Welcome to Elm!

Please follow these instructions to get set up:

`github.com/rtfeldman/elm-0.19-workshop`

Introduction

What is Elm?

Who uses Elm?

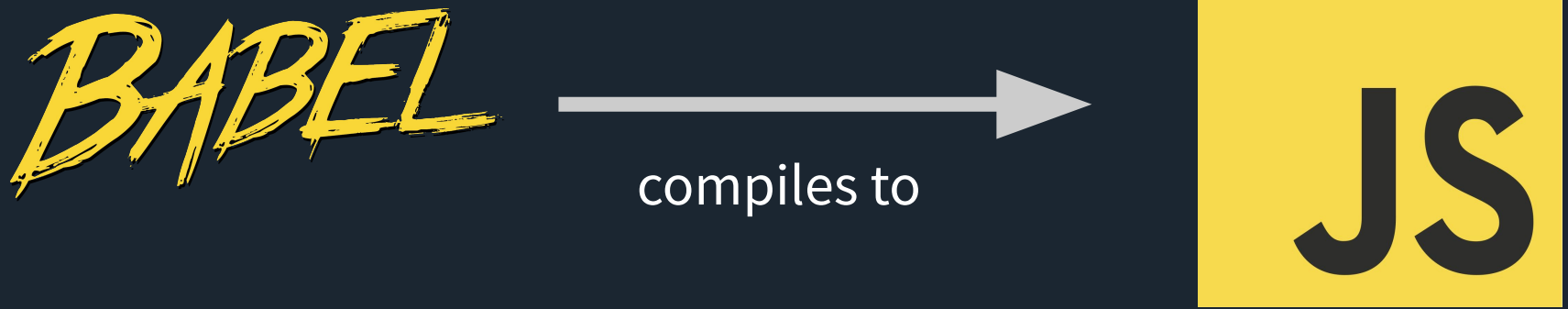
Costs & Benefits

Workshop Structure

elm

compiles to

JavaScript


BABEL
compiles to
JS


TS
compiles to
JS

Companies of all sizes use Elm

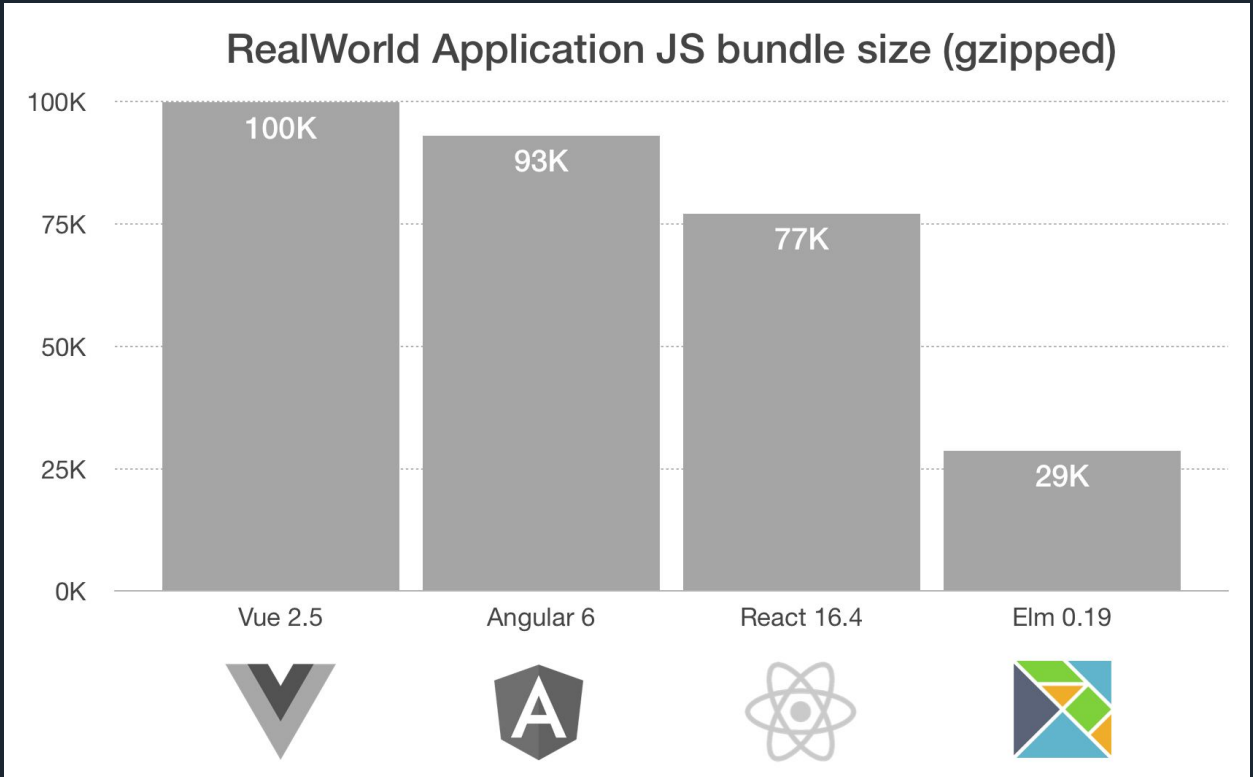
COSTS

1. Learning a new language
2. Smaller ecosystem
3. Fewer Web APIs have first-class support

Why are companies choosing Elm?

1. Measurable technical advantages
2. It makes hiring easier
3. Cohesive, high-quality ecosystem

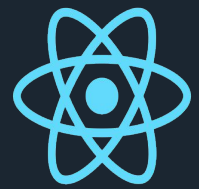
1. Measurable technical advantages



elm-lang.org/blog/small-assets-without-the-headache

1. Measurable technical advantages

BUNDLE SIZE


React


Angular


Vue

Ember

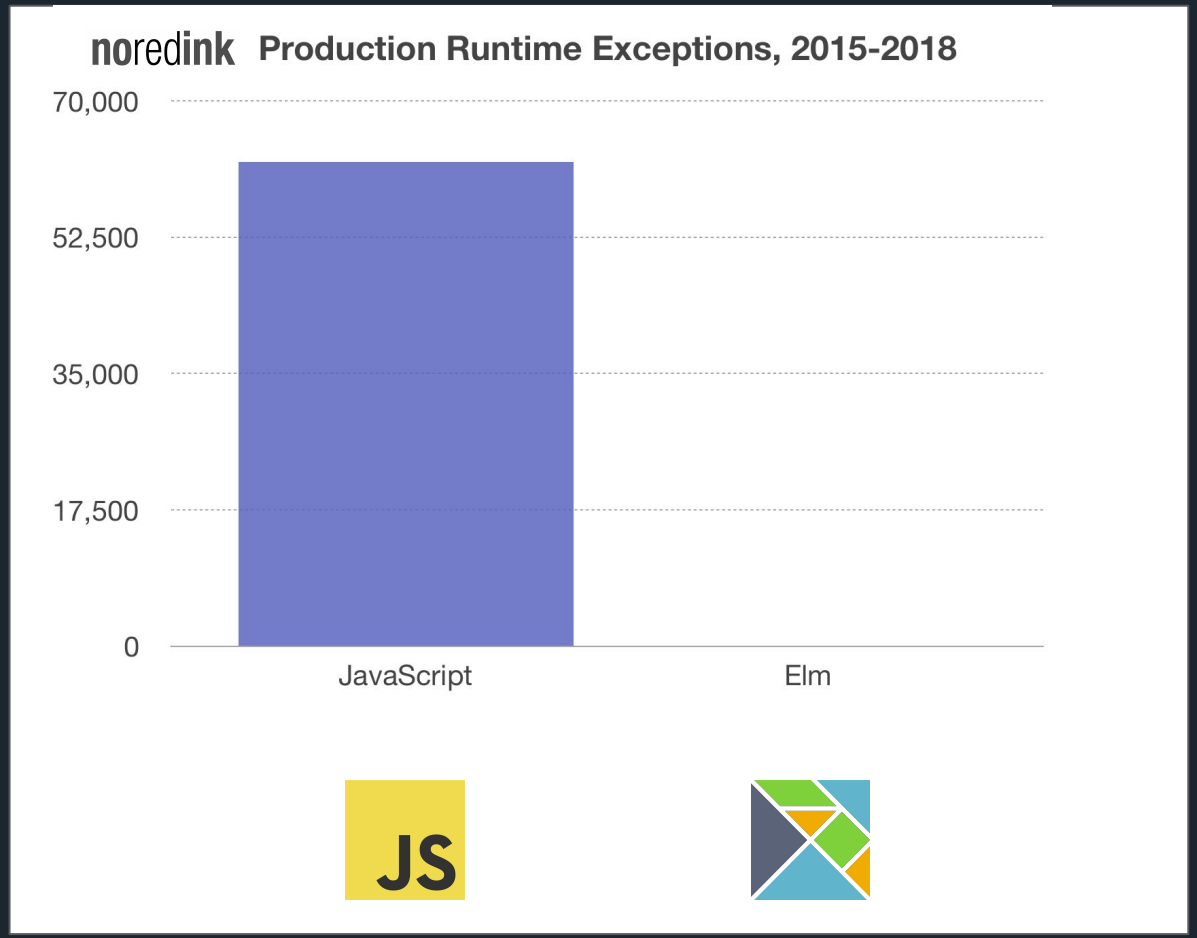

Elm


Preact


Svelte

Raw JS

1. Measurable technical advantages



"No runtime exceptions."

not **zero**,
but negligible

2. It makes hiring easier

noredink **REMOTE POSITIONS**

Elm is **#1 reason** developers apply.

“I have never seen an

inbound pipeline this strong.”

LOCAL POSITIONS

Pacific
health Dynamics

“There is not a large pool of potential candidates for Elm in **Sydney**.
However the ***quality*** of candidates seems to be higher, so we’ve been fortunate enough to fill our current needs.”

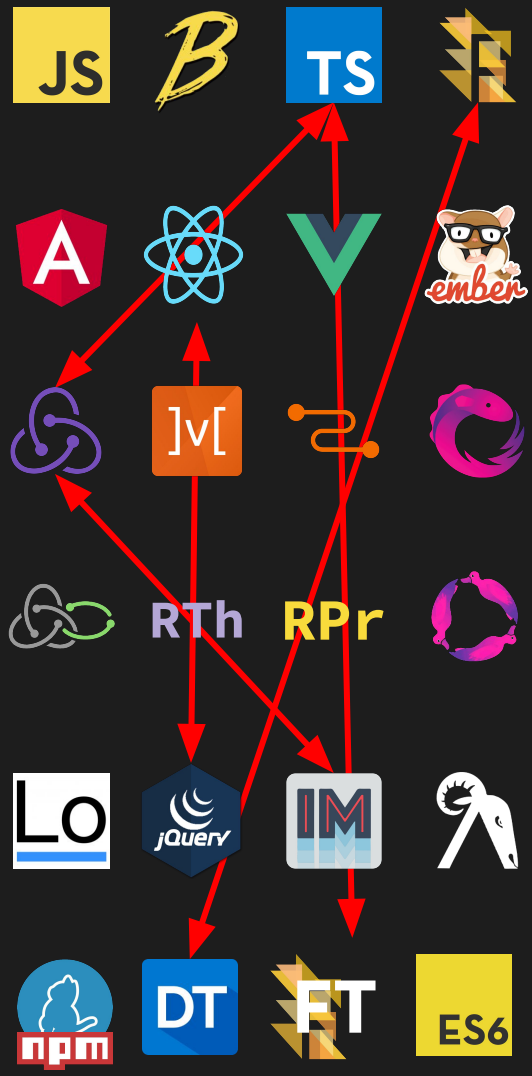
ONBOARDING

JavaScript bootcamp

noredink

writing production Elm

FIRST WEEK OF FIRST JOB



Dialect

UI

State

Async

Utilities

Packages

Dialect	
UI	`view`
State	`model`
Async	`update`
Utilities	`core`
Packages	`elm install`

cohesive ecosystem

fast

reliable

tiny assets

no semicolon debates

Dialect	
UI	`view`
State	`model`
Async	`update`
Utilities	`core`
Packages	`elm install`

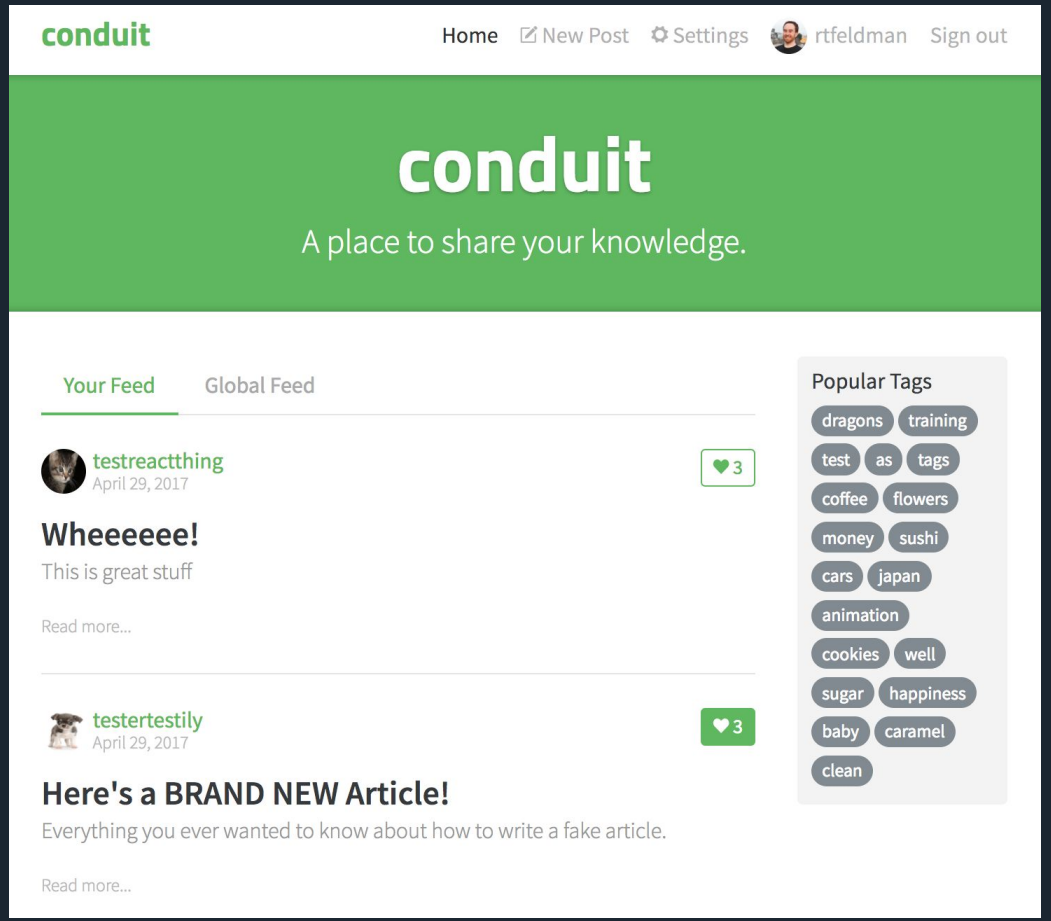
WORKSHOP STRUCTURE

RealWorld

example app

9 lessons

9 exercises



1. Rendering a Page

Compiling

Functions

if-expressions

Virtual DOM


```
$ elm make Main.elm --output elm.js

Dependencies loaded from local cache.

Dependencies ready!

Success! Compiled 1 module.
```

index.html

```
<head>
  <link rel="stylesheet" href="main.css">
  <script src="elm.js"></script>
</head>
```

```
<head>
  <link rel="stylesheet" href="main.css">
  <script src="elm.js"></script>
</head>
<body>
  <div id="app"></div>
  <script>
    Elm.Main.init({
      node: document.getElementById("app")
    });
  </script>
</body>
```

INCREMENTAL ADOPTION

functions

User Interface Example

LEAF SEARCH

Your search returned 3 leaves:

 Elm leaf

 Maple leaf

 Oak leaf

Your search returned 2 leaves:

 Elm leaf

 Maple leaf

Your search returned 1 leaves:

 Elm leaf

Your search returned 1 leaves:

 Elm leaf

```
console.log(pluralize("leaf", "leaves", 1));
leaf

let pluralize =
```

```
console.log(pluralize("leaf", "leaves", 3));
leaves

let pluralize =
  (singular, plural, quantity) => {
    if (quantity === 1) {
      return singular;
    } else {
      return plural;
    }
  };
```

BABEL

```
let pluralize =
  (singular, plural, quantity) => {
    if (quantity === 1) {
      return singular;
    } else {
      return plural;
    }
  };
```

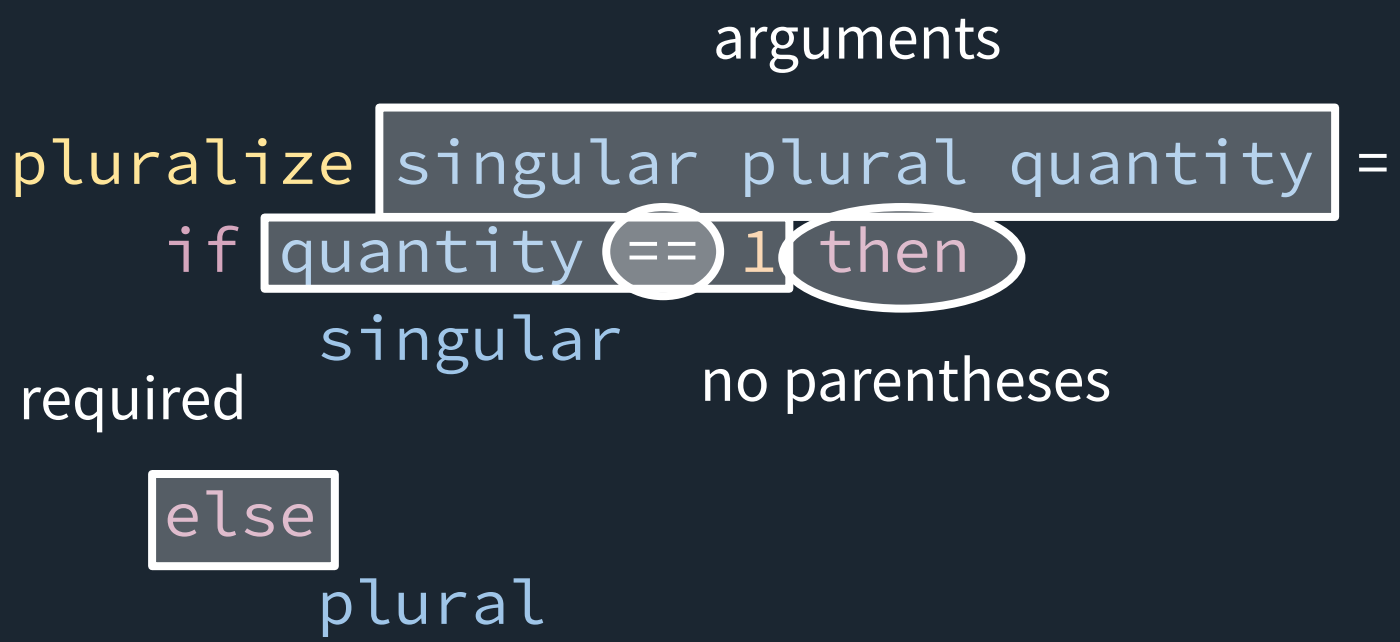
BABEL

this is all the browser ever sees!

```
var pluralize =
    function pluralize(
      singular, plural, quantity) {
        if (quantity === 1) {
          return singular;
        } else {
          return singular;
        }
    };
```

elm

```
pluralize singular plural quantity =
    if quantity == 1 then
        singular

    else
        plural
```


arguments
pluralize singular plural quantity =
if quantity == 1 then
singular
required
no parentheses
else
plural

```
x = if quantity == 1 then
      singular

    else
      plural
```

expression

```
x = (quantity === 1 ? singular : plural)
```

JS

```
pluralize singular plural quantity =
    if quantity == 1 then
        singular

    else
        plural

main =
    text (pluralize "leaf" "leaves" 1)
```

call **pluralize** passing 3 arguments

```
pluralize singular plural quantity =
    if quantity == 1 then
        singular

    else
        plural

main =
    text (pluralize "leaf" "leaves" 1)
```

call **text** passing 1 argument

```
{- this comment can
   span multiple lines! -}
pluralize singular plural quantity =
    if quantity == 1 then
        singular

    else
        plural

main = -- this is an inline comment
    text (pluralize "leaf" "leaves" 1)
```

