A World Without Assignment

I've Lost My Voice

Video Of This Talk At Mountain West Ruby Conf Is On ConFreaks

Please Be Nice

Please Be Quiet

2010 golden gate Ruby conf

Structure and Interpretation of Computer Programs

Second Edition

Harold Abelson and
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with Julie Sussman

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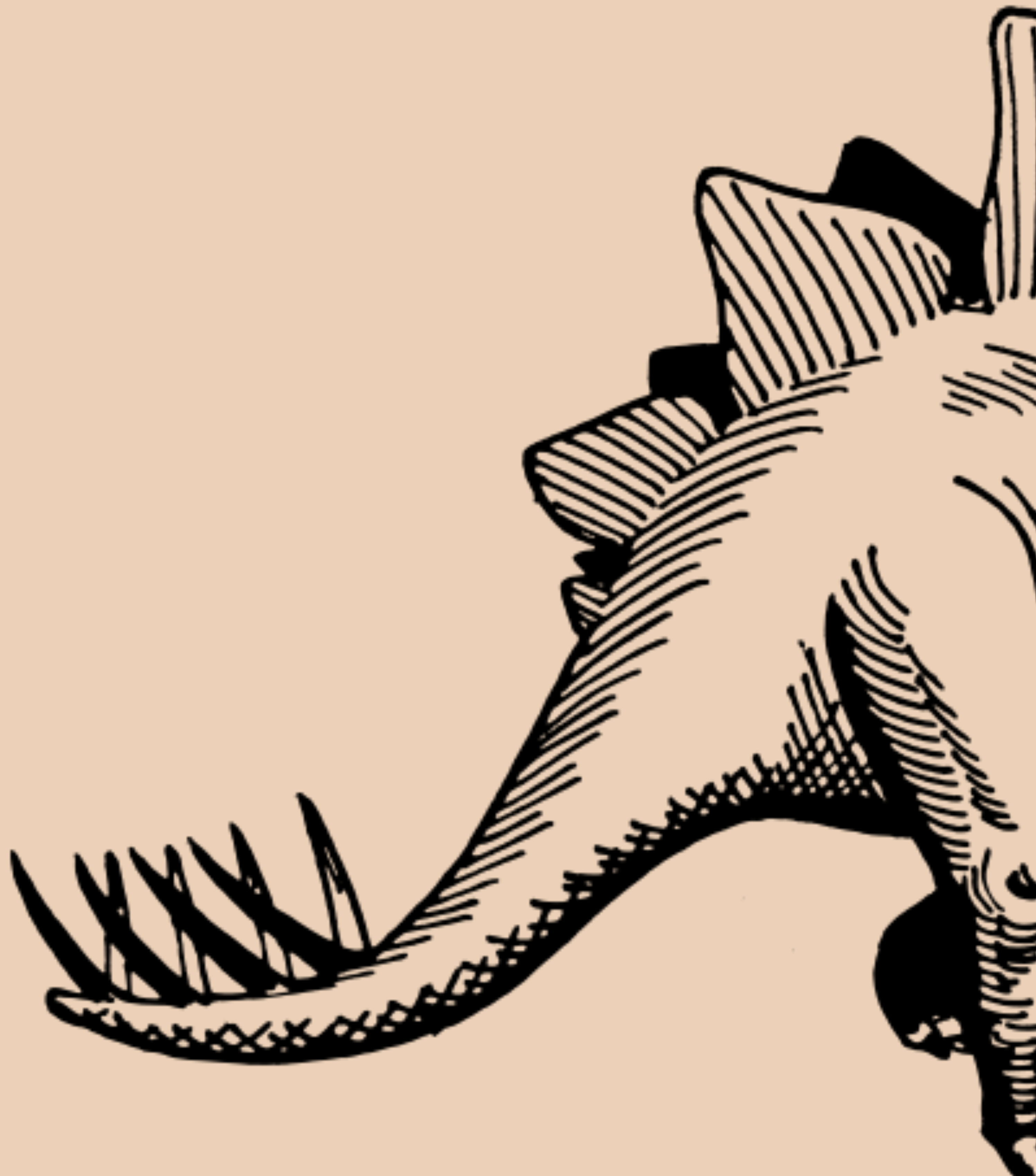
@thagomizer_rb

http://github.com/thagomizer

http://www.thagomizer.com



Functional Programming

What's That?

“In computer science, ***functional programming*** *is a* ***programming paradigm****, a style of building the structure and elements of computer programs, that treats computation as the evaluation of mathematical functions and avoids state and mutable data.”*

"The entire idea of mutable state is suspicious and easy to mess up"

“A functional language is just about calling functions.”

“No it's not about calling functions it is about creating functions that do things.”

This Talk

~~Assignment~~

Setting Expectations

- 112 slides
- Lots of Code
- Lots of Parenthesis
- No Ponies

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Why Should I Care?

