VOXXED DAYS LUXEMBOURG

Programmation fonctionnelle en JavaScript

Philippe Charrière

@k33g

@k33g_org

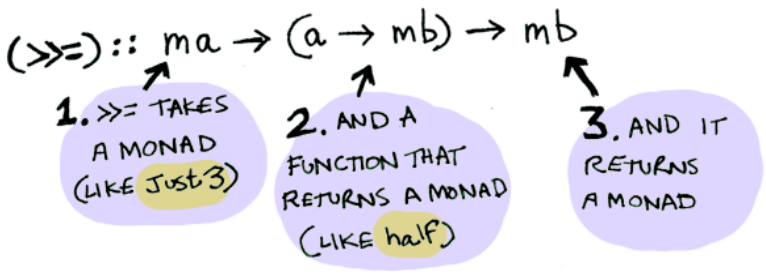
https://github.com/k33g/q/issues

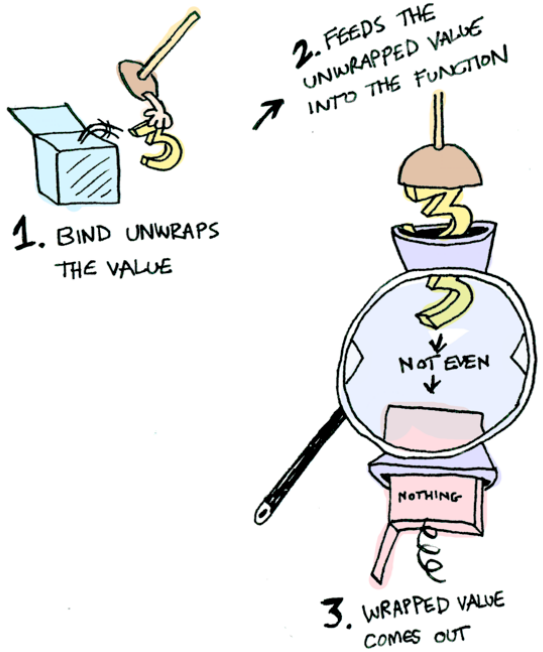
GitHub

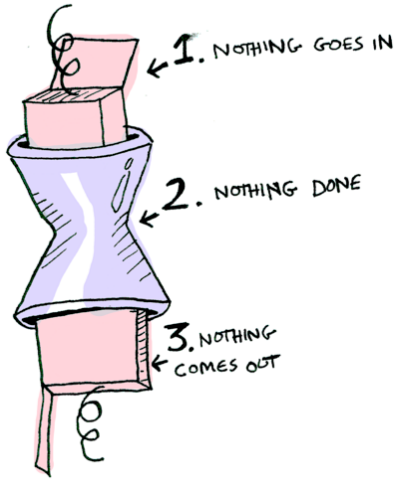
mix-IT

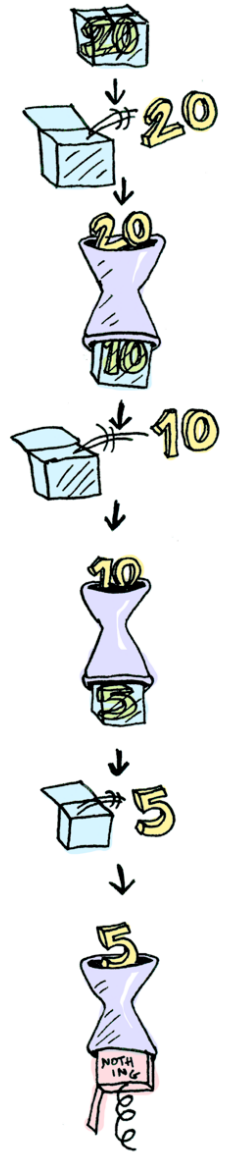
Pourquoi ce talk? … Pour qui?

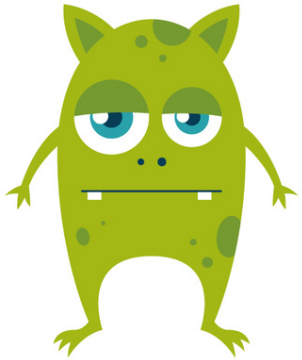
http://adit.io/posts/2013-04-17-functors,_applicatives,_and_monads_in_pictures.html









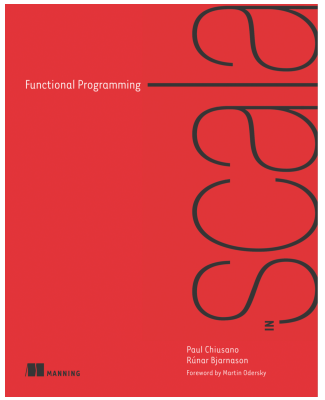


Précautions d’usage

> vocabulaire(s)
> implémentations incomplètes
> échanges de points de vue:
https://github.com/k33g/voxxed.lu.functional.js/issues

Programmation fonctionnelle?

Définition



> Coder avec uniquement des fonctions pures
> = fonctions sans “side effect”
  > toujours retourner le même résultat
  > ne pas modifier de variable
  > ne pas propager d’exception ou s’arrêter lors d’une erreur
  > pas de print, pas de input
  > pas de lecture / écriture de fichier
  > …

développeurs fonctionnels

Nous allons voir

> 2, 3 trucs utiles
> Container
> Functor
> Monad
> Maybe
> Either
> Applicative Functor
> Validation

Quelques bases utiles

“**currying** is a way of constructing functions that allows partial application of a function’s arguments”

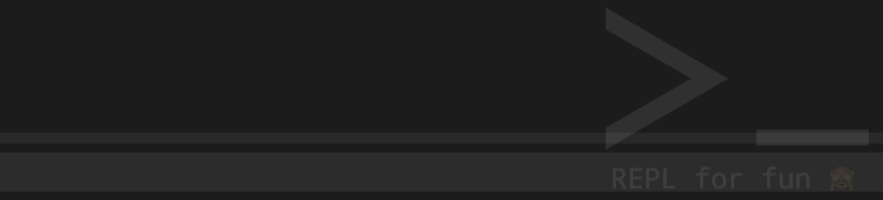
```
let addition = function(a,b) {
  return a+b;
};

// currying addition
let add = function(a) {
  return function(b) {
    return a + b;
  }
};
```

```
add(40)(2)

incrementBy1 = add(1)
incrementBy2 = add(2)

incrementBy1(41)

let arr1 = [100, 200, 300, 400, 500];

arr1.map((x)=>{ return x + 1 })

arr1.map(incrementBy1)
```

