4ummary

Legend

- Yellow coloured words or sentences are key words;
- Green coloured words are jargon terms;
- Blue coloured words are copy and paste and is unknown what it means;
- Red coloured words may be wrong *.
- Function composition is saying that a part of the lecture has not be made a summary of, as it isn't yet understood.

* everything may be wrong… XD?

Lesson 1

Theory

The computational model is essentially based on types (primitives (int, float, string)) and functions. The basic on

```
        f : a -> b
```
F is the name of the function, a is the input type and the return value.

```
        let incr = Fun<number,number>(x => x + 1)
```
The function above should be read as:

```
        Let name = Fun<input,output>(body)
```

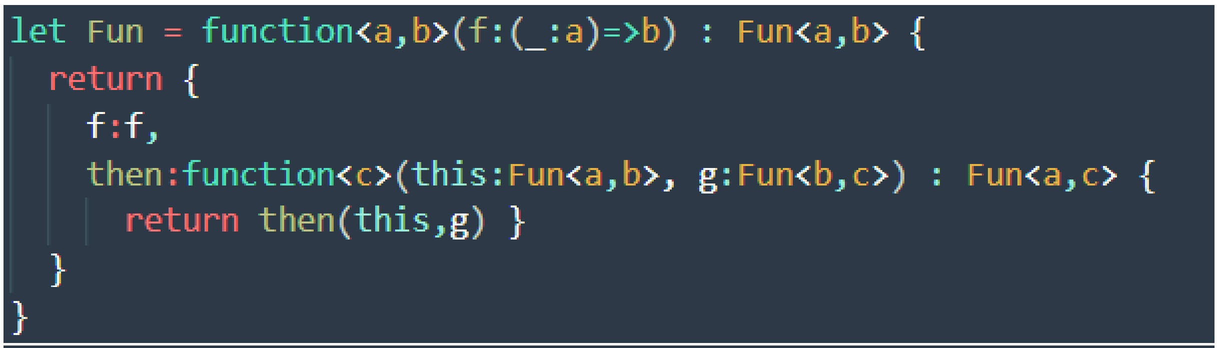
Primitive types can be combined (or used) to get a new outcome. I.e. 5 + 2 = 10.

Function composition is combing two functions together. I.e. function F and G could be combined. This is often done by creating a new function which feeds its input to F and gives the output of F to G. The output of G becomes the output of the new function that combined the two. Note: that the functions do need to be compatible. Input variable for the function will be ‘a’ and will be given to fun ‘f’ which output ‘b’. Fun ‘g’ will take the outcome of fun ‘f’ which is ‘b’ and will produce ‘c’.

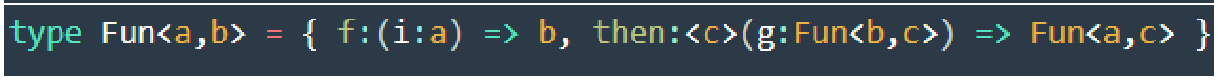
Identity function takes an input a give it back right away.

Referential transparency is to ensure that a function works on every value. I.e. doesn’t matter if a 4 or 5 is given the function will work. If a function has a counter that only runs after the function is called 1000 times, then the function is not referential transparent as conditions depend the outcome of the test.

Code



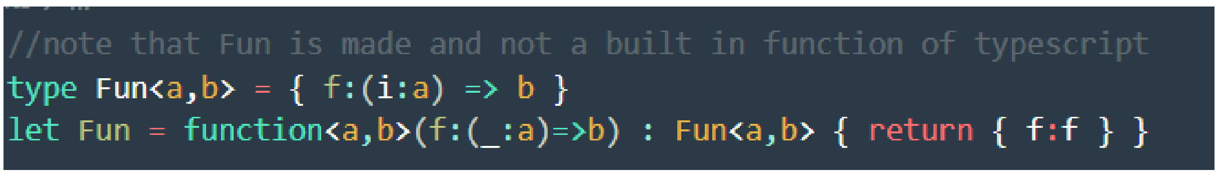
```
let Fun = function<a,b>(f:(_:a)=>b) : Fun<a,b> {
  return {
    f:f,
    then:function<c>(this:Fun<a,b>, g:Fun<b,c>) : Fun<a,c> {
      return then(this,g) }
  }
}
```



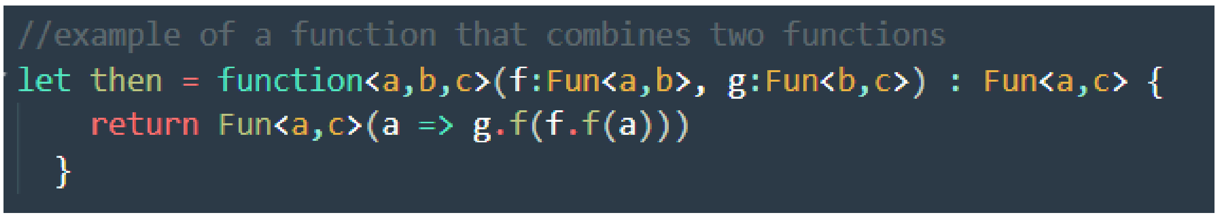
```
type Fun<a,b> = { f:(i:a) => b, then:<c>(g:Fun<b,c>) => Fun<a,c> }
```

F:f is saying methode name is f (as it must according to the type (interface) is equal/containing parameter f (that is the body or the function that will be executed).