Easier to Test

Concurrency

Safe Reuse

Brevity

You Already Use It

Ruby Makes It Easy

Scheme Basics

Prefix Notation

```
(+ 5 3)
  8

(* 1 2 3)
  6

(+ (* 3 5) (- 10 6))
  19

(add1 6)
  7
```

```
5 + 3
  8

1 * 2 * 3
  6

(3 * 5) + (10 - 6)
  19

6.add1
  7
```

Functions

```
(define (square n)
  (* n n)
)


(square 5)
  25
```

```
def square n
  n * n
end


square 5
  25
```

Conditionals

```
(define (abs x)
  (cond
   ((> x 0)
    x)
   ((= x 0)
    0)
   (else
    (- x))))
```

```
def abs x
  case
  when x > 0
    x
  when x == 0
    0
  else
    x * -1
  end
end
```

Side Note

```
case
when x > 0
  x
when x == 0
  0
else
  x * -1
end
```

Conditionals

```
(define (abs x)
  (cond
   ((> x 0) x)
   ((= x 0) 0)
   (else    (- x))))
```

```
def abs x
  case
  when x > 0
    x
  when x == 0
    0
  else
    x * -1
  end
end
```

Conditionals

```scheme
(define (balmy t)
  (if (> t 65)
       #t
       #f))
```

```ruby
def balmy? t
  if t > 65
    true
  else
    false
  end
end
```

Lists

```
'(1 2 3)
```

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

Lists

```
'(1 2 3)

(car '(1 2 3))
  1
```

```
[1, 2, 3]

[1, 2, 3].first
  1
```

Lists

```
'(1 2 3)

(car '(1 2 3))
  1

(cdr '(1 2 3))
  '(2 3)
```

```
[1, 2, 3]

[1, 2, 3].first
  1

[1, 2, 3][1..-1]
[2, 3]
```

Lists

```
'(1 2 3)

(car '(1 2 3))
  1

(cdr '(1 2 3))
  '(2 3)
```

```
[1, 2, 3]

[1, 2, 3].first
  1

[1, 2, 3].rest
[2, 3]
```

Lists

```
'(1 2 3)

(car '(1 2 3))
  1

(cdr '(1 2 3))
  '(2 3)


(null? '())
  #t
```

```
[1, 2, 3]

[1, 2, 3].first
  1

[1, 2, 3].rest
[2, 3]


[].empty?
  true
```

Recursion

Factorial

```
(define (fact n)
  (if (= n 1)
      1
      (* n
     (fact (- n 1)))
  )
)
```

```
def fact n
  if n == 1
    1
  else
    n * fact(n - 1)
  end
end
```

```scheme
(define (fib n)
  (cond ((= n 0)
         0)
        ((= n 1)
         1)
        (else
         (+
          (fib (-n 1))
          (fib (-n 2)))))))
```

```ruby
def fib n
  case n
  when 0
    0
  when 1
    1
  else
    fib(n-1) + fib(n-2)
  end
end
```

Tail Call Optimization

Exponentiation

```
(define (expt b n)
  (if (= n 0)
    1
    (* b
       (expt b(- n 1)))))
```

```
def expt(b, n)
  if n == 0
    1
  else
    b * expt(b,n-1)
  end
end
```

```
expt(2, 4)
2 * expt(2, 3)
2 * 2 * expt(2, 2)
2 * 2 * 2 * expt(2, 1)
2 * 2 * 2 * 2 * expt(2, 0)
2 * 2 * 2 * 2 * 1
2 * 2 * 2 * 2
2 * 2 * 4
2 * 8
16
```

Tail Call Optimization

```scheme
(define (expt b n)
  (expt-t b n 1))

(define (expt-t b c p)
  (if (= c 0)
      p
      (expt-t b
              (- c 1)
              (* b p))))
```

```ruby
def expt(b, n)
  expt_t(b, n, 1)
end

def expt_t(b, c, p)
  if c == 0
    p
  else
    expt_t(b, c-1,b*p)
  end
end
```

```
expt(2, 4)
  expt–t(2, 4, 1)
  expt–t(2, 3, 2)
  expt–t(2, 2, 4)
  expt–t(2, 1, 8)
  expt–t(2, 0, 16)
16
```

Semi-Contrived Example

Making Change

How many different ways can you make change of $1.00, given half-dollars, quarters, dimes, nickels, and pennies?

Simplify

How many ways can you make ***some amount***
with
some coins?

```ruby
def count_change(amount, coins)

end
```

```
amount: number of cents
```

`coins: a list of denominations`

How many ways can you make

some amount

with

some coins?

SIMPLIFY

How many ways can you make

1 cent

using

no coins?

0

```ruby
def count_change(amount, coins)
  case
  when coins.empty?
    0
  end
end
```

```
> count_change(1, [])
0
```

```
alias cc count_change
```

```
> cc(1, [])
0
```

How many ways can you make
1 cent
using
pennies?

1

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```
def cc(amount, coins)
  case
  when coins.empty?
    0
  when amount == coins.first
    1
  end
end
```