“Function **composition** is the act of pipelining the result of one function, to the input of another, creating an entirely new function.”

```
compose2 = (f, g) => {
  return function(x) {
    return f(g(x));
  }
};

compose3 = (f, g, h) => {
  return function(x) {
    return f(g(h(x)));
  }
};
```

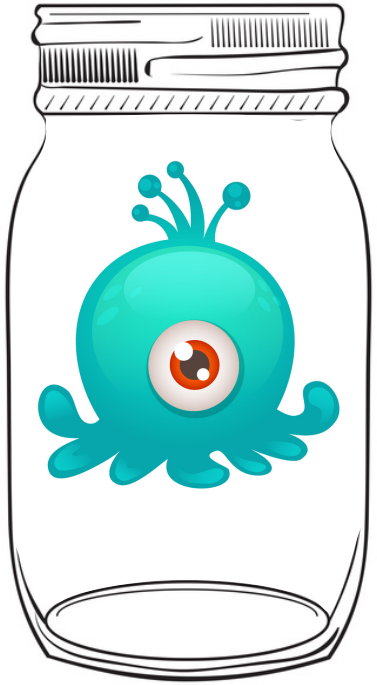
```
addOne = n => n + 1
▶ () {}

multiplyByFive = n => n * 5
▶ () {}

a1m5 = compose2(multiplyByFive, addOne)
▶ function (x) {}

a1m5(4)
25

m5a1 = compose2(addOne, multiplyByFive)
▶ function (x) {}

m5a1(4)
21
```



```
> 1
```

REPL for fun

Container

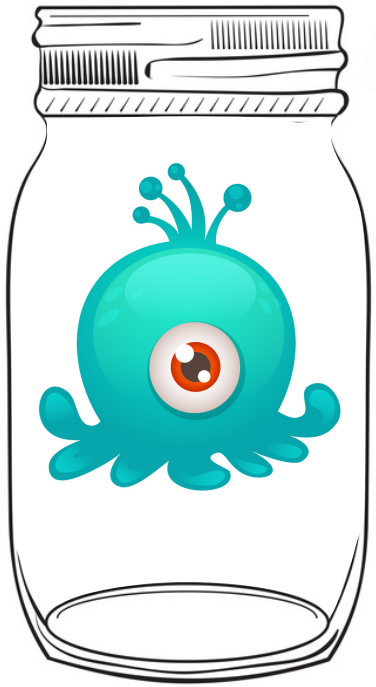


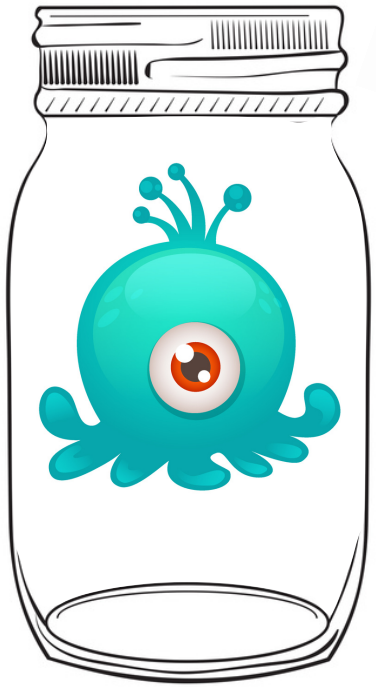
```
class Container {
  constructor(x) {
    const value = x;
    Object.defineProperty(this, "value", { get: () => value })
  }

  static of(x) {
    return new Container(x);
  }
}
```

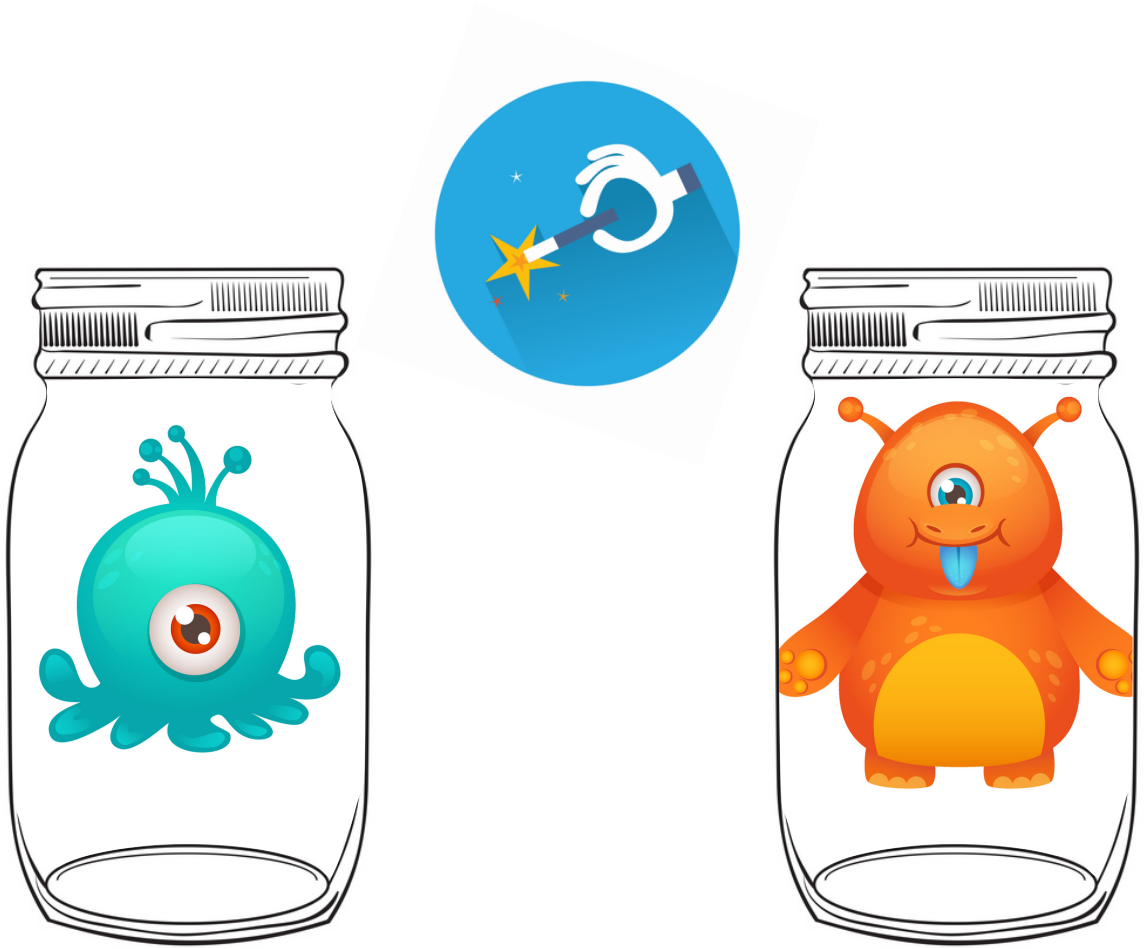
```
bob = Container.of("Bob Morane");
▼ Container {} #
  value: "Bob Morane"
  __proto__: ▶ Container {}

bob.value
"Bob Morane"

bob.value = 'John Doe'
"John Doe"

bob
▼ Container {} #
  value: "Bob Morane"
  __proto__: ▶ Container {}

> 1
```

