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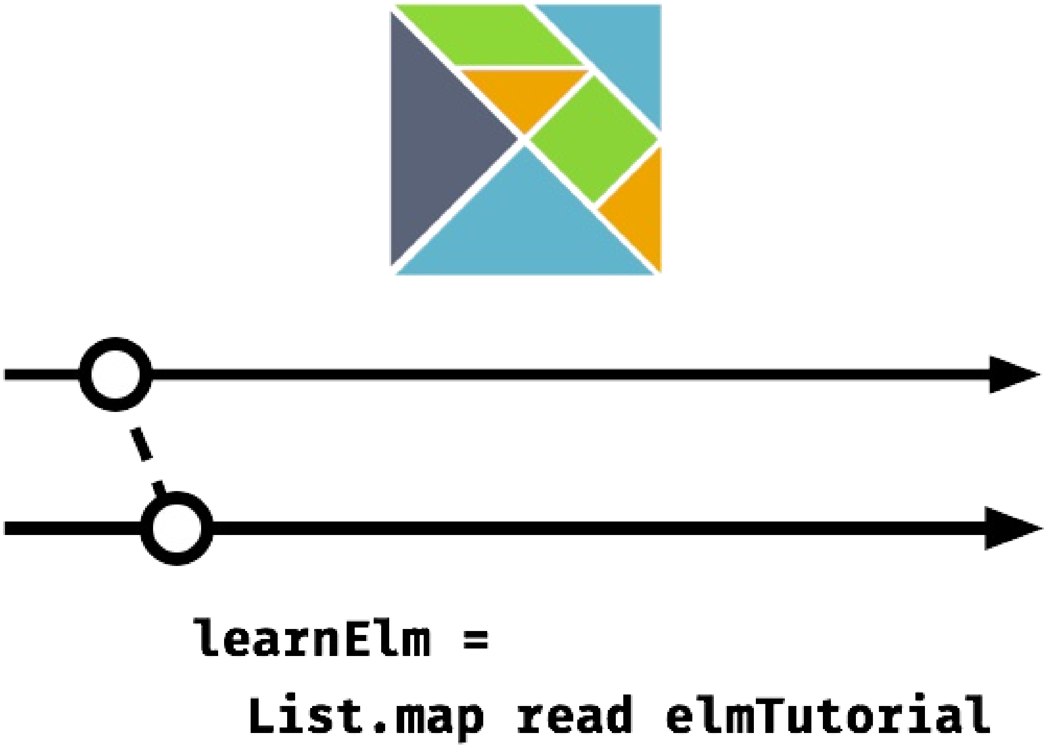

Elm Tutorial

A tutorial on developing single page web applications (SPAs) with Elm.

This tutorial covers:

- Some Elm foundations
- Understanding commands and subscriptions in Elm
- Understanding the Elm architecture
- Breaking an application in sub components and resources
- Integrating CSS
- Fetching and parsing JSON
- Routing
- CRUD operations

Read it online here.

You can also download offline version here (PDF, ePub, Mobi).

Code

Code for the example application built in the second part of this tutorial can be found at https://github.com/sporto/elm-tutorial-app.

Requirements

For this tutorial you will need:

- Elm version 0.18 (Installation is covered later in the tutorial)
- Node JS version 4 +

Contributing

Please open issues and send PRs at https://github.com/sporto/elm-tutorial.

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Foundations

This chapter covers:

- Running a basic Elm application
- Basic of functions and types in Elm

Hello World

Installing Elm

Go to http://elm-lang.org/install and download the appropriate installer for your system.

Our first Elm application

Let's write our first Elm application. Create a folder for your application. In this folder run the following command in the terminal:

```
elm package install elm-lang/html
```

This will install the *html* module. Then add a `Hello.elm` file, with the following code:

```
module Hello exposing (..)

import Html exposing (text)


main =
    text "Hello"
```

Go to this folder on the terminal and type:

```
elm reactor
```

This should show you:

```
elm reactor 0.17.0
Listening on http://0.0.0.0:8000/
```

Open `http://0.0.0.0:8000/` on a browser. And click on `Hello.elm`. You should see `Hello` on your browser.

Note to you might see a warning about a missing type annotation for `main`. Ignore this for now, we will get to type annotations later.

Let's review what is happening here:

Module declaration

```
module Hello exposing (..)
```

Every module in Elm must start with a module declaration, in this case the module name is called `Hello`. It is a convention to name the file and the module the same e.g. `Hello.elm` contains `module Hello`.

The `exposing (..)` part of the declaration specifies what function and types this module exposes to the other modules importing this. In this case we expose everything `(..)`.

Imports

```
import Html exposing (text)
```

In Elm you need to import the **modules** you want to use explicitly. In this case we want to use the **Html** module.

This module has many functions to work with html. We will be using `.text` so we import this function into the current namespace by using `exposing`.

Main

```
main =
    text "Hello"
```

Front end applications in Elm start on a function called `main`. `main` is a function that returns an element to draw into the page. In this case it returns an Html element (created by using `text`).

Elm reactor

Elm **reactor** creates a server that compiles Elm code on the fly. **reactor** is useful for developing applications without worrying too much about setting up a build process. However **reactor** has limitations, so we will need to switch to a build process later on.

Function basics

This chapter covers basic Elm syntax that is important to get familiar with: functions, function signatures, partial application and the pipe operator.

Functions

Elm supports two kind of functions:

- anonymous functions
- named functions

Anonymous function

An anonymous function, as its name implies, is a function we create without a name:

```
\x -> x + 1

\x y -> x + y
```

Between the backslash and the arrow, you list the arguments of the function, and on the right of the arrow, you say what to do with those arguments.

Named functions

A named function in Elm looks like this:

```
add1 : Int -> Int
add1 x =
  x + 1
```

- The first line in the example is the function signature. This signature is optional in Elm, but recommended because it makes the intention of your function clearer.
- The rest is the implementation of the function. The implementation must follow the signature defined above.

In this case the signature is saying: Given an integer (Int) as argument return another integer.

You call it like:

```
add1 3
```

In Elm we use *whitespace* to denote function application (instead of using parenthesis).

Here is another named function:

```
add : Int -> Int -> Int
add x y =
  x + y
```

This function takes two arguments (both Int) and returns another Int. You call this function like:

```
add 2 3
```

No arguments

A function that takes no arguments is a constant in Elm:

```
name =
  "Sam"
```

How functions are applied

As shown above a function that takes two arguments may look like:

```
divide : Float -> Float -> Float
divide x y =
    x / y
```

We can think of this signature as a function that takes two floats and returns another float:

```
divide 5 2 == 2.5
```

However, this is not quite true, in Elm all functions take exactly one argument and return a result. This result can be another function. Let's explain this using the function above.

```
-- When we do:

divide 5 2

-- This is evaluated as:

((divide 5) 2)

-- First `divide 5` is evaluated.
-- The argument `5` is applied to `divide`, resulting in an intermediate function.

divide 5 -- -> intermediate function

-- Let's call this intermediate function `divide5`.
-- If we could see the signature and body of this intermediate function, it would look like:

divide5 : Float -> Float
divide5 y =
  5 / y

-- So we have a function that has the `5` already applied.

-- Then the next argument is applied i.e. `2`

divide5 2

-- And this returns the final result
```

The reason we can avoid writing the parenthesis is because function application **associates to the left**.

Grouping with parentheses

When you want to call a function with the result of another function call you need to use parentheses for grouping the calls:

```
add 1 (divide 12 3)
```

Here the result of `divide 12 3` is given to `add` as the second parameter.

In contrast, in many other languages it would be written:

```
add(1, divide(12, 3))
```

Partial application

As explained above every function takes only one argument and returns another function or a result. This means you can call a function like `add` above with only one argument, e.g. `add 2` and get a *partially applied function** back. This resulting function has a signature `Int -> Int`.

`add 2` returns another function with the value `2` bound as the first parameter. Calling the returned function with a second value returns `2 +` the second value:

```
add2 = add 2
add2 3 -- result 5
```

Partial application is incredibly useful in Elm for making your code more readable and passing state between functions in your application.

The pipe operator

As shown above you can nest functions like:

```
add 1 (multiply 2 3)
```

This is a trivial example, but consider a more complex example:

```
sum (filter (isOver 100) (map getCost records))
```

This code is difficult to read, because it resolves inside out. The pipe operator allows us to write such expressions in a more readable way:

```
3
    |> multiply 2
    |> add 1
```

This relies heavily on partial application as explained before. In this example the value `3` is passed to a partially applied function `multiply 2`. Its result is in turn passed to another partially applied function `add 1`.

Using the pipe operator the complex example above would be written like:

```
records
    |> map getCost
    |> filter (isOver 100)
    |> sum
```

More on functions

Type variables

Consider a function with a type signature like:

```
indexOf : String -> List String -> Int
```

This hypothetical function takes a string and a list of strings and returns the index where the given string was found in the list or -1 if not found.

But what if we instead have an list of integers? We wouldn't be able to use this function. However, we can make this function **generic** by using **type variables** or **stand-ins** instead of specific types.

```
indexOf : a -> List a -> Int
```

By replacing `String` with `a`, the signature now says that `indexOf` takes a value of any type `a` and a list of that same type `a` and returns an integer. As long as the types match the compiler will be happy. You can call `indexOf` with a `String` and a list of `String`, or an `Int` and a list of `Int`, and it will work.

This way functions can be made more generic. You can have several **type variables** as well:

```
switch : ( a, b ) -> ( b, a )
switch ( x, y ) =
  ( y, x )
```

This function takes a tuple of types `a`, `b` and returns a tuple of types `b`, `a`. All these are valid calls:

```
switch (1, 2)
switch ("A", 2)
switch (1, ["B"])
```

Note that any lowercase identifier can be used for type variables, `a` and `b` are just a common convention. For example the following signature is perfectly valid:

```
indexOf : thing -> List thing -> Int
```

Functions as arguments

Consider a signature like:

```
map : (Int -> String) -> List Int -> List String
```

This function:

- takes a function: the `(Int -> String)` part
- a list of integers
- and returns a list of strings

The interesting part is the `(Int -> String)` fragment. This says that a function must be given conforming to the `(Int -> String)` signature.

For example, `toString` from core is such function. So you could call this `map` function like:

```
map toString [1, 2, 3]
```

But `Int` and `String` are too specific. So most of the time you will see signatures using stand-ins instead:

```
map : (a -> b) -> List a -> List b
```

This function maps a list of `a` to a list of `b`. We don't really care what `a` and `b` represent as long as the given function in the first argument uses the same types.

For example, given functions with these signatures:

```
convertStringToInt : String -> Int
convertIntToString : Int -> String
convertBoolToInt : Bool -> Int
```

We can call the generic map like:

```
map convertStringToInt ["Hello", "1"]
map convertIntToString [1, 2]
map convertBoolToInt [True, False]
```

Imports and modules

In Elm you import a module by using the `import` keyword e.g.

```
import Html
```

This imports the `Html` module. Then you can use functions and types from this module by using its fully qualified path:

```
Html.div [] []
```

You can also import a module and expose specific functions and types from it:

```
import Html exposing (div)
```

`div` is mixed in the current scope. So you can use it directly:

```
div [] []
```

You can even expose everything in a module:

```
import Html exposing (..)
```

Then you would be able to use every function and type in that module directly. But this is not recommended most of the time because we end up with ambiguity and possible clashes between modules.

Modules and types with the same name

Many modules export types with the same name as the module. For example, the `Html` module has an `Html` type and the `Task` module has a `Task` type.

So this function that returns an `Html` element:

```
import Html

myFunction : Html.Html
myFunction =
    ...
```

Is equivalent to:

```
import Html exposing (Html)

myFunction : Html
myFunction =
    ...
```

In the first one we only import the `Html` module and use the fully qualified path `Html.Html`.

In the second one we expose the `Html` type from the `Html` module. And use the `Html` type directly.

Module declarations

When you create a module in Elm, you add the `module` declaration at the top:

```
module Main exposing (..)
```

`Main` is the name of the module. `exposing (..)` means that you want to expose all functions and types in this module. Elm expects to find this module in a file called **Main.elm**, i.e. a file with the same name as the module.

You can have deeper file structures in an application. For example, the file **Players/Utils.elm** should have the declaration:

```
module Players.Utils exposing (..)
```

You will be able to import this module from anywhere in your application by:

```
import Players.Utils
```

Union types

In Elm, **Union Types** are used for many things as they are incredibly flexible. A union type looks like:

```
type Answer = Yes | No
```

`Answer` can be either `Yes` or `No` . Union types are useful for making our code more generic. For example a function that is declared like this:

```
respond : Answer -> String
respond answer =
    ...
```

Can either take `Yes` or `No` as the first argument e.g. `respond Yes` is a valid call.