```
> cc(1, [1])
1
```

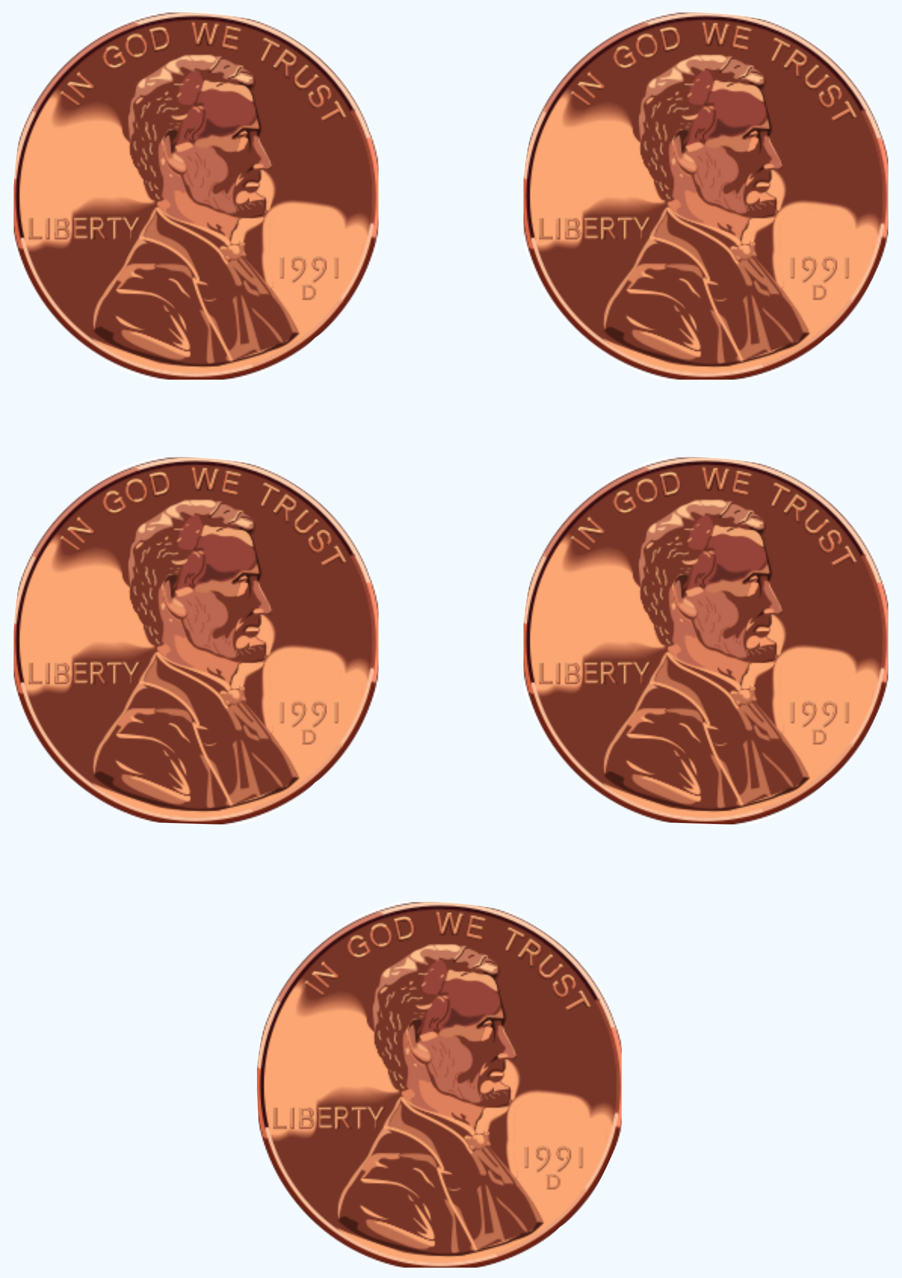
How many ways can you make

5 cents

using

pennies?

1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```
def cc(amount, coins)
  case
  when coins.empty?
    0
  when amount == coins.first
    1
  else
    cc(amount - coins.first, coins)
  end
end
```

```
> cc(5, [1])
1
```