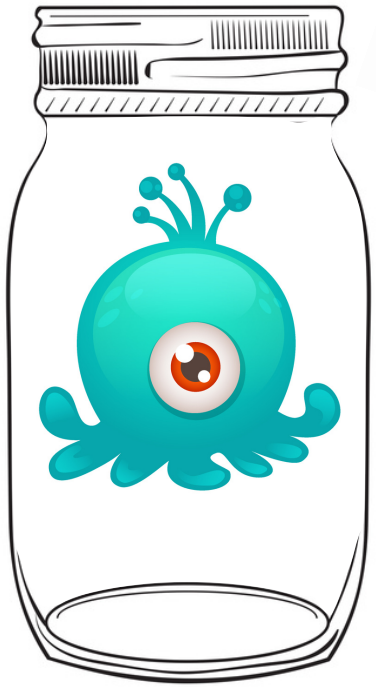
REPL for fun

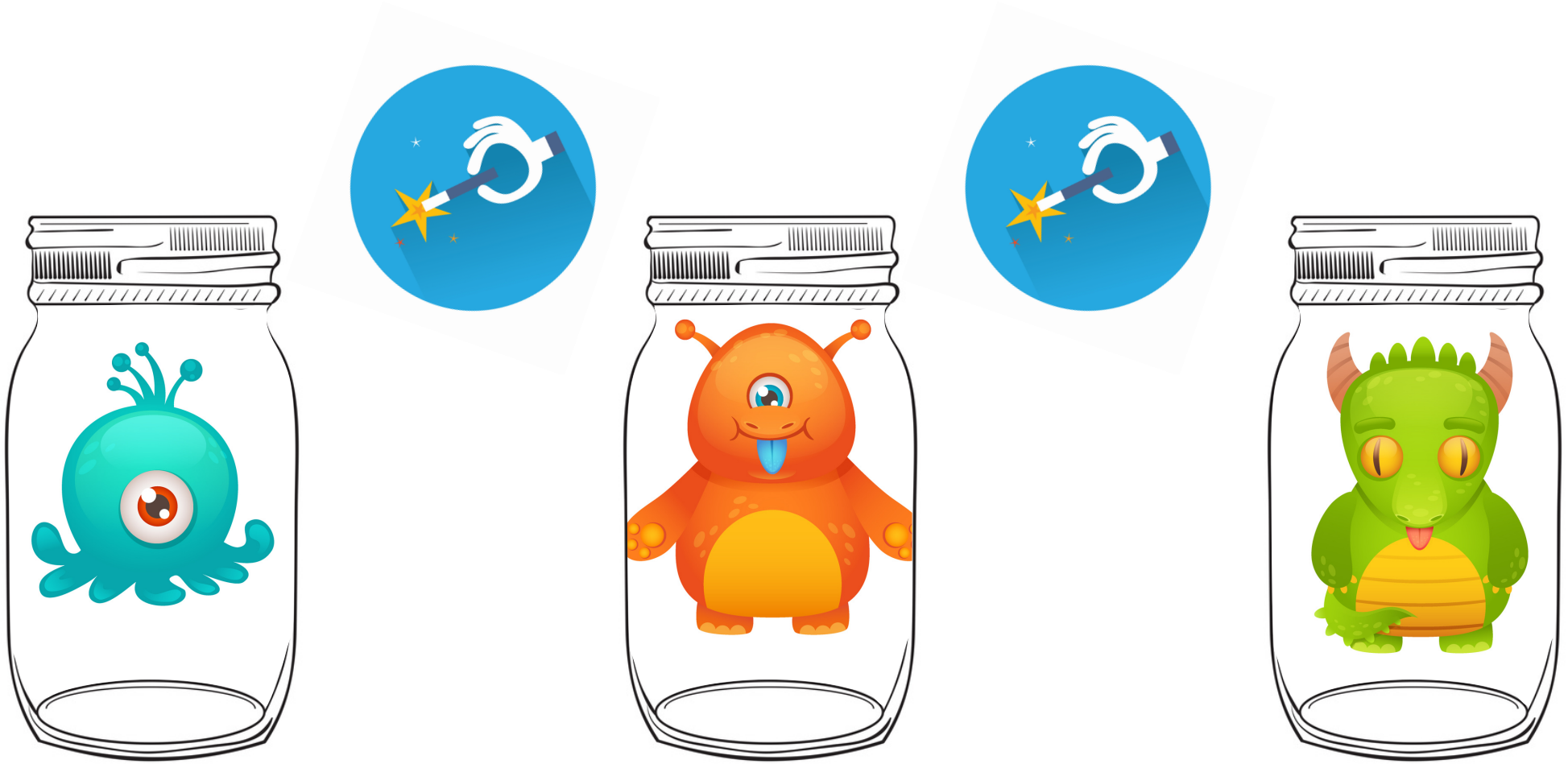
Functor











```
class Functor {
  constructor(x) {
    const value = x;
    Object.defineProperty(this, "value", { get: () => value })
  }

  static of(x) {
    return new Functor(x);
  }

  map (fn) {
    return Functor.of(fn(this.value));
  }
```

I'm a Functor!

```
map(function)
```

```
panda = Functor.of('🐼')
▼ Functor {} #
  value: "🐼"
  __proto__: ▶ Functor {}

addLapinouBuddy = (me) => me + '🐰'
▶ (me) {}

buddies = panda.map(addLapinouBuddy)
▼ Functor {} #
  value: "🐼🐰"
  __proto__: ▶ Functor {}

addCatBuddy = (me) => me + '🐱'
▶ (me) {}

buddies.map(addCatBuddy)
▼ Functor {} #
  value: "🐼🐰🐱"
  __proto__: ▶ Functor {}

panda
▼ Functor {} #
  value: "🐼"
  __proto__: ▶ Functor {}

buddies
▼ Functor {} #
  value: "🐼🐰"
  __proto__: ▶ Functor {}
```