JS

pluralize("leaf", "leaves", 1) leaf

```
let pluralize =
  (singular, plural, quantity) => {
    if (quantity === 1) {
      return singular;
    } else {
      return plural;
    }
  };
```

JS

```
pluralize("leaf", "leaves", 3)    leaves
```

```
let pluralize =
  (singular, plural, quantity) => {
    if (quantity === 1) {
      return singular;
    } else {
      return plural;
    }
  };
```

JS

pluralize("leaf", "leaves", 3) leaves

```
let pluralize =
  (singular, plural, quantity) => {
    if (quantity === 1) {
      return singula;
    } else {
      return plural;
    }
  };
```

JS

```
pluralize("leaf", "leaves", 1)
```

```
Uncaught ReferenceError: singula is not defined
```

```
let pluralize =
  (singular, plural, quantity) => {
    if (quantity === 1) {
      return singula;
    } else {
      return plural;
    }
  };
```

pluralize("leaf", "leaves", 1)

```
let pluralize =
  (singular, plural, quantity) => {
    if (quantity === 1) {
      return singula;
    } else {
      return plural;
    }
  };
```

error TS2552:
Cannot find name 'singula'.
Did you mean 'singular'?

```
pluralize "leaf" "leaves" 1
```

```
pluralize singular plural quantity =
    if quantity == 1 then
        singular

    else
        plural
```

```
pluralize "leaf" "leaves" 1
```

```
pluralize singular plural quantity =
    if quantity == 1 then
        singula

    else
        plural
```

Cannot find variable **singula**.

Maybe you want one of the following?

singular

JS

pluralize("leaf", "leaves", 3) leaves

```
let pluralize =
  (singular, plural, quantity) => {
    if (quantity === "1") {
      return singular;
    } else {
      return plural;
    }
  };
```

```
pluralize("leaf", "leaves", 1)    leaves
```

```
let pluralize =
  (singular, plural, quantity) => {
    if (quantity === "1") {
      return singular;
    } else {
      return plural;
    }
  };
```

```
pluralize("leaf", "leaves", 1)    leaves
```

```
let pluralize =
  (singular, plural, quantity) => {
    if (quantity === "1") {
      return singular;
    } else {
      return plural;
    }
  };
```

```
pluralize "leaf" "leaves" 1
```

type inference!

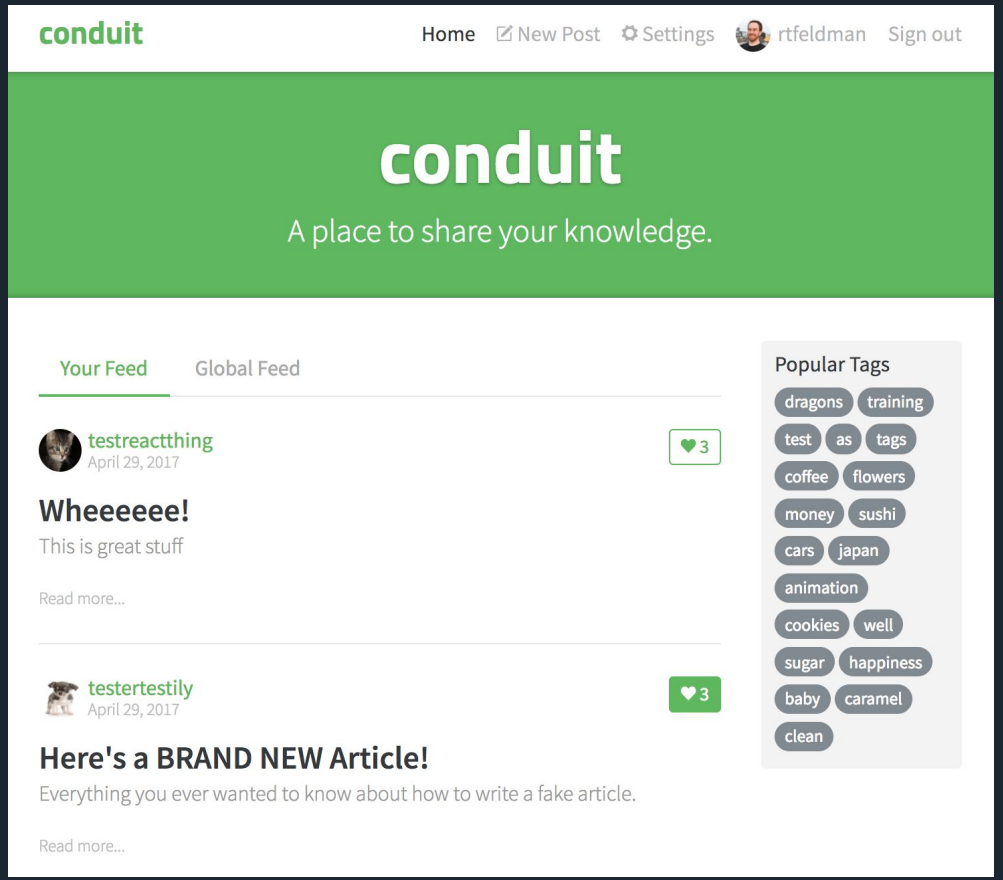
```
pluralize singular plural quantity =
    if quantity == "1" then
        singular

    else
        plural
```

The 3rd argument to function **`pluralize`** is causing a mismatch.

Function **`pluralize`** is expecting the 3rd argument to be: **`String`**

But it is: **`number`**

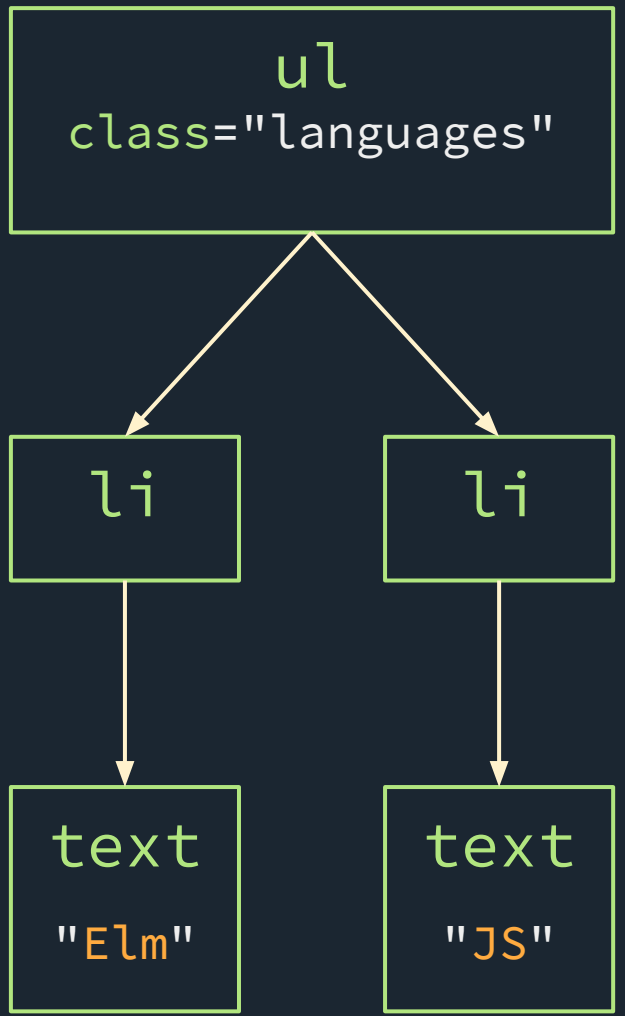
What we'll be building



Virtual DOM

```
<ul class="languages">
    <li>Elm</li>
    <li>JS</li>
</ul>
```

```
ul [ class "languages" ] [
  [ li [] [ text "Elm" ],
  , li [] [ text "JS" ]
  ]
```



```
li [] [ text "Elm" ] li [] [ text "JS" ]
```

error: passing 5 arguments to **`li`**!

```
ul [ class "languages" ] [
    li [] [ text "Elm" ],
    li [] [ text "JS" ]
  ]
```

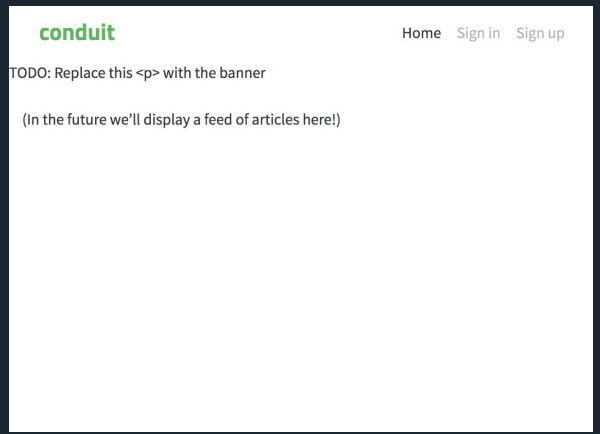
```
ul [ class "languages" ]
  [ li [] [ text "Elm" ]
  , li [] [ text "JS" ]
  ]
```

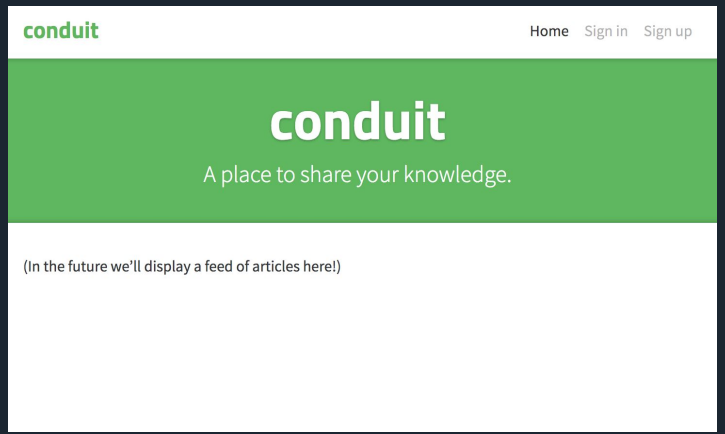
```
ul [ class "languages" ]
  [ li [] [ text "Elm" ]
  , li [] [ text "JS" ]
  , li [] [ text "Bash" ]
  ]
```

Review of Part 1

Compiling	`elm make Main.elm --output elm.js`
Functions	`pluralize "leaf" "leaves" 1`
if-expressions	`if quantity == 1 then`
Virtual DOM	`li [] [ text "Elm" ]`

Exercises for Part 1





Follow the instructions in **`part1/README.md`**

2. Manipulating Values

Strings

let-expressions

Lists

Partial application

strings

```
"foo" ++ "bar"  ⟶  "foobar"
```

JS

```
"foo" + "bar"  ⟶  "foobar"
```

```
pluralize singular plural quantity =
    if quantity == 1 then
        quantity ++ " " ++ singular

    else
        quantity ++ " " ++ plural
```

```
pluralize singular plural quantity =
    if quantity == 1 then
        String.fromInt quantity ++ " " ++ singular

    else
        String.fromInt quantity ++ " " ++ plural
```

code duplication

let-expressions

```
pluralize singular plural quantity =
    let
        quantityStr =
            String.fromInt quantity

        prefix =
            quantityStr ++ " "
    in
    if quantity == 1 then
        prefix ++ singular

    else
        prefix ++ plural
```

let-expression

```
pluralize singular plural quantity =
    let
        quantityStr =
            String.fromInt quantity
        prefix =
            quantityStr ++ " "
    in
    if quantity == 1 then
        prefix ++ singular

    else
        prefix ++ plural
```

accessible inside *let*

```
pluralize singular plural quantity =
    let
        quantityStr =
            String.fromInt quantity
        prefix =
            quantityStr ++ " "
    in
    if quantity == 1 then
        prefix ++ singular

    else
        prefix ++ plural
```

inaccessible in outside scope

```
pluralize singular plural quantity =
    let
        quantityStr =
            String.fromInt quantity

        prefix =
            quantityStr ++ " "
    in
    if quantity == 1 then
        prefix ++ singular

    else
        prefix ++ plural
```

entire expression evaluates to this

```
pluralize singular plural quantity =
    let
        quantityStr =
            String.fromInt quantity
        prefix =
            quantityStr ++ " "
    in
    if quantity == 1 then
        prefix ++ singular

    else
        prefix ++ plural
```

must have same indentation level

lists

```
[ 1, 2, 3 ]

[ [ "foo", "bar" ], [ "baz" ] ]

[ "foo", 65 ]
```

```
["pow", "zap", "blam"].map(
    (str) => { return str.toUpperCase() + "!"; }
)

[ "POW!", "ZAP!", "BLAM!" ]



["pow", "zap", "blam", 500].map(
    (str) => { return str.toUpperCase() + "!"; }
)
```

```
Uncaught TypeError: str.toUpperCase is not a function
```

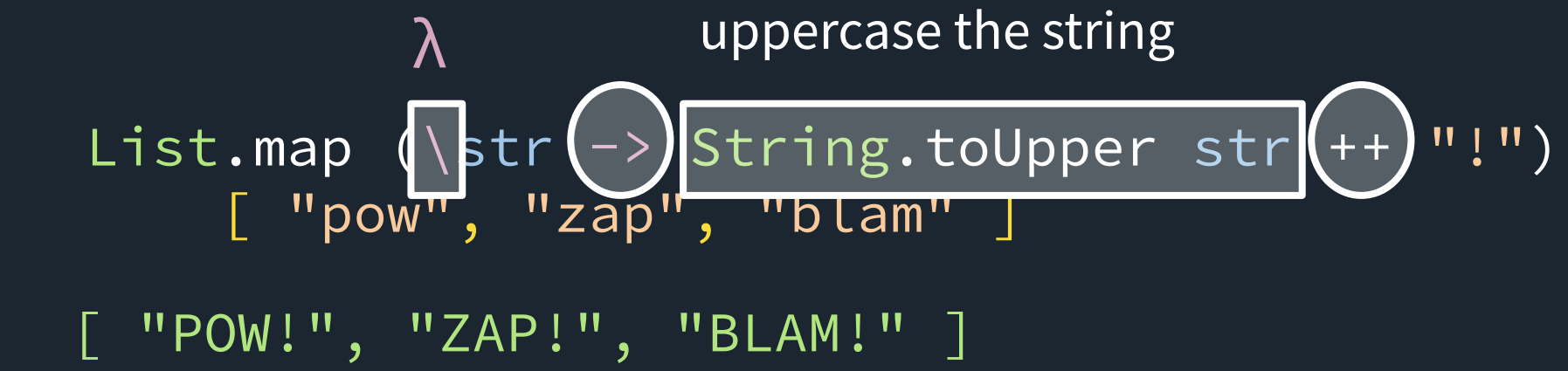
solution:

require **consistent** entries

```
["pow", "zap", "blam", 500].map(
   (str) => { return str.toUpperCase() + "!"; }
)
```

anonymous function

```
List.map (\str -> String.toUpper str ++ "!")
    [ "pow", "zap", "blam" ]
```




```
List.map (\str -> String.toUpper str ++ "!")
    [ "pow", "zap", "blam", 500 ]
```

The 3rd and 4th entries in this list are different types of values.

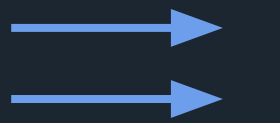
Hint: Every entry in a list needs to be the same type of value.

partial application

```
List.map (\num -> pluralize "leaf" "leaves" num)
    [ 0, 1, 2 ]


[ "0 leaves", "1 leaf", "2 leaves" ]


List.map (pluralize "leaf" "leaves") [ 0, 1, 2 ]
 (\num -> pluralize "leaf" "leaves" num)
```

`List.map` for rendering

```
names =                    ul []
    [ "Erica"                [ li [] [ text "Erica" ]
    , "Shuri"                , li [] [ text "Shuri" ]
    , "Lee"                  , li [] [ text "Lee" ]
    ]                        ]
```

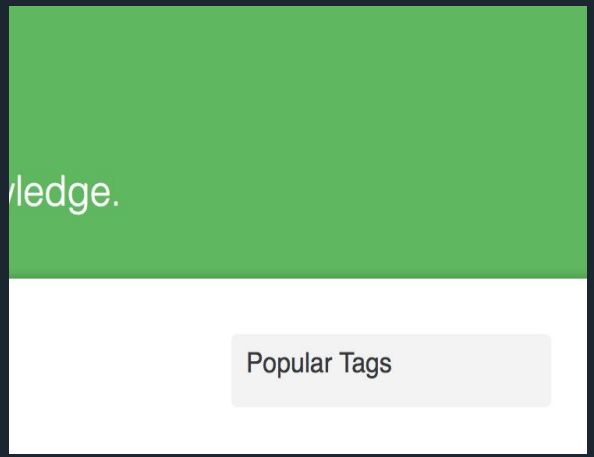


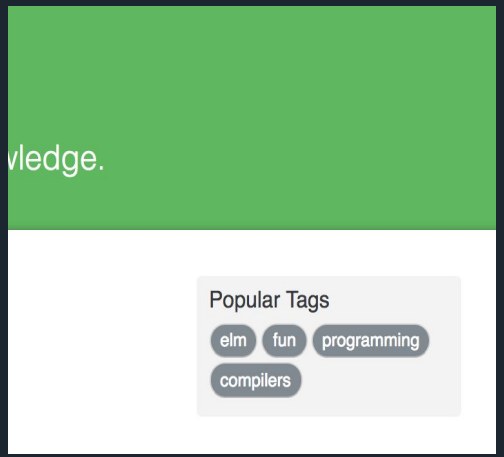
```
viewName name =
    li [] [ text name ]


ul [] (List.map viewName names)
```

Review of Part 2

Strings	`"d" ++ String.fromInt 6 → "d6"`
let-expressions	`let x = 5 in x * 2`
Lists	`List.map (\x -> x + 1) nums`
Partial application	`pluralize "leaf" "leaves"`

Exercises for Part 2





Follow the instructions in **`part2/README.md`**

3. Introducing Interaction

Records

Record Updates

Booleans

The Elm Architecture

records

```
record = { name = "foo", x = 1, y = 3 }
```

plain, immutable data

no prototypes

no **this**

no mutating

```
record.name → "foo"
record.x → 1
record.y → 3
```

```
record =
    { name = "foo", x = 1, y = 3 }

newRecord =
    { record | name = "bar" }

newRecord =
    { name = "bar"
    , x = 1
    , y = 3
    }
```

iteration

```
[ 1, 2, 3 ]
```

`map` works fine

~~`[ 1, 2, "foo" ]`~~

`map` would break

```
{ x = 1, y = "foo" }
```

	iteration	mixed entries
lists	supported	unsupported
records	unsupported	supported

```
booleans        True   False

              x == y
          not (x == y)
              x /= y

x || y        x && y
```

booleans for list membership

```
List.member 1 [ 1, 2, 3 ]
  True

List.member 9 [ 1, 2, 3 ]
  False
```

booleans for filtering lists

```
[ 1, 2, 3 ]
```

```
isKeepable num =
    num > 1
```

```
List.filter  isKeepable  [ 1, 2, 3 ]

[ 2, 3 ]
```

```
\num -> num > 1
```

```
isKeepable num =
    num > 1
```

```
List.filter (\num -> num > 1) [ 1, 2, 3 ]
```

```
[ 2, 3 ]
```

conduit

A place to share your knowledge.