Union types are also commonly called **tags** in Elm.

Payload

Union types can have associated information with them:

```
type Answer = Yes | No | Other String
```

In this case, the tag `Other` will have an associated string. You could call `respond` like this:

```
respond (Other "Hello")
```

You need the parenthesis otherwise Elm will interpret this as passing two arguments to respond.

As constructor functions

Note how we add a payload to `Other` :

```
Other "Hello"
```

This is just like a function call where `Other` is the function. Union types behave just like functions. For example given a type:

```
type Answer = Message Int String
```

You will create a `Message` tag by:

```
Message 1 "Hello"
```

You can do partial application just like any other function. These are commonly called `constructors` because you can use this to construct complete types, i.e. use `Message` as a function to construct `(Message 1 "Hello")` .

Nesting

It is very common to 'nest' one union type in another.

```
type OtherAnswer = DontKnow | Perhaps | Undecided

type Answer = Yes | No | Other OtherAnswer
```

Then you can pass this to our `respond` function (which expect `Answer`) like this:

```
respond (Other Perhaps)
```

Type variables

It is also possible to use type variables or stand-ins:

```
type Answer a = Yes | No | Other a
```

This is an `Answer` that can be used with different types, e.g. Int, String.

For example, respond could look like this:

```
respond : Answer Int -> String
respond answer =
    ...
```

Here we are saying that the `a` stand-in should be of type `Int` by using the `Answer Int` signature.

So later we will be able to call respond with:

```
respond (Other 123)
```

But `respond (Other "Hello")` would fail because `respond` expects an integer in place of `a`.

A common use

One typical use of union types is passing around values in our program where the value can be one of a known set of possible values.

For example, in a typical web application, we have actions that can be performed, e.g. load users, add user, delete user, etc. Some of these actions would have a payload.

It is common to use union types for this:

```
type Action
    = LoadUsers
    | AddUser
    | EditUser UserId
    ...
```

There is a lot more about Union types. If interested read more about this here.

Type aliases

A **type alias** in Elm is, as its name says, an alias for something else. For example, in Elm you have the core `Int` and `String` types. You can create aliases for them:

```
type alias PlayerId = Int

type alias PlayerName = String
```

Here we have created a couple of type alias that simply point to other core types. This is useful because instead of having a function like:

```
label: Int -> String
```

You can write it like:

```
label: PlayerId -> PlayerName
```

In this way, it is much clearer what the function is asking for.

Records

A record definition in Elm looks like:

```
{ id : Int
, name : String
}
```

If you were to have a function that takes a record, you would have to write a signature like:

```
label: { id : Int, name : String } -> String
```

Quite verbose, but type aliases help a lot with this:

```
type alias Player =
    { id : Int
    , name : String
    }

label: Player -> String
```

Here we create a `Player` type alias that points to a record definition. Then we use that type alias in our function signature.

Constructors

Type aliases can be used as **constructor** functions. Meaning that we can create a real record by using the type alias as a function.

```
type alias Player =
    { id : Int
    , name : String
    }

Player 1 "Sam"
==> { id = 1, name = "Sam" }
```

Here we create a `Player` type alias. Then, we call `Player` as a function with two parameters. This gives us back a record with the proper attributes. Note that the order of the arguments determines which values will be assigned to which attributes.

The unit type

The empty tuple `()` is called the **unit type** in Elm. It is so prevalent that it deserves some explanation.

Consider a type alias with a **type variable** (represented by `a`):

```
type alias Message a =
    { code : String
    , body : a
    }
```

You can make a function that expects a `Message` with the `body` as a `String` like this:

```
readMessage : Message String -> String
readMessage message =
    ...
```

Or a function that expects a `Message` with the `body` as a List of Integers:

```
readMessage : Message (List Int) -> String
readMessage message =
    ...
```

But what about a function that doesn't need a value in the body? We use the unit type for indicating that the body should be empty:

```
readMessage : Message () -> String
readMessage message =
    ...
```

This function takes `Message` with an **empty body**. This is not the same as **any value**, just an **empty** one.

So the unit type is commonly used as a placeholder for an empty value.

Task

A real world example of this is the `Task` type. When using `Task`, you will see the unit type very often.

A typical task has an **error** and a **result**:

```
Task error result
```

- Sometimes we want a task where the error can be safely ignored: `Task () result`
- Or the result is ignored: `Task error ()`
- Or both: `Task () ()`

The Elm architecture

This chapter covers:

- Overview of the Elm architecture
- Introduction to Html.program
- Messages
- Commands
- Subscriptions

> This page covers Elm 0.18

Introduction

When building front end applications in Elm, we use the pattern known as the Elm architecture. This pattern provides a way of creating self contained components that can be reused, combined, and composed in endless variety.

Elm provides the `Html` module for this. This is easier to understand by building a small app.

Install elm-html:

```
elm package install elm-lang/html
```

Create a file called **App.elm**:

```
module App exposing (..)

import Html exposing (Html, div, text, program)


-- MODEL


type alias Model =
    String


init : ( Model, Cmd Msg )
init =
    ( "Hello", Cmd.none )



-- MESSAGES


type Msg
    = NoOp



-- VIEW


view : Model -> Html Msg
view model =
    div []
        [ text model ]



-- UPDATE


update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        NoOp ->
            ( model, Cmd.none )



-- SUBSCRIPTIONS


subscriptions : Model -> Sub Msg
subscriptions model =
    Sub.none



-- MAIN


main : Program Never Model Msg
main =
    program
        { init = init
        , view = view
        , update = update
        , subscriptions = subscriptions
        }
```

You can run this program running:

```
elm reactor
```

And opening http://localhost:8000/App.elm

This is a lot of code for just showing "Hello", but it will help us understand the structure of even very complicated Elm applications.

> This page covers Elm 0.18

Structure of Html.program

Imports

```
import Html exposing (Html, div, text, program)
```

- We will use the `Html` type from the `Html` module, plus a couple of functions `div` , `text` and `program` .

Model

```
type alias Model =
    String


init : ( Model, Cmd Msg )
init =
    ( "Hello", Cmd.none )
```

- First we define our application model as a type alias, in this kind. Here it is just a `String` .
- Then we define an `init` function. This function provides the initial input for the application.

Html.program expects a tuple with `(model, command)` . The first element in this tuple is our initial state, e.g. "Hello". The second element is an initial command to run. More on this later.

When using the elm architecture, we compose all components models into a single state tree. More on this later too.

Messages

```
type Msg
    = NoOp
```

Messages are things that happen in our applications that our component responds to. In this case, the application doesn't do anything, so we only have a message called `NoOp` .

Other examples of messages could be `Expand` or `Collapse` to show and hide a widget. We use union types for messages:

```
type Msg
    = Expand
    | Collapse
```

View

```
view : Model -> Html Msg
view model =
    div []
        [ text model ]
```

The function `view` renders an Html element using our application model. Note that the type signature is `Html Msg` . This means that this Html element would produce messages tagged with Msg. We will see this when we introduce some interaction.

Update

```
update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        NoOp ->
            ( model, Cmd.none )
```

Next we define an `update` function, this function will be called by `Html.program` each time a message is received. This update function responds to messages updating the model and returning commands as needed.

In this example, we only respond to `NoOp` and return the unchanged model and `Cmd.none` (meaning no command to perform).

Subscriptions

```
subscriptions : Model -> Sub Msg
subscriptions model =
    Sub.none
```

We use subscriptions to listen for external input to our application. Some examples of subscriptions are:

- Mouse movements
- Keyboard events
- Browser location changes

In this case, we are not interested in any external input so we use `Sub.none`.

Main

```
main : Program Never Model Msg
main =
    program
        { init = init
        , view = view
        , update = update
        , subscriptions = subscriptions
        }
```

Finally `Html.program` wires everything together and returns an html element that we can render in the page. `program` takes our `init`, `view`, `update` and `subscriptions`.

> This page covers Elm 0.18

Messages

In the last section, we created an application using Html.program that was just static Html. Now let's create an application that responds to user interaction using messages.

```
module Main exposing (..)

import Html exposing (Html, button, div, text, program)
import Html.Events exposing (onClick)


-- MODEL


type alias Model =
    Bool


init : ( Model, Cmd Msg )
init =
    ( False, Cmd.none )



-- MESSAGES


type Msg
    = Expand
    | Collapse



-- VIEW


view : Model -> Html Msg
view model =
    if model then
        div []
            [ button [ onClick Collapse ] [ text "Collapse" ]
            , text "Widget"
            ]
    else
        div []
            [ button [ onClick Expand ] [ text "Expand" ] ]



-- UPDATE


update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        Expand ->
            ( True, Cmd.none )

        Collapse ->
            ( False, Cmd.none )



-- SUBSCRIPTIONS
```

```
subscriptions : Model -> Sub Msg
subscriptions model =
    Sub.none



-- MAIN


main =
    program
        { init = init
        , view = view
        , update = update
        , subscriptions = subscriptions
        }
```

This program is very similar to the previous program we did, but now we have two messages: `Expand` and `Collapse`. You can run this program by copying it into a file and opening it using Elm reactor.

Let's look more closely at the `view` and `update` functions.

View

```
view : Model -> Html Msg
view model =
    if model then
        div []
            [ button [ onClick Collapse ] [ text "Collapse" ]
            , text "Widget"
            ]
    else
        div []
            [ button [ onClick Expand ] [ text "Expand" ] ]
```

Depending on the state of the model we show either the collapsed or the expanded view.

Note the `onClick` function. As this view is of type `Html Msg` we can trigger messages of that type using `onClick`. Collapse and Expand are both of type Msg.

Update

```
update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        Expand ->
            ( True, Cmd.none )

        Collapse ->
            ( False, Cmd.none )
```

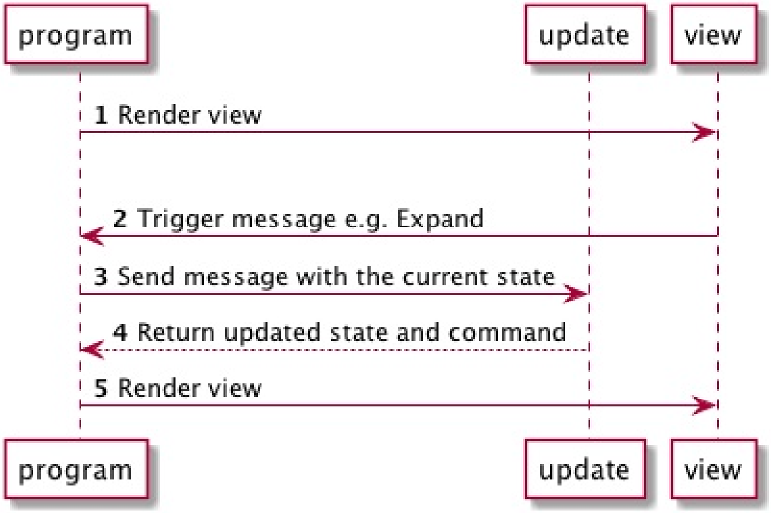
`update` responds to the possible messages. Depending on the message, it returns the desired state. When the message is `Expand`, the new state will be `True` (expanded).

Next let's see how **Html.program** orchestrates these pieces together.

> This page covers Elm 0.18

Application flow

The following diagram illustrates how the pieces of our application interact with Html.program.


program
update
view
1 Render view
2 Trigger message e.g. Expand
3 Send message with the current state
4 Return updated state and command
5 Render view
program
update
view

1. `Html.program` calls our view function with the initial model and renders it.
2. When the user clicks on the Expand button, the view triggers the `Expand` message.
3. `Html.program` receives the `Expand` message which calls our `update` function with `Expand` and the current application state.
4. The update function reponds to the message by returning the updated state and a command to run (or `Cmd.none`).
5. `Html.program` receives the updated state, stores it, and calls the view with the updated state.

Usually `Html.program` is the only place where an Elm application holds state, it is centralised in one big state tree.

