We are OUDL.

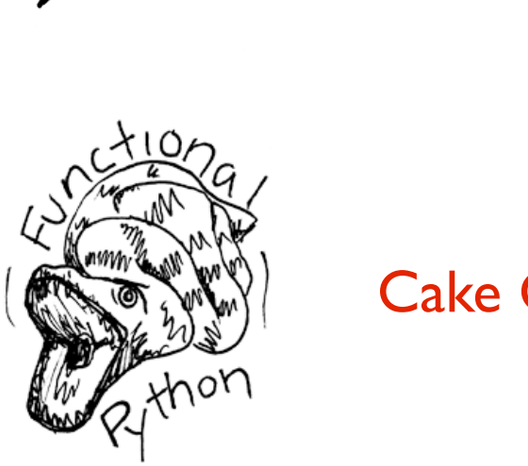
Organization for the Understanding of Dynamic Languages

http://meetup.com/dynamic/

What makes Objective C dynamic?

What makes Objective C dynamic?

Kamehameha Bakery donuts



Otto Cake cheesecake

Cake Couture cupcakes

Fendu Bakery croissants & cookies

Saint Germain Bakery palmiers

Mahalo.

HTDC
Cultivating Hawaii's tech sector

THE BOX JELLY

HICAP
hicapacity.org

Y combinator

Examples in Clojure.
Also includes: blenders and kittens.
Caveat emptor: I make no effort to teach you Clojure.

Kyle Oba
@mudphone
Pas de Chocolat

Not this one.

This one.

```
(defn Y
  [g]
  ((fn [x] (x x)) (fn [x]
                    (g (fn [y] ((x x) y))))))
```

Let's get started.

Here's a non-recursive definition of factorial, using the Y combinator.

```clojure
(defn Y
  [g]
  ((fn [x] (x x)) (fn [x]
                    (g (fn [y] ((x x) y))))))

(defn almost-factorial
  [f]
  (fn [n]
    (if (= n 0)
      1
      (* n (f (dec n))))))

(defn factorial
  [n]
  ((Y almost-factorial) n))
```

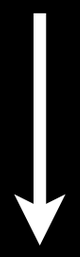
Questions?

An example: 5!

```
(factorial 5) = 5 * 4 * 3 * 2 * 1 = 120
```

```
(defn factorial
  [n]
  (if (= n 0)
    1
    (* n (factorial (dec n)))))
```

here to here?



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(defn factorial
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  ((fn [x] (x x)) (fn [x]
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(defn factorial
  [n]
  ((Y almost-factorial) n))
```

2 Things

1) recursion

2) functions

2 Things

1) recursion

2) functions

"The Y combinator allows recursion...
as a set of ***rewrite rules***,

without requiring native recursion
support in the language."

-- Someone on Wikipedia

replace
“native recursion”
with
manual recursion

```clojure
(defn factorial
  [n]
  (if (= n 0)
    1
    (* n (factorial (dec n)))))
```

```clojure
(defn fact
  [n]
  (if (= n 0)
    1
    (* n (ERROR (dec n)))))
```

```clojure
(defn factorial
  [n]
  (if (= n 0)
    1
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  [n]
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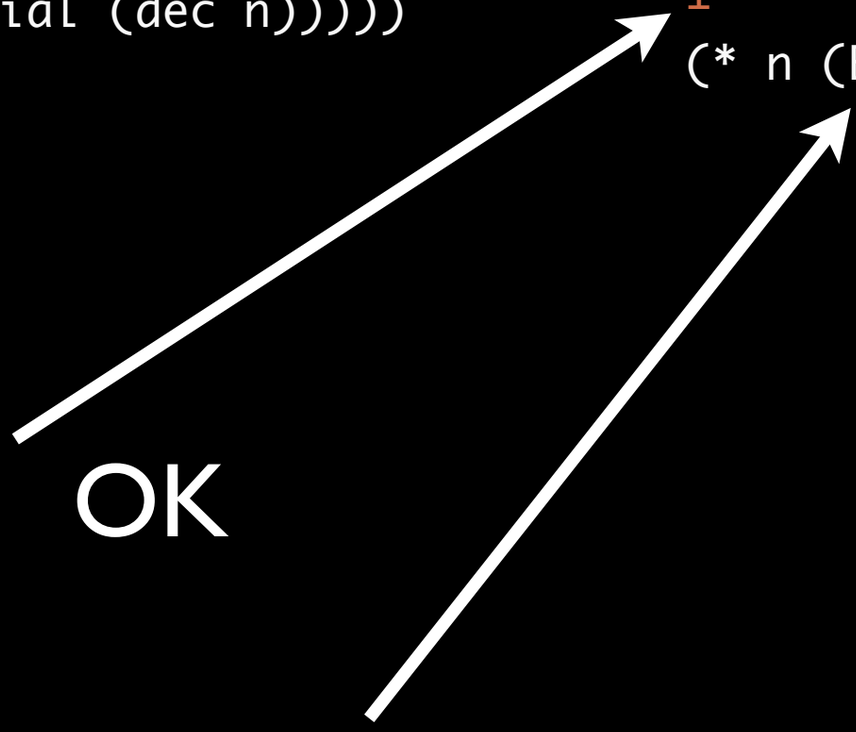