Elm is fun!

Elm

Read more...

Who says undefined isn't a function anyway?

Functions

Read more...

This compiler is pretty neat

Elm

Read more...

Popular Tags

elm fun programming dragons

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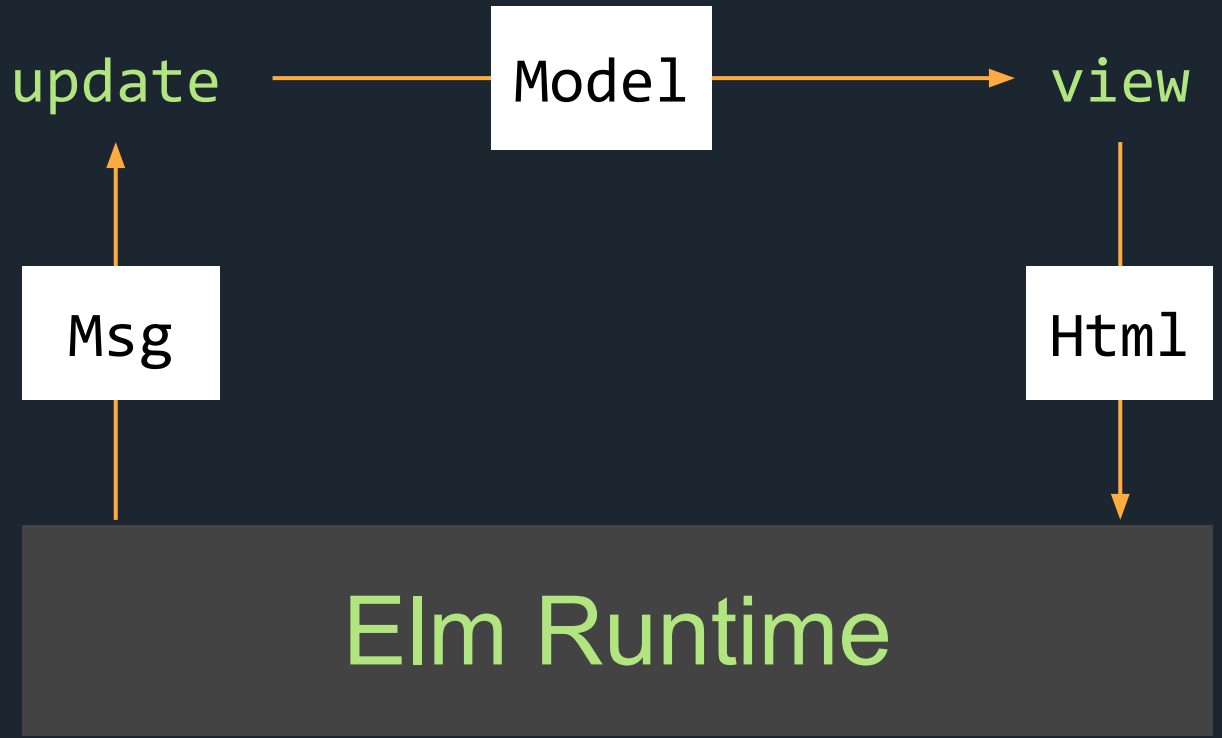
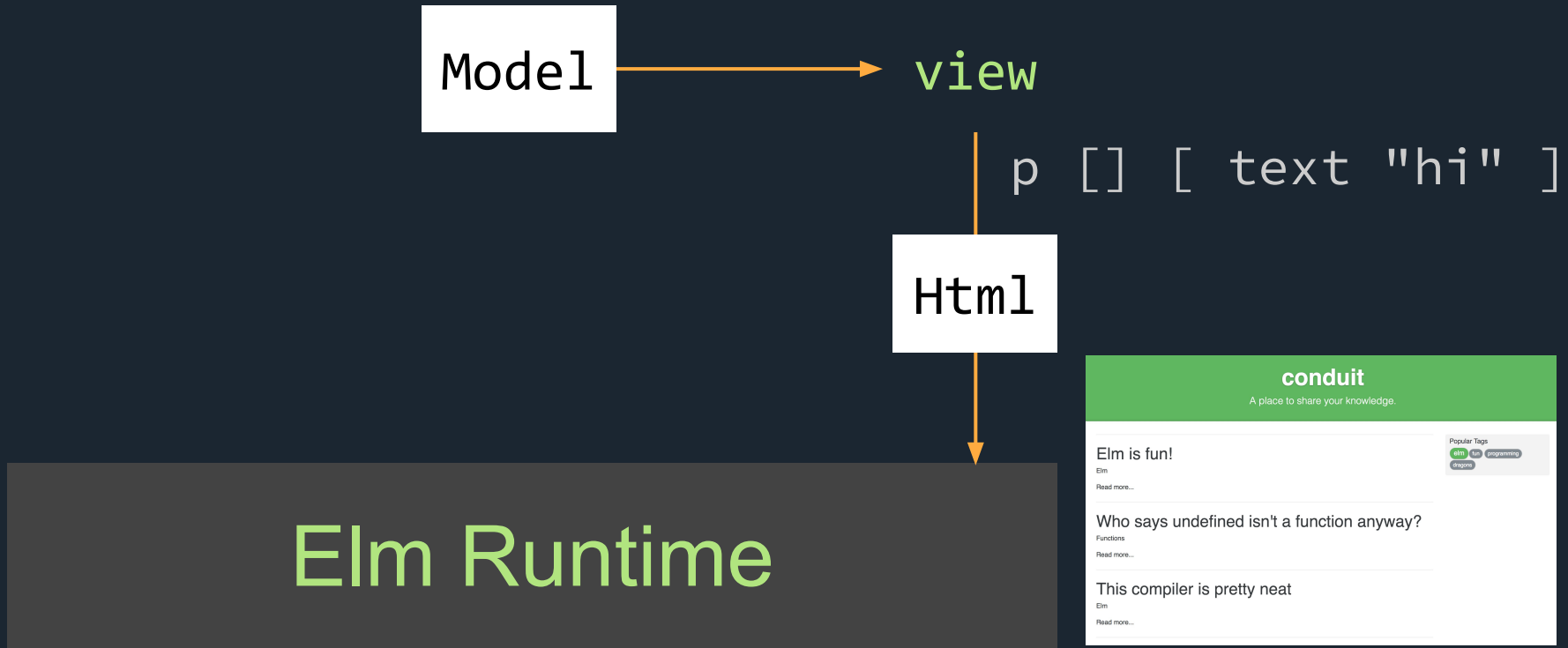
The Elm Architecture



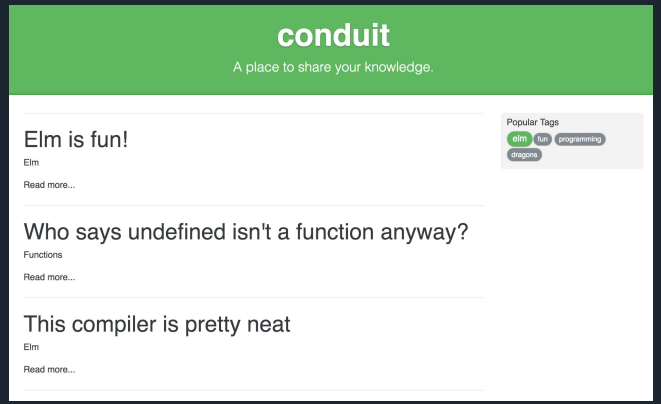
entire application state

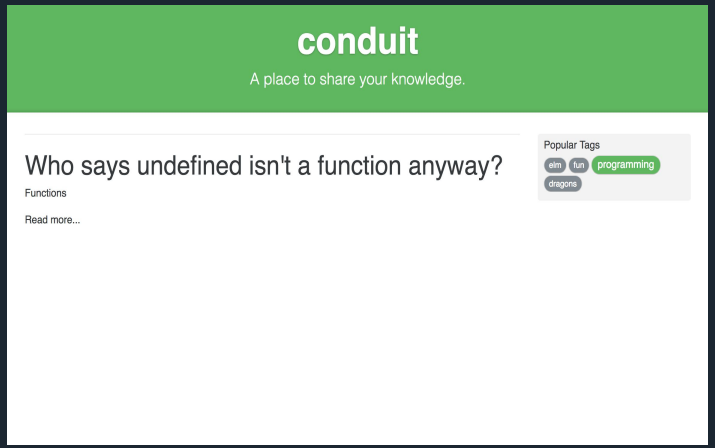
```
view model =
    p [] [ text "hi" ]
```


Model
view
p [] [text "hi"]
Html
Elm Runtime
conduit
A place to share your knowledge.
Elm is fun!
Elm
Read more...
Who says undefined isn't a function anyway?
Functions
Read more...
This compiler is pretty neat
Elm
Read more...
Popular Tags
elm
fun
programming
dragons

```
view model = …
```

initial `Model` → `Model` with different tag selected

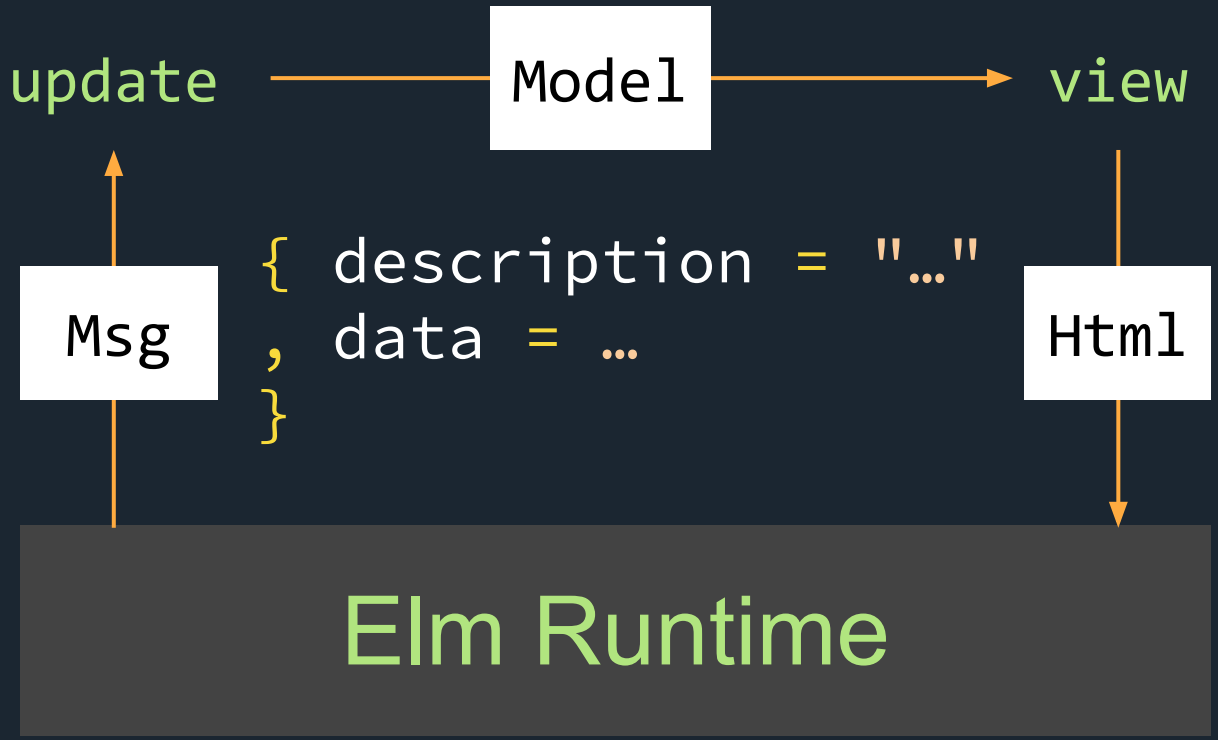


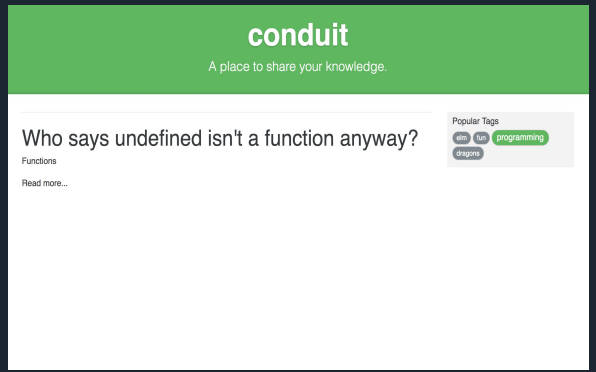


```
update msg model =
    { model | selectedTag = "elm"  }
```

returns a new model


update msg model =
button
[onClick
{ description = "ClickedTag"
, data = "elm"
}
]
[text "elm"]

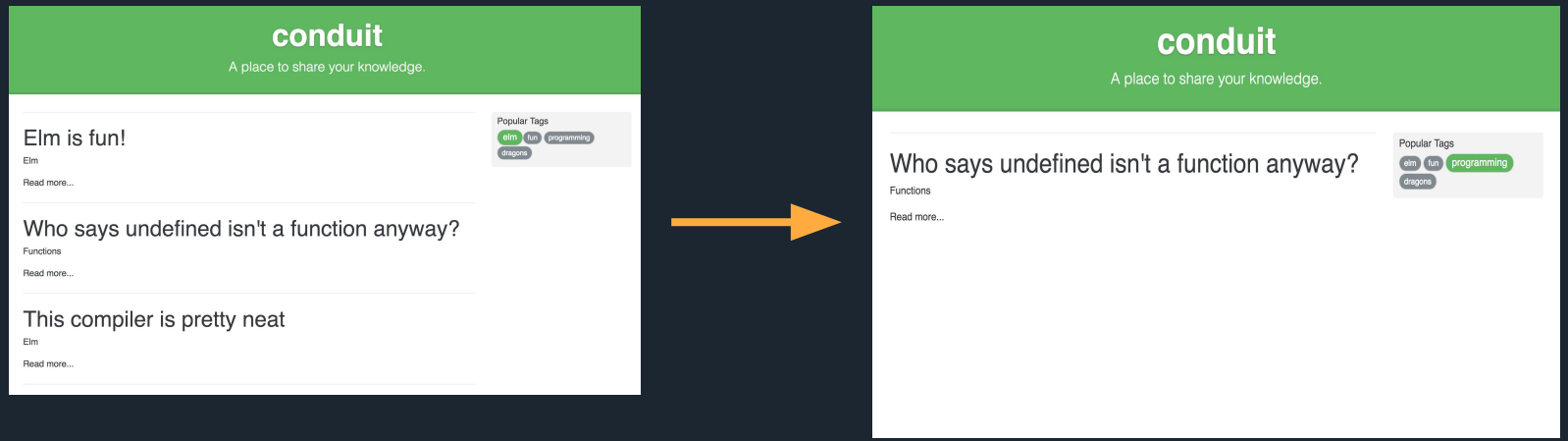

update
Model
view
{ description = "…"
, data = …
}
Msg
Html
Elm Runtime


conduit
A place to share your knowledge.
Who says undefined isn't a function anyway?
Functions
Read more...
Popular Tags
elm
fun
programming
dragons

Review of Part 3

Records	`foo = { bar = "baz", x = 5 }`
Record Updates	`{ foo | x = 42 }`
Booleans	`not (foo || bar) && True`
The Elm Architecture	`model, view, update`

Exercises for Part 3



Follow the instructions in **`part3/README.md`**

4. Type Annotations

Primitives

Parameters

Aliases

Functions

```
-- username is a string
username = "rtfeldman"


username : String
username = "rtfeldman"
```

```
totalPages : Int
totalPages = 5


isActive : Bool
isActive = True
```

```
round : Float -> Int

not : Bool -> Bool

String.length : String -> Int
```

`:` is for **types**

```
searchResult : { name : String, stars : Int }
searchResult = { name = "blah", stars = 215 }
```

`=` is for **values**

Parameterized Type

Type Parameter

```
names : List String
names = [ "Sam", "Casey", "Pat" ]
```


“List of Strings”
names : List String
names = ["Sam", "Casey", "Pat"]

```
names : List Bool
names = [ True, True, False ]
```

```
names : List Float
names = [ 1.1, 2.2, 3.3 ]
```

```
names : List Int
names = [ 1.1, 2.2, 3.3 ]
```