> This page covers Elm 0.18

Messages with payload

You can send a payload in your message:

```
module Main exposing (..)

import Html exposing (Html, button, div, text, program)
import Html.Events exposing (onClick)


-- MODEL


type alias Model =
    Int


init : ( Model, Cmd Msg )
init =
    ( 0, Cmd.none )



-- MESSAGES


type Msg
    = Increment Int



-- VIEW


view : Model -> Html Msg
view model =
    div []
        [ button [ onClick (Increment 2) ] [ text "+" ]
        , text (toString model)
        ]



-- UPDATE


update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        Increment howMuch ->
            ( model + howMuch, Cmd.none )



-- SUBSCRIPTIONS


subscriptions : Model -> Sub Msg
subscriptions model =
    Sub.none



-- MAIN


main : Program Never Model Msg
main =
    program
        { init = init
        , view = view
        , update = update
        , subscriptions = subscriptions
        }
```

Note how the `Increment` message requires an integer:

```
type Msg
    = Increment Int
```

Then in the view we trigger that message with a payload:

```
onClick (Increment 2)
```

And finally in update we use **pattern matching** to extract the payload:

```
update msg model =
    case msg of
        Increment howMuch ->
            ( model + howMuch, Cmd.none )
```

> This page covers Elm 0.18

Composing

One of the big benefits of using the Elm architecture is the way it handles composition of components. To understand this, let's build an example:

- We will have a parent component `App`
- And a child component `Widget`

Child component

Let's begin with the child component. This is the code for **Widget.elm**.

```elm
module Widget exposing (..)

import Html exposing (Html, button, div, text)
import Html.Events exposing (onClick)


-- MODEL


type alias Model =
    { count : Int
    }


initialModel : Model
initialModel =
    { count = 0
    }



-- MESSAGES


type Msg
    = Increase



-- VIEW


view : Model -> Html Msg
view model =
    div []
        [ div [] [ text (toString model.count) ]
        , button [ onClick Increase ] [ text "Click" ]
        ]



-- UPDATE


update : Msg -> Model -> ( Model, Cmd Msg )
update message model =
    case message of
        Increase ->
            ( { model | count = model.count + 1 }, Cmd.none )
```

This component is nearly identical to the application that we made in the last section, except for subscriptions and main. This component:

- Defines its own messages (Msg)
- Defines its own model
- Provides an `update` function that responds to its own messages, e.g. `Increase`.

Note how the component only knows about things declared here. Both `view` and `update` only use types declared within the component (`Msg` and `Model`).

In the next section we will create the parent component.

> This page covers Elm 0.18

Composing

The parent component

This is the code for the parent component.

```
module Main exposing (..)

import Html exposing (Html, program)
import Widget


-- MODEL


type alias AppModel =
    { widgetModel : Widget.Model
    }


initialModel : AppModel
initialModel =
    { widgetModel = Widget.initialModel
    }


init : ( AppModel, Cmd Msg )
init =
    ( initialModel, Cmd.none )



-- MESSAGES


type Msg
    = WidgetMsg Widget.Msg



-- VIEW


view : AppModel -> Html Msg
view model =
    Html.div []
        [ Html.map WidgetMsg (Widget.view model.widgetModel)
        ]



-- UPDATE


update : Msg -> AppModel -> ( AppModel, Cmd Msg )
update message model =
    case message of
        WidgetMsg subMsg ->
            let
                ( updatedWidgetModel, widgetCmd ) =
                    Widget.update subMsg model.widgetModel
            in
                ( { model | widgetModel = updatedWidgetModel }, Cmd.map WidgetMsg widgetCmd )
```

```
-- SUBSCIPTIONS


subscriptions : AppModel -> Sub Msg
subscriptions model =
    Sub.none



-- APP


main : Program Never AppModel Msg
main =
    program
        { init = init
        , view = view
        , update = update
        , subscriptions = subscriptions
        }
```

Let's review the important sections of this code.

Model

```
type alias AppModel =
    { widgetModel : Widget.Model ❶
    }
```

The parent component has its own model. One of the attributes on this model contains the `Widget.Model` ❶. Note how this parent component doesn't need to know about what `Widget.Model` is.

```
initialModel : AppModel
initialModel =
    { widgetModel = Widget.initialModel ❷
    }
```

When creating the initial application model, we simply call `Widget.initialModel` ❷ from here.

If you were to have multiple children components, you would do the same for each, for example:

```
initialModel : AppModel
initialModel =
    { navModel = Nav.initialModel,
    , sidebarModel = Sidebar.initialModel,
    , widgetModel = Widget.initialModel
    }
```

Or we could have multiple children components of the same type:

```
initialModel : AppModel
initialModel =
    { widgetModels = [Widget.initialModel]
    }
```

Messages

```
type Msg
    = WidgetMsg Widget.Msg
```

We use a **union type** that wraps `Widget.Msg` to indicate that a message belongs to that component. This allows our application to route messages to the relevant components (This will become clearer after looking at the update function).

In an application with multiple children components we could have something like:

```
type Msg
    = NavMsg Nav.Msg
    | SidebarMsg Sidebar.Msg
    | WidgetMsg Widget.Msg
```

View

```
view : AppModel -> Html Msg
view model =
    Html.div []
        [ Html.map❶ WidgetMsg❷ (Widget.view❸ model.widgetModel❹)
        ]
```

The main application `view` renders the `Widget.view` ❸. But `Widget.view` emits `Widget.Msg` so it is incompatible with this view which emits `Main.Msg` .

- We use `Html.map` ❶ to map emitted messages from Widget.view to the type we expect (Msg). `Html.map` tags messages coming from the sub view using the `WidgetMsg` ❷ tag.
- We only pass the part of the model that the children component cares about i.e. `model.widgetModel` ❹.

Update

```
update : Msg -> AppModel -> (AppModel, Cmd Msg)
update message model =
    case message of
        WidgetMsg❶ subMsg❷ ->
            let
                (updatedWidgetModel, widgetCmd)❹ =
                    Widget.update❸ subMsg model.widgetModel
            in
                ({ model | widgetModel = updatedWidgetModel }, Cmd.map❺ WidgetMsg widgetCmd)
```

When a `WidgetMsg` ❶ is received by `update` we delegate the update to the children component. But the children component will only update what it cares about, which is the `widgetModel` attribute.

We use pattern matching to extract the `subMsg` ❷ from `WidgetMsg` . This `subMsg` will be the type that `Widget.update` expects.

Using this `subMsg` and `model.widgetModel` we call `Widget.update` ❸. This will return a tuple with an updated `widgetModel` and a command.

We use pattern matching again to destructure ❹ the response from `Widget.update` .

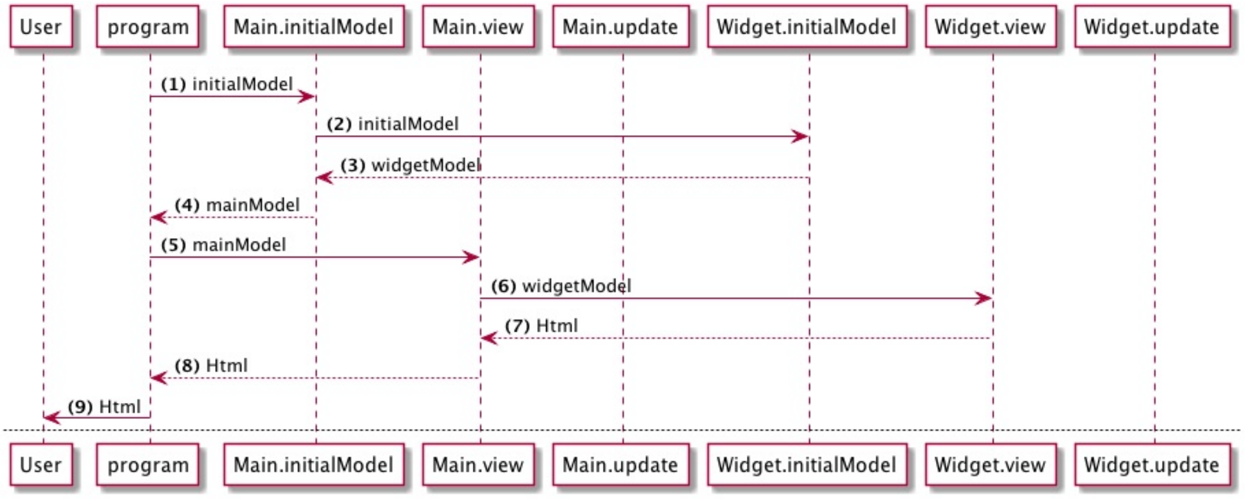
Finally we need to map the command returned by `Widget.update` to the right type. We use `Cmd.map` ❺ for this and tag the command with `WidgetMsg` , similar to what we did in the view.

> This page covers Elm 0.18

Composing

Here are two diagrams that illustrate this architecture:

Intial render



(1) **program** calls **Main.initialModel** to get the initial model for the application

(2) **Main** calls **Widget.initialModel**

(3) **Widget** returns its initial model

(4) **Main** returns a composed main model which includes the widget model

(5) **program** calls **Main.view**, passing the **main model**

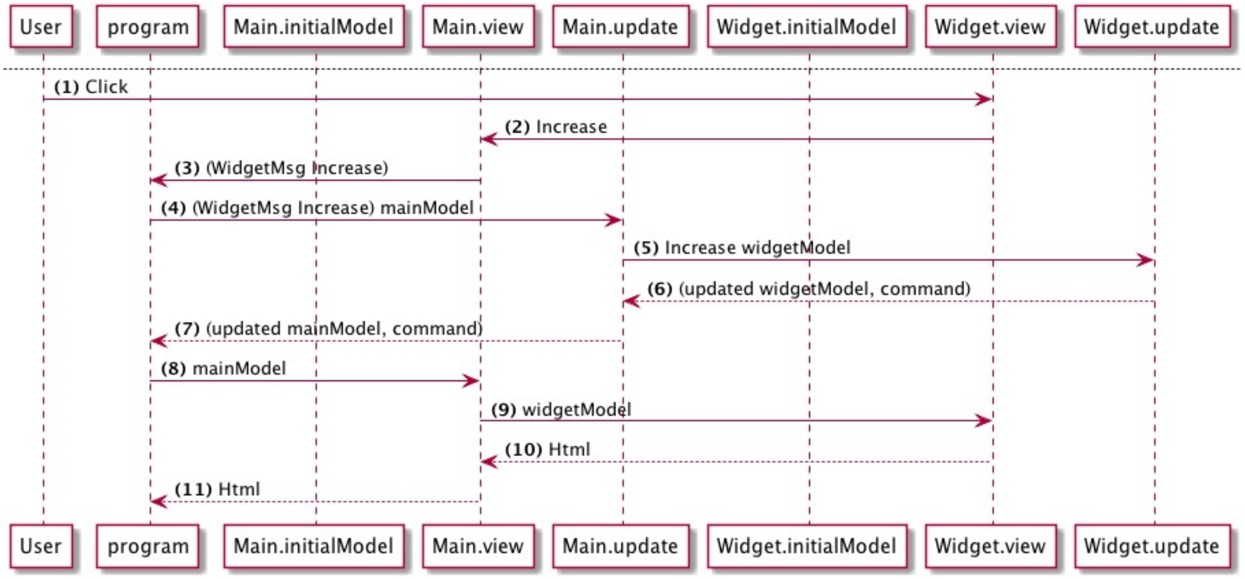
(6) **Main.view** calls **Widget.view**, passing the **widgetModel** from the main model

(7) **Widget.view** returns the rendered Html to **Main**

(8) **Main.view** returns the rendered Html to **program**

(9) **program** renders this to the browser.

User interaction



(1) User clicks on the increase button

(2) **Widget.view** emits an **Increase** message which is picked up by **Main.view**.

(3) **Main.view** tags this message so it becomes (WidgetMsg Increase) and it is sent along to **program**

(4) **program** calls **Main.update** with this message and the main model

(5) As the message was tagged with **WidgetMsg**, **Main.update** delegates the update to **Widget.update**, sending along the way the **widgetModel** part of the main model

(6) **Widget.update** modifies the model according to the given message, in this case **Increase**. And returns the modified **widgetModel** plus a command

(7) **Main.update** updates the main model and returns it to **program**

(8) **program** then renders the view again passing the updated main model

Key points

- The Elm architecture offers a clean way to compose (or nest) components at as many levels as you need.
- A child component does not need to know anything about its parent. Child components define their own types and messages.
- If a child component needs something in particular (e.g. an additional model) it "asks" for it by using the function signatures. The parent is responsible for providing what the children need.
- A parent doesn't need to know what is in its children's models, or what their messages are. It only needs to provide what its children ask.

Subscriptions and Commands

In order to listen to external input and create **side effects** in our application we need to learn about **Subscriptions** and **Commands**.

This chapter covers:

- Subscriptions
- Commands

> This page covers Elm 0.18

Subscriptions

In Elm, using **subscriptions** is how your application can listen for external input. Some examples are:

- Keyboard events
- Mouse movements
- Browser locations changes
- Websocket events

To illustrate this let's create an application that responds to both keyboard and mouse events.