> _

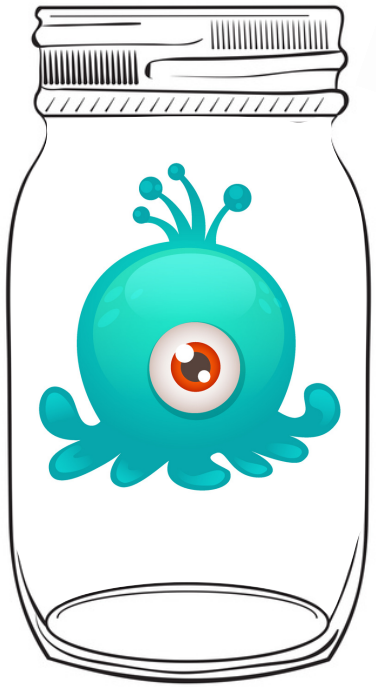
REPL for fun

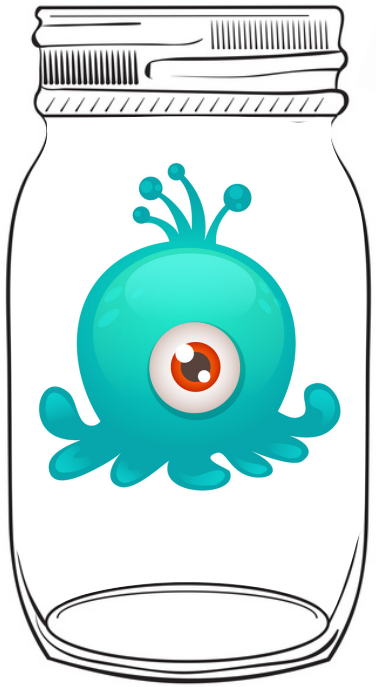
```
1
```

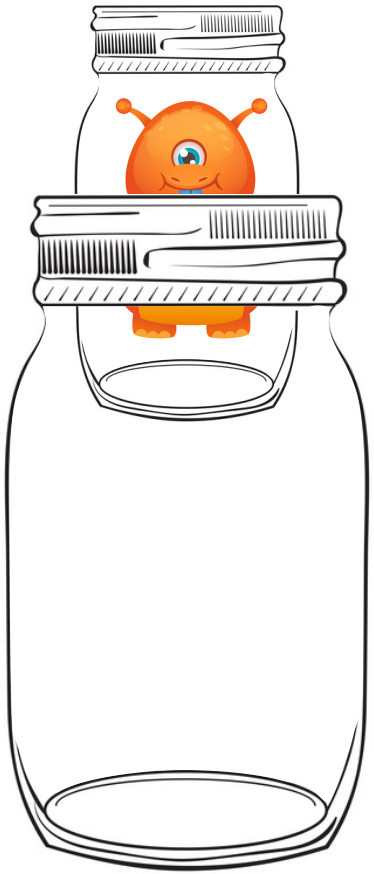
“un peu” plus sérieusement

```
addOne = (value) => value + 1;
multiplyBy5 = (value) => value * 5;
divideByThree = (value) => value / 3;

a = Functor.of(23.2);

b = a
  .map(addOne)
  .map(addOne)
  .map(multiplyBy5)
  .map(divideByThree);
```

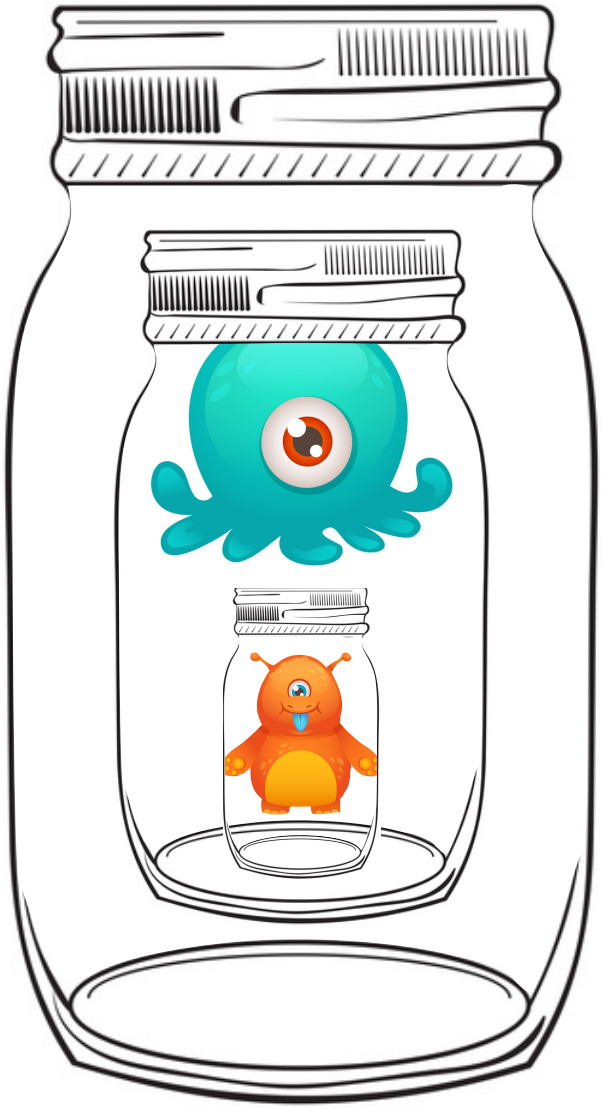
Monad







```
panda = Functor.of('🐼')
▼ Functor {} #
  value: "🐼"
  __proto__: ▶ Functor {}

addTigrouBuddy = (me) => Functor.of(me + '😽')
▶ (me) {}

buddies = panda.map(addTigrouBuddy)
▼ Functor {} #
  value: ▼ Functor {} #
           value: "🐼😽"
           __proto__: ▶ Functor {}
  __proto__: ▶ Functor {}

buddies.value.value
"🐼😽"

> 1
```



```
class Monad {
  constructor(x) {
    const value = x;
    Object.defineProperty(this, "value", { get: () => value })
  }

  static of(x) {
    return new Monad(x);
  }

  map (fn) {
    return Monad.of(fn(this.value));
  }

  fmap (fn) { // flatMap, bind
    return fn(this.value);
  }
}
```