ERROR!

```
model :
    { selectedTag : String
    , articles :
        List
            { title : String
            , tags : List String
            , body : String
            }
    }
```

```
type alias Article =
    { title : String
    , tags : List String
    , body : String
    }


type alias Model =
    { selectedTag : String
    , articles : List Article
    }
```

```
type alias Msg =
    { description : String
    , data : String
    }


view model =
    button
        [ onClick
            { description = "ClickedClear"
            , data = "ALL"
            }
        ]
        [ text "X" ]
```

```elm
view : Model -> Html String
view model =
    button [ onClick "ClickedClearAll" ] [ text "X" ]


view : Model -> Html Msg
view model =
    button
        [ onClick
            { description = "ClickedClear"
            , data = "ALL"
            }
        ]
        [ text "X" ]
```

```elm
view : Model -> Html String
view model =
    button [ onClick "…" ] [ text "X" ]


view : Model -> Html Msg
view model =
    button [ onClick { … } ] [ text "X" ]


view : Model -> Html Float
view model =
    button [ onClick 2.6 ] [ text "X" ]
```

```
type alias Msg =
    { description : String
    , data : String
    }


view : Model -> Html Msg
view model =


update : Msg -> Model -> Model
update msg model =
```

elm repl

```
> pluralize "leaf" "leaves" 3
  "3 leaves" : String

> pluralize
  String -> String -> Int -> String

> pluralize "leaf" "leaves"
  Int -> String
```

```
(pluralize "leaf"  "leaves") 3                String

(pluralize "leaf"  "leaves")          Int -> String

(pluralize "leaf"  "leaves") 3                String
```

```
 pluralize  :  String ->  String ->  Int -> String
```

```
 (pluralize)    String -> (String -> (Int -> String))

 (pluralize "leaf")        String -> (Int -> String)

((pluralize "leaf") "leaves")          Int -> String

((pluralize "leaf") "leaves") 3                String
```

```
update : Msg -> Model -> Model
```

Review of Part 4

Annotations	`point : { x : Int, foo : Bool }`
Parameters	`List String` `Html Msg`
Aliases	`type alias Model = { … }`
Functions	`update : Msg -> Model -> Model`

Exercises for Part 4

```
{-| 👉 TODO: Replace this comment with a type annotation for `update`
-}
update msg model =
    if msg.description == "ClickedTag" then
        { model | selectedTag = msg.data }

    else
        model
```

Follow the instructions in **part4/README.md**

5. Custom Types

case-expressions

Enumerations

Containers

Variant Functions

ADDING FEATURES TO THE FEED

kaka111
August 10, 2018

0

a

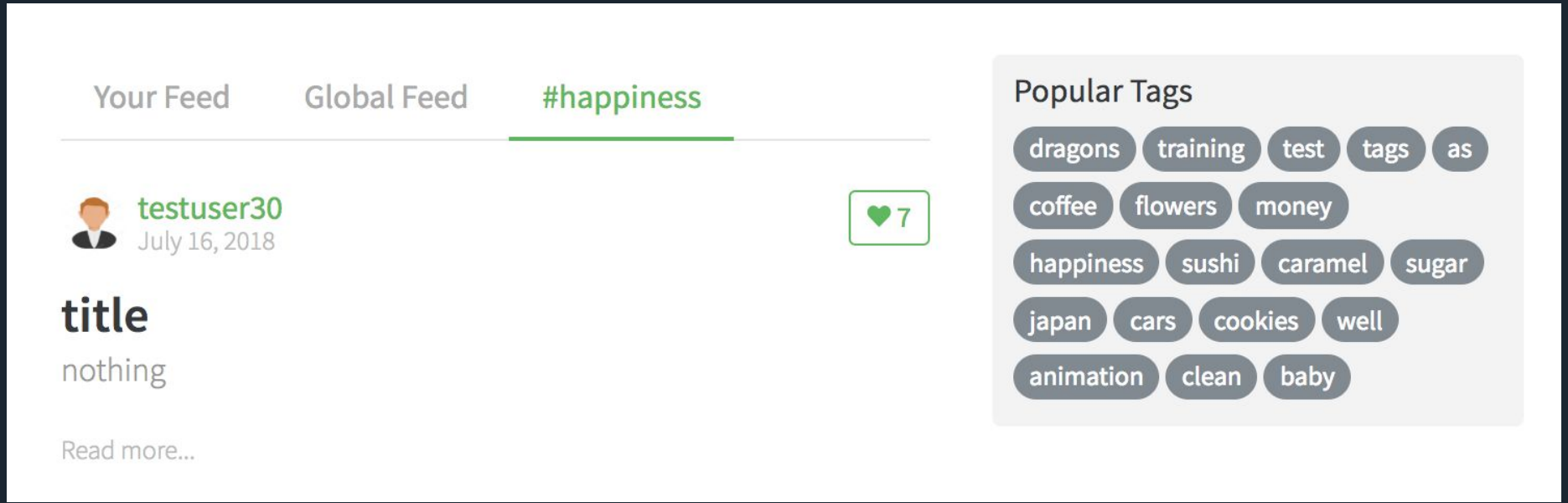
a

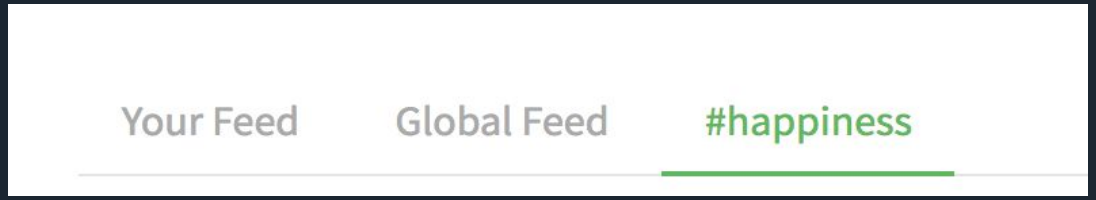
Read more...

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	
42	43	44	45	46	47	48	49	50											

PAGINATION

TABS


Your Feed
Global Feed
#happiness
testuser30
July 16, 2018
7
title
nothing
Read more...
Popular Tags
dragons
training
test
tags
as
coffee
flowers
money
happiness
sushi
caramel
sugar
japan
cars
cookies
well
animation
clean
baby




```
type alias Model =
    { tab : String
    , …
    }


yourFeed    = "YourFeed"
globalFeed = "GlobalFeed"
tagFeed     = "TagFeed"
```

```
if model.tab == "YourFeed" then
    -- show Your Feed

else if model.tab == "GlobalFeed" then
    -- show Global Feed

else
    -- show Tag Feed
```

```
case model.tab of
    "YourFeed" ->
        -- show Your Feed

    "GlobalFeed" ->
        -- show Global Feed

    _ ->
        -- show Tag Feed
```

must have same
indentation level

also known in other languages as...

“sum types” “union types” “ADTs”

custom type

```
type Tab =
    YourFeed | GlobalFeed | TagFeed
```

variants

```
yours : Tab
yours =
    YourFeed

global : Tab
global =
    GlobalFeed

tag : Tab
tag =
    TagFeed
```

```
type Tab
    = YourFeed
    | GlobalFeed
    | TagFeed
```

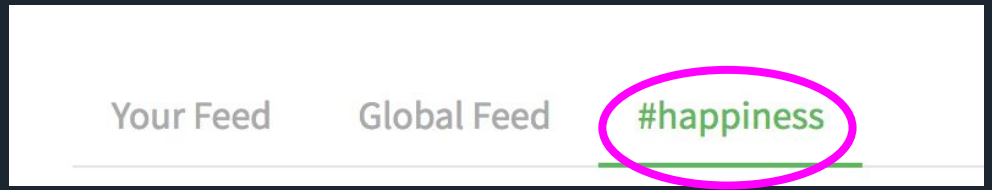
```
type Bool
    = True
    | False
```

custom type

variants

CUSTOM TYPE

```
type Tab
    = YourFeed
    | GlobalFeed
    | TagFeed
```

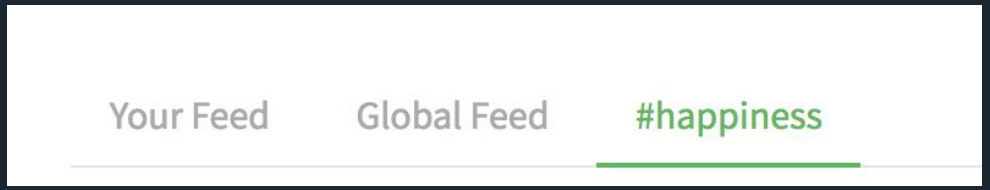



```
type alias Model =
    { tab : Tab
    , selectedTag : String
    , …
    }
```


```
case model.tab of
    YourFeed ->
        -- show your feed

    GlobalFeed ->
        -- show global feed

    TagFeed ->
        -- show tag feed
```

no default case!

```
type Tab
    = YourFeed
    | GlobalFeed
    | TagFeed String
```



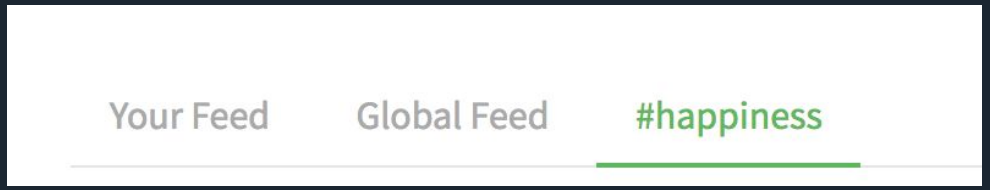

```
> TagFeed "happiness"
TagFeed "happiness" : Tab
```

```
> TagFeed
<function> : String -> Tab
```

```
yours : Tab
yours =
    YourFeed
```

```
happiness : Tab
happiness =
    TagFeed "happiness"
```

```
type Tab
    = YourFeed
    | GlobalFeed
    | TagFeed String
```




```
case model.tab of
    YourFeed ->
        -- show your feed

    GlobalFeed ->
        -- show global feed

    TagFeed selectedTag ->
        -- show tag feed
```

~~enumeration~~

container

kaka111
August 10, 2018

♥ 0

a

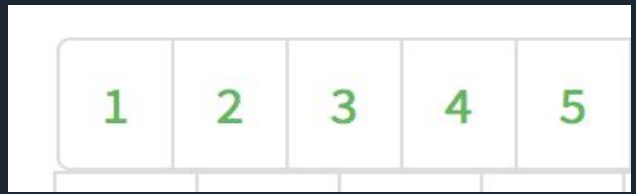
a

Read more...

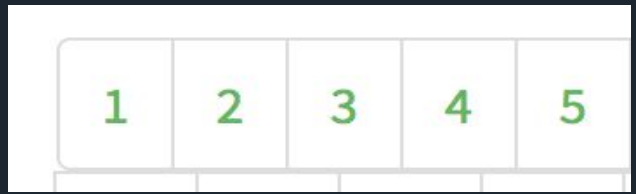
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	
42	43	44	45	46	47	48	49	50												

PAGINATION

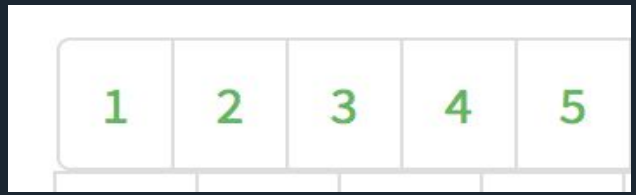
```
type alias Msg =
    { description : String
    , data : String
    }


    { description = "ClickedTag"
    , data = "cars"
    }


    { description = "ClickedPage"
    , data = 2
    }
```



```
type alias Msg =
    { description : String
    , stringData : String
    , intData : Int
    }

    { description = "ClickedTag"
    , data = "cars"
    }


    { description = "ClickedPage"
    , data = 2
    }
```



```
type alias Msg =
    { description : String
    , stringData : String
    , intData : Int
    }

    { description = "ClickedTag"
    , stringData = "cars"
    , intData = -1
    }

    { description = "ClickedPage"
    , stringData = ""
    , intData = 2
    }
```

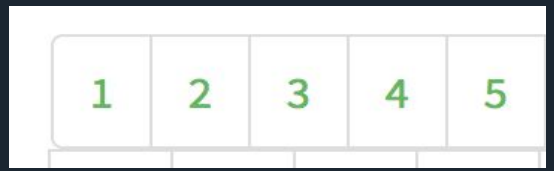


```
type alias Msg =
    { description : String
    , stringData : String
    , intData : Int
    }

    { description = "ClickedTag"
    , stringData = "cars"
    , intData = -1
    }

    { description = "ClickedPage"
    , stringData = ""
    , intData = 2
    }
```

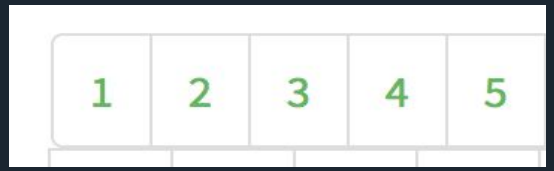
```
type Msg
    = ClickedTag String
    | ClickedPage Int

    ClickedTag "cars"

    ClickedPage 2
```

```elm
type Msg
    = ClickedTag String
    | ClickedPage Int


update msg model =
   case msg of
       ClickedTag selectedTag ->
           -- use tag here

       ClickedPage page ->
           -- use page here
```

```
type Msg
    = ClickedTag String
    | ClickedPage Int


pageButton : Int -> Html Msg
pageButton pageNumber =
    button [ onClick { description = … } ]
```



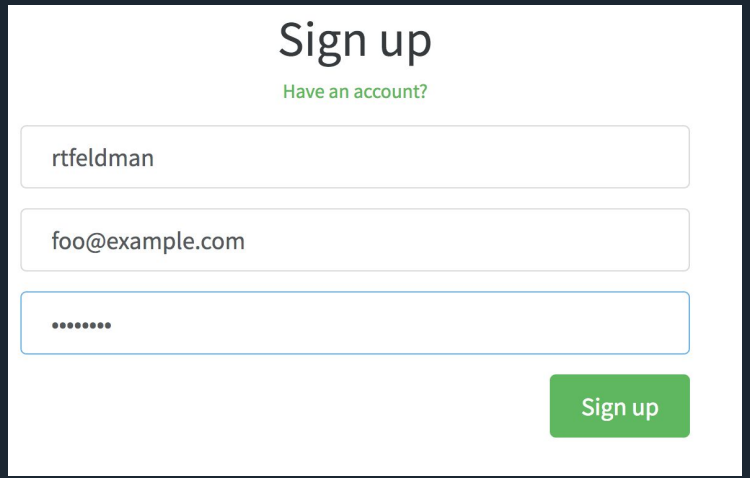
```
type Msg
    = ClickedTag String
    | ClickedPage Int


pageButton : Int -> Html Msg
pageButton pageNumber =
    button [ onClick (ClickedPage pageNumber) ]
        [ text (String.fromInt pageNumber) ]
```



Review of Part 5

case-expressions	`case msg of`
Enumerations	`type Bool = True | False`
Containers	`type Msg = ClickedPage Int | …`
Variant Functions	`onClick (ClickedPage pageNumber)`

Exercises for Part 5



Follow the instructions in **part5/README.md**

6. Maybe

`List.head`

`Maybe`

Type Variables

Pipelines

```
first = (users) => {
    return users[0];
}


first(["Sam", "Jess"])

"Sam"


first([])

undefined
```

```
first users =
    List.head users


first [ "Sam", "Jess" ]

Just "Sam"


first []

Nothing
```

```
first = (users) => {
    return users[0];
}
```

```
first users =
    List.head users
```

```
"Sam"
```

```
Just "Sam"
```

```
undefined
```

```
Nothing
```

```
first(newUsers).length
```

```
3
```

TypeError: Cannot read property 'length' of undefined

```
case first newUsers of
    Just user ->
        String.length user

    Nothing ->
        0
```

```
List.head [ "Sam", "Jess" ]  ⟶  Just "Sam"
          List String              Maybe String

List.head [ 3.14, 7.77 ]     ⟶  Just 3.14
          List Float               Maybe Float

List.head [ True, False ]    ⟶  Just True
          List Bool                Maybe Bool

List.head : ???
```

Type Variables

```
List.head       : List elem -> Maybe elem

List.head       : List val  -> Maybe val

List.head       : List v    -> Maybe v
```

Type Variables

```
List.head      : List elem -> Maybe elem


List.reverse   : List item -> List item
List.reverse     [ 1, 2, 3 ] ↠ [ 3, 2, 1 ]


List.singleton :        val -> List val
List.singleton          "foo" ↠ [ "foo" ]
```

Type Variables

```
List.head : List elem -> Maybe elem


type Maybe val
    = Just val
    | Nothing
```

PIPELINES

```
List.reverse (List.filter (\x -> x < 5) [ 2, 4, 6 ])
```

```
[ 2, 4, 6 ]
    |> List.filter (\x -> x < 5)
    |> List.reverse
```

```
List.reverse (List.filter (\x -> x < 5) [ 2, 4, 6 ])
```

```
[ 2, 4, 6 ]
    |> List.filter (\x -> x < 5)
    |> List.reverse
    |> List.map negate
```

```
List.reverse (List.filter (\x -> x < 5) [ 2, 4, 6 ])
```

```
[ 2, 4, 6 ]
    |> List.filter (\x -> x < 5)
    |> List.reverse
    |> List.map negate
    |> List.head
```

Pipelines

Review of Part 6

List.head

```
List.head [ 1, 2, 3 ]  →  Just 1
```

Maybe

```
type Maybe v = Just v | Nothing
```

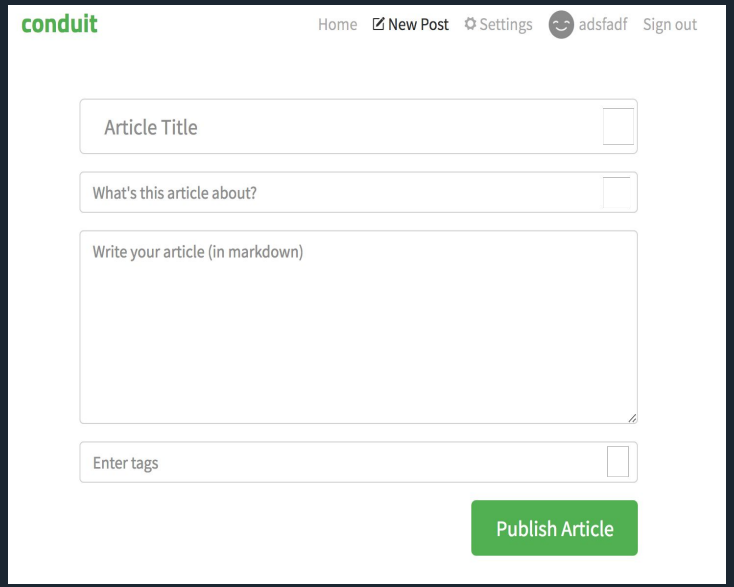
Type Variables

```
head : List elem -> Maybe elem
```