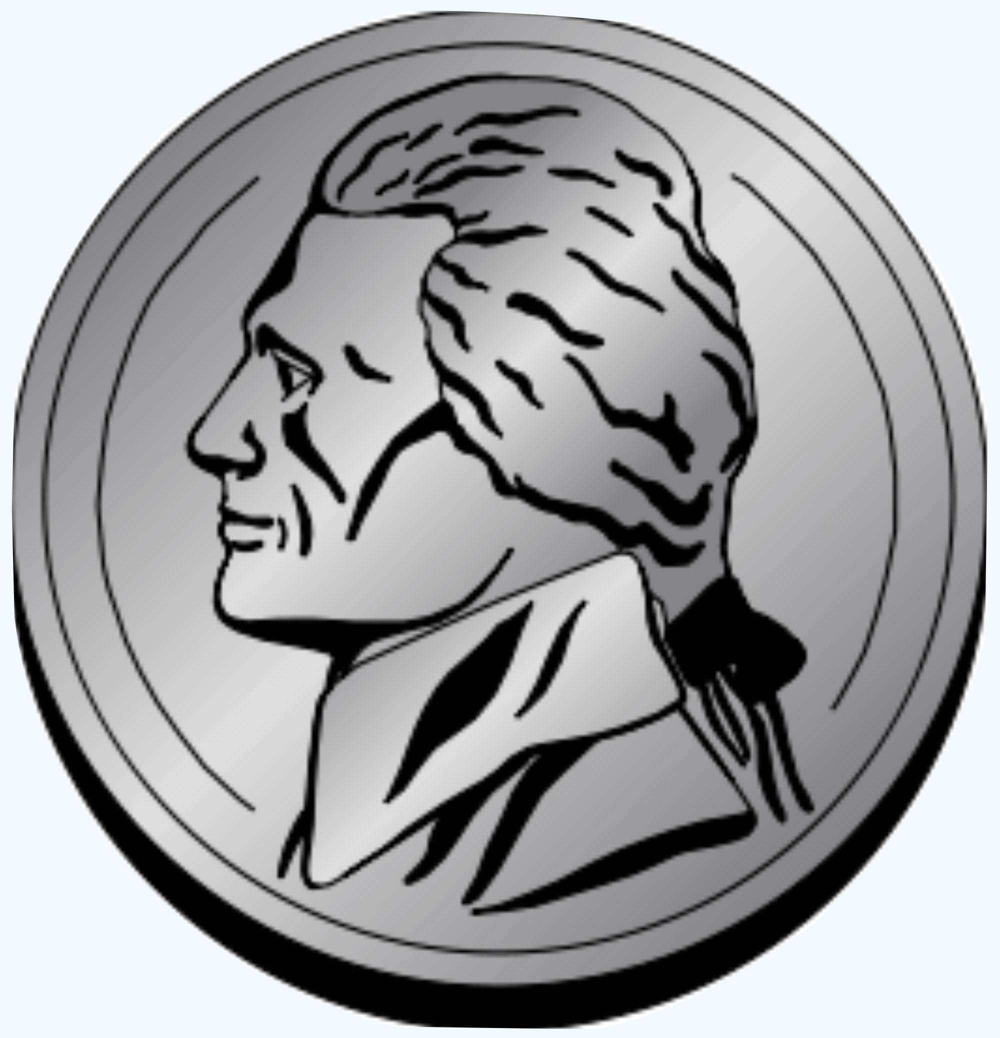
How many ways can you make

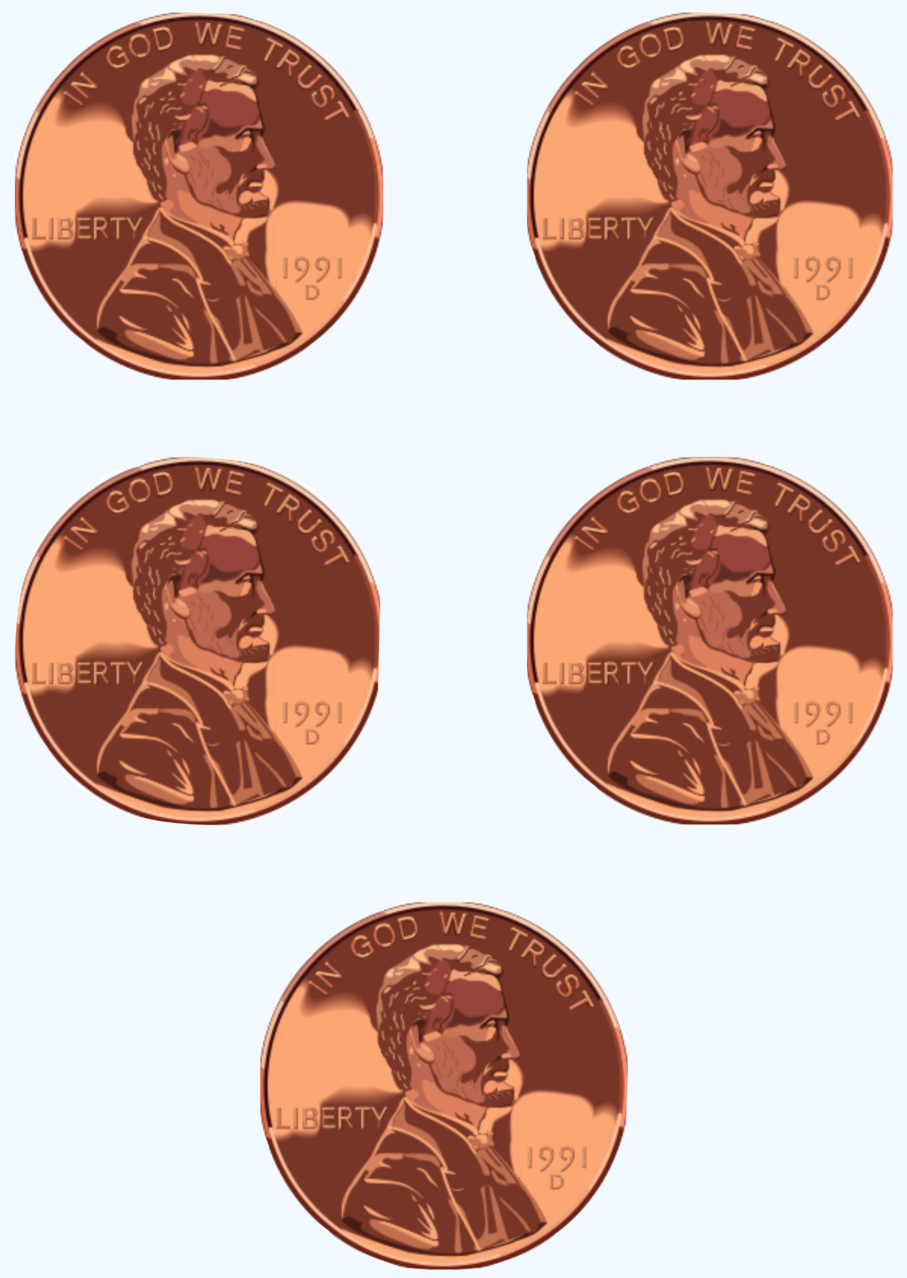
5 cents

using

nickels and pennies?