Simple version of ‘Fun’ (without then):

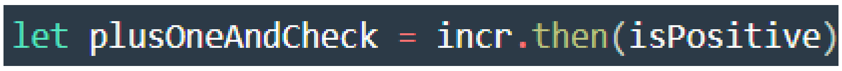


```
//note that Fun is made and not a built in function of typescript
type Fun<a,b> = { f:(i:a) => b }
let Fun = function<a,b>(f:(_:a)=>b) : Fun<a,b> { return { f:f } }
```



```
//example of a function that combines two functions
let then = function<a,b,c>(f:Fun<a,b>, g:Fun<b,c>) : Fun<a,c> {
    return Fun<a,c>(a => g.f(f.f(a)))
}
```

Variable ‘a’ (i.e. 5) is given and run through fun ‘f’ that returns ‘b’ (may be the same type or different). ‘b’ is given and run through g that will return type ‘c’.



```
let plusOneAndCheck = incr.then(isPositive)
```

Then functions return a ‘Fun’, hence doesn’t have to receive A (variable) and not be executed.

Questions/observation

- Can I see ‘type’ like a kind of an interface?
- The return type ‘b’ just gets randomly generated?

Lesson 2

Lesson

This lecture is about structure preserving transformation.

In statically typed programming like TypeScript ensures that nothing else exists outside the given data types, hence data type structed the application.

A container is a strictly defined predetermined structure that cannot be altered. There are containers with a generic structure which the type of a value (i.e. number or string) isn't yet defined.

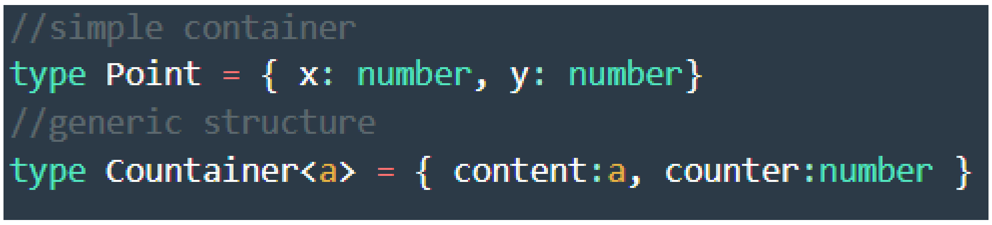
Transforming containers can transform a value of a container. If a container has a value named A (generic in this example) and another value named B, then chancing the value A into another value will mean creating a new container. Important is to keep the other data, meaning keeping the value named B. I.e. container a with values content: 'A' and counter: 3 will become a container containing: content: False and counter: 3. Often this is called a map container.

Composition of functors is creating something new that is based entirely on the two original functors.

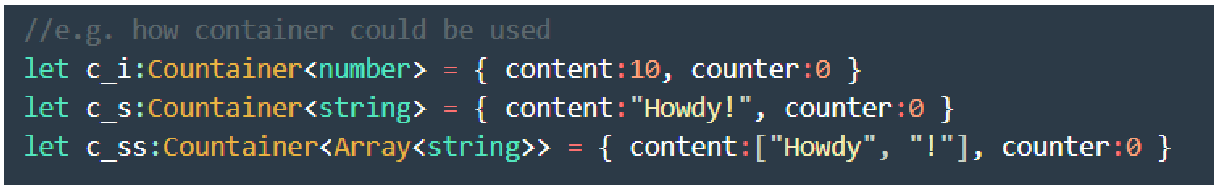
Pipeline is using the 'then' function.

Generalization, distribution, indenity and other aspects are not (yet) covered within this document.