First install the required libraries

```
elm package install elm-lang/mouse
elm package install elm-lang/keyboard
```

And create this program

```
module Main exposing (..)

import Html exposing (Html, div, text, program)
import Mouse
import Keyboard


-- MODEL


type alias Model =
    Int


init : ( Model, Cmd Msg )
init =
    ( 0, Cmd.none )



-- MESSAGES


type Msg
    = MouseMsg Mouse.Position
    | KeyMsg Keyboard.KeyCode



-- VIEW


view : Model -> Html Msg
view model =
    div []
        [ text (toString model) ]



-- UPDATE


update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        MouseMsg position ->
```

```
            ( model + 1, Cmd.none )

        KeyMsg code ->
            ( model + 2, Cmd.none )



-- SUBSCRIPTIONS


subscriptions : Model -> Sub Msg
subscriptions model =
    Sub.batch
        [ Mouse.clicks MouseMsg
        , Keyboard.downs KeyMsg
        ]



-- MAIN


main : Program Never Model Msg
main =
    program
        { init = init
        , view = view
        , update = update
        , subscriptions = subscriptions
        }
```

Run this program with Elm reactor, each time you click the mouse you will see the counter increasing by one, each time you press a key you will see the counter increasing by 2.

Let's review the important parts relevant to subscriptions in this program.

Messages

```
type Msg
    = MouseMsg Mouse.Position
    | KeyMsg Keyboard.KeyCode
```

We have two possible messages `MouseMsg` and `KeyMsg`. This will trigger when the mouse or the keyboard are pressed accordingly.

Update

```
update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        MouseMsg position ->
            ( model + 1, Cmd.none )

        KeyMsg code ->
            ( model + 2, Cmd.none )
```

Our update function responds to each message differently, so it increases the counter by one when we press the mouse or by two when we press a key.

Subscriptions

```
subscriptions : Model -> Sub Msg
subscriptions model =
    Sub.batch ❸
        [ Mouse.clicks MouseMsg ❶
        , Keyboard.downs KeyMsg ❷
        ]
```

Here we declare the things we want to listen to. We want to listen to `Mouse.clicks` ❶ and `Keyboard.downs` ❷. Both of these functions take a message constructor and return a subscription.

We use `Sub.batch` ❸ so we can listen to both of them. Batch takes a list of subscriptions and returns one subscription which includes all of them.

> This page covers Elm 0.18

Commands

In Elm, commands (Cmd) are how we tell the runtime to execute things that involve side effects. For example:

- Generate a random number
- Make an http request
- Save something into local storage

A `Cmd` can be one or a collection of things to do. We use commands to gather all the things that need to happen and hand them to the runtime. Then the runtime will execute them and feed the results back to the application.

In other words, every function returns a value in a functional language such as Elm. Function side effects in the traditional sense are forbidden by the language design and Elm takes an alternative approach to modeling them. Essentially, a function returns a command value which names the desired effect. Due to the Elm architecture, the main Html.program we've been using is the ultimate recipient of this command value. The update method of the Html.program then contains the logic to execute the named command.

Let's try an example app using commands:

```
module Main exposing (..)

import Html exposing (Html, div, button, text, program)
import Html.Events exposing (onClick)
import Random


-- MODEL


type alias Model =
    Int


init : ( Model, Cmd Msg )
init =
    ( 1, Cmd.none )



-- MESSAGES


type Msg
    = Roll
    | OnResult Int



-- VIEW


view : Model -> Html Msg
view model =
    div []
        [ button [ onClick Roll ] [ text "Roll" ]
        , text (toString model)
        ]



-- UPDATE


update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        Roll ->
            ( model, Random.generate OnResult (Random.int 1 6) )

        OnResult res ->
            ( res, Cmd.none )



-- MAIN


main : Program Never Model Msg
main =
    program
        { init = init
        , view = view
        , update = update
        , subscriptions = (always Sub.none)
        }
```

If you run this application it will show a button that will generate a random number each time you click it.

Let's review the relevant parts:

Messages

```
type Msg
    = Roll
    | OnResult Int
```

We have two possible messages in our application. `Roll` for rolling a new number. `OnResult` for getting a generated number back from the `Random` library.

Update

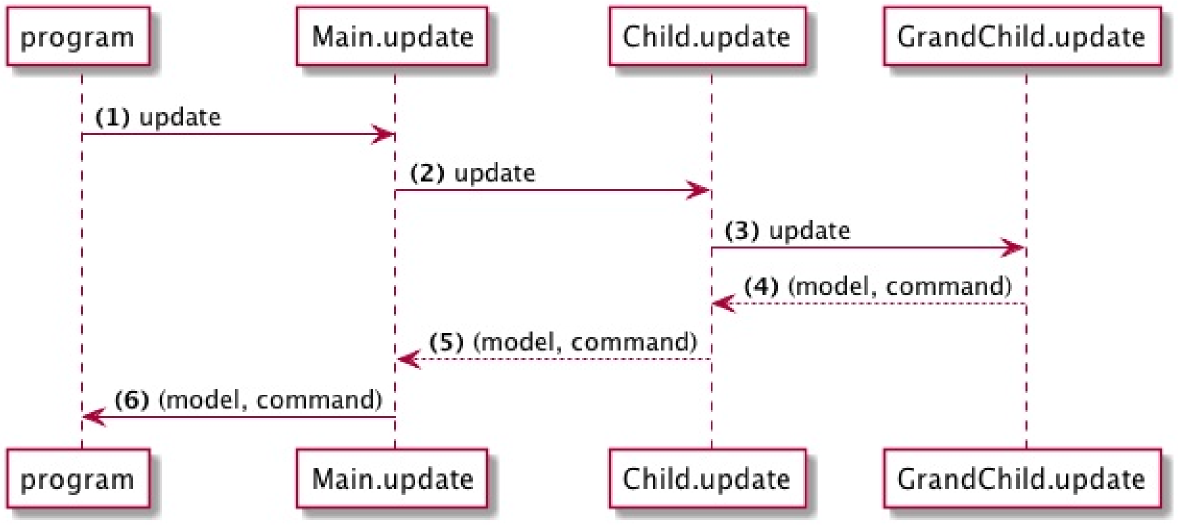
```
update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        Roll ->
            ( model, Random.generate❶ OnResult (Random.int 1 6) )

        OnResult res ->
            ( res, Cmd.none )
```

❶ `Random.generate` creates a command that will generate random numbers. This function requires the first argument to be a constructor for the message that will be fed back to our application. In this case our constructor is `OnResult` .

So when the command is run Elm will call `OnResult` with the generated number, producing `OnResult 2` for example. Then **Html.program** will feed this message back to application.

In case you're wondering, `OnResult res` denotes a message, OnResult, containing an additional payload of information, the Integer 'res' in this case. This pattern is known as parameterized types.

In a bigger application with many nested components we can potentially send many commands at once to **Html.program**. Take this diagram for example:



Here we collect commands from three different levels. At the end we send all these commands to **program** to run.

Starting an application

In this chapter we start building an example Elm application.

This tutorial will cover the following aspects about building an application:

- Application structure
- Fetching resources
- Views
- Routing
- User interaction and saving changes

See next page for details about the application.

> This page covers Elm 0.18

Planning

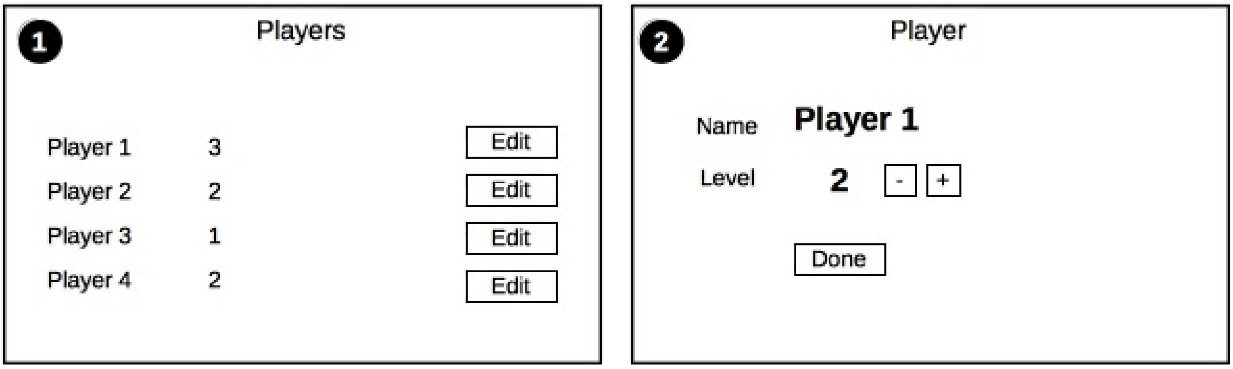
We will build a basic application to track an imaginary role playing game.

Resources

During the rest of this guide I will use the word **resources** to refer to models that are the subject of our application. These are **players** in this application. Using the word **model** can be confusing because component specific state is also a model (for example the expanded / collapse state of a component).

Wireframes

The application will have two views:



Screen 1

Will show a list of players. From here you can:

- Navigate to edit a player

Screen 2

Shows the edit view for a player. In this screen you can:

- Change the level

This is a very simple application that will demonstrate:

- Multiple views
- Nested components
- Breaking the application into resources
- Routing
- Shared state across the application
- Read and edit operation on the records
- Ajax requests

> This page covers Elm 0.18

Backend

We will need a backend for our application, we can use **json-server** for this.

json-server is an npm package that provides a quick way to create fake APIs.

Start a new node project:

```
npm init
```

Accept all the defaults.

Install **json-server**:

```
npm i json-server@0.9 -S
```

Make **api.js** in the root of the project:

```
var jsonServer = require('json-server')

// Returns an Express server
var server = jsonServer.create()

// Set default middlewares (logger, static, cors and no-cache)
server.use(jsonServer.defaults())

var router = jsonServer.router('db.json')
server.use(router)

console.log('Listening at 4000')
server.listen(4000)
```

Add **db.json** at the root:

```
{
  "players": [
    { "id": "1", "name": "Sally", "level": 2 },
    { "id": "2", "name": "Lance", "level": 1 },
    { "id": "3", "name": "Aki", "level": 3 },
    { "id": "4", "name": "Maria", "level": 4 },
    { "id": "5", "name": "Julian", "level": 1 },
    { "id": "6", "name": "Jaime", "level": 1 }
  ]
}
```

Start the server by running:

```
node api.js
```

Test this fake API by browsing to:

- http://localhost:4000/players

> This page covers Elm 0.18

Webpack

Elm reactor is great for prototyping simple applications, but for a bigger app it falls short. As it is now, **reactor** doesn't support talking with external JavaScript or importing external CSS. To overcome these issues we will use **Webpack** to compile our Elm code instead of Elm reactor.

Webpack is a code bundler. It looks at your dependency tree and only bundles the code that is imported. Webpack can also import CSS and other assets inside a bundle. Read more about Webpack here.

There are many alternatives that you can use to achieve the same as Webpack, for example:

- Browserify
- Gulp
- StealJS
- JSPM
- Or if using a framework like Rails or Phoenix you can bundle the Elm code and CSS using them.

Requirements

You will need Node JS version 4 or more for these libraries to work as expected.

Installing webpack and loaders

Install webpack and associated packages:

```
npm i webpack@1 webpack-dev-middleware@1 webpack-dev-server@1 elm-webpack-loader@3 file-loader@0 style-loader@0 css-l
oader@0 url-loader@0 -S
```

This tutorial is using **webpack** version **1.13** and **elm-webpack-loader** version **3.0**.

Loaders are extensions that allow webpack to load different formats. E.g. `css-loader` allows webpack to load .css files.

We also want to use a couple of extra libraries:

- Basscss for CSS, `ace-css` is the Npm package that bundles common Basscss styles
- FontAwesome for icons

```
npm i ace-css@1 font-awesome@4 -S
```

Webpack config

We need to add a **webpack.config.js** at the root:

```
var path = require("path");

module.exports = {
  entry: {
    app: [
      './src/index.js'
    ]
  },

  output: {
    path: path.resolve(__dirname + '/dist'),
    filename: '[name].js',
  },

  module: {
    loaders: [
      {
        test: /\.(css|scss)$/,
        loaders: [
          'style-loader',
          'css-loader',
        ]
      },
      {
        test:    /\.html$/,
        exclude: /node_modules/,
        loader:  'file?name=[name].[ext]',
      },
      {
        test:    /\.elm$/,
        exclude: [/elm-stuff/, /node_modules/],
        loader:  'elm-webpack?verbose=true&warn=true',
      },
      {
        test: /\.woff(2)?(\?v=[0-9]\.[0-9]\.[0-9])?$/,
        loader: 'url-loader?limit=10000&mimetype=application/font-woff',
      },
      {
        test: /\.(ttf|eot|svg)(\?v=[0-9]\.[0-9]\.[0-9])?$/,
        loader: 'file-loader',
      },
    ],

    noParse: /\.elm$/,
  },

  devServer: {
    inline: true,
    stats: { colors: true },
  },

};
```

Things to note:

- This config creates a Webpack dev server, see the key `devServer`. We will be using this server for development instead of Elm reactor.
- Entry point for our application will be `./src/index.js`, see the `entry` key.