Pipelines

```
    |> List.head
```

Exercises for Part 6



Follow the instructions in **part6/README.md**

7. Decoding JSON

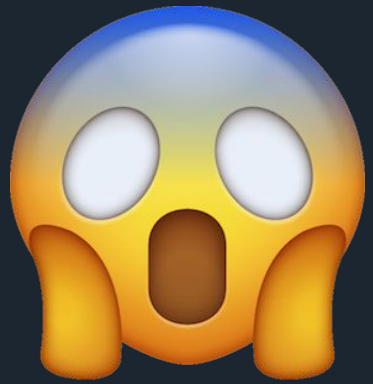
Decoding

`Result`

Pipeline Decoding

Optional & Nullable

```
parseInt "42"  ⟶  42

parseInt "hi"  ⟶  NaN
```



```elm
case String.toInt str of
    Just num ->
        num * 10

    Nothing ->
        0
```

```
String.toInt "42"
```



```
Just 42
```

```
String.toInt "hi"
```



```
Nothing
```

```
case String.toInt str of
    Just num ->
        num * 10

    Nothing ->
        0
```

```
type Maybe val
    = Just val
    | Nothing
```

```
case decodeString Json.Decode.int "42" of
```

```elm
case decodeString int "42" of
    Ok num ->
        -- Do something with num : Int

    Err error ->
        -- Do something with the error
```

```elm
type Maybe val
    = Just val
    | Nothing
```

```elm
type Result okVal errVal
    = Ok okVal
    | Err errVal
```

```
{
  "user_id": 27,
  "first_name": "Al",
  "last_name": "Kai"
}
```


```
id = json.id
```

undefined


```
id = json.id
```

undefined

```
{
  "user_id": 27,
  "first_name": "Al",
  "last_name": "Kai"
}
```

```
id = json.id
```

undefined

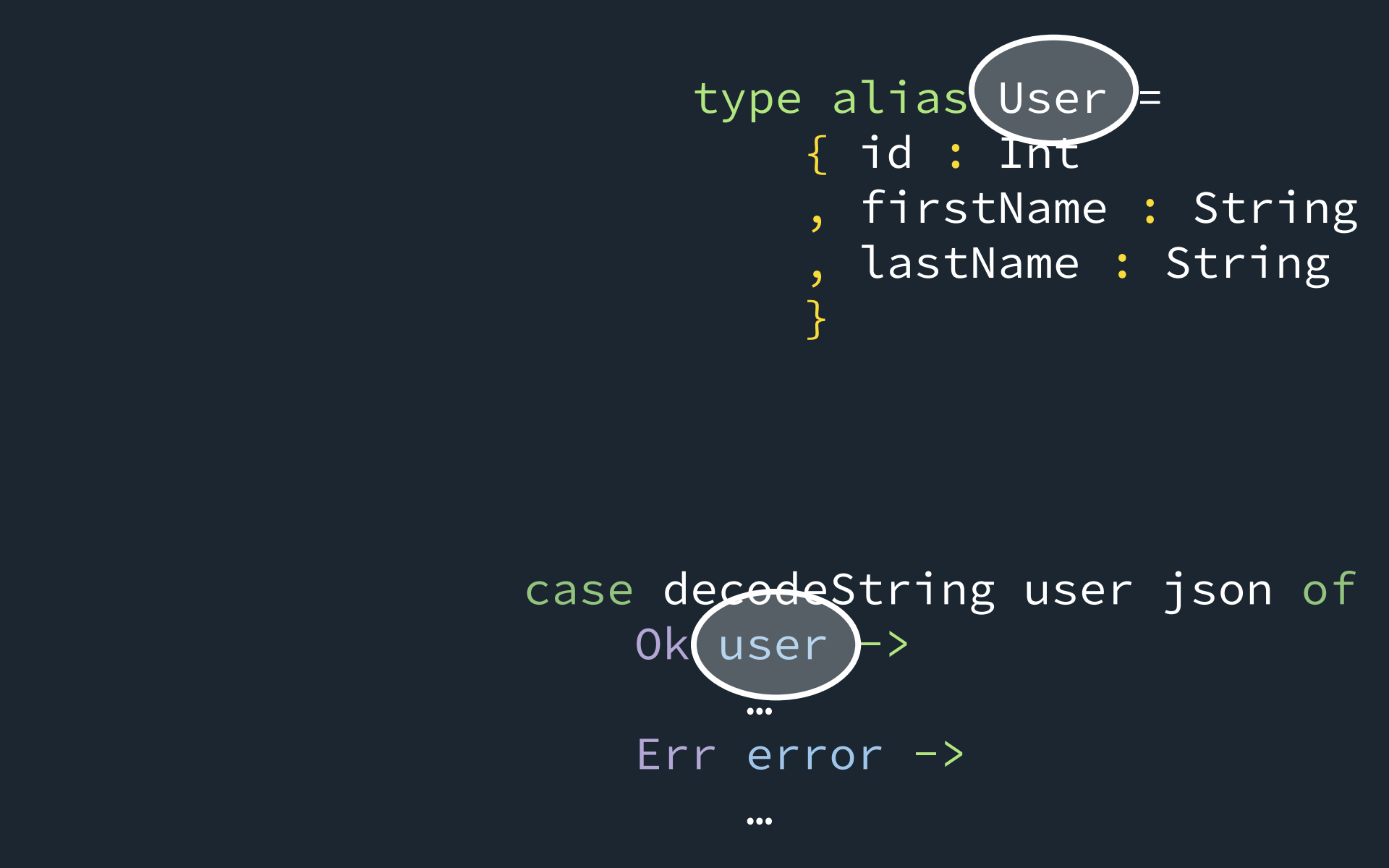
```
id : int = json.id
```

undefined

```
{
  "user_id": 27,
  "first_name": "Al",
  "last_name": "Kai"
}
```

```
type alias User =
    { id : Int
    , firstName : String
    , lastName : String
    }
```

```
user : Decoder User
user =
    Json.Decode.succeed User
        |> required "user_id" int
        |> required "first_name" string
        |> required "last_name" string
```


type alias User =
{ id : Int
, firstName : String
, lastName : String
}
case decodeString user json of
Ok user ->
…
Err error ->
…

```elm
string : Decoder String

int : Decoder Int


user : Decoder User


users : Decoder (List User)
users =
    list user
```

```
{
  "user_id": 27,
  "name": null
}
```

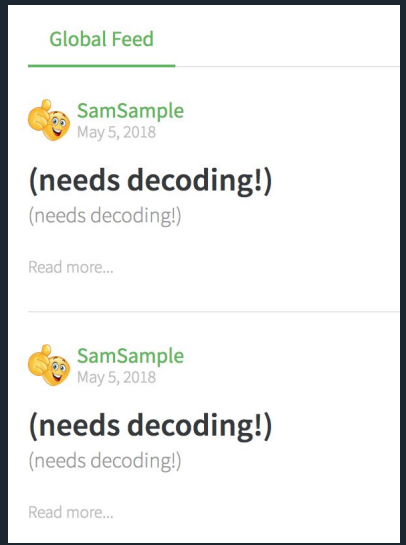
```
type alias User =
    { id : Int
    , name : Maybe String
    , email : String
    }
```

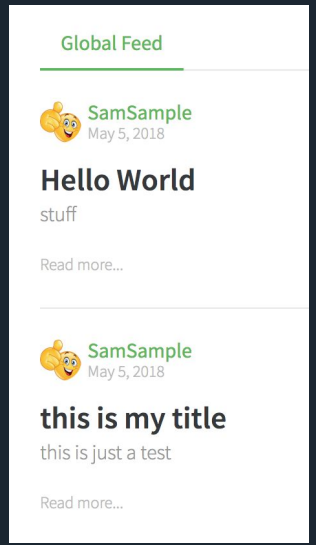
```
user : Decoder User
user =
    Json.Decode.succeed User
        |> required "user_id" int
        |> required "name" (nullable string)
        |> optional "email" string "me@foo.com"
```

Review of Part 7

Decoding	`decodeString int "5"`
Result	`type Result x a = Ok a | Err x`
Pipeline Decoding	`|> required "id" int`
Optional & Nullable	`required "id" (nullable int)`

Exercises for Part 7





Follow the instructions in **part7/README.md**

8. Talking to Servers

Tuples

Randomness

Commands

HTTP

TUPLES

serve the same purpose as records

except with **field positions** instead of **field names**

```
x = Tuple.first ( 5, 7 )

( name, x, y ) = ( "foo", 5, 7 )
```

3 elements max!

```
x = { x = 5, y = 7 }.x

{ name, x, y } = { name = "foo", x = 5, y = 7 }
```

records and tuples are nothing more than **groups of values that travel together**

```
animate { name = "foo", x = 1, y = 3 }

animate ( "foo", 1, 3 )

animate "foo" 1 3
```

...but **custom types** can be so much more!

function guarantees

same arguments?

same return value

Math.random()

~~Math.random()~~

Random.generate

Random.generate

```
pickGreeting : List String -> String
```

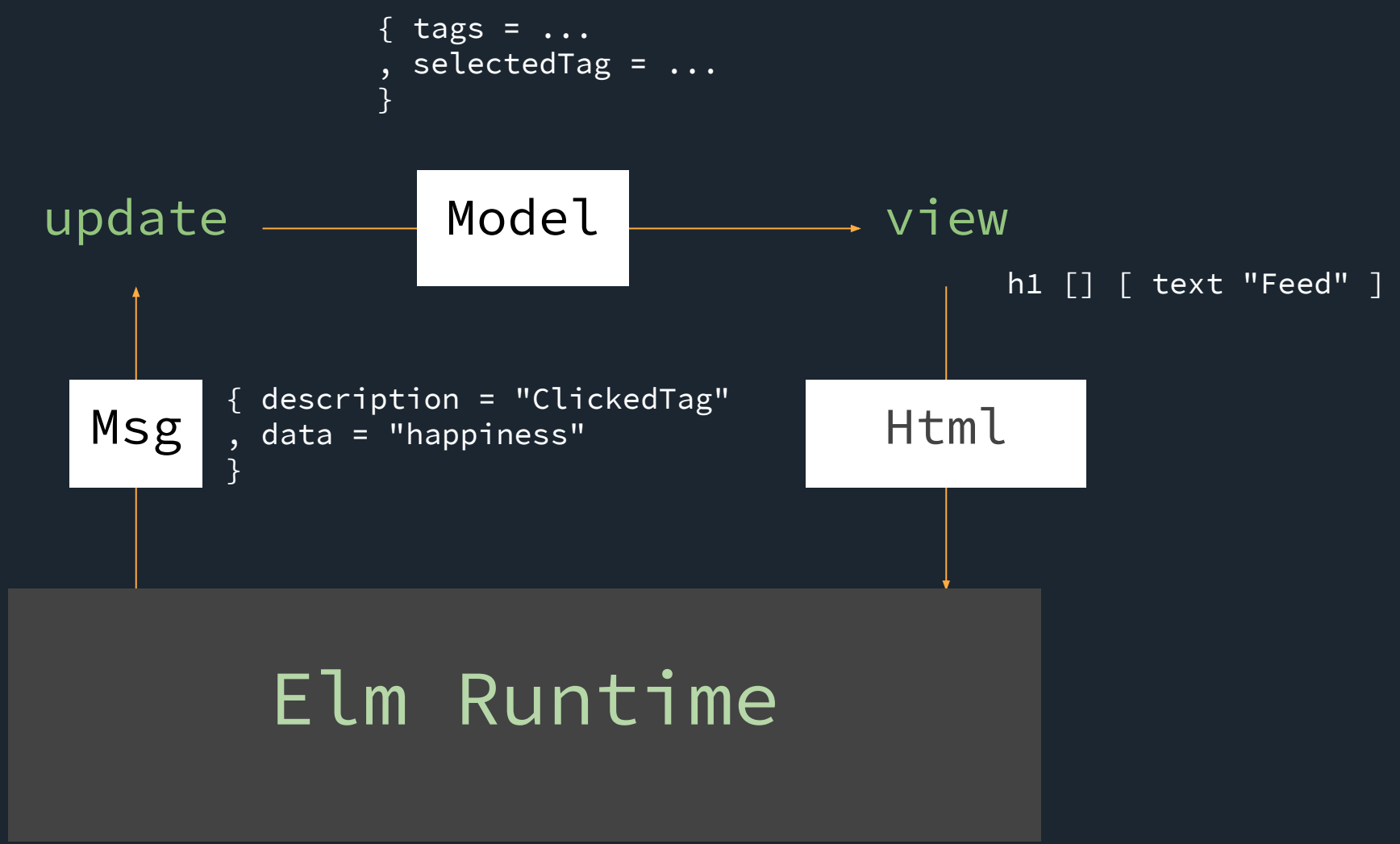
Random.generate

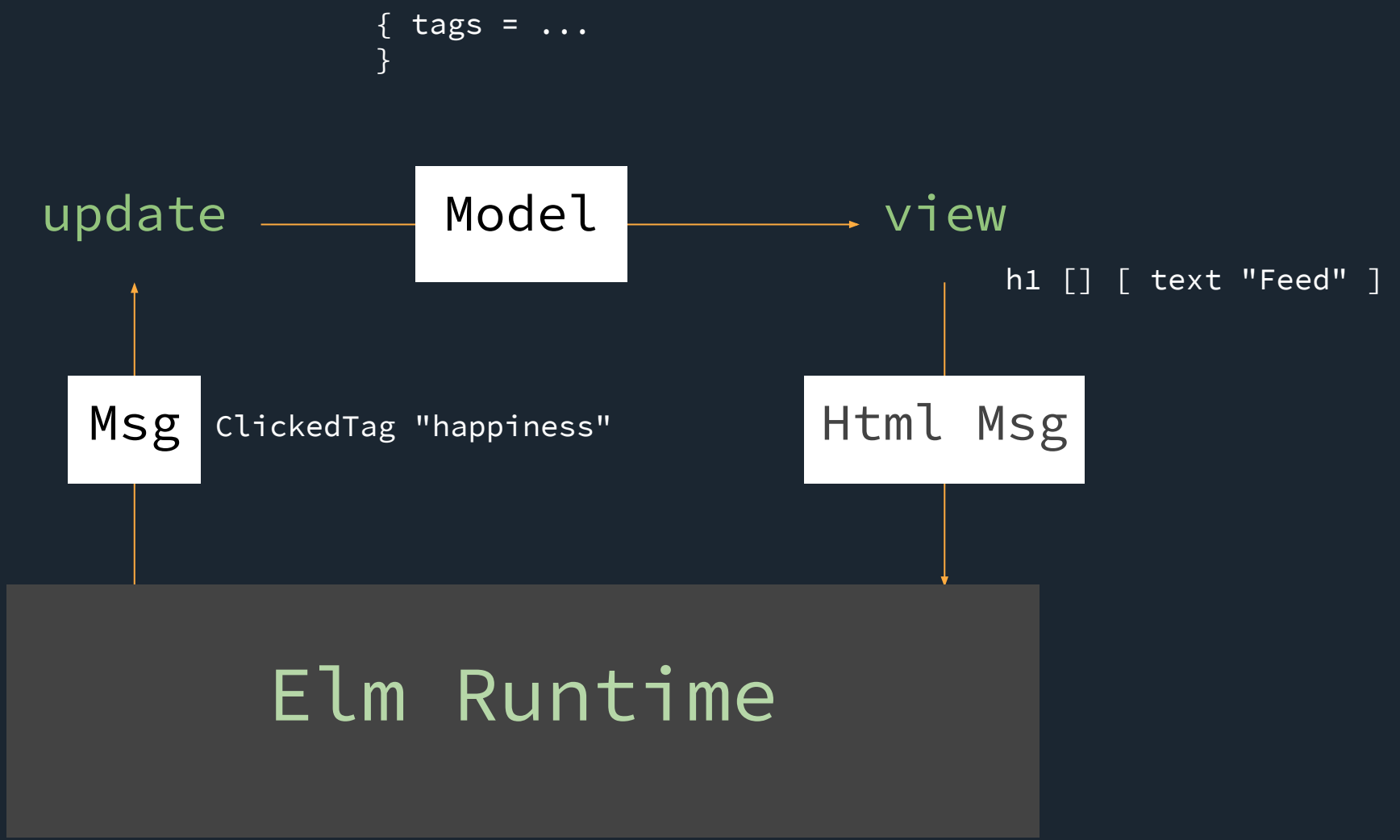
~~pickGreeting : List String -> String~~