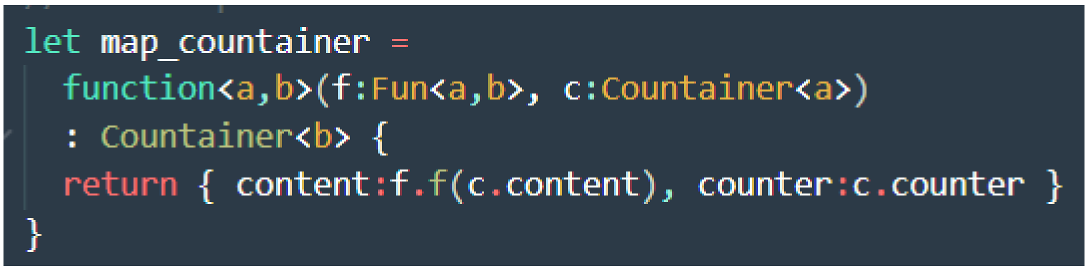
Code



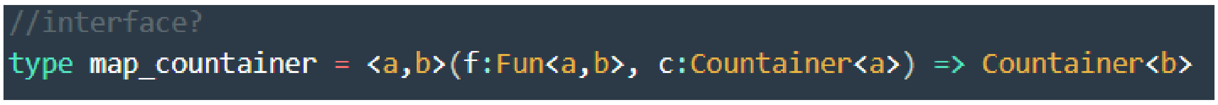
```
//simple container
type Point = { x: number, y: number}
//generic structure
type Countainer<a> = { content:a, counter:number }
```



```
//e.g. how container could be used
let c_i:Countainer<number> = { content:10, counter:0 }
let c_s:Countainer<string> = { content:"Howdy!", counter:0 }
let c_ss:Countainer<Array<string>> = { content:["Howdy", "!"], counter:0 }
```



```
let map_countainer =
  function<a,b>(f:Fun<a,b>, c:Countainer<a>)
  : Countainer<b> {
  return { content:f.f(c.content), counter:c.counter }
}
```



```
//interface?
type map_countainer = <a,b>(f:Fun<a,b>, c:Countainer<a>) => Countainer<b>
```

Questions/observation

- Don’t understand the code *map_f* and *identity*? Unable to get it to work.
-

Lesson 3

Lesson

Datatypes support some operations, as example number support the “+” which allows the following result: a + b = c. Also, arrays of ‘arbitrary’ types support this. Generalization to apply operations on datatypes is called: monoid. I.e. a <+> (b <+> c) = (a <+> b) <+> c.

Monoids

Code

```
type Id<a> = a
let map_Id = function<a,b>(f:Fun<a,b>) : Fun<Id<a>, Id<b>> { return f }
```

Questions/observation

- Functors are simply functions?
- What is the “concat” operation?
- Monoid definition code is unknown how to implement it?

Lesson 4

Lesson

Functors can have a monoidal structure meaning having unit and join functions.

The benefits of monads are:

- exception handling;
- list comprehensions;
- state management;
- concurrency;
- backtracking ("classic AI").

Some operators of monads are bind and Kleisli. When the when the return value is encapsulated in an instance of a monad, is also known as Kleisli composition.

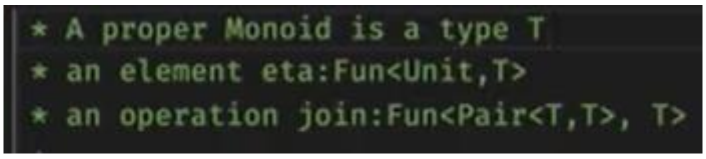
GrandeOmega says about bind:

> The attentive reader might have noticed that this pattern is very common, in this very same format, in the JavaScript world: `Promise`, the fundamental data structure used to perform remote calls, has a `then` method which is used exactly as we just described. The only minor difference is that instead of `unit`, we would then use `Promise.resolve`, which has the very same meaning but another name.
>
> The bind operator allows us to merge together (the "content") of a monad to a function which turns that content into another monad. The result of this merging operation is a monad itself.

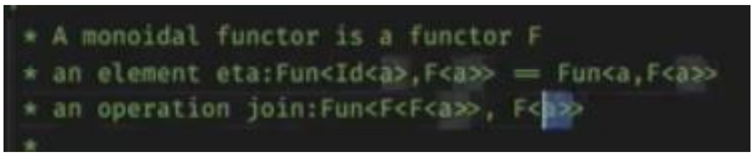
Pair function of monads are like containers.

Notes from video:

Monad is in domain of simple things. I.e. is type T (i.e. number) – 1+1 =2.



```
* A proper Monoid is a type T
* an element eta:Fun<Unit,T>
* an operation join:Fun<Pair<T,T>, T>
```



```
* A monoidal functor is a functor F
* an element eta:Fun<Id<a>,F<a>> = Fun<a,F<a>>
* an operation join:Fun<F<F<a>>, F<a>>
*
```

Code

…

Questions/observation

- What is pair function in nomads?

Lesson 5

Lesson

...

Code

...

Questions/observation

...

Lesson 6

Lesson

...

Code

...

Questions/observation

...

Lesson 7

Lesson

...

Code

...

Questions/observation

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Lesson 8

Lesson

...

Code

...

Questions/observation

...

Typescript

Create new NPM project:

```
Run: Npm init
Run: Npm install typescript
Make a typescript file
Run: .\node_modules\.bin\tsc .\main.ts -w
Run another NPM: node .\main.js
```