> This page covers Elm 0.18

Webpack 2

index.html

As we are not using Elm reactor anymore we will need to create our own HTML for containing the application. Create **src/index.html**:

```
<!DOCTYPE html>
<html>
  <head>
    <meta charset="utf-8" />
    <title>Elm SPA example</title>
  </head>
  <body>
    <div id="main"></div>
    <script src="/app.js"></script>
  </body>
</html>
```

index.js

This is the entry point that Webpack will look for when creating a bundle. Add **src/index.js**:

```
'use strict';

require('ace-css/css/ace.css');
require('font-awesome/css/font-awesome.css');

// Require index.html so it gets copied to dist
require('./index.html');

var Elm = require('./Main.elm');
var mountNode = document.getElementById('main');

// .embed() can take an optional second argument. This would be an object describing the data we need to start a prog
ram, i.e. a userID or some token
var app = Elm.Main.embed(mountNode);
```

Install Elm packages

Run:

```
elm package install elm-lang/html
```

Source directory

We will be adding all our source code in the `src` folder, so we need to tell Elm where to search for dependencies. In **elm-package.json** change:

```
...
"source-directories": [
    "src"
],
...
```

Without this the Elm compiler will try to find the imports in the root of our project and fail.

> This page covers Elm 0.18

Webpack 3

Initial Elm app

Create a basic Elm app. In **src/Main.elm**:

```
module Main exposing (..)

import Html exposing (Html, div, text, program)


-- MODEL


type alias Model =
    String


init : ( Model, Cmd Msg )
init =
    ( "Hello", Cmd.none )



-- MESSAGES


type Msg
    = NoOp



-- VIEW


view : Model -> Html Msg
view model =
    div []
        [ text model ]



-- UPDATE


update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        NoOp ->
            ( model, Cmd.none )



-- SUBSCRIPTIONS


subscriptions : Model -> Sub Msg
subscriptions model =
    Sub.none



-- MAIN


main : Program Never Model Msg
main =
    program
        { init = init
        , view = view
        , update = update
        , subscriptions = subscriptions
        }
```

> This page covers Elm 0.18

Webpack 4

package.json

Finally we want to add some npm scripts so we can run our servers easily. In **package.json** replace `scripts` with:

```
"scripts": {
    "api": "node api.js",
    "build": "webpack",
    "watch": "webpack --watch",
    "dev": "webpack-dev-server --port 3000"
},
```

- So now `npm run api` will run our fake server.
- `npm run build` will create a webpack build and put the bundles in `dist` .
- `npm run watch` runs the webpack watcher which puts the bundles in `dist` as we change our source code.
- `npm run dev` runs the webpack dev server.

Node Foreman

We have two servers to run for developing: the Api and the Frontend, we will need to launch both manually to test our application, this is ok but there is a nicer way.

Install Node Foreman:

```
npm install -g foreman
```

The create a file called `Procfile` in the root of the project with:

```
api: npm run api
client: npm run dev
```

This will give us a cli command called `nf` that allows to launch and kill both processed at the same time.

Test it

Let's test our setup

In a terminal window run:

```
nf start
```

If you browse to `http://localhost:3000/` you should see our application, which outputs "Hello". Use `Ctrl-c` to stop the servers.

Your application code should look like https://github.com/sporto/elm-tutorial-app/tree/02-webpack.

> This page covers Elm 0.18

Multiple modules

Our application is going to grow soon, so keeping things in one file will become hard to maintain quite fast.

Circular dependencies

Another issue we are likely to hit at some point will be circular dependencies. For example we might have:

- A `Main` module which has a `Player` type on it.
- A `View` module that imports the `Player` type declared in `Main`.
- `Main` importing `View` to render the view.

We now have a circular dependency:

```
Main --> View
View --> Main
```

How to break it?

In this case what we need to do is to move the `Player` type out of `Main`, somewhere it can be imported by both `Main` and `View`.

To deal with circular dependencies in Elm the easiest thing to do is to split your application into smaller modules. In this particular example we can create another module that can be imported by both `Main` and `View`. We will have three modules:

- Main
- View
- Models (contains the Player type)

Now the dependencies will be:

```
Main --> Models
View --> Models
```

There is no circular dependency anymore.

Try creating separate modules for things like **messages**, **models**, **commands** and **utilities**, which are modules that are usually imported by many components.

Let's break the application in smaller modules:

src/Messages.elm

```
module Messages exposing (..)


type Msg
    = NoOp
```

src/Models.elm

```
module Models exposing (..)


type alias Model =
    String
```

src/Update.elm

```
module Update exposing (..)

import Messages exposing (Msg(..))
import Models exposing (Model)


update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        NoOp ->
            ( model, Cmd.none )
```

src/View.elm

```
module View exposing (..)

import Html exposing (Html, div, text)
import Messages exposing (Msg)
import Models exposing (Model)


view : Model -> Html Msg
view model =
    div []
        [ text model ]
```

src/Main.elm

```
module Main exposing (..)

import Html exposing (Html, div, text, program)
import Messages exposing (Msg)
import Models exposing (Model)
import Update exposing (update)
import View exposing (view)


init : ( Model, Cmd Msg )
init =
    ( "Hello", Cmd.none )


subscriptions : Model -> Sub Msg
subscriptions model =
    Sub.none



-- MAIN


main : Program Never Model Msg
main =
    program
        { init = init
        , view = view
        , update = update
        , subscriptions = subscriptions
        }
```

You can find the code here https://github.com/sporto/elm-tutorial-app/tree/018-03-multiple-modules

---

There are lots of little modules now, this is overkill for a trivial application. But for a bigger application splitting it makes it easier to work with.

Resources

Up to this point your code should look like https://github.com/sporto/elm-tutorial-app/tree/018-03-multiple-modules

In this chapter we will add the first resource to our application: Players.

The Players resource

We will organise our application structure by the name of the resources in our application. In this app, we only have one resource (`Players`) so there will be only a `Players` directory.

The `Players` directory will have modules just like the main level, one module per component of the Elm architecture:

- Players/Messages.elm
- Players/Models.elm
- Players/Update.elm

However, we will have different views for players: A list and a edit view. Each view will have its own Elm module:

- Players/List.elm
- Players/Edit.elm

> This page covers Elm 0.18

Players modules

Players messages

Create **src/Players/Messages.elm**

```
module Players.Messages exposing (..)


type Msg
    = NoOp
```

Here we will put all the messages related to players.

Players Model

Create **src/Players/Models.elm**

```
module Players.Models exposing (..)


type alias PlayerId =
    String


type alias Player =
    { id : PlayerId
    , name : String
    , level : Int
    }


new : Player
new =
    { id = "0"
    , name = ""
    , level = 1
    }
```

Here we define how a player record looks. It has an id, a name and a level.

Also note the definition for `PlayerId`, it is just an alias to `String`, doing this is useful for clarity later on when we have function that takes many ids. For example:

```
addPerkToPlayer : Int -> Int -> Player
```

is much clearer when written as:

```
addPerkToPlayer : PerkId -> PlayerId -> Player
```

Players Update

Add **src/Players/Update.elm**

```
module Players.Update exposing (..)

import Players.Messages exposing (Msg(..))
import Players.Models exposing (Player)


update : Msg -> List Player -> ( List Player, Cmd Msg )
update message players =
    case message of
        NoOp ->
            ( players, Cmd.none )
```

This update doesn't do anything at the moment.

This is the basic pattern that all resources in a bigger application would follow:

```
Messages
Models
Update
Players
    Messages
    Models
    Update
Perks
    Messages
    Models
    Update
...
```

> This page covers Elm 0.18

Players List

Create **src/Players/List.elm**

```
module Players.List exposing (..)

import Html exposing (..)
import Html.Attributes exposing (class)
import Players.Messages exposing (..)
import Players.Models exposing (Player)


view : List Player -> Html Msg
view players =
    div []
        [ nav players
        , list players
        ]


nav : List Player -> Html Msg
nav players =
    div [ class "clearfix mb2 white bg-black" ]
        [ div [ class "left p2" ] [ text "Players" ] ]


list : List Player -> Html Msg
list players =
    div [ class "p2" ]
        [ table []
            [ thead []
                [ tr []
                    [ th [] [ text "Id" ]
                    , th [] [ text "Name" ]
                    , th [] [ text "Level" ]
                    , th [] [ text "Actions" ]
                    ]
                ]
            , tbody [] (List.map playerRow players)
            ]
        ]


playerRow : Player -> Html Msg
playerRow player =
    tr []
        [ td [] [ text player.id ]
        , td [] [ text player.name ]
        , td [] [ text (toString player.level) ]
        , td []
            []
        ]
```

This view shows a list of players.

> This page covers Elm 0.18

Main

The main level needs to be hooked up with the Players modules we created.

We need to create links from:

```
Main Messages  --->    Players Messages
Main Models    --->    Players Models
Main Update    --->    Players Update
```

Main Messages

Modify **src/Messages.elm** to include players messages:

```
module Messages exposing (..)

import Players.Messages


type Msg
    = PlayersMsg Players.Messages.Msg
```

Main Models

Modify **src/Models.elm** to include players:

```
module Models exposing (..)

import Players.Models exposing (Player)


type alias Model =
    { players : List Player
    }


initialModel : Model
initialModel =
    { players = [ Player "1" "Sam" 1 ]
    }
```

Here we have a hardcoded player for now.

Main Update

Change **src/Update.elm** to:

```elm
module Update exposing (..)

import Messages exposing (Msg(..))
import Models exposing (Model)
import Players.Update


update : Msg -> Model -> ( Model, Cmd Msg )
update msg model =
    case msg of
        PlayersMsg subMsg ->
            let
                ( updatedPlayers, cmd ) =
                    Players.Update.update subMsg model.players
            in
                ( { model | players = updatedPlayers }, Cmd.map PlayersMsg cmd )
```

Here we follow the Elm architecture:

- All `PlayersMsg` are routed to `Players.Update`.
- We extract the result for `Players.Update` using pattern matching
- Return the model with the updated player list and any command that needs to run.

> This page covers Elm 0.18

Main View

Modify **src/View.elm** to include the list of players:

```
module View exposing (..)

import Html exposing (Html, div, text)
import Messages exposing (Msg(..))
import Models exposing (Model)
import Players.List


view : Model -> Html Msg
view model =
    div []
        [ page model ]


page : Model -> Html Msg
page model =
    Html.map PlayersMsg (Players.List.view model.players)
```

> This page covers Elm 0.18

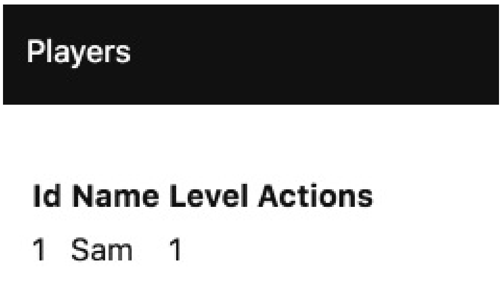
Main

Finally modify **src/Main.elm** to call `initialModel`:

```
module Main exposing (..)

import Html exposing (Html, div, text, program)
import Messages exposing (Msg)
import Models exposing (Model, initialModel)
import Update exposing (update)
import View exposing (view)


init : ( Model, Cmd Msg )
init =
    ( initialModel, Cmd.none )


subscriptions : Model -> Sub Msg
subscriptions model =
    Sub.none

-- MAIN

main : Program Never Model Msg
main =
    program
        { init = init
        , view = view
        , update = update
        , subscriptions = subscriptions
        }
```

Here we added `initialModel` in the import and `init`.

When you run the application you should see a list with one user.



Players

Id	Name	Level	Actions
1	Sam	1	

The application should look like https://github.com/sporto/elm-tutorial-app/tree/018-04-resources

Fetching resources

This chapter covers fetching the players' collection from the fake API.