n = 0 OK

n = 1 BOOM!

```clojure
(defn factorial
  [n]
  (if (= n 0)
    1
    (* n (factorial (dec n)))))
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n = 0 OK

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(defn fact
  [n]
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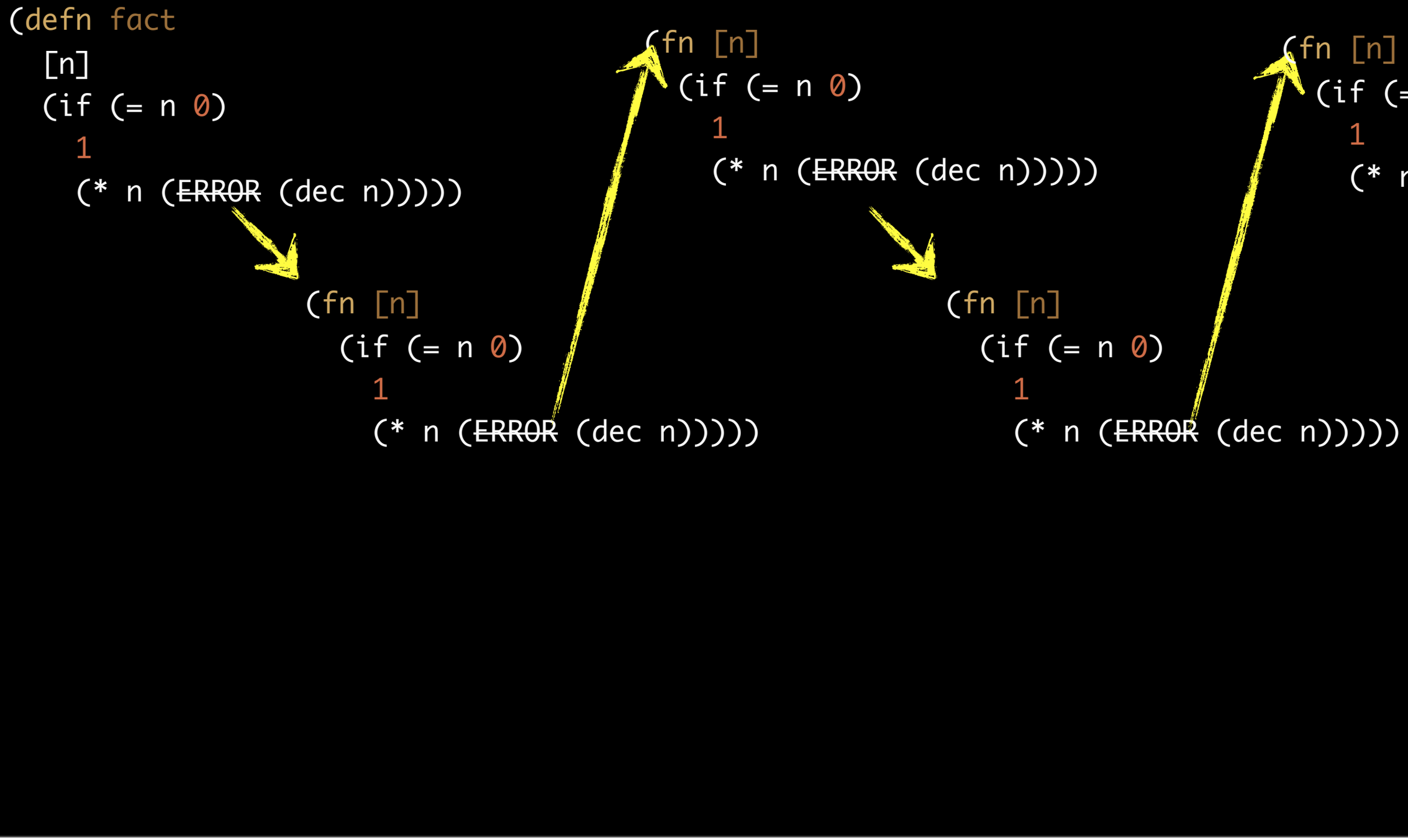
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```
(fn [n]
  (if (= n 0)
    1
    (* n (ERROR (dec n)))))
```