Mancy - REPL(1)

```
panda = Monad.of('🐼')
▼ Monad {} #
  value: "🐼"
  __proto__: ▶ Monad {}

addTigrouBuddy = (me) => Monad.of(me + '😻')
▶ (me) {}

buddies = panda.fmap(addTigrouBuddy)
▼ Monad {} #
  value: "🐼😻"
  __proto__: ▶ Monad {}

fullOfBuddies = panda
  .fmap(addTigrouBuddy)
  .fmap(addTigrouBuddy)
  .fmap(addTigrouBuddy)
  .fmap(addTigrouBuddy)
▼ Monad {} #
  value: "🐼😻😻😻😻"
  __proto__: ▶ Monad {}
```


```
> 1
```

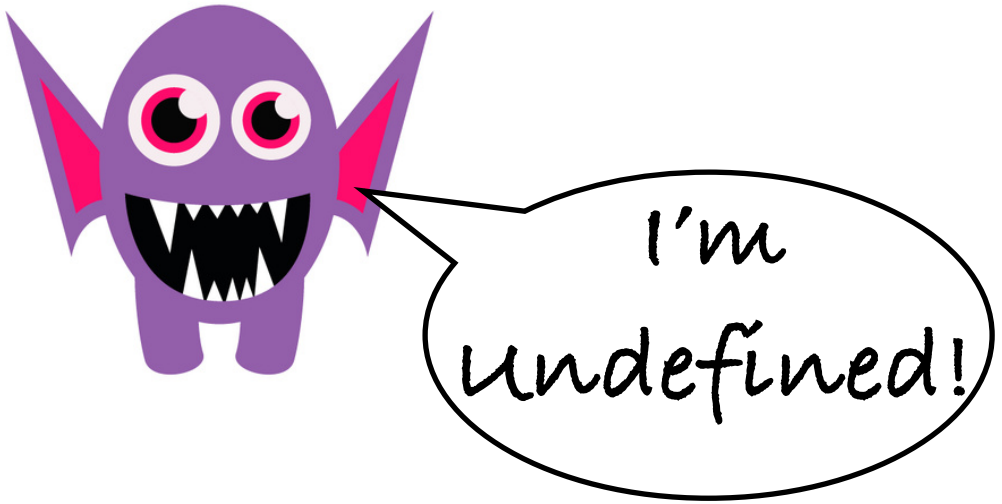
I'm a Monad!

```
fmap(function)
```

```
map(function)
```

Maybe

Pain points



```
bob = {
  id:'bob',
  address:{
    email:'bob@github.com',
    country:'US'
  }
};

john = {
  id:'john',
  address:{
    country:'US'
  }
};

jane = {
  id:'jane'
};

buddies = [bob, john, jane];
```

```
getMailById = (id, buddies) => {
  let email = buddies
    .find(buddy => buddy.id == id)
    .address.email;

  if(email === null || email === undefined) {
    return "no email"
  }
  return email
};
```

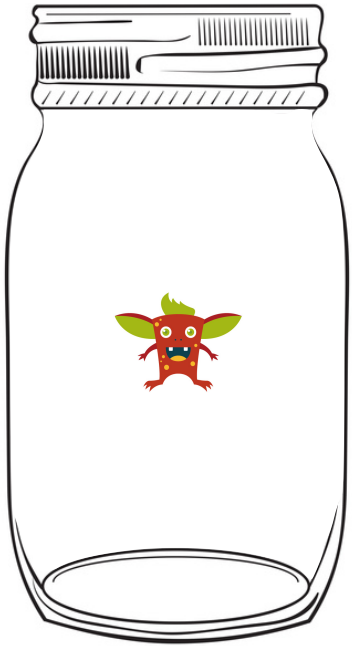
Mancy - REPL(1)

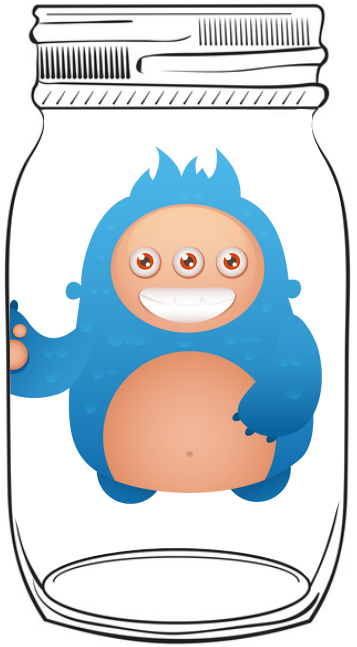
```
buddies
▶ Array[3]

getMailById('bob', buddies)
bob@github.com

getMailById('john', buddies)
"no email"

getMailById('jane', buddies)
▶ TypeError:  Cannot read property 'email' of undefined

getMailById('sam', buddies)
▶ TypeError:  Cannot read property 'address' of undefined

1
```

REPL for fun

Maybe

None **Some**





```
class Maybe {

  static Some(x) { return new Some(x); }

  static None() { return new None(); }

  static fromNullable(x) {
    return (x !== null && x !== undefined)
      ? Maybe.Some(x)
      : Maybe.None();
  }

  static of(x) { return Maybe.Some(x); }
}
```

```
class None {
  constructor() {
    const value = null;
    Object.defineProperty(this, "value", { get: () => value })
  }

  map() { return this; }

  fmap (fn) { return this.value; }

  getOrElse(value) { return value; }

  isNone() { return true; }

  isSome() { return false; }
}
```

```
class Some {
  constructor(x) {
    const value = x;
    Object.defineProperty(this, "value", { get: () => value })
  }

  map(fn) {
    let res = fn(this.value);
    if(res == null || x == undefined) { return new None(); }
    return new Some(res);
  }

  fmap (fn) { return fn(this.value); }

  getOrElse() { return this.value; }

  isNone() { return false; }

  isSome() { return true; }
}
```

“functional” refactoring

```
bob = {
  id:'bob',
  address:{
    email:'bob@github.com',
    country:'US'
  }
};

john = {
  id:'john',
  address:{
    country:'US'
  }
};

jane = {
  id:'jane'
};

buddies = [bob, john, jane];
```

```
getMailById = (id, buddies) => {
  return Maybe.fromNullable(
      buddies.find(buddy => buddy.id == id)
    )
    .map(buddy => buddy.address)
    .map(address => address.email)
    .getOrElse('no email!')
};
```

Mancy - REPL(1)

```
buddies
▶ Array[3]

getMailById = (id, buddies) => {
  return Maybe.fromNullable(buddies.find(buddy => buddy.id == id))
    .map(buddy => buddy.address) // return address of buddy
    .map(address => address.email) // return email of address
    .getOrElse('no email!')
};
▶ (id, buddies) {}

getMailById('bob', buddies)
bob@github.com

getMailById('john', buddies)
"no email!"

getMailById('jane', buddies)
"no email!"

getMailById('sam', buddies)
"no email!"
```

REPL for fun

```
1
```

Maybe

`null`, “expliqué” par le type: `None()`

pas d’information sur l’erreur

I'm a Maybe!