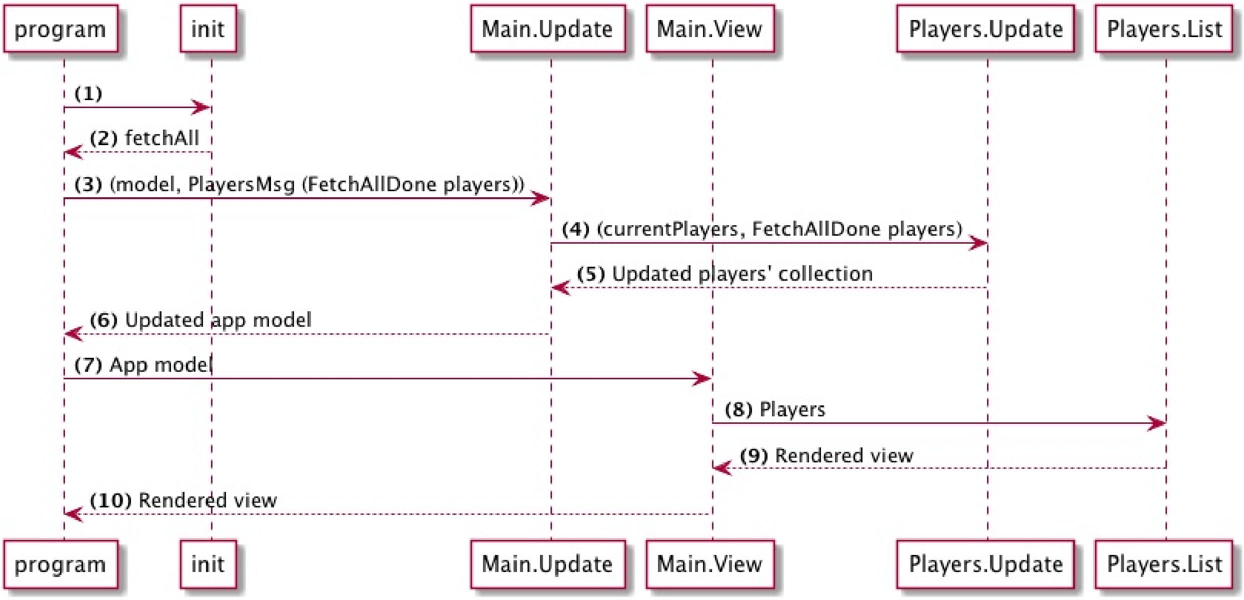
Up to this point your application code looks like https://github.com/sporto/elm-tutorial-app/tree/018-04-resources

> This page covers Elm 0.18

Plan

The next step is to fetch the list of players from the fake API we created before.

This is the plan:



(1-2) When the application loads, we trigger a command to initiate an Http request to fetch the players. This will be done in the `init` of Html.program.

(3-6) When the request is done, we trigger a `FetchAllDone` with the data, this message flows down to `Players.Update` which updates the collection of players.

(7-10) Then the application renders with the updated players' list.

Dependencies

We will need the `http` , install it using:

```
elm package install elm-lang/http
```

> This page covers Elm 0.18

Players messages

First let's create the messages we need for fetching players. Add a new import and message to **src/Players/Messages.elm**

```
module Players.Messages exposing (..)

import Http
import Players.Models exposing (PlayerId, Player)


type Msg
    = OnFetchAll (Result Http.Error (List Player))
```

`OnFetchAll` will be called when we get the response from the server. This message will carry a `Result` which can be either an `Http.Error` or the the list of fetched players.

> This page covers Elm 0.18

Players Update

When the request for players is done, we trigger the `OnFetchAll` message.

src/Players/Update.elm should account for this new message. Change `update` to:

```
...
update : Msg -> List Player -> ( List Player, Cmd Msg )
update message players =
    case message of
        OnFetchAll (Ok newPlayers) ->
            ( newPlayers, Cmd.none )

        OnFetchAll (Err error) ->
            ( players, Cmd.none )
```

When we get `OnFetchAll` we can use pattern matching to decide what to do.

- In the `Ok` case we return the fetched players in order to update the players collection.
- In the `Err` case we just return what we had before for now (A better approach would be to show an error to the user, but for simplicity of the tutorial we won't be doing this now).

> This page covers Elm 0.18

Players commands

Now we need to create the tasks and command to fetch the players from the server. Create **src/Players/Commands.elm**:

```
module Players.Commands exposing (..)

import Http
import Json.Decode as Decode exposing (field)
import Players.Models exposing (PlayerId, Player)
import Players.Messages exposing (..)


fetchAll : Cmd Msg
fetchAll =
    Http.get fetchAllUrl collectionDecoder
        |> Http.send OnFetchAll


fetchAllUrl : String
fetchAllUrl =
    "http://localhost:4000/players"


collectionDecoder : Decode.Decoder (List Player)
collectionDecoder =
    Decode.list memberDecoder


memberDecoder : Decode.Decoder Player
memberDecoder =
    Decode.map3 Player
        (field "id" Decode.string)
        (field "name" Decode.string)
        (field "level" Decode.int)
```

Let's go through this code.

```
fetchAll : Cmd Msg
fetchAll =
    Http.get fetchAllUrl collectionDecoder
        |> Http.send OnFetchAll
```

Here we create a command for our application to run.

- `Http.get` creates a `Request`
- We then send this request to `Http.send` which wraps it in a command

```
collectionDecoder : Decode.Decoder (List Player)
collectionDecoder =
    Decode.list memberDecoder
```

This decoder delegates the decoding of each member of a list to `memberDecoder`

```
memberDecoder : Decode.Decoder Player
memberDecoder =
    Decode.map3 Player
        (field "id" Decode.string)
        (field "name" Decode.string)
        (field "level" Decode.int)
```

`memberDecoder` creates a JSON decoder that returns a `Player` record.

To understand how the decoder works let's play with the Elm repl.

In a terminal run `elm repl`. Import the Json.Decoder module:

```
> import Json.Decode exposing (..)
```

Then define a Json string:

```
> json = "{\"id\":99, \"name\":\"Sam\"}"
```

And define a decoder to extract the `id`:

```
> idDecoder = (field "id" int)
```

This creates a decoder that given a string tries to extract the `id` key and parse it into a integer.

Run this decoder to see the result:

```
> result = decodeString idDecoder  json
Ok 99 : Result.Result String Int
```

We see `Ok 99` meaning that decoding was successful and we got 99. So this is what `(field "id" Decode.int)` does, it creates a decoder for a single key.

This is one part of the equation. Now for the second part, define a type:

```
> type alias Player = { id: Int, name: String }
```

In Elm you can create a record calling a type as a function. For example, `Player 1 "Sam"` creates a player record. Note that the order of parameters is significant like any other function.

Try it:

```
> Player 1 "Sam"
{ id = 1, name = "Sam" } : Repl.Player
```

With these two concepts let's create a complete decoder:

```
> nameDecoder = (field "name" string)
> playerDecoder = map2 Player idDecoder nameDecoder
```

`map2` takes a function as first argument (Player in this case) and two decoders. Then it runs the decoders and passes the results as the arguments to the function (Player).

Try it:

```
> result = decodeString playerDecoder json
Ok { id = 99, name = "Sam" } : Result.Result String Repl.Player
```

Remember that none of this actually executes until we send the command to **program**.

> This page covers Elm 0.18

Main

Main Model

Remove the hardcoded list of players in **src/Models.elm**

```
initialModel : Model
initialModel =
    { players = []
    }
```

Main

Finally, we want to run the `fetchAll` when starting the application.

Update **src/Main.elm**:

```
...
import Messages exposing (Msg(..))
...
import Players.Commands exposing (fetchAll)

init : ( Model, Cmd Msg )
init =
    ( initialModel, Cmd.map PlayersMsg fetchAll )
```

Now `init` returns a list of commands to run when the application starts.

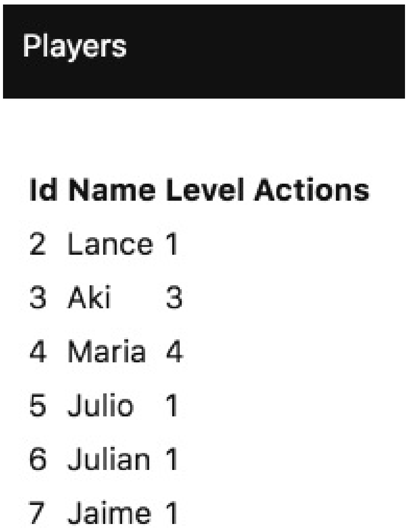
> This page covers Elm 0.18

Try it

Try it! Run the app in one terminal using:

```
nf start
```

Refresh the browser, our application should now fetch the list of players from the server. The app should look like:



Players

Id	Name	Level	Actions
2	Lance	1	
3	Aki	3	
4	Maria	4	
5	Julio	1	
6	Julian	1	
7	Jaime	1	

Your application code should look at this stage like https://github.com/sporto/elm-tutorial-app/tree/018-05-fetch.

Routing

This chapter covers adding routing to our application.

Up to this point the application code looks like https://github.com/sporto/elm-tutorial-app/tree/05-fetch

> This page covers Elm 0.18

Routing introduction

Let's add a routing to our application. We will be using the Elm Navigation package and UrlParser.

- Navigation provides the means to change the browser location and respond to changes
- UrlParser provides route matchers

First install the packages:

```
elm package install elm-lang/navigation
elm package install evancz/url-parser
```

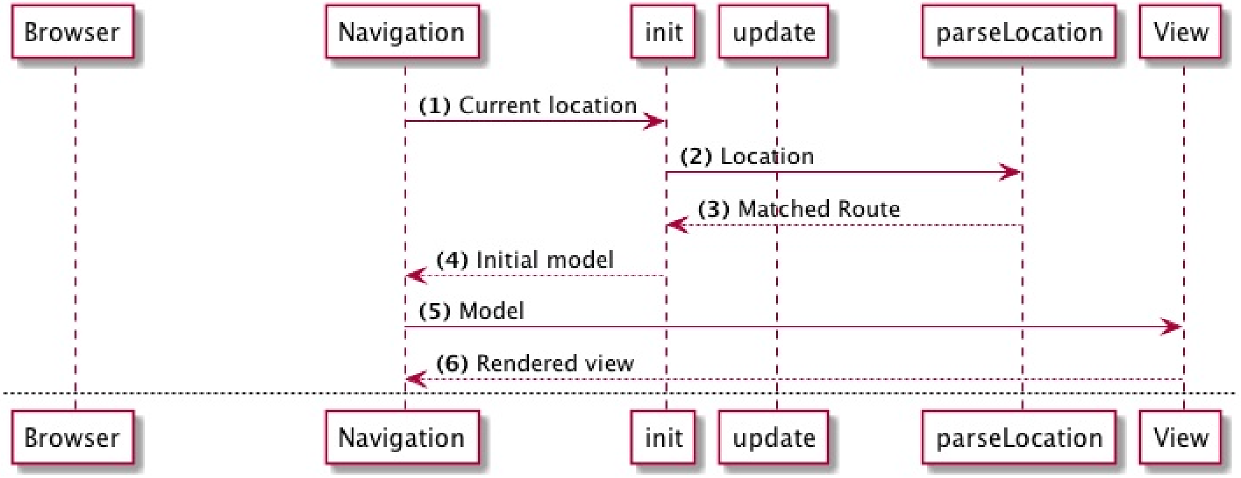
`Navigation` is a library that wraps `Html.program`. It has all the functionality of `Html.program` plus some extra things:

- Listens for location changes on the browser
- Triggers a message when the location changes
- Provides ways of changing the browser location

Flow

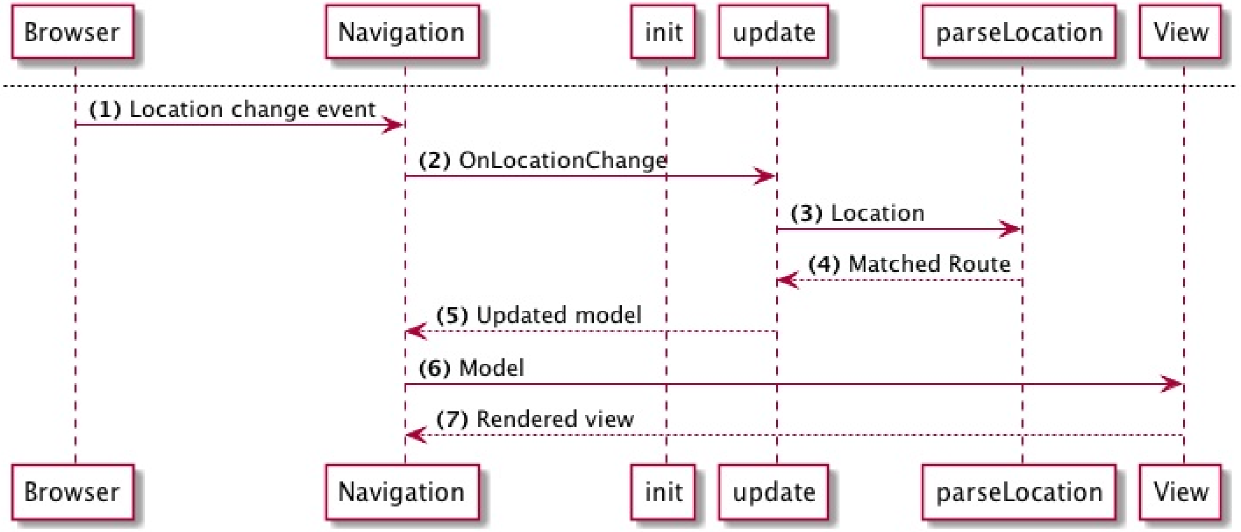
Here are a couple of diagrams to understand how routing will work.

