UC Berkeley EECS
Lecturer
Michael Ball