J'ai 2 sous types

None
Some

`fmap(function)`

`map(function)`

Either

Either

Left **Right**

```
class Either {
  constructor(x) {
    const value = x;
    Object.defineProperty(this, "value", { get: () => value })
  }

  static Left(x) { return new Left(x); }

  static Right(x) { return new Right(x); }

  static fromNullable(x) {
    return (x !== null && x !== undefined)
      ? Either.Right(x)
      : Either.Left();
  }

  static of(x) { return Either.Right(x); }
}
```

```
class Left {
  constructor(err) {
    const value = err;
    Object.defineProperty(this, "value", { get: () => err })
  }

  map() { return this; }

  fmap (fn) { return this; }

  getOrElse(value) {return value; }

  orElse(fn) { return fn(this.value); }

  cata(leftFn, rightFn) { return leftFn(this.value); }
}
```

```
class Right {
  constructor(x) {
    const value = x;
    Object.defineProperty(this, "value", { get: () => value })
  }

  map(fn) { return new Right(fn(this.value)); }

  fmap (fn) {
    let res = fn(this.value);
    if(res == null || res == undefined) {return new Left(res);}
    return new Right(res);
  }

  getOrElse() { return this.value; }
  orElse() { return this; }

  cata(leftFn, rightFn) { return rightFn(this.value); }
}
```

utilisation

```
function getMonthName(mo) {
    mo = mo-1; // Adjust month number for array index (1=Jan, 12=Dec)
    var months = ["Jan", "Feb", "Mar", "Apr", "May", "Jun", "Jul",
        "Aug", "Sep", "Oct", "Nov", "Dec"];
    if (months[mo] !== undefined) {
        return months[mo];
    } else {
        throw new UserException("Invalid Month Number");
    }
}

function getDayName(da) {
    da = da-1; // Adjust day number for array index
    var days = ["Mo", "Tu", "We", "Th", "Fr", "Sa", "Su"];
    if (days[da] !== undefined) {
        return days[da];
    } else {
        throw new UserException("Invalid Day Number");
    }
}
```

```
getMonthName(12)
"Dec"

getMonthName(13)
▼ UserException:  Invalid Month Number
    at UserException.ExtendableException (repl:6:7)
    at UserException (repl:3:1)
    at getMonthName (mancy-repl:8:13)
    at mancy-repl:1:1
    at ContextifyScript.cxt.runInContext (/Applications/Mancy-darwin-x64/Mancy.app/Contents/Resources/app/common/ReplContext.js
  :203:18)
    at Object.runInContext (/Applications/Mancy-darwin-x64/Mancy.app/Contents/Resources/app/common/ReplCommon.js :427:23)
    at ReplActiveInput.transpileAndExecute (/Applications/Mancy-darwin-
  x64/Mancy.app/Contents/Resources/app/components/ReplActiveInput.js :678:32)
    at /Applications/Mancy-darwin-x64/Mancy.app/Contents/Resources/app/components/ReplActiveInput.js :843:20

getDayName(42)
▼ UserException:  Invalid Day Number
    at UserException.ExtendableException (repl:6:7)
    at UserException (repl:3:1)
    at getDayName (mancy-repl:18:13)
    at mancy-repl:1:1
    at ContextifyScript.cxt.runInContext (/Applications/Mancy-darwin-x64/Mancy.app/Contents/Resources/app/common/ReplContext.js
  :203:18)
    at Object.runInContext (/Applications/Mancy-darwin-x64/Mancy.app/Contents/Resources/app/common/ReplCommon.js :427:23)
    at ReplActiveInput.transpileAndExecute (/Applications/Mancy-darwin-
  x64/Mancy.app/Contents/Resources/app/components/ReplActiveInput.js :678:32)
    at /Applications/Mancy-darwin-x64/Mancy.app/Contents/Resources/app/components/ReplActiveInput.js :843:20

> REPL for fun
1
```

on “cache” les exceptions

```
giveMeMonthName = (monthNumber) => {
  try {
    return Either.Right(getMonthName(monthNumber));
  } catch (err) {
    return Either.Left(err);
  }
};

giveMeDayName = (dayNumber) => {
  try {
    return Either.Right(getDayName(dayNumber));
  } catch (err) {
    return Either.Left(err);
  }
};
```

```
giveMeMonthName(12)
▼ Right {} #
  value: "Dec"
  __proto__: ▶ Right {}

giveMeMonthName(42)
▼ Left {} #
  value: ▶ UserException:  Invalid Month Number
  __proto__: ▶ Left {}

giveMeDayName(1)
▼ Right {} #
  value: "Mo"
  __proto__: ▶ Right {}

giveMeDayName(42)
▼ Left {} #
  value: ▶ UserException:  Invalid Day Number
  __proto__: ▶ Left {}
```

REPL for fun

```
> 1
```

catamorphisme

```
giveMeMonthName(12).cata(
    leftnFn= (err) => {
        return JSON.stringify(err);
    },
    rightFn= (value) => {
        return `Yes! Month name is ${value}`
    }
)
"Yes! Month name is Dec"

giveMeMonthName(42).cata(
    leftnFn= (err) => {
        return JSON.stringify(err);
    },
    rightFn= (value) => {
        return `Yes! Month name is ${value}`
    }
)
"{"name":"UserException"}"
```

REPL for fun

```
1
```

mais...

```
checkMonthAndDay = (monthNumber,dayNumber) => {
  try {
    let month = getMonthName(monthNumber);
    let day = getDayName(dayNumber);
    return Either.Right({month, day});
  } catch (err) {
    return Either.Left(err);
  }
}
```

```
checkMonthAndDay = (monthNumber,dayNumber) => {…
▶ (monthNumber,dayNumber) {}

checkMonthAndDay(1,42)
▼ Left {} #
  value: ▶ UserException:  Invalid Day Number
  __proto__: ▶ Left {}

checkMonthAndDay(42,5)
▼ Left {} #
  value: ▶ UserException:  Invalid Month Number
  __proto__: ▶ Left {}

checkMonthAndDay(42,42)
▼ Left {} #
  value: ▶ UserException:  Invalid Month Number
  __proto__: ▶ Left {}

1
```

REPL for fun

On ne trace pas toutes les erreurs

I'm an Either!