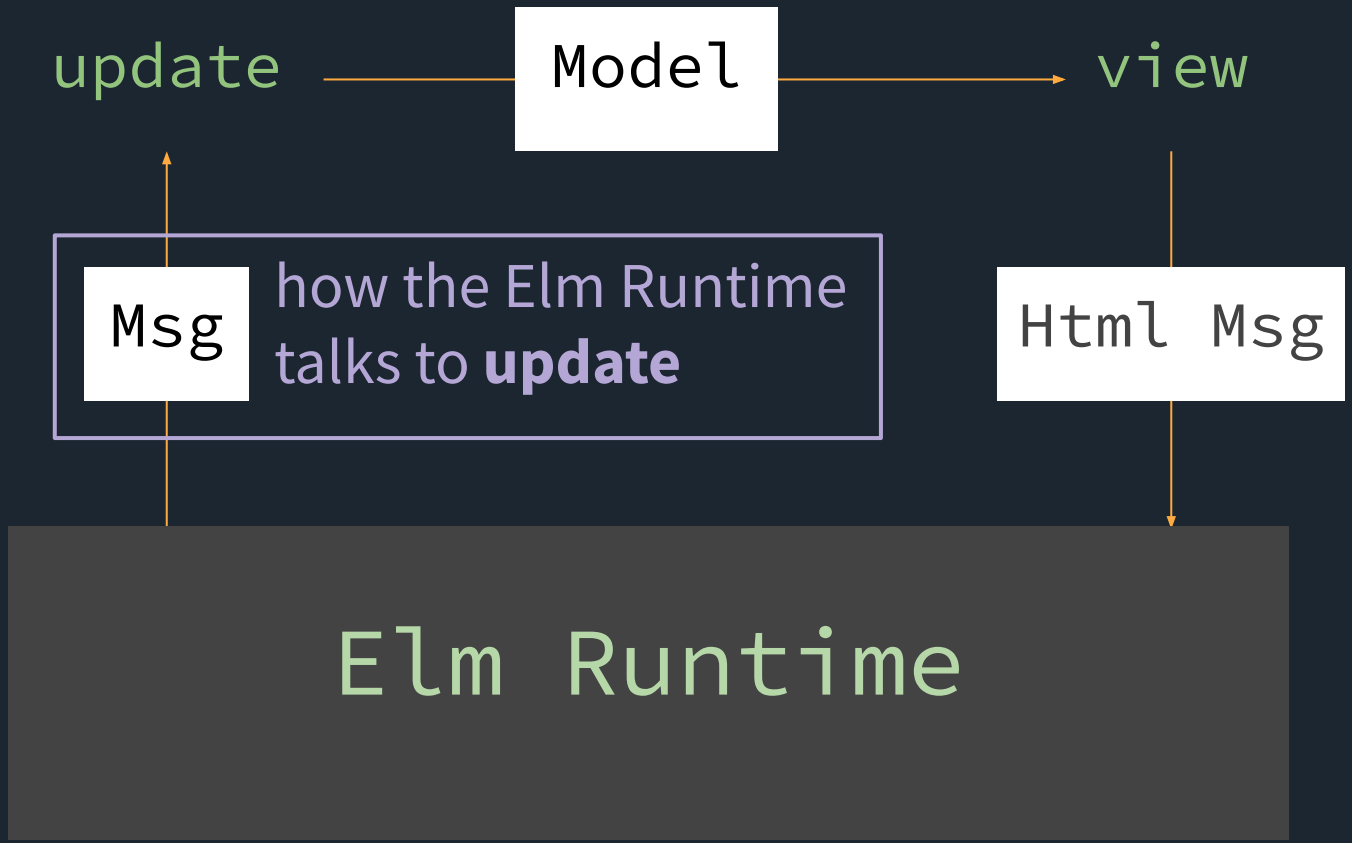
Random.generate

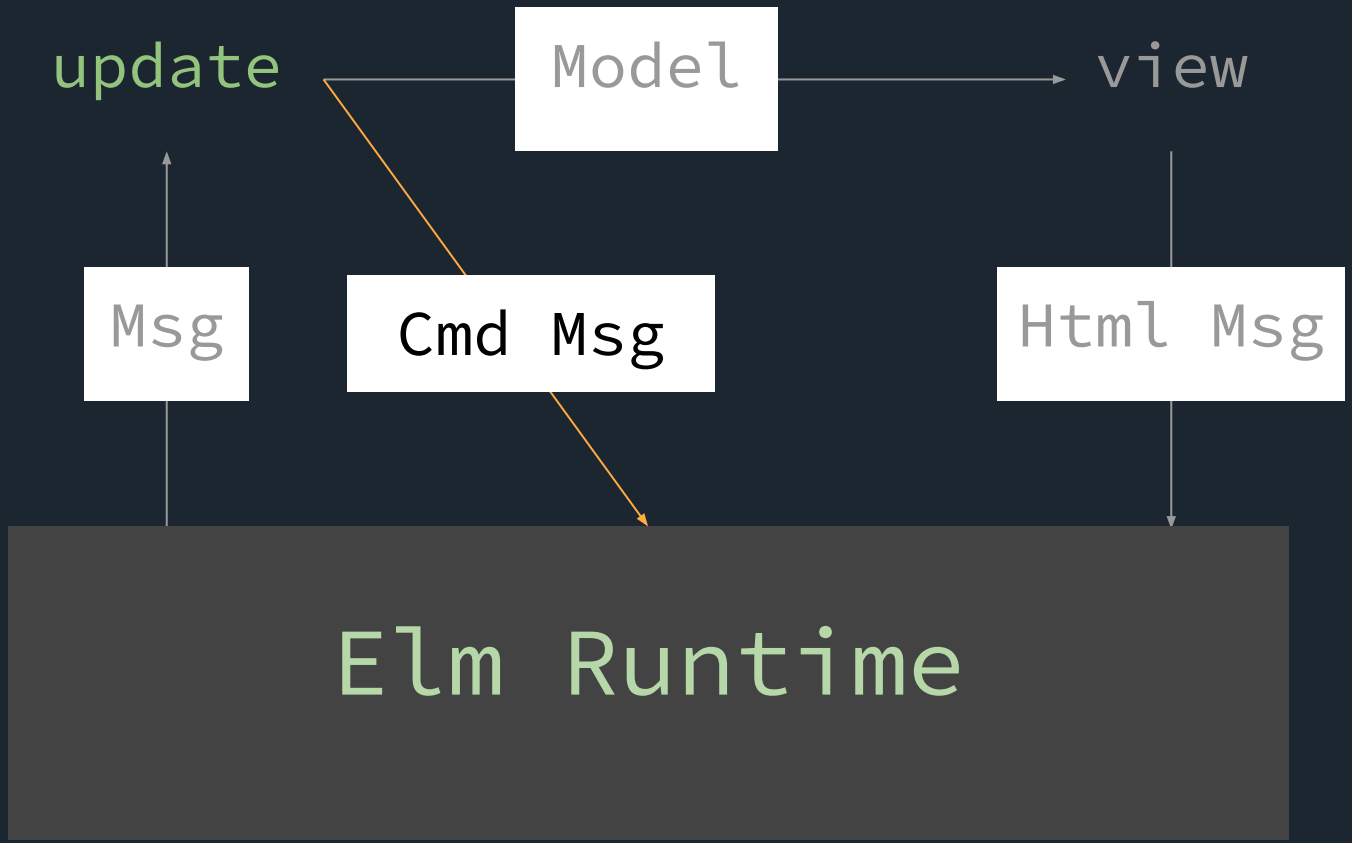
~~pickGreeting : List String -> String~~

```
pickGreeting : List String -> Cmd Msg
```

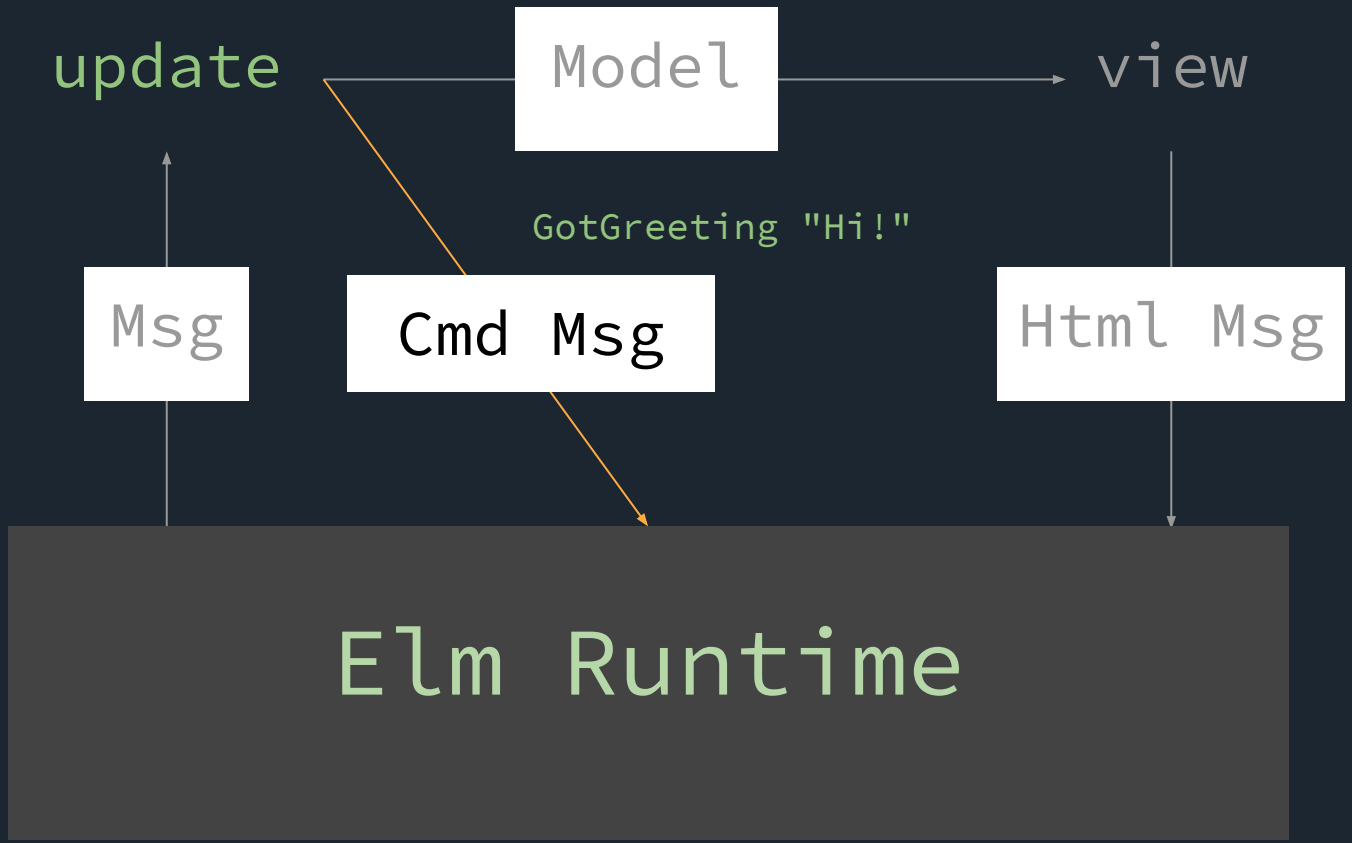

{ tags = ...
, selectedTag = ...
}
update
Model
view
h1 [] [text "Feed"]
Msg
{ description = "ClickedTag"
, data = "happiness"
}
Html
Elm Runtime


{ tags = ...
}
update
Model
view
h1 [] [text "Feed"]
Msg
ClickedTag "happiness"
Html Msg
Elm Runtime


update
Model
view
Msg
how the Elm Runtime
talks to **update**
Html Msg
Elm Runtime


update
Model
view
Msg
Cmd Msg
Html Msg
Elm Runtime

```
pickGreeting : List String -> Cmd Msg
```



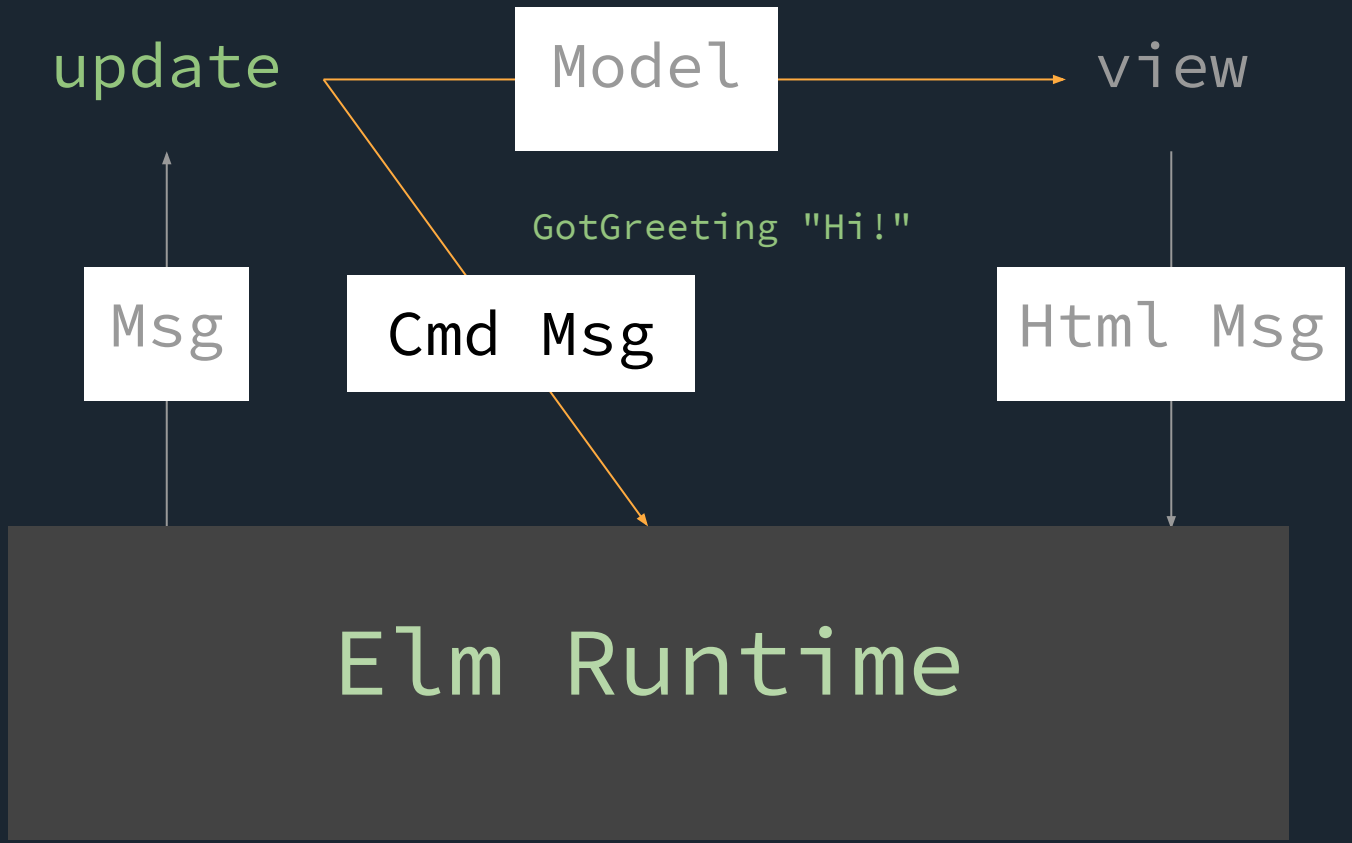
Browser.sandbox

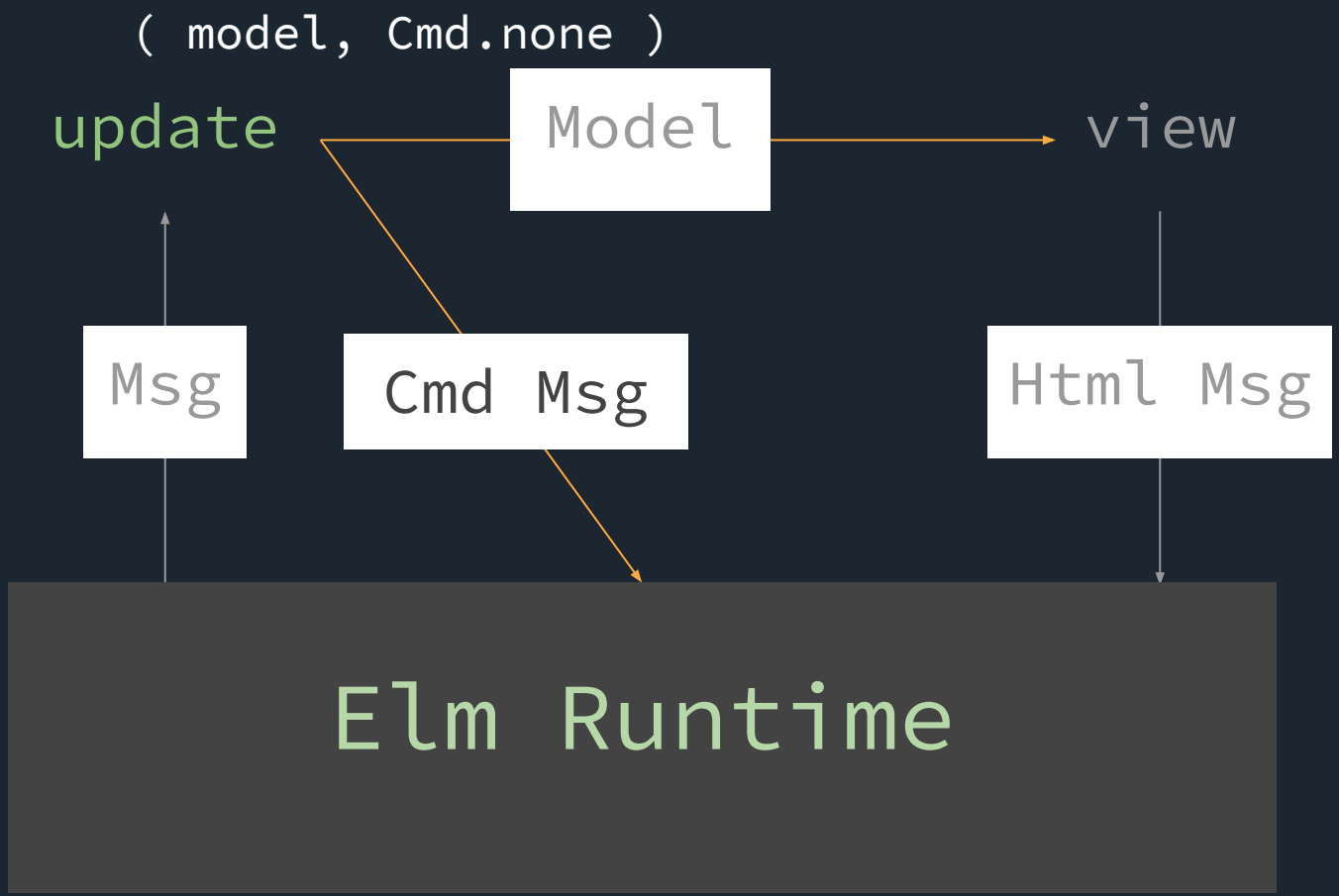
```
update : Msg -> Model -> Model
```

Browser.element

```
update : Msg -> Model -> ( Model, Cmd Msg )
```

```
pickGreeting : List String -> Cmd Msg
( model, pickGreeting greetings )
```




(model, Cmd.none)
update
Model
view
Msg
Cmd Msg
Html Msg
Elm Runtime

another function guarantee

no side effects

no modifying external state

fire-and-forget HTTP POST

fire-and-forget HTTP POST

✓ same arguments, same result

fire-and-forget HTTP POST

✓ same arguments, same result

✗ does not modify external state

side effects

~~side effects~~

managed effects

Cmd

```
Http.getString
```

what if it looked like this?

```
getString : String -> Cmd String
```

it **always** produces a string?

```
getString : String -> Request String
```

result if request succeeds

```
Http.send
```

translate failure into a **Msg**

translate success into a **Msg**

```
CompletedLoadFeed (Result Error String)
```

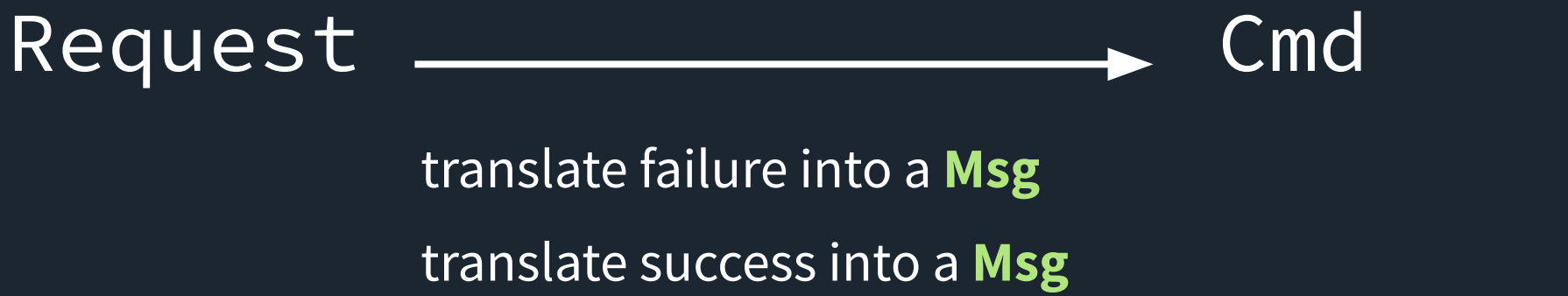
result if request fails

```
Http.send
    (\result -> CompletedLoadFeed result)
    (Http.getString "/feed?tag=happiness")
```