n = 0 n = 1 n = 2 n = 3 n = 4

replace
“native recursion”
with
~~manual recursion~~
“rewrite rules”

2 Things

1) recursion

2) functions

2 Things

1) recursion

2) functions

Functions are machines.

Functions are relationships,
between inputs and outputs.

A function is a blender.

FIRST ORDER BLENDER

A normal blender that consumes single input and creates output.

FIRST ORDER BLENDER

A normal blender that consumes single input and creates output.

HIGHER ORDER BLENDER

A special blender that consumes a blender and outputs another blender.

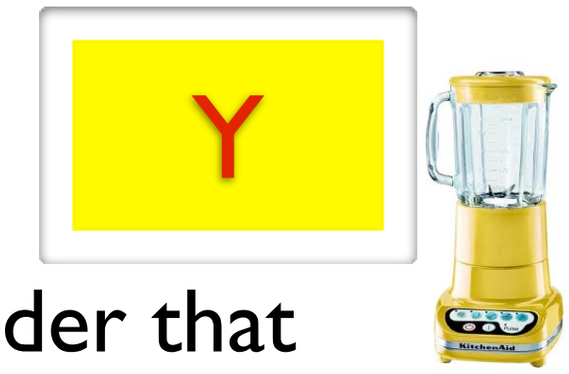
FIRST ORDER BLENDER

A normal blender that consumes single input and creates output.

HIGHER ORDER BLENDER

A special blender that consumes a blender and outputs another blender.

FIXPOINT (BLENDER) COMBINATOR



Consumes a blender and produces a new blender that can consume any number of inputs.

ONE

ONE

```
(defn almost-factorial
  [f]
  (fn [n]
    (if (= n 0)
      1
      (* n (f (dec n))))))
```

ONE

```
(defn almost-factorial
  [f]
  (fn [n]
    (if (= n 0)
      1
      (* n (f (dec n))))))
```

ANY

ONE

ANY

```
(defn almost-factorial
  [f]
  (fn [n]
    (if (= n 0)
      1
      (* n (f (dec n))))))
```

factorial

if you squint

```clojure
(defn factorial
  [n]
  (if (= n 0)
    1
    (* n (factorial (dec n)))))
```

```clojure
(defn almost-factorial
  [f]
  (fn [n]
    (if (= n 0)
      1
      (* n (f (dec n))))))

(defn Y
  [g]
  ((fn [x] (x x)) (fn [x]
                    (g (fn [y] ((x x) y))))))

(defn factorial
  [n]
  ((Y almost-factorial) n))
```

I'm so sorry.

No kittens were blended during the creation of this presentation.

No really, done now.

No kittens were blended during the creation of this presentation.