J'ai 2 sous types

Left
Either

```
fmap(function)
```

```
map(function)
```

```
cata(
  left function,
  right function
)
```

Validation

Applicative Functor ???

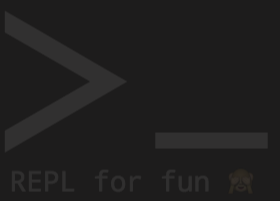
c’est un  avec
une méthode `ap()`

Méthode `ap()`

"`ap` is a function that can apply the function contents of one functor to the value contents of another"

```
class ApplicativeFunctor {
  constructor(x) {
    const value = x;
    Object.defineProperty(this, "value", { get: () => value })
  }
  static of(x) {
    return new ApplicativeFunctor(x);
  }

  map (fn) {
    return ApplicativeFunctor.of(fn(this.value));
  }

  ap(otherContainer) { // has to be a functor
    return otherContainer.map(this.value)
  }
}
```

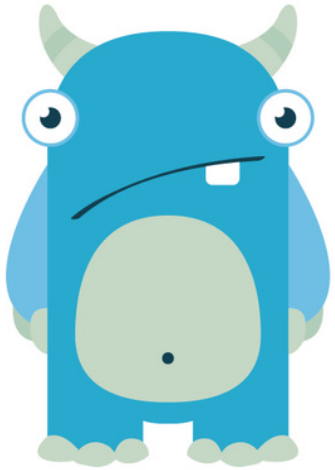
```
addTwo = (n) => n + 2
▶ (n) {}

ap1 = ApplicativeFunctor.of(addTwo)
▼ ApplicativeFunctor {} #
  value: ▼ (n) {} #
           length: 1
           name: ""
           __proto__: ▶ Function {}
         (n) => n + 2
  __proto__: ▶ ApplicativeFunctor {}

ap2 = ApplicativeFunctor.of(40)
▼ ApplicativeFunctor {} #
  value: 40
  __proto__: ▶ ApplicativeFunctor {}

ap3 = ap1.ap(ap2)
▼ ApplicativeFunctor {} #
  value: 42
  __proto__: ▶ ApplicativeFunctor {}
```




```
> 1
```

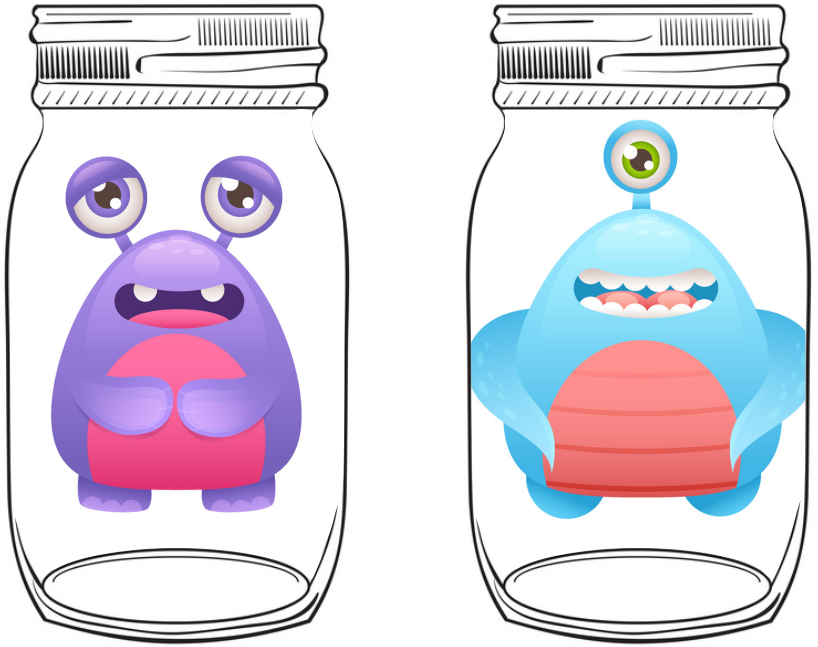
```
add = a => b => a + b
▼ () {} #
  length: 1
  name: ""
  __proto__: ▶ Function {}
a => b => a + b

add(40)(2)
42

ApplicativeFunctor.of(2)
    .map(add)
    .ap(ApplicativeFunctor.of(40))
▼ ApplicativeFunctor {} #
  value: 42
  __proto__: ▶ ApplicativeFunctor {}

> 1
```

REPL for fun



Validation

Fail **Success**



```
class Validation {
  constructor(x) {
    const value = x;
    Object.defineProperty(this, "value", { get: () => value })
  }

  static Success(x) { return new Success(x); }

  static Fail(x) { return new Fail(x); }

  static of(x) { return Validation.Success(x); }
}
```

```
class Success {
  constructor(err) {
    const value = err;
    Object.defineProperty(this, "value", { get: () => err })
  }

  map(fn) { return new Success(fn(this.value)); }

  isSuccess() { return true; }
  isFail() { return false; }

  ap(otherContainer) { // has to be at least a functor
    return otherContainer instanceof Fail
      ? otherContainer
      : otherContainer.map(this.value)
  }

  cata(failureFn, successFn) { return successFn(this.value); }
}
```

```
class Fail {
  constructor(x) {
    const value = x;
    Object.defineProperty(this, "value", { get: () => value })
  }

  map() { return this; }

  isSuccess() { return false; }
  isFail() { return true; }

  ap(otherContainer) { // has to be a functor
    return otherContainer instanceof Fail
      ? new Fail(this.value.concat(otherContainer.value))
      : this
  }

  cata(failureFn, successFn) { return failureFn(this.value); }
}
```

