Discussion 02: More Environments and Recursion

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Agenda

1. Feedback!
2. Attendance
3. Announcements
4. Check Your Understanding
5. Recursion
6. Environment diagrams again (slides skipped in class)
7. Lambdas (slides skipped in class)

Thanks for your feedback! Some common trends:

Too much talking, not enough "doing"

- I will blab a bit less
- If I go through slides too quickly, check them out later online!

Attendance

Sign in at tiny.cc/jerrydisc

Announcements

Homework 2 due Tuesday

- HW Party in 247 Cory Monday 6:30pm-8:30pm

Sign ups for CSM sections are open! Sections start next week

Piazza — please, no public code!

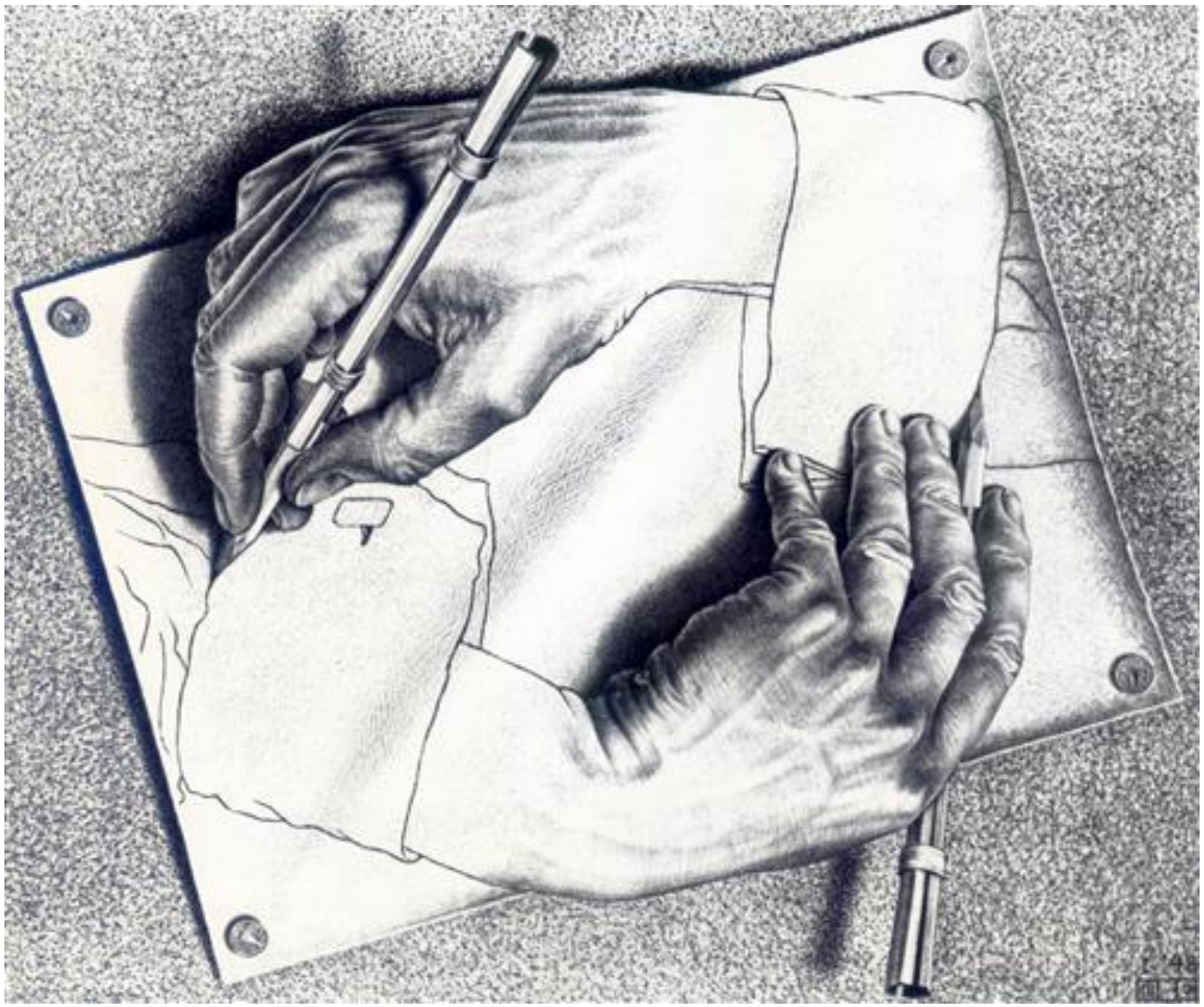
Check Your Understanding

```
square = lambda x: x * x

def test(f, x):
    if f(x) % 2 == 0:
        return lambda g, x: g(square, x)
    else:
        return f(x)

print(test(lambda s: s // 2, 20)(test, 7))
```

Recursion



Drawing Hands by M. C. Escher

Recursion

Recursion, what is it good for?