2

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```
> cc(5, [5, 1])
1
```

?????

```ruby
def cc(amount, coins)
  case
  when coins.empty?
    0
  when amount == coins.first
    1
  else
    cc(amount - coins.first, coins)
  end
end
```

```
def cc(5, [5,1])
  case
  when [5,1].empty?
    0
  when 5 == 5
    1
  else
    cc(5 - 5, [5,1])
  end
end
```

```
def cc(5, [5,1])
  case
  when [5,1].empty?
    0
  when 5 == 5
    1
  else
    cc(5 - 5, [5,1])
  end
end
```

```
def cc(5, [5,1])
  case
  when [5,1].empty?
    0
  when 5 == 5
    1
  else
    cc(5 - 5, [5,1])
  end
end
```

```
def cc(amount, coins)
  case
  when coins.empty?
    0
  when amount == coins.first
    1 + cc(amount, coins.rest)
  else
    cc(amount - coins.first, coins)
  end
end
```

```
> cc(5, [5, 1])
2
```

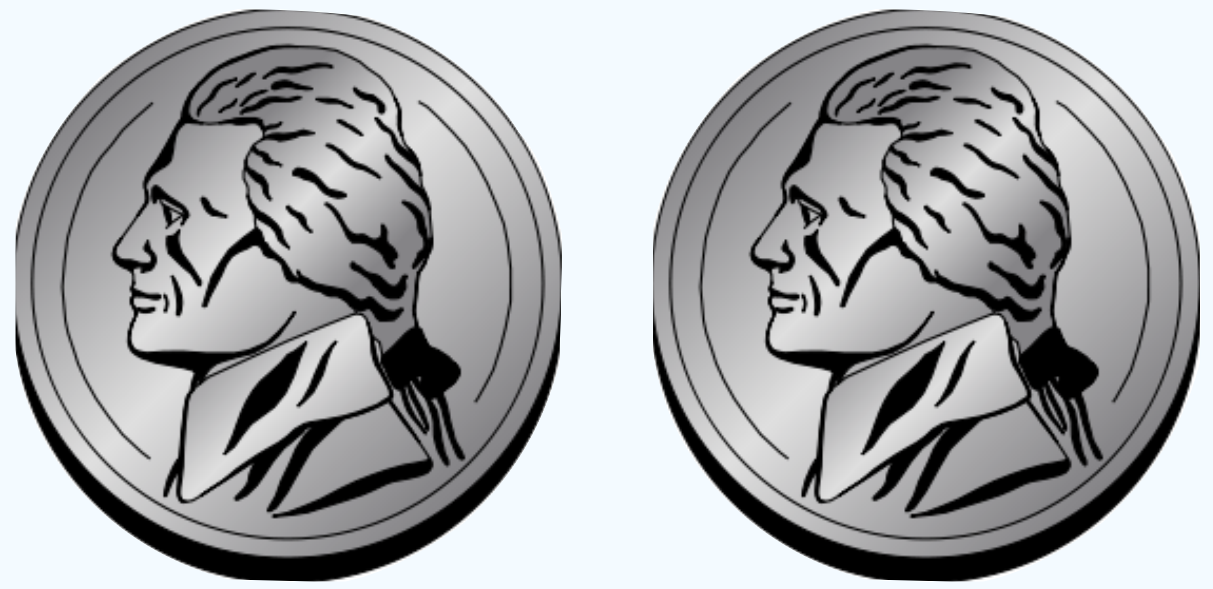
How many ways can you make

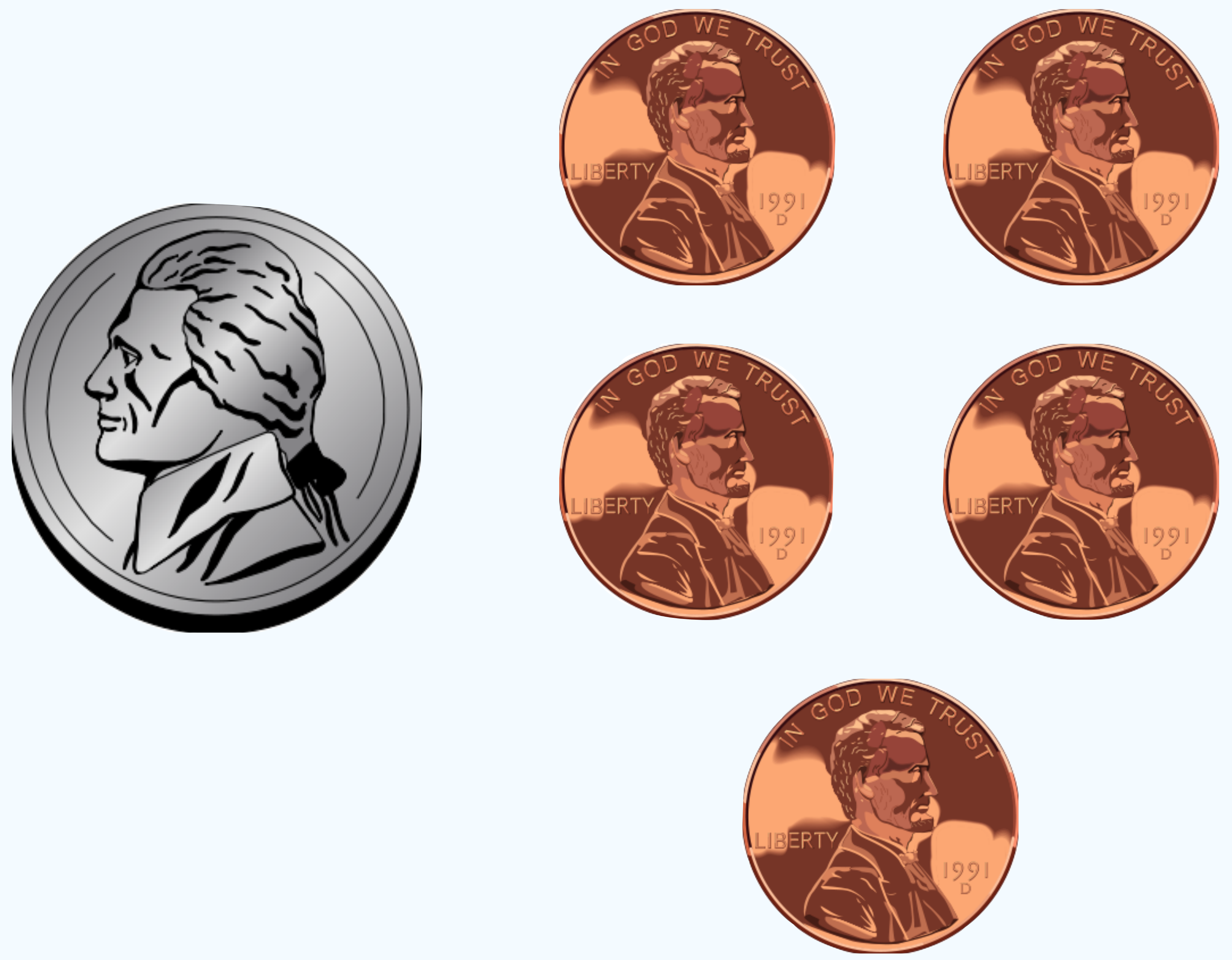
10 cents

using

nickels and pennies?

3

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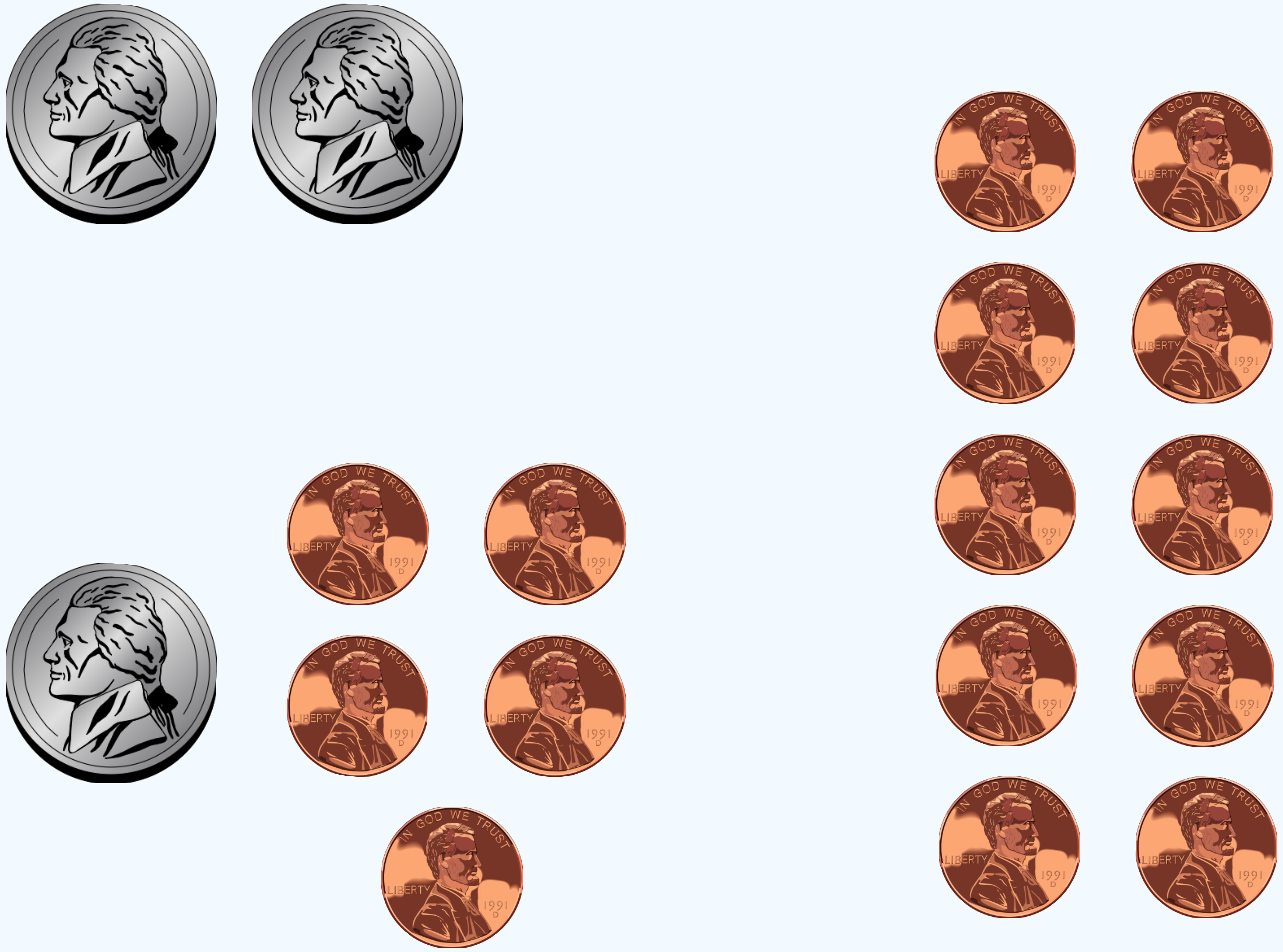
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```
> cc(10, [5, 1])
2
```