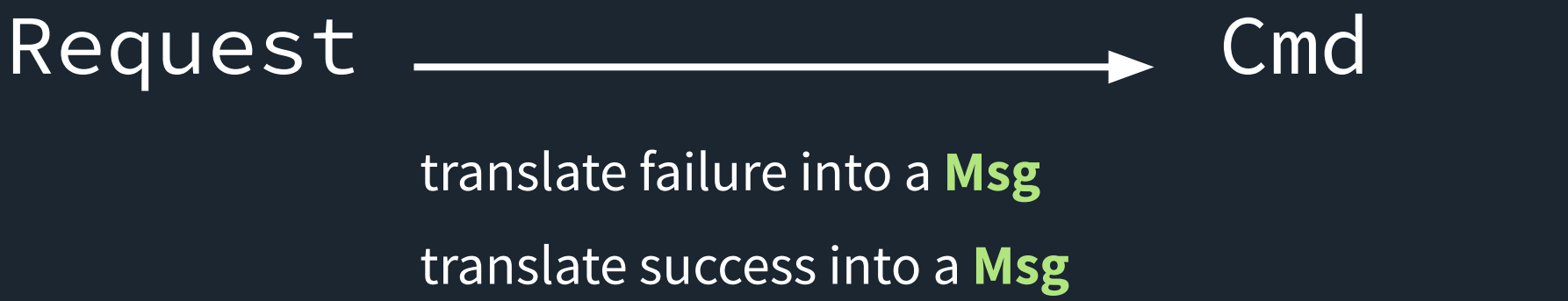
translate failure into a **Msg**

translate success into a **Msg**

```
Http.send
    CompletedLoadFeed
    (Http.getString "/feed?tag=happiness")
```



```
Http.getString "/feed?tag=happiness"
    |> Http.send CompletedLoadFeed
```



```
cmd : Cmd Msg
cmd =
    Http.getString "/feed?tag=happiness"
        |> Http.send CompletedLoadFeed
```

translate failure into a **Msg**

translate success into a **Msg**

```
CompletedLoadFeed (Result Error (List Article))

-- success gives you a String
Http.getString url

-- success gives you a List Article
Http.get articlesDecoder url
```

PATTERN MATCHING

```
        case msg of
            CompletedLoadFeed (Ok articles) ->
                ...

            CompletedLoadFeed (Err error) ->
                ...
```

Review of Part 8

Tuples	`( Model, Cmd Msg )`
Randomness	`Random.generate`
Commands	Description of an effect to be run
HTTP	`Http.send CompletedLoad request`

Exercises for Part 8

Follow the instructions in **part8/README.md**

Complete the TODOs in **part8/Main.elm**

9. Talking to JavaScript

Subscriptions

Guarantees

Sending data to JS

Receiving data from JS

Responding to Custom Events

```
on : String -> Decoder msg -> Attribute msg
```

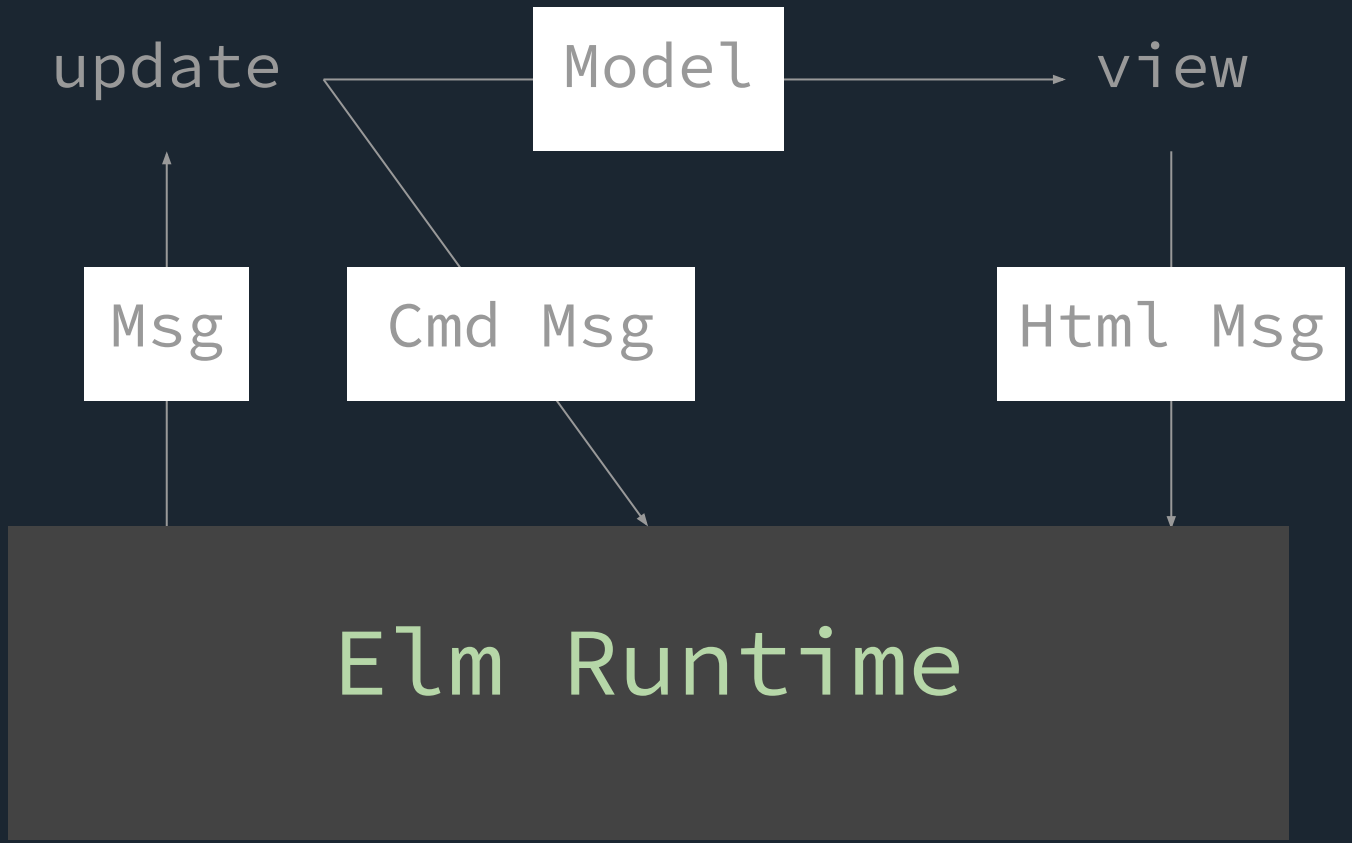
```
div [ on "mousemove" mousePointDecoder ] […]
```

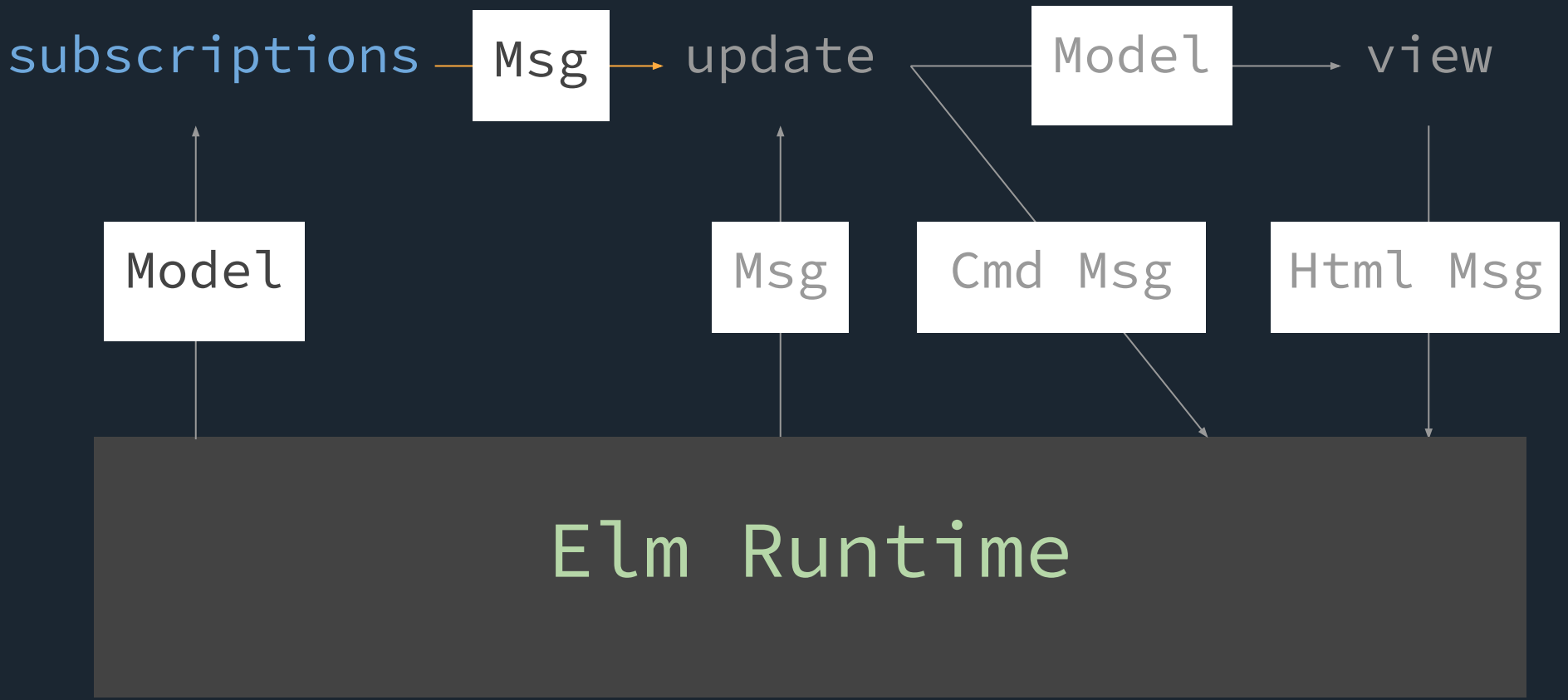
Responding to Window Events

```
on : String -> Decoder msg -> Attribute msg
```

```
Browser.onMouseMove : Decoder msg -> Sub msg
```

subscription


update
Model
view
Msg
Cmd Msg
Html Msg
Elm Runtime


subscriptions
Msg
update
Model
view
Model
Msg
Cmd Msg
Html Msg
Elm Runtime

function guarantees

same arguments?
same return value

no side effects

all Elm functions are **pure**

```
Math.random()
```

```
localStorage.foo = "bar";
```

access huge JS ecosystem

while maintaining guarantees

"client/server" communication

Elm sends data to JS

JS sends data to Elm

no direct function calls!

`Cmd` on the Elm side

callback on JS side

Cmd Msg

~~Cmd Msg~~

Cmd msg

Type Variables

```
List.head    : List elem -> Maybe elem
List.reverse : List val -> List val
List.length  : List a -> Int
```

Unbound Type Variable

```
          [] : List a
[ 1.1, 2.2 ] : List Float
[ "a", "b" ] : List String
```

Unbound Type Variable

```
[] : List a


String.concat : List String -> String

String.concat [ "ab", "c" ] --> "abc"
String.concat []            --> ""
```

Unbound Type Variable

```
[] : List a
```

```
String.lines : String -> List String

String.lines   "A\nB" ⟶ [ "A", "B" ]
String.lines       "" ⟶ []
```

Unbound Type Variable

```
[] : List a

div [ onClick Toggle ] [] : Html Msg

img [ src "logo.png" ] [] : Html a

img [ src "logo.png" ] [] : Html msg
```

"this is compatible with Html that produces Msg"

```
banner : Html Msg
banner =
    header []
        [ h1 [] [ text "conduit" ]
        , ...
        ]
```

"this is compatible with Html that produces anything"

```
banner : Html msg
banner =
    header []
        [ h1 [] [ text "conduit" ]
        , ...
        ]
```

```
banner : Html a
banner =
    header []
        [ h1 [] [ text "conduit" ]
        , ...
        ]
```

produces messages of type **Msg**

works with **update** functions that accept **Msg**

```
Cmd Msg
```

~~`Cmd Msg`~~

`Cmd msg`

works with any **update** function

...because it never produces any messages!

the `port` keyword

&

`index.html`

port module

```
port storeSession : Maybe String -> Cmd msg
port onSessionChange : (String -> msg) -> Sub msg
```

Elm creates the implementation!

can be **null**!

```
port storeSession : Maybe String -> Cmd msg

port onSessionChange : (String -> msg) -> Sub msg
```

```
var app = Elm.Main.init({flags: session});

app.ports.storeSession.subscribe(function(str){
    // JS code goes here
});

app.ports.onSessionChange.send(someString);
```

STORING SESSION DATA IN

localForage

```
localForage.getItem("key", function(val) { … })

localForage.setItem("key", "val", function() { … } )
```

Who owns this state?

 or 

(pick **one**!)

STORING SESSION DATA IN `localForage`

owns this state

caches it

Review of Part 9

Subscriptions	`Sub Msg`
Guarantees	all Elm functions are **pure**
Sending data to JS	`port send : Int -> Cmd msg`
Receiving data from JS	`port receive : … -> Sub msg`

Exercises for Part 9

Follow the instructions in **part9/README.md**

Complete the TODOs in **part9/Main.elm**

Wrap-Up

Summary

Resources

Community

Elm at Work

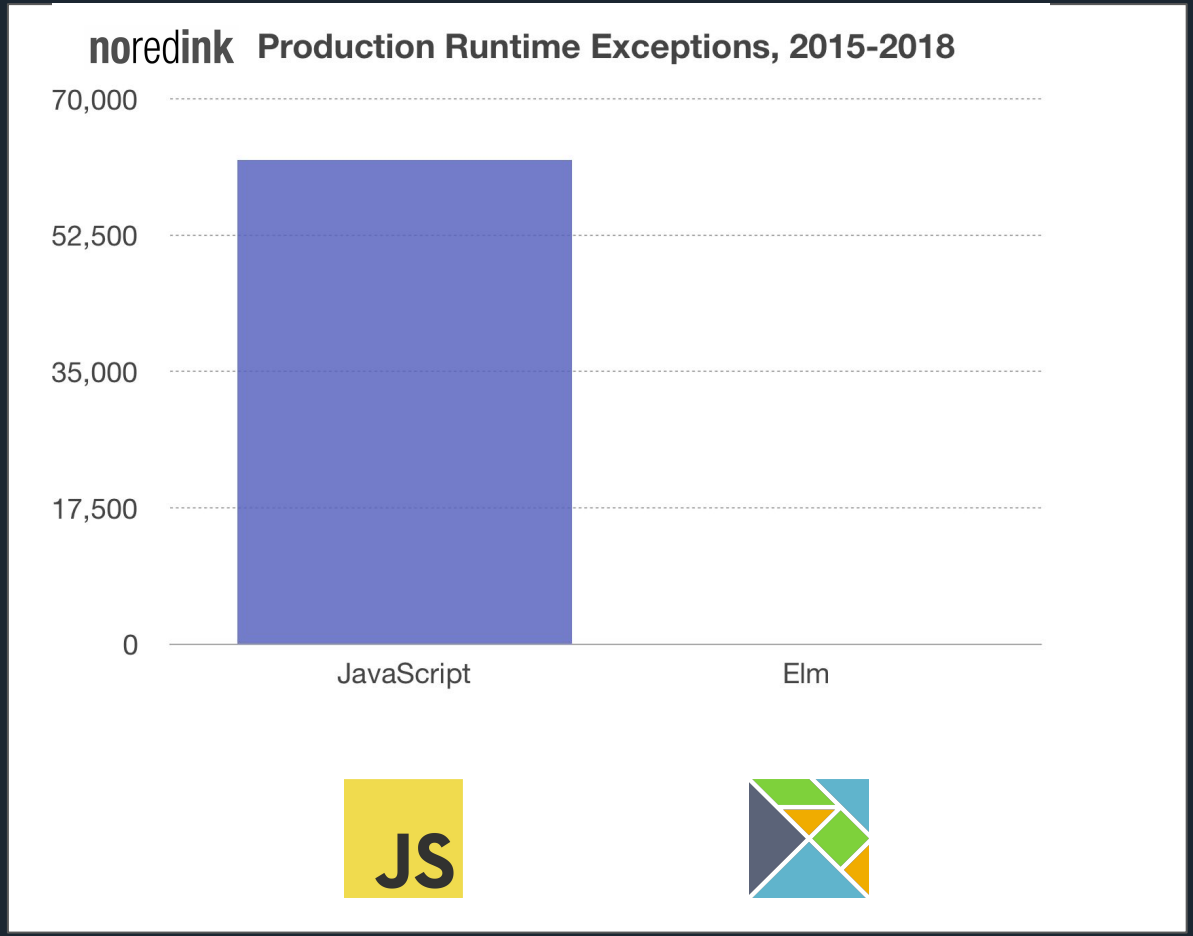
elm

compiles to

JavaScript

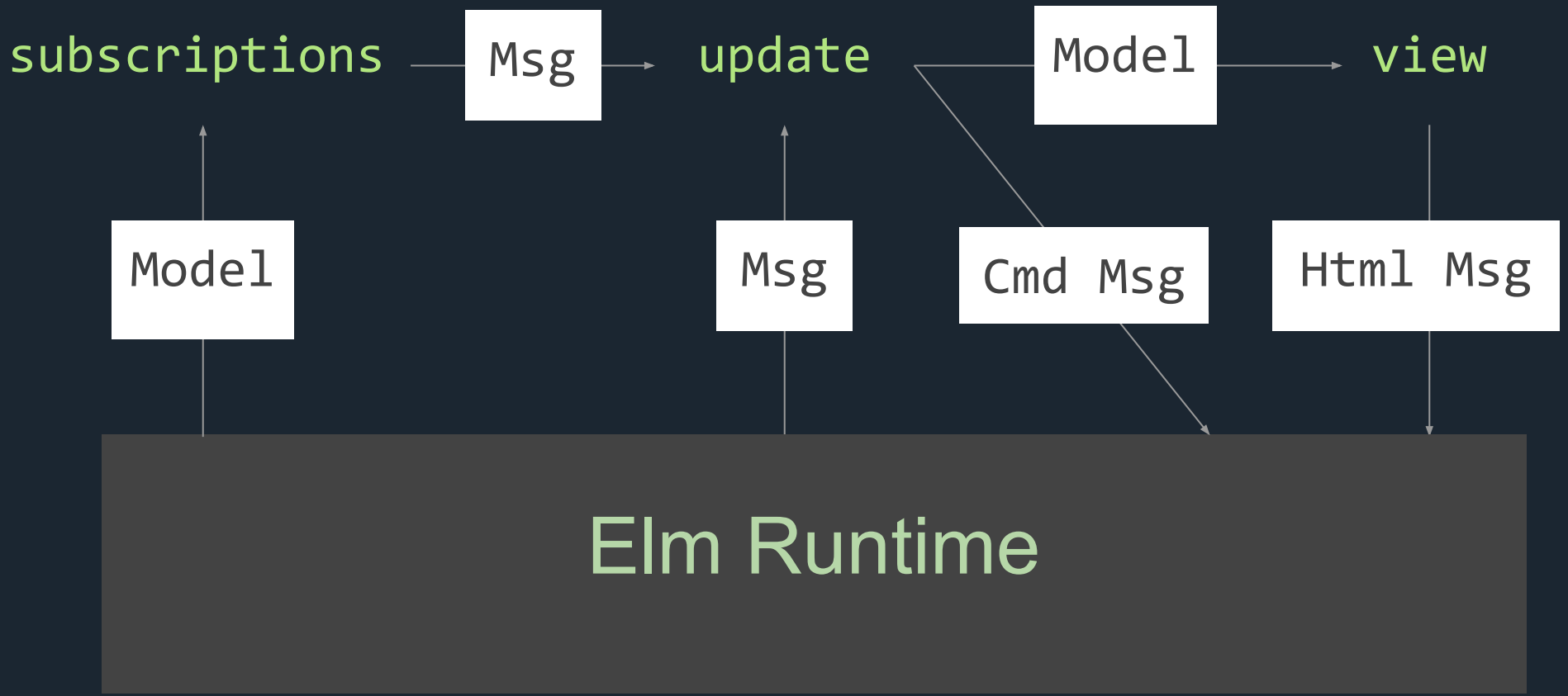
Companies of all sizes use Elm

“No runtime exceptions”