A Clojure Primer

PARENTHESIS

```
(+ 1 2 3)
;; => 6
```

PREFIX NOTATION

```
(operator arg1 arg2 arg3)
```

FUNCTIONS

```
(defn multby2
  [n]
  (* n 2))
;; (multby2 4) => 8
```

```
(fn [n] (* n 2))
```

```clojure
(defn simple-factorial
  [n]
  (if (= n 0)
    1
    (* n (simple-factorial (dec n)))))
```

```clojure
(defn simple-factorial
  [n]
  (if (= n 0)
    1
    (* n (simple-factorial (dec n)))))
```

```clojure
(defn part
  [self n]
  (if (= n 0)
    1
    (* n (self self (dec n)))))
;; (part part 5) => 120
```

```clojure
(defn simple-factorial
  [n]
  (if (= n 0)
    1
    (* n (simple-factorial (dec n)))))
```

```clojure
(defn part
  [self n]
  (if (= n 0)
    1
    (* n (self self (dec n)))))
;; (part part 5) => 120
```

```clojure
(defn part
  [self n]
  (if (= n 0)
    1
    (* n (self self (dec n)))))
;; (part part 5) => 120

(defn part2
  [self]
  (fn [n]
    (if (= n 0)
      1
      (* n ((self self) (dec n))))))
;; ((part2 part2) 5) => 120
```

```clojure
(defn part
  [self n]
  (if (= n 0)
    1
    (* n (self self (dec n)))))
;; (part part 5) => 120

(defn part2
  [self]
  (fn [n]
    (if (= n 0)
      1
      (* n ((self self) (dec n))))))
;; ((part2 part2) 5) => 120
```

```clojure
(defn part2
  [self]
  (fn [n]
    (if (= n 0)
      1
      (* n ((self self) (dec n))))))
;; ((part2 part2) 5) => 120
```

```clojure
(defn part3
  [self]
  (let [f (self self)]
    (fn [n]
      (if (= n 0)
        1
        (* n (f (dec n)))))))
```

```clojure
(defn part2
  [self]
  (fn [n]
    (if (= n 0)
      1
      (* n ((self self) (dec n))))))
;; ((part2 part2) 5) => 120
```

```clojure
(defn part3
  [self]
  (let [f (self self)]
    (fn [n]
      (if (= n 0)
        1
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  [self]
  (let [f (self self)]
    (fn [n]
      (if (= n 0)
        1
        (* n (f (dec n)))))))
```

```clojure
(defn part4
  [self]
  (let [f (fn [y] ((self self) y))]
    (fn [n]
      (if (= n 0)
        1
        (* n (f (dec n)))))))
```

```clojure
(defn part3
  [self]
  (let [f (self self)]
    (fn [n]
      (if (= n 0)
        1
        (* n (f (dec n)))))))
```

```clojure
(defn part4
  [self]
  (let [f (fn [y] ((self self) y))]
    (fn [n]
      (if (= n 0)
        1
        (* n (f (dec n)))))))
```

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```

```clojure
(defn almost-factorial
  [f]
  (fn [n]
    (if (= n 0)
      1
      (* n (f (dec n))))))
```

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(defn part4
  [self]
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```clojure
(defn almost-factorial
  [f]
  (fn [n]
    (if (= n 0)
      1
      (* n (f (dec n))))))
```

```clojure
(defn part5
  [self]
  (let [f (fn [y] ((self self) y))]
    (almost-factorial f)))
```

```clojure
(defn almost-factorial
  [f]
  (fn [n]
    (if (= n 0)
      1
      (* n (f (dec n))))))
```

```clojure
(defn part5
  [self]
  (let [f (fn [y] ((self self) y))]
    (almost-factorial f)))
```

```clojure
(defn part5
  [self]
  (let [f (fn [y] ((self self) y))]
    (almost-factorial f)))
```

```clojure
(defn fact5
  [n]
  ((part5 part5) n))
```

```clojure
(defn part5
  [self]
  (let [f (fn [y] ((self self) y))]
    (almost-factorial f)))
```

```clojure
(defn fact5
  [n]
  ((part5 part5) n))
```

```clojure
(defn fact5
  [n]
  ((part5 part5) n))
```

```clojure
(def fact6
  (let [part (fn [self]
               (let [f (fn [y] ((self self) y))]
                 (almost-factorial f)))]
    (part part)))
```

```clojure
(defn fact5
  [n]
  ((part5 part5) n))
```

```clojure
(def fact6
  (let [part (fn [self]
               (let [f (fn [y] ((self self) y))]
                 (almost-factorial f)))]
    (part part)))
```

```clojure
(def fact6
  (let [part (fn [self]
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                 (almost-factorial f)))]
    (part part)))
```