exemple(s)

```
checkMonth = (monthNumber) => {
  try {
    let month = getMonthName(monthNumber);
    return Validation.Success(month)
  } catch (err) {
    return Validation.Fail([err])
  }
};

checkDay = (dayNumber) => {
  try {
    let day = getDayName(dayNumber);
    return Validation.Success(day)
  } catch (err) {
    return Validation.Fail([err])
  }
};
```

```
checkDay(42)
▼ Fail {} #
  value: ▼ Array[1] #
           0: ▶ UserException:  Invalid Day Number
           length: 1
           __proto__: ▶ Array {}
  __proto__: ▶ Fail {}

checkDay(42).ap(checkMonth(42)).ap(checkMonth(42))
▼ Fail {} #
  value: ▼ Array[3] #
           0: ▶ UserException:  Invalid Day Number
           1: ▶ UserException:  Invalid Month Number
           2: ▶ UserException:  Invalid Month Number
           length: 3
           __proto__: ▶ Array {}
  __proto__: ▶ Fail {}

checkDay(42).ap(checkMonth(12)).ap(checkMonth(42))
▼ Fail {} #
  value: ▼ Array[2] #
           0: ▶ UserException:  Invalid Day Number
           1: ▶ UserException:  Invalid Month Number
           length: 2
           __proto__: ▶ Array {}
  __proto__: ▶ Fail {}

> 1
```

REPL for fun

```
checkMonthOnData = (data) => {
  try {
    let month = getMonthName(data.month);
    return Validation.Success(month)
  } catch (err) {
    return Validation.Fail([err])
  }
};

checkDayOnData = (data) => {
  try {
    let day = getDayName(data.day);
    return Validation.Success(day)
  } catch (err) {
    return Validation.Fail([err])
  }
};
```

```
checkMonthAndDay = (data) => Validation.of(
  day => {
    console.log('dayName:', day)
    return month => {
      console.log('monthName:', month)
      return `==> ${day}:${month}`
    };
  }).ap(checkDayOnData(data)).ap(checkMonthOnData(data));
```

Mancy - REPL(0)

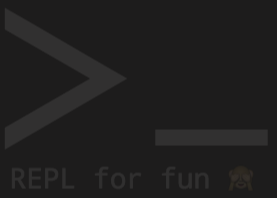
```
checkMonthAndDay = (data) => Validation.of(
  day => {
    console.log('dayName:', day)
    return month => {
      console.log('monthName:', month)
      return `==> ${day}:${month}`
    };
}).ap(checkDayOnData(data)).ap(checkMonthOnData(data))
▶ (data) {}

checkMonthAndDay({day:2,month:12})
▼ Success {} #
 value: "==> Tu:Dec"
 __proto__: ▶ Success {}

checkMonthAndDay({day:42,month:42})
▼ Fail {} #
 value: ▼ Array[2] #
         0: ▶ UserException:  Invalid Day Number
         1: ▶ UserException:  Invalid Month Number
         length: 2
         __proto__: ▶ Array {}
 __proto__: ▶ Fail {}

> 1
```

REPL for fun

catamorphisme

Mancy - REPL(0)

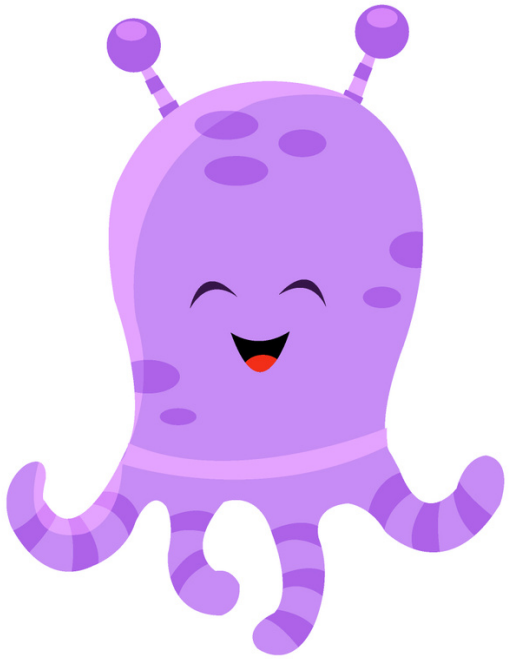
```
checkMonthAndDay = (data) => Validation.of(
  day => {
    console.log('dayName:', day)
    return month => {
      console.log('monthName:', month)
      return `==> ${day}:${month}`
    };
}).ap(checkDayOnData(data)).ap(checkMonthOnData(data))
▶ (data) {}

checkMonthAndDay({day:42,month:42}).cata(
  failureFn = (errors) => errors.join('|'),
  successFn = (res) => res
)
"UserException: Invalid Day Number|UserException: Invalid Month Number"

checkMonthAndDay({day:2,month:12}).cata(
  failureFn = (errors) => errors.join('|'),
  successFn = (res) => res
)
"==> Tu:Dec"

> 1
```



I'm a validation!

J'ai 2 sous types

Fail
Success



```
ap(validation)
```

```
map(function)
```

```
cata(
  failureFn function,
  successFn function
)
```

Paysage Fonctionnel côté JS

Quelques libs

> Monet.js: https://cwmyers.github.io/monet.js/
> Ramda.js: http://ramdajs.com/0.21.0/index.html
> Underscore: http://underscorejs.org/
> Lodash: https://lodash.com/
> Folktale: http://folktalejs.org/
> Fantasy Land: https://github.com/fantasyland

Ressources

Lectures

Mostly Adequate Guide (Brian Lonsdorf): https://www.gitbook.com/book/drboolean/mostly-adequate-guide/details

Functional Programming in Java (Pierre-Yves Saumont): https://www.manning.com/books/functional-programming-in-java

Functional Programming in JavaScript (Luis Atencio): https://www.manning.com/books/functional-programming-in-javascript

Functional Programming in Scala (Paul Chiusano and Rúnar Bjarnason): https://www.manning.com/books/functional-programming-in-scala

Le code source de Golo:

https://github.com/eclipse/golo-lang/blob/master/src/main/golo/errors.golo

https://github.com/eclipse/golo-lang/blob/master/src/main/java/gololang/error/Result.java

Talks

Gérer les erreurs avec l'aide du système de types de Scala !
(David Sferruzza):
https://www.youtube.com/watch?v=TwJQKrZ23Vs

TDD, comme dans Type-Directed Development
(Clément Delafargue):
https://www.youtube.com/watch?v=XhcgCF0xXRs

Remerciements

Merci

> Loïc Descotte @loic_d

> Julien Ponge @jponge

> @voxxed_lu

https://github.com/k33g/voxxed.lu.functional.js

Questions

https://github.com/k33g/voxxed.lu.functional.js/issues