Initial render



- (1) When the page first loads the `Navigation` module will fetch the current `Location` and send it to the application `init` function.
- (2) In `init` we parse this location and get a matching `Route`.
- (3, 4) We then store this matched `Route` in our initial model and return this model to `Navigation`.
- (5, 6) `Navigation` then renders the view by sending this initial model.

When the location changes



- (1) When the browser location changes the Navigation library receives an event
- (2) A `OnLocationChange` message is sent to our `update` function. This message will contain the new `Location` .
- (3, 4) In `update` we parse the `Location` and return the matching `Route` .
- (5) From `update` we return the updated model which contains the update `Route` .
- (6, 7) Navigation then renders the application as normal

> This page covers Elm 0.18

Routing

Create a module **src/Routing.elm** for defining the application routing configuration.

In this module we define:

- the routes for our application
- how to match browser paths to routes using path matchers
- how to react to routing messages

In **src/Routing.elm**:

```
module Routing exposing (..)

import Navigation exposing (Location)
import Players.Models exposing (PlayerId)
import UrlParser exposing (..)


type Route
    = PlayersRoute
    | PlayerRoute PlayerId
    | NotFoundRoute


matchers : Parser (Route -> a) a
matchers =
    oneOf
        [ map PlayersRoute top
        , map PlayerRoute (s "players" </> string)
        , map PlayersRoute (s "players")
        ]


parseLocation : Location -> Route
parseLocation location =
    case (parseHash matchers location) of
        Just route ->
            route

        Nothing ->
            NotFoundRoute
```

Let's go over this module.

Routes

```
type Route
    = PlayersRoute
    | PlayerRoute PlayerId
    | NotFoundRoute
```

These are the available routes in our application. `NotFoundRoute` will be used when no route matches the browser path.

Matchers

```
matchers : Parser (Route -> a) a
matchers =
    oneOf
        [ map PlayersRoute top
        , map PlayerRoute (s "players" </> string)
        , map PlayersRoute (s "players")
        ]
```

Here we define route matchers. These parsers are provided by the url-parser library.

We want three matchers:

- One for the top route which will resolve to `PlayersRoute`
- One for `/players` which will resolve to `PlayersRoute` as well
- And one for `/players/id` which will resolve to `PlayerRoute id`

Note that the order is important.

See more details about this library here http://package.elm-lang.org/packages/evancz/url-parser.

parseLocation

```
parseLocation : Location -> Route
parseLocation location =
    case (parseHash matchers location) of
        Just route ->
            route

        Nothing ->
            NotFoundRoute
```

Each time the browser location changes, the Navigation library will trigger a message containing a `Navigation.Location` record. From our main `update` we will call `parseLocation` with this record.

`parseLocation` is a function that parses this `Location` record and returns the matched `Route` if possible. If all matchers fail we return `NotFoundRoute` .

In this case we `UrlParser.parseHash` as we will be routing using the hash. You could use `UrlParser.parsePath` to route with the path instead.

> This page covers Elm 0.18

Player edit view

We need a new view to show when hitting `/players/3`.

Create **src/Players/Edit.elm**:

```elm
module Players.Edit exposing (..)

import Html exposing (..)
import Html.Attributes exposing (class, value, href)
import Players.Messages exposing (..)
import Players.Models exposing (..)


view : Player -> Html Msg
view model =
    div []
        [ nav model
        , form model
        ]


nav : Player -> Html Msg
nav model =
    div [ class "clearfix mb2 white bg-black p1" ]
        []


form : Player -> Html Msg
form player =
    div [ class "m3" ]
        [ h1 [] [ text player.name ]
        , formLevel player
        ]


formLevel : Player -> Html Msg
formLevel player =
    div
        [ class "clearfix py1"
        ]
        [ div [ class "col col-5" ] [ text "Level" ]
        , div [ class "col col-7" ]
            [ span [ class "h2 bold" ] [ text (toString player.level) ]
            , btnLevelDecrease player
            , btnLevelIncrease player
            ]
        ]


btnLevelDecrease : Player -> Html Msg
btnLevelDecrease player =
    a [ class "btn ml1 h1" ]
        [ i [ class "fa fa-minus-circle" ] [] ]


btnLevelIncrease : Player -> Html Msg
btnLevelIncrease player =
    a [ class "btn ml1 h1" ]
        [ i [ class "fa fa-plus-circle" ] [] ]
```

This view shows a form with the player's level. At the moment we have some dummy buttons that will be implemented later e.g. `btnLevelIncrease`.

> This page covers Elm 0.18

Main model

In our main application model we want to store the current route. Change **src/Models.elm** to:

```
module Models exposing (..)

import Players.Models exposing (Player)
import Routing


type alias Model =
    { players : List Player
    , route : Routing.Route
    }


initialModel : Routing.Route -> Model
initialModel route =
    { players = []
    , route = route
    }
```

Here we:

- added `route` to the model
- changed `initialModel` so it takes a `route`

> This page covers Elm 0.18

Main messages

When the browser location changes we will trigger a new message.

Change **src/Messages.elm** to:

```
module Messages exposing (..)

import Navigation exposing (Location)
import Players.Messages


type Msg
    = PlayersMsg Players.Messages.Msg
    | OnLocationChange Location
```

- We are now importing `Navigation`
- And we added a `OnLocationChange Location` message

> This page covers Elm 0.18

Main update

We need our main `update` function to respond to the new `OnLocationChange` message.

In **src/Update.elm** add a new branch:

```
...
import Routing exposing (parseLocation)

...

update msg model =
    case msg of
        ...
        OnLocationChange location ->
            let
                newRoute =
                    parseLocation location
            in
                ( { model | route = newRoute }, Cmd.none )
```

Here when we receive the `OnLocationChange` message, we parse this location and store the matched route in the model.

> This page covers Elm 0.18

Main view

Our main application view needs to show different pages as we change the browser location.

Change **src/View.elm** to:

```
module View exposing (..)

import Html exposing (Html, div, text)
import Messages exposing (Msg(..))
import Models exposing (Model)
import Players.Edit
import Players.List
import Players.Models exposing (PlayerId)
import Routing exposing (Route(..))


view : Model -> Html Msg
view model =
    div []
        [ page model ]


page : Model -> Html Msg
page model =
    case model.route of
        PlayersRoute ->
            Html.map PlayersMsg (Players.List.view model.players)

        PlayerRoute id ->
            playerEditPage model id

        NotFoundRoute ->
            notFoundView


playerEditPage : Model -> PlayerId -> Html Msg
playerEditPage model playerId =
    let
        maybePlayer =
            model.players
                |> List.filter (\player -> player.id == playerId)
                |> List.head
    in
        case maybePlayer of
            Just player ->
                Html.map PlayersMsg (Players.Edit.view player)

            Nothing ->
                notFoundView


notFoundView : Html msg
notFoundView =
    div []
        [ text "Not found"
        ]
```

Showing the correct view

```
page : Model -> Html Msg
page model =
    case model.route of
        PlayersRoute ->
            Html.map PlayersMsg (Players.List.view model.players)

        PlayerRoute id ->
            playerEditPage model id

        NotFoundRoute ->
            notFoundView
```

Now we have a function `page` which has a case expression to show the correct view depending on what is in `model.route`.

When the player edit route matches (e.g. `#players/2`) we will get the player id from the route i.e. `PlayerRoute playerId`.

Finding the player

```
playerEditPage : Model -> PlayerId -> Html Msg
playerEditPage model playerId =
    let
        maybePlayer =
            model.players
                |> List.filter (\player -> player.id == playerId)
                |> List.head
    in
        case maybePlayer of
            Just player ->
                Html.map PlayersMsg (Players.Edit.view player)

            Nothing ->
                notFoundView
```

We have the `playerId`, but we might not have the actual player record for that id. We filter the players' list by that id and have a case expression that show the correct view depending if the player is found or not.

notFoundView

`notFoundView` is shown when no route matches. Note the type `Html msg` instead of `Html Msg`. This is because this view doesn't produce any messages so can use a generic type variable `msg` instead of and specific type `Msg`.

> This page covers Elm 0.18

Main

Finally we need to wire everything in the Main module.

Change **src/Main.elm** to:

```
module Main exposing (..)

import Messages exposing (Msg(..))
import Models exposing (Model, initialModel)
import Navigation exposing (Location)
import Players.Commands exposing (fetchAll)
import Routing exposing (Route)
import Update exposing (update)
import View exposing (view)


init : Location -> ( Model, Cmd Msg )
init location =
    let
        currentRoute =
            Routing.parseLocation location
    in
        ( initialModel currentRoute, Cmd.map PlayersMsg fetchAll )


subscriptions : Model -> Sub Msg
subscriptions model =
    Sub.none


main : Program Never Model Msg
main =
    Navigation.program OnLocationChange
        { init = init
        , view = view
        , update = update
        , subscriptions = subscriptions
        }
```

New imports

We added imports for `Navigation` and `Routing`.

Init

```
init : Location -> ( Model, Cmd Msg )
init location =
    let
        currentRoute =
            Routing.parseLocation location
    in
        ( initialModel currentRoute, Cmd.map PlayersMsg fetchAll )
```

Our init function will now take an initial `Location` from the `Navigation`. We parse this `Location` using the `parseLocation` function we created before. Then we store this initial **route** in our model.

main

`main` now uses `Navigation.program` instead of `Html.program`. `Navigation.program` wraps `Html.program` but also triggers a message when the browser location changes. In our case this message will be `OnLocationChange`.

Try it

Let's try what we have so far. Run the application by doing:

```
nf start
```

Then go to `http://localhost:3000` in your browser. You should see the list of users.

If you go to `http://localhost:3000/#players/2` then you should see one user.

Next we will add some navigation.

Up to this point your application code should look https://github.com/sporto/elm-tutorial-app/tree/018-06-routing.

> This page covers Elm 0.18

Navigation

Next let's add buttons to navigate between views.

EditPlayer message

Change **src/Players/Messages.elm** to include two new actions:

```
...

type Msg
    = OnFetchAll (Result Http.Error (List Player))
    | ShowPlayers
    | ShowPlayer PlayerId
```

We added `ShowPlayers` and `ShowPlayer`.

Players List

The players' list needs to show a button for each player to trigger the `ShowPlayer` message.

In **src/Players/List.elm**. First add `Html.Events`:

```
import Html.Events exposing (onClick)
```

Add a new function for this button at the end:

```
editBtn : Player -> Html Msg
editBtn player =
    button
        [ class "btn regular"
        , onClick (ShowPlayer player.id)
        ]
        [ i [ class "fa fa-pencil mr1" ] [], text "Edit" ]
```

Here we trigger `ShowPlayer` with the id of the player that we want to edit.

And change `playerRow` to include this button:

```
playerRow : Player -> Html Msg
playerRow player =
    tr []
        [ td [] [ text (toString player.id) ]
        , td [] [ text player.name ]
        , td [] [ text (toString player.level) ]
        , td []
            [ editBtn player ]
        ]
```

Player Edit

Let's add the navigation button to the edit view. In **/src/Players/Edit.elm**:

Add one more import:

```
import Html.Events exposing (onClick)
```

Add a new function at the end for the list button:

```
listBtn : Html Msg
listBtn =
    button
        [ class "btn regular"
        , onClick ShowPlayers
        ]
        [ i [ class "fa fa-chevron-left mr1" ] [], text "List" ]
```

Here we send the `ShowPlayers` when the button is clicked.

And add this button to the list, change the `nav` function to:

```
nav : Player -> Html Msg
nav model =
    div [ class "clearfix mb2 white bg-black p1" ]
        [ listBtn ]
```

Players Update

Finally, **src/Players/Update.elm** needs to respond to the new messages.

```
import Navigation
```

And add two new branches to the case expression:

```
update : Msg -> List Player -> ( List Player, Cmd Msg )
update message players =
    case message of
        ...

        ShowPlayers ->
            ( players, Navigation.newUrl "#players" )

        ShowPlayer id ->
            ( players, Navigation.newUrl ("#players/" ++ id) )
```

`Navigation.newUrl` returns a command. When this command is run by Elm the location of the browser will change.

Test it

Go to the list `http://localhost:3000/#players` . You should now see an Edit button, upon clicking it the location should change to the edit view.