- Recursive data structures later on
- Can be used to reason about tricky problems, but…
    - In practice, iteration is often faster and cheaper

Recursion

Components of a recursive function

- **Base case,** a simple stopping condition
- **Recursive calls** on smaller problem
- **Putting it together:** solve our prob using recursive result

Leap of faith: assume our recursive function solves any smaller version of the problem

Recursion

Factorial example

```
def factorial(n):
    if n == 0:
        return 1
    return n * factorial(n - 1)
```

Recursion

Fast Exponentiation

```
def exp(b, n):
    if n == 0:
        return 1
    if n % 2 == 0:
        return exp(b ** 2, n / 2)
    else:
        return b * exp(b, n - 1)
```

Recursion

What's Wrong?

```
def hailstone(n):
    print(n)
    if n == 1:
        return
    elif n % 2 == 0:
        hailstone(n - 1)
    else:
        hailstone(n - 1)
```

Recursion

What's Wrong?

```
def hailstone(n):
    print(n)
    if n == 1:
        return
    elif n % 2 == 0:
        n = n // 2
        hailstone(n - 1)
    else:
        n = 3 * n + 1
        hailstone(n - 1)
```

Tree Recursion

Recursive functions can sometimes require more than one call!

```
Fib(n) = Fib(n - 1) + Fib(n - 2)
```

Very powerful, but also potentially very slow (why?)

Useful when you want to represent choices (e.g. taking one stair or two stairs)

Environment Diagrams

New: Names can also be bound to functions!

Some rules:

- **Function call: create and number new frame** (f1, f2, etc.) — always start in global frame

- **Assignment:** write variable name and expression value

- **Def statements:** record function name and bind function object. Remember parent frame!

- **Frames return values** upon completion (Global is special)

Environment Diagrams

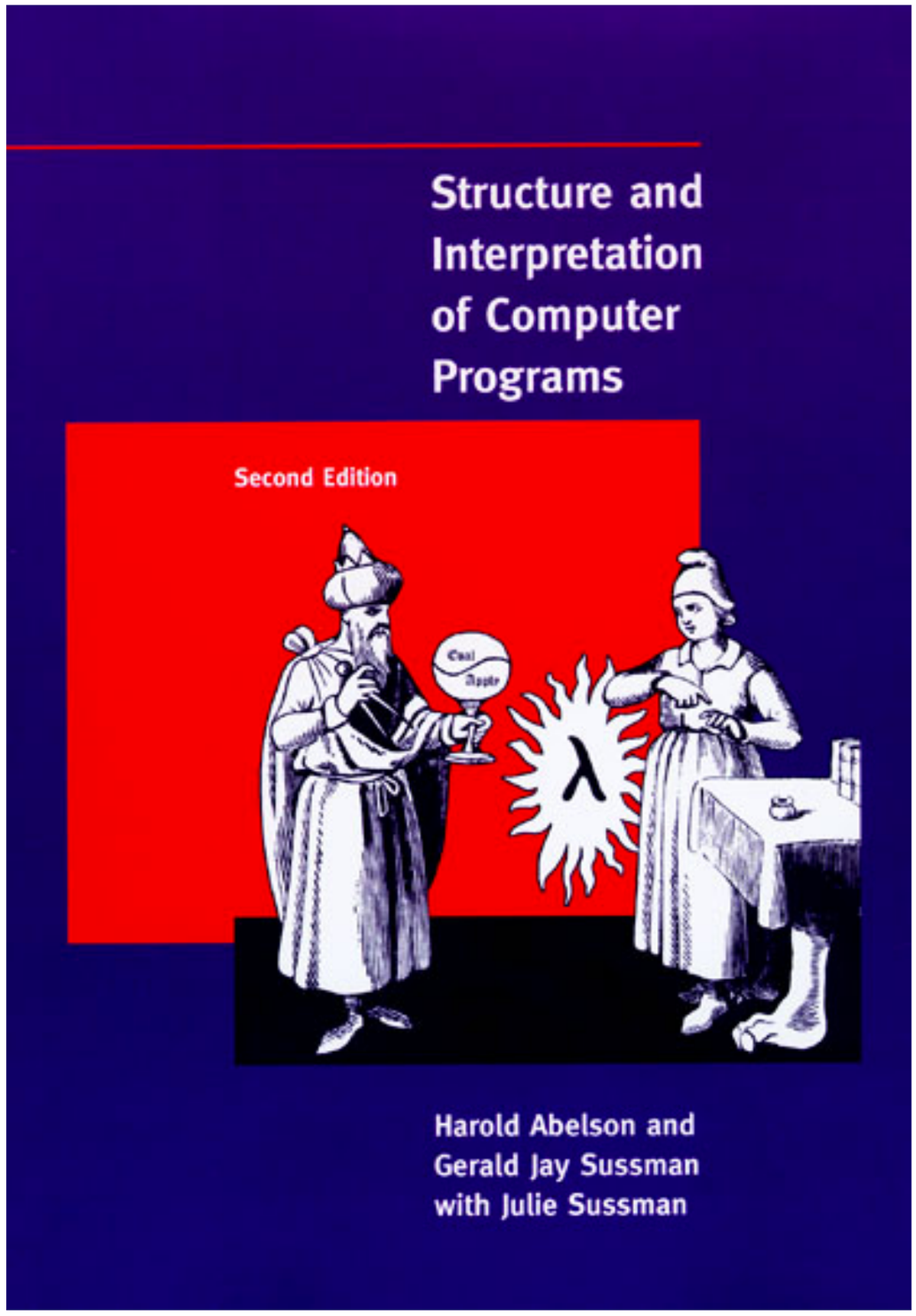
From Kevin Chen's Fall 2015 Review (https://goo.gl/Z6GNwi)

```
x = 2
def dread(pirate):
    x = 30
    def roberts(westley):
        x = 400
        return westley + pirate(x)

    return roberts(x)

dread(lambda spot: x + spot)
```

A Lambda Detour



A Lambda Detour

```
(lambda x, y: x + y * y)(4, 5)
```

Lambda definition

Lambda call

Result (after currying):

```
(lambda x = 4, y = 5: x + y * y)
```