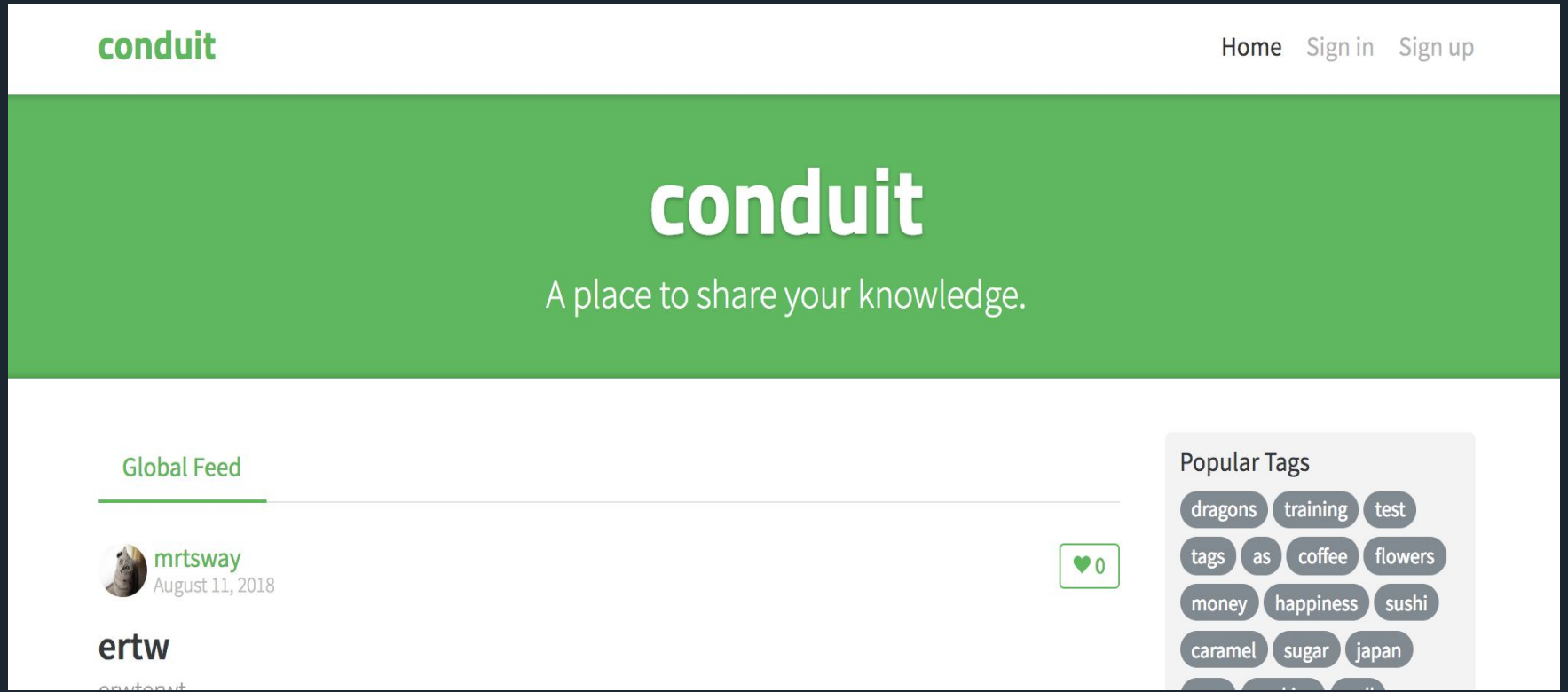


```
<body>
  <div id="app"></div>
  <script>
    Elm.Main.init({
      node: document.getElementById("app")
    });
  </script>
</body>
```

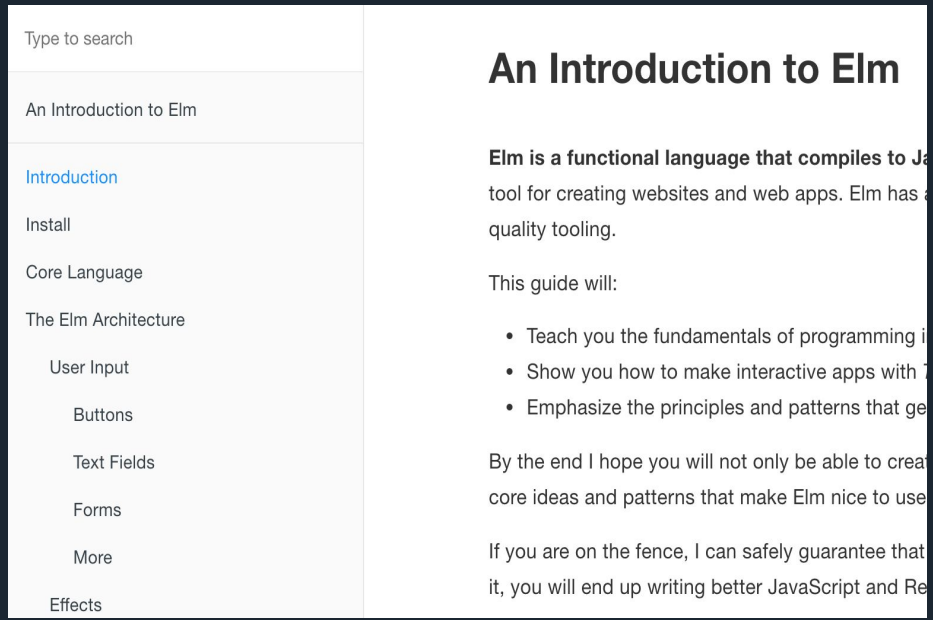
INCREMENTAL ADOPTION

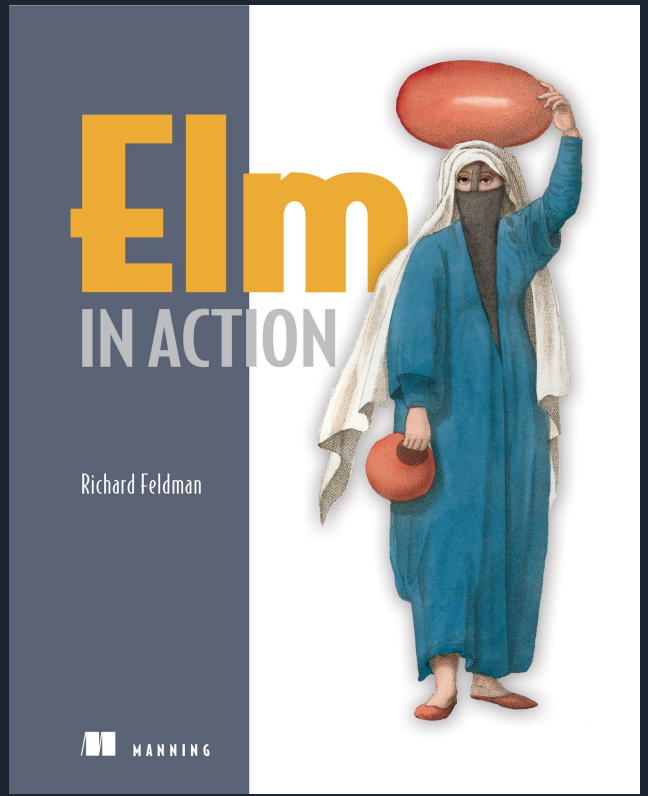

subscriptions
Msg
update
Model
view
Model
Msg
Cmd Msg
Html Msg
Elm Runtime

github.com/rtfeldman/**elm-spa-example**

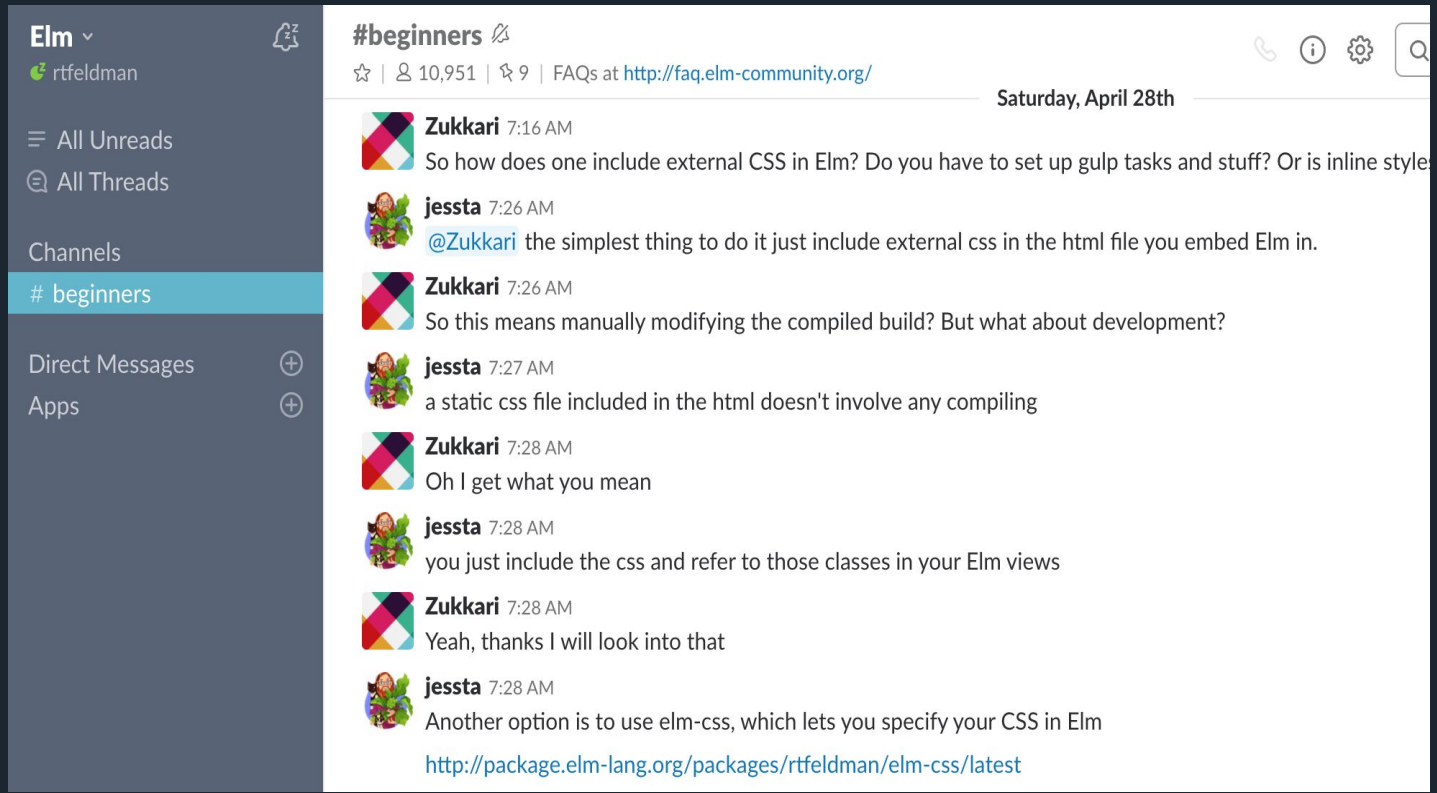


guide.elm-lang.org

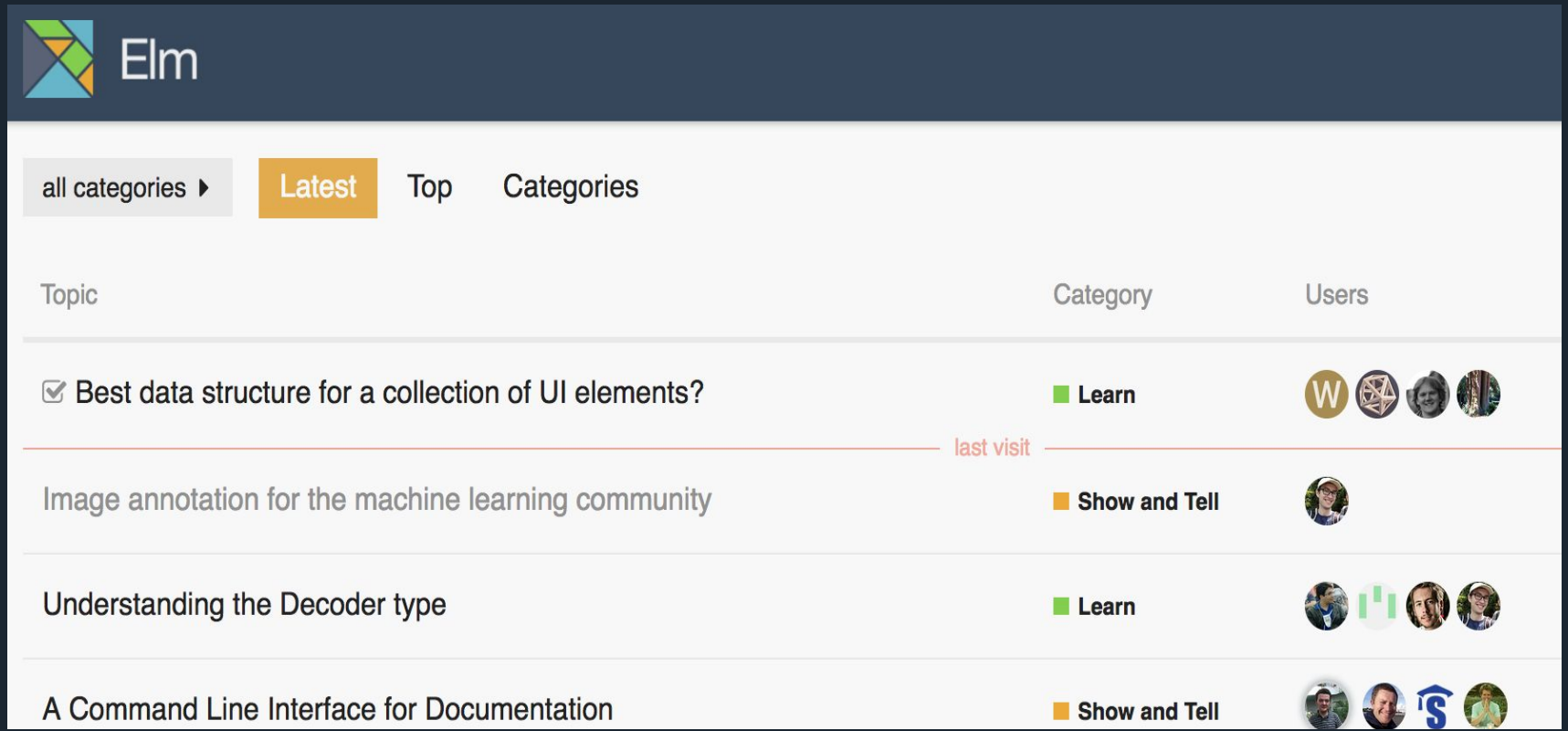




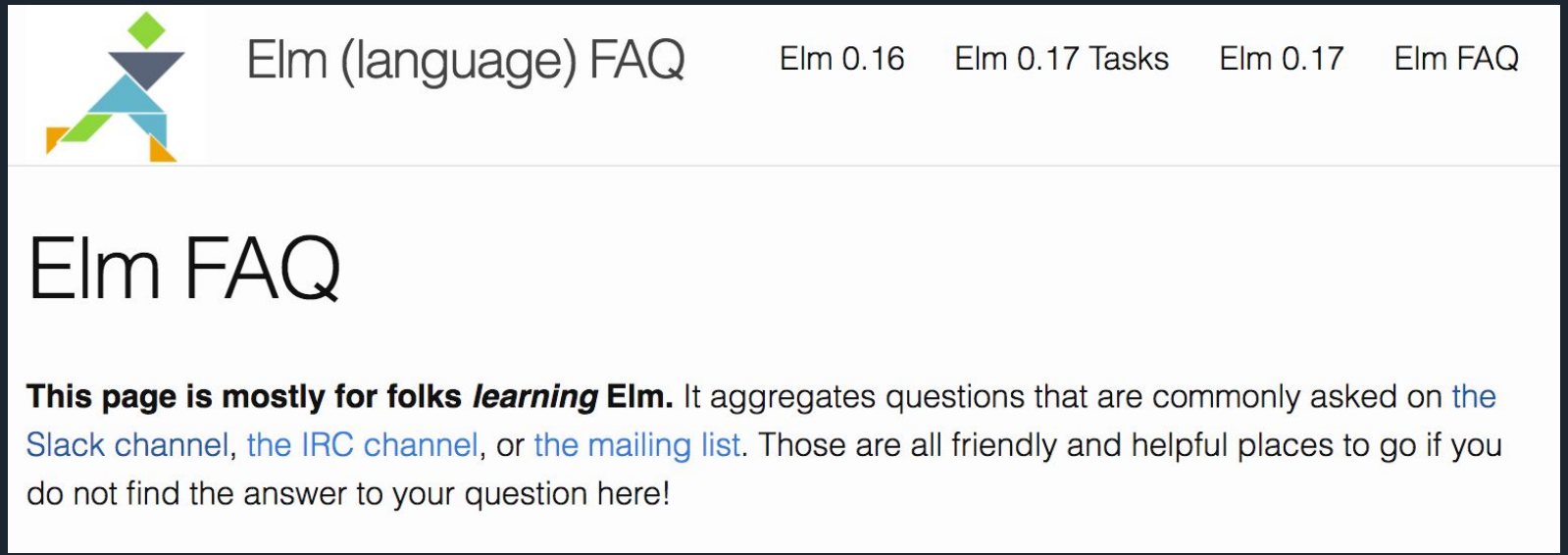
elmlang.herokuapp.com



discourse.elm-lang.org



faq.elm-community.org



https://**elmtown.github.io**

Elm Town Podcast

SUCCESS STORIES

How Elm made our work better

Ossi Hanhinen
Hypertext Elementalist

TOPICS functional, reactive, web, frontend, Elm

Christian Charukiewicz HOME

Elm In Production: 25,000 Lines Later

One year of Elm in production

Tomas Zemanovic Mar 23 *Originally published at tzemanovic.github.io on Mar 06, 2018*

YOUR SUCCESS STORY GOES HERE!