ErrorValue:'TError
```

- Discriminated Union
- gibt es leider in C# nicht

F#

FUNKTIONEN

```
let validate1 input =
    if input.name = "" then Error "Name must not be blank"
    else Ok input

let validate2 input =
    if input.name.Length > 50 then Error "Name must not be longer than 50
    else Ok input

let validate3 input =
    if input.email = "" then Error "Email must not be blank"
    else Ok input
```

F#

BIND

```
let bind switchFunction twoTrackInput =
    match twoTrackInput with
    | Ok s → switchFunction s
    | Error f → Error f
```

zur Erinnerung: C# Bind

```
static class ResultExtensions
{
    static Result<TSuccess2, TError> OnSuccess
        (this Result<TSuccess, TError> result,
        Func<TSuccess, Result<TSuccess2, TError>> func)
    {
        if (result.IsSuccess)
            return func(result.Success)

        return result.Failure;
    }
})
```

F# RAILWAY ORIENTED PROGRAMMING

VERSION 1

```
let combinedValidation =
    let validate2' = bind validate2
    let validate3' = bind validate3
    validate1 >> validate2' >> validate3'

let input1 = {name=""; email=""}
let result = combinedValidation input1
result2 ▷ printfn "Result=%A"

// Result=Error "Name must not be blank"
```

F# RAILWAY ORIENTED PROGRAMMING

VERSION 2

```
let combinedValidation =
    validate1
    >> bind validate2
    >> bind validate3

let input1 = {name=""; email=""}
let result = combinedValidation input1
result2 ▷ printfn "Result=%A"

// Result=Error "Name must not be blank"
```

F# RAILWAY ORIENTED PROGRAMMING

VERSION 3

```
let (>=>) twoTrackInput switchFunction =
    bind switchFunction twoTrackInput

let combinedValidation x =
    x
    |> validate1
    >=> validate2
    >=> validate3

let input1 = {name=""; email=""}
let result = combinedValidation input1
result2 |> printfn "Result=%A"

// Result=Error "Name must not be blank"
```

Um **Railway Oriented Programming** zu praktizieren, muss man nichts über Funktoren, Monoiden oder Monaden wissen

FAZIT: RAILWAY ORIENTED PROGRAMMING

- lesbarer & wartbarer Code
- kompakte Fehlerbehandlung
- **Fehlerbehandlung wird Bestandteil der Domäne!**

...nebenbei haben wir Sinn und Zweck der "Either-Monade" verstanden... ☺

LINKS

- Scott Wlaschin "the original talk" http://fsharpforfunandprofit.com/rop/
- Vladimir Khorikov "Functional C#: Handling failures" http://enterprisecraftsmanship.com/2015/03/20/functional-c-handling-failures-input-errors/
- C# Bibliotheken
  - CSharpFunctionalExtensions https://github.com/vkhorikov/CSharpFunctionalExtensions
  - LaYumba.Functional https://github.com/la-yumba/functional-csharp-code
  - language-ext https://github.com/louthy/language-ext

DANKE!

- Slides & Code
  https://github.com/redheads/2019-05-nug-ruhr-railway-oriented-programming
- Kontakt
  - patrick.drechsler@redheads.de
  - @drechsler
  - draptik