```clojure
(def fact7
  (let [x (fn [x]
            (let [f (fn [y] ((x x) y))]
              (almost-factorial f)))]
    (x x)))
```

```clojure
(def fact6
  (let [part (fn [self]
               (let [f (fn [y] ((self self) y))]
                 (almost-factorial f)))]
    (part part)))
```

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(def fact7
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              (almost-factorial f)))]
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(def fact7
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```clojure
(def fact8
  ((fn [x]
     (x x)) (fn [x]
              (let [f (fn [y] ((x x) y))]
                (almost-factorial f)))))
```

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(def fact7
  (let [x (fn [x]
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```

```
(defn nearly-Y
  [g]
  ((fn [x] (x x)) (fn [x]
                    (let [f (fn [y] ((x x) y))]
                      (g f)))))
```

```
(def fact8
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```
(defn factorial
  [n]
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(defn Y
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I'm so sorry.

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```clojure
(defn almost-factorial
  [f]
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```clojure
(Y almost-factorial)
;; ((Y almost-factorial) 5) => 120
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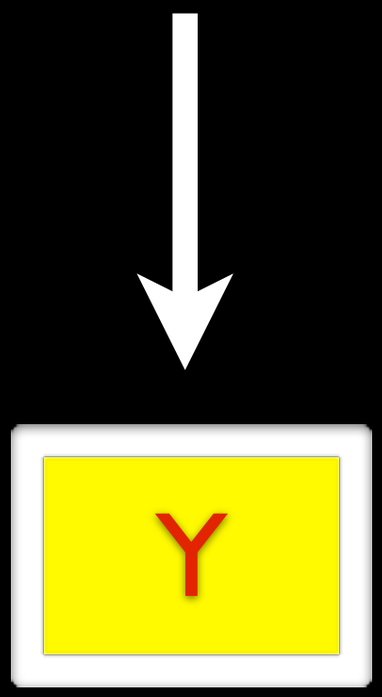


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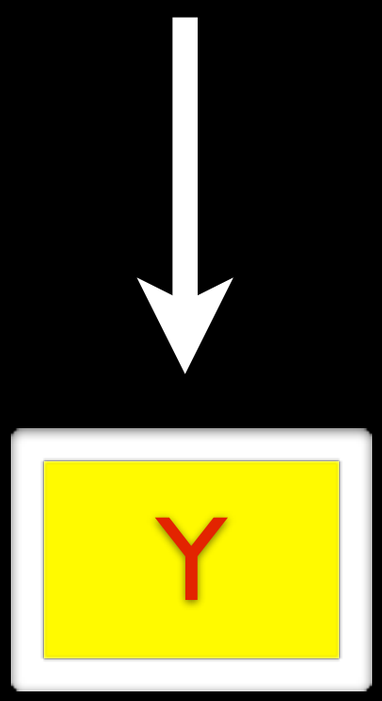

FACTORIAL

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```

```clojure
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;; ((Y almost-factorial) 5) => 120
```

Y

```clojure
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  [n]
  (if (= n 0)
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    (* n (ERROR (
```

FACTORIAL

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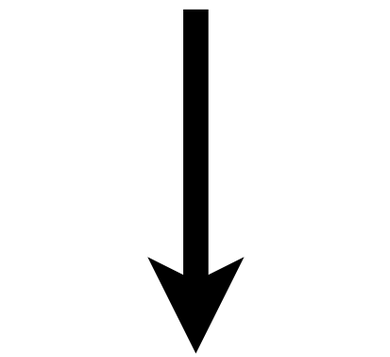

factorial

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factorial

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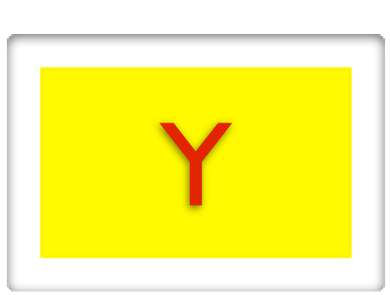

ONE

factorial

```
(defn almost-factorial
  [f]
  (fn [n]
    (if (= n 0)
      1
      (* n (f (dec n))))))
```

factorial

ONE

ANY