Up to this point your application code should look https://github.com/sporto/elm-tutorial-app/tree/018-07-navigation.

Edit

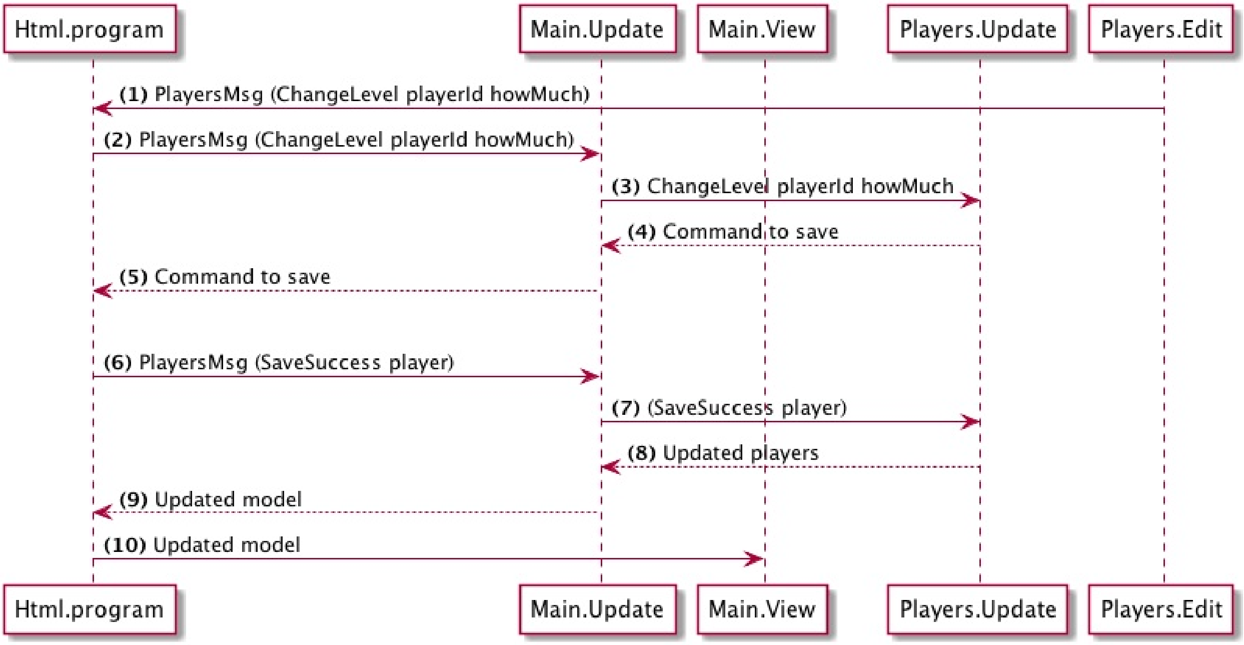
In this last chapter of the tutorial we will edit a player's level and save it to the backend.

Up to this point your application code should look like https://github.com/sporto/elm-tutorial-app/tree/07-navigation.

> This page covers Elm 0.18

Plan

The plan for changing a player's level is as follows:



(1) When the user clicks the increase or decrease button we trigger a message `ChangeLevel` with the `playerId` and `howMuch` as payload.

(2) **Html.program** (which Navigation wraps) will send this message back to `Main.Update` which will route it to `Players.Update` (3).

(4) `Players.Update` will return a command to save the player, this command flows up to **Html.program** (5).

(6) The Elm runtime executes the command (trigger an API call) and we will get a result back, either a succesful save or a failure. In the success case we trigger a `SaveSuccess` message with the updated player as payload.

(7) `Main.Update` routes the `SaveSuccess` message to `Players.Update` .

(8) In `Players.Update` we update the `players` model and return it. This flows back to Html.program (9).

(10) Then Html.program will render the application with the updated model.

> This page covers Elm 0.18

Messages

Let's start by adding the messages we will need.

In **src/Players/Messages.elm** add:

```
type Msg
    ...
    | ChangeLevel PlayerId Int
    | OnSave (Result Http.Error Player)
```

- `ChangeLevel` will trigger when the user wants to change the level. The second parameter is an integer that indicates how much to change the level e.g. -1 to decrease or 1 to increase.
- Then we will send a request to update the player to the API. `OnSave` will be triggered after the response from the API is received.
- `OnSave` will either carry the updated player on success or the Http error on failure.

> This page covers Elm 0.18

Player edit view

We created a `ChangeLevel` message. Let's trigger this message from the player's edit view.

In **src/Players/Edit.elm** change `btnLevelDecrease` and `btnLevelIncrease` :

```
...
btnLevelDecrease : Player -> Html Msg
btnLevelDecrease player =
    a [ class "btn ml1 h1", onClick (ChangeLevel player.id -1) ]
        [ i [ class "fa fa-minus-circle" ] [] ]


btnLevelIncrease : Player -> Html Msg
btnLevelIncrease player =
    a [ class "btn ml1 h1", onClick (ChangeLevel player.id 1) ]
        [ i [ class "fa fa-plus-circle" ] [] ]
```

In these two buttons we added `onClick (ChangeLevel player.id howMuch)` . Where `howMuch` is `-1` to decrease level and `1` to increase it.

> This page covers Elm 0.18

Players Commands

Next let's create the command to updated the player through our API.

In **src/Players/Commands.elm** add:

```
import Json.Encode as Encode

...

saveUrl : PlayerId -> String
saveUrl playerId =
    "http://localhost:4000/players/" ++ playerId


saveRequest : Player -> Http.Request Player
saveRequest player =
    Http.request
        { body = memberEncoded player |> Http.jsonBody
        , expect = Http.expectJson memberDecoder
        , headers = []
        , method = "PATCH"
        , timeout = Nothing
        , url = saveUrl player.id
        , withCredentials = False
        }


save : Player -> Cmd Msg
save player =
    saveRequest player
        |> Http.send OnSave


memberEncoded : Player -> Encode.Value
memberEncoded player =
    let
        list =
            [ ( "id", Encode.string player.id )
            , ( "name", Encode.string player.name )
            , ( "level", Encode.int player.level )
            ]
    in
        list
            |> Encode.object
```

Save request

```
saveRequest : Player -> Http.Request Player
saveRequest player =
    Http.request
        { body = memberEncoded player |> Http.jsonBody ❶
        , expect = Http.expectJson memberDecoder ❷
        , headers = []
        , method = "PATCH" ❸
        , timeout = Nothing
        , url = saveUrl player.id
        , withCredentials = False
        }
```

❶ Here we encode the given player and then convert the encoded value to a JSON string ❷ Here we specify how to parse the response, in this case we want to parse the returned JSON back into and Elm value. ❸ `PATCH` is the http method that our API expects when updating records.

Save

```
save : Player -> Cmd Msg
save player =
    saveRequest player ❶
        |> Http.send OnSave ❷
```

Here we create the save request ❶ and then generate a command to send the request using `Http.send` ❷. `Http.send` takes a message constructor (`OnSave` in this case). After the request is done, Elm will trigger the `OnSave` message with the response for the request.

> This page covers Elm 0.18

Players Update

Finally we need to account for the new messages in our `update` function. In **src/Players/Update.elm**:

Add a new import:

```
import Players.Models exposing (Player, PlayerId)
import Players.Commands exposing (save)
```

Create update commands

Add a helper function for creating commands for saving a player to the API.

```
changeLevelCommands : PlayerId -> Int -> List Player -> List (Cmd Msg)
changeLevelCommands playerId howMuch players =
    let
        cmdForPlayer existingPlayer =
            if existingPlayer.id == playerId then
                save { existingPlayer | level = existingPlayer.level + howMuch }
            else
                Cmd.none
    in
        List.map cmdForPlayer players
```

This function will be called when we receive the `ChangeLevel` message. This function:

- Receives the player id and the level difference to increase / decrease
- Receives a list of existing players
- Maps through each of the players on the list comparing its id with the id of the player we want to change
- If the id is the one we want then we return a command to change the level of that player
- And finally returns a list of commands to execute

Update the players

Add another helper function for updating a player when we receive the response from the server:

```
updatePlayer : Player -> List Player -> List Player
updatePlayer updatedPlayer players =
    let
        select existingPlayer =
            if existingPlayer.id == updatedPlayer.id then
                updatedPlayer
            else
                existingPlayer
    in
        List.map select players
```

This function will be used when we receive an updated player from the API via `SaveSuccess`. This function:

- Takes the updated player and a list of existing players
- Maps through each of the players comparing their ids with the updated player
- If the ids are the same then we return the updated player, otherwise we return the existing player

Add branches to update

Add new branches to the `update` function:

```
update message players =
    case message of
        ...

        ChangeLevel id howMuch ->
            ( players, changeLevelCommands id howMuch players |> Cmd.batch )

        OnSave (Ok updatedPlayer) ->
            ( updatePlayer updatedPlayer players, Cmd.none )

        OnSave (Err error) ->
            ( players, Cmd.none )
```

- In `ChangeLevel` we call the helper function `changeLevelCommands` we defined above. That function return a list of commands to run, so we then batch them into one command using `Cmd.batch`.
- In `OnSave (Ok updatedPlayer)` we call the helper function `updatePlayer` which will update the relevant player from the list.

Try it

This is all the setup necessary for changing a player's level. Try it, go to the edit view and click the - and + buttons. You should see the level changing and if you refresh your browser that change should be persisted on the server.

Up to this point your application code should look https://github.com/sporto/elm-tutorial-app/tree/018-08-edit.

Conclusion

This concludes this tutorial but keep reading for some ideas on improvements and features.

I would like to hear your feedback to improve this tutorial. Please open issues at https://github.com/sporto/elm-tutorial.

Thanks!

Improvements

Here is a list of possible improvement you can try on this app.

Create and delete players

I have left this off in order to keep the tutorial short, definitely an important feature.

Change the name of a player

Show an error message when an Http request fails

At the moment if fetching or saving players fail we do nothing. It would be nice to show an error message to the user.

Even better error messages

Even better than just showing error messages it would be great to:

- Show different types of flash messages e.g. error and info
- Show several flash messages at the same time
- Have the ability to dismiss a message
- Remove a message automatically after a few seconds

Optimistic updates

At the moment all update functions are pesimistic. Meaning that they don't change the models until there is a succesful response from the server. One big improvement to the application would be to add optimistic creation, update and deletion. But this will also mean better error handling.

Validations

We should avoid having players without name. One nice feature would be to have a validation on the player's name so it cannot be empty.

Add perks and bonuses

We can add a list of perks that a player can have. These perk would be equipment, apparel, scrolls, accessories, etc. e.g. "Steel sword" would be one. Then we would have associations between players and perks.

Each perk would have a bonus associated with it. Then players will have a calculated strength that is their level plus all the bonuses they have.

For a more featured version of this application see the master branch of https://github.com/sporto/elm-tutorial-app.

Contexts

Typical `update` or `view` functions look like:

```
view : Model -> Html Msg
view model =
  ...
```

Or

```
update : Msg -> Model -> (Model, Cmd Msg)
update message model =
  ...
```

It is very easy to get stuck in thinking that you need to pass only the `Model` that belongs to this component. Sometimes you need extra information and is perfectly fine to ask for it. For example:

```
type alias Context =
  { model : Model
  , time : Time
  }

view : Context -> Html Msg
view context =
  ...
```

This function asks for the component model plus a `time` which is defined in its parent's model.

Point free style

Point free is a style of writing a function where you omit one or more arguments in the body. To understand this let's see an example.

Here we have a function that adds 10 to a number:

```
add10 : Int -> Int
add10 x =
    10 + x
```

We can rewrite this using the `+` using a prefix notation:

```
add10 : Int -> Int
add10 x =
    (+) 10 x
```

The argument `x` in this case is not strictly necessary, we could rewrite this as:

```
add10 : Int -> Int
add10 =
    (+) 10
```

Note how `x` is missing as both an input argument to `add10` and argument to `+`. `add10` is still a function that requires and integer to calculate a result. Omitting arguments like this is called **point free style**.

Some more examples

```
select : Int -> List Int -> List Int
select num list =
    List.filter (\x -> x < num) list

select 4 [1, 2, 3, 4, 5] == [1, 2, 3]
```

is the same as:

```
select : Int -> List Int -> List Int
select num =
    List.filter (\x -> x < num)

select 4 [1, 2, 3, 4, 5] == [1, 2, 3]
```

```
process : List Int -> List Int
process list =
    reverse list |> drop 3
```

is the same as:

```
process : List Int -> List Int
process =
    reverse >> drop 3
```

Troubleshooting

If you find some weird compiler behaviour during development try deleting `elm-stuff/build-artifacts` and compiling again, this usually fixes several issues.