?????

```
def cc(10, [5,1])
  case
  when [5,1].empty?
    0
  when 10 == 5
    1 + cc(amount, coins.rest)
  else
    cc(10 - 5, [5,1])
  end
end
```

```
def cc(10, [5,1])
  case
  when [5,1].empty?
    0
  when 10 == 5
    1 + cc(amount, coins.rest)
  else
    cc(10 - 5, [5,1])
  end
end
```

```
def cc(10, [5,1])
  case
  when [5,1].empty?
    0
  when 10 == 5
    1 + cc(amount, coins.rest)
  else
    cc(10 - 5, [5,1])
  end
end
```

```
def cc(10, [5,1])
  case
  when [5,1].empty?
    0
  when 10 == 5
    1 + cc(amount, coins.rest)
  else
    cc(10 - 5, [5,1])
  end
end
```

```ruby
def cc(amount, coins)
  case
  when coins.empty?
    0
  when amount == coins.first
    1 + cc(amount, coins.rest)
  else
    cc(amount, coins.rest) +
    cc(amount - coins.first, coins)
  end
end
```

```
> cc(10, [5, 1])
3
```

How many ways can you make
7 cents
with
nickels?

0

```
> cc(7, [5])
SystemStackError: stack level too deep
```

Uh-Oh

```
def cc(7, [5])
  case
  when [5].empty?
    0
  when 7 == [5].first
    1 + cc(7, [])
  else
    cc(7, []) +
    cc(7 - 5, [5])
  end
end
```

```
def cc(amount, coins)
 case
 when coins.empty?
   0
  when amount < coins.first
    cc(amount, coins.rest)
  when amount == coins.first
    1 + cc(amount, coins.rest)
  else
    cc(amount, coins.rest) +
      cc(amount - coins.first, coins)
  end
end
```

```
> cc(7, [5])
0
```

How many different ways can you make change of $1.00, given half-dollars, quarters, dimes, nickels, and pennies?

```
> cc(100, [50, 25, 10, 5, 1])
292
```

```
(define (cc amount coins)
  (cond
   ((null? coins) 0)
   ((< amount (car coins))
    (cc amount (cdr coins)))
   ((= amount (car coins))
    (+ 1
       (cc amount (cdr coins))))
   (else
    (+
     (cc amount (cdr coins))
     (cc (- amount (car coins)) coins)))))
```

More Functions!

Member

```scheme
(define (member l n)
  (cond ((null? l)
         #f)
        ((= (car l) n)
         #t)
        (else
         (member
          (cdr l) n))))
```

```ruby
def member(l, n)
  case
  when l.empty?
    false
  when l.first == n
    true
  else
    member(l.rest, n)
  end
end
```

Member

```
(define (member l n)
  (cond ((null? l)
         #f)
        ((= (car l) n)
         #t)
        (else
         (member
          (cdr l) n))))
```

```
def member(l, n)
  case
  when l.empty?
    false
  when l.first == n
    true
  else
    member(l.rest, n)
  end
end
```

Any?

```scheme
(define (any l pred)
  (cond ((null? l)
         #f)
        ((pred (car l))
         #t)
        (else
         (any
          (cdr l) pred))))
```

```ruby
def any(l, pred)
  case
  when l.empty?
    false
  when pred.call(l.first)
    true
  else
    any(l.rest, pred)
  end
end
```

Any?

```scheme
(define (any l pred)
  (cond ((null? l)
         #f)
        ((pred (car l))
         #t)
        (else
         (any
          (cdr l) pred))))
```

```ruby
def any(l, pred)
  case
  when l.empty?
    false
  when pred.call(l.first)
    true
  else
    any(l.rest, pred)
  end
end
```

Anon. Functions

```
((lambda (x)
  (* x x))
  3)

9
```

```
lambda { |x|
  x * x
}.call(3)

9
```

```
> (any '(1 2)
  (lambda (x)
  (< x 5)))
#t

> (any '(1 2)
    (lambda (x)
     (= x 5)))
#f
```

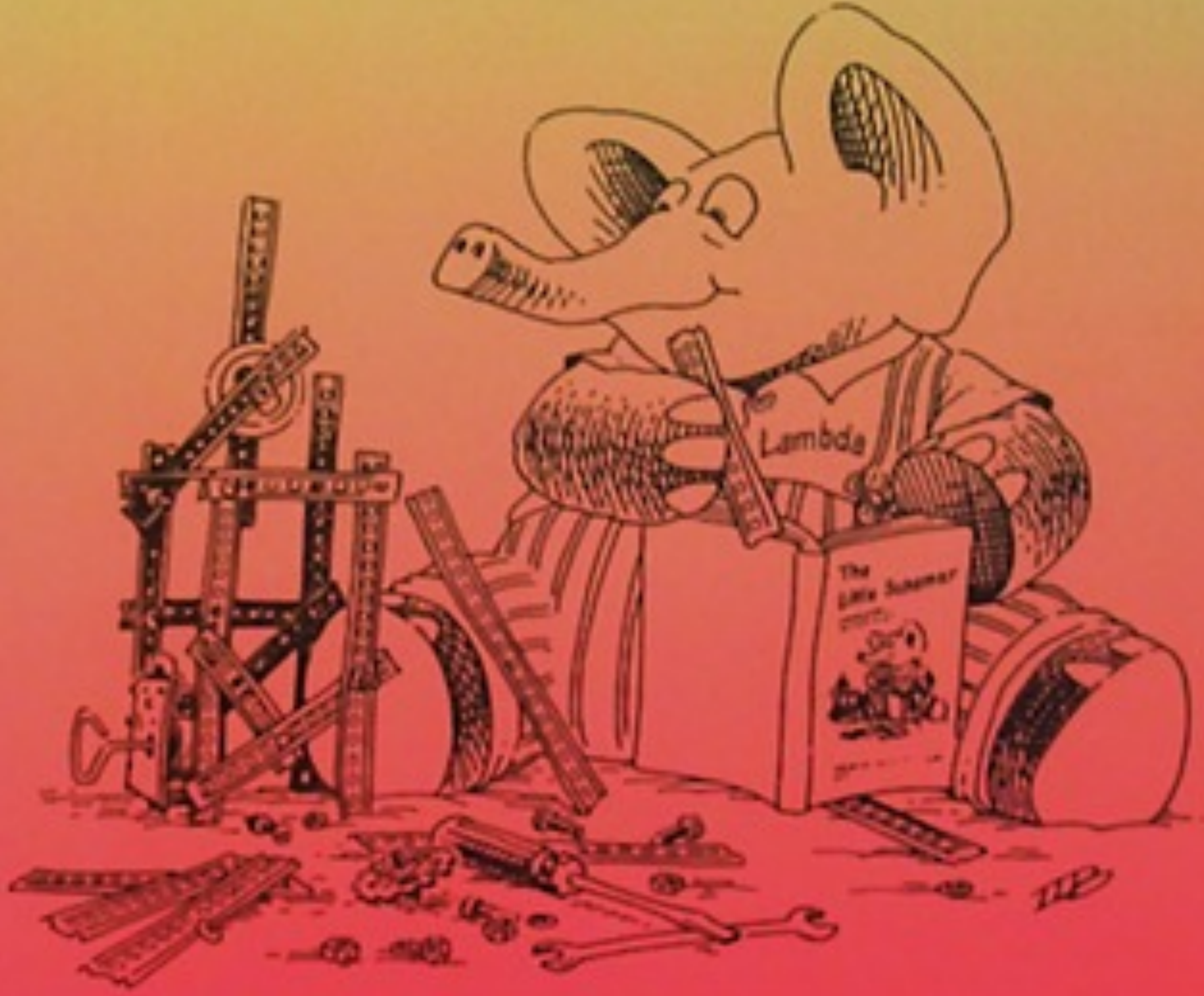
```
> any([1, 2],
      lambda { |x|
        x < 5})
true

> any([1, 2],
      lambda { |x|
        x == 5})
false
```

Learn More

The Little Schemer

Fourth Edition



Daniel P. Friedman and Matthias Felleisen

Foreword by Gerald J. Sussman

What is (

What is (− 17 9)

8.

What is (− 18 25)

No answer. There are no negative numbers.

Try to write the function −
Hint: Use *sub1*

How about this:

```
(define −¹
  (lambda (n m)
    (cond
      ((zero? m) n)
      (else (sub1 (− n (sub1 m)))))))
```

¹ L, S: This is like -. Write it as o- (see preface).

Can you describe how (− *n m*) works?

It takes two numbers as arguments, and reduces the second until it hits zero. It subtracts one from the result as many times as it did to cause the second one to reach zero.

Is this a tup?
(2 11 3 79 47 6)

Yes: tup is short for tuple.

Is this a tup?
(8 55 5 555)

Yes, of course, it is also a list of numbers.

Is this a tup?
(1 2 8 apple 4 3)

No, it is just a list of atoms.

Is this a tup?
(3 (7 4) 13 9)

No, because it is not a list of numbers.
(7 4) is not a number.

Structure and Interpretation of Computer Programs

Second Edition

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Talks

- *Functional Programming and Ruby* by Pat Shaughnessy (GoRuCo 2013)
- *(Parenthetically Speaking)* by Jim Weirich (GoGaRuCo 2010)
- *Functional Principles for OO Development* by Jessica Kerr (Ruby Midwest 2013)
- *Y Not -- Adventures in Functional Programming* by Jim Weirich (Ruby Conf 2012)

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- http://cgeta.deviantart.com/art/Boring-Pinkie-Vector-205068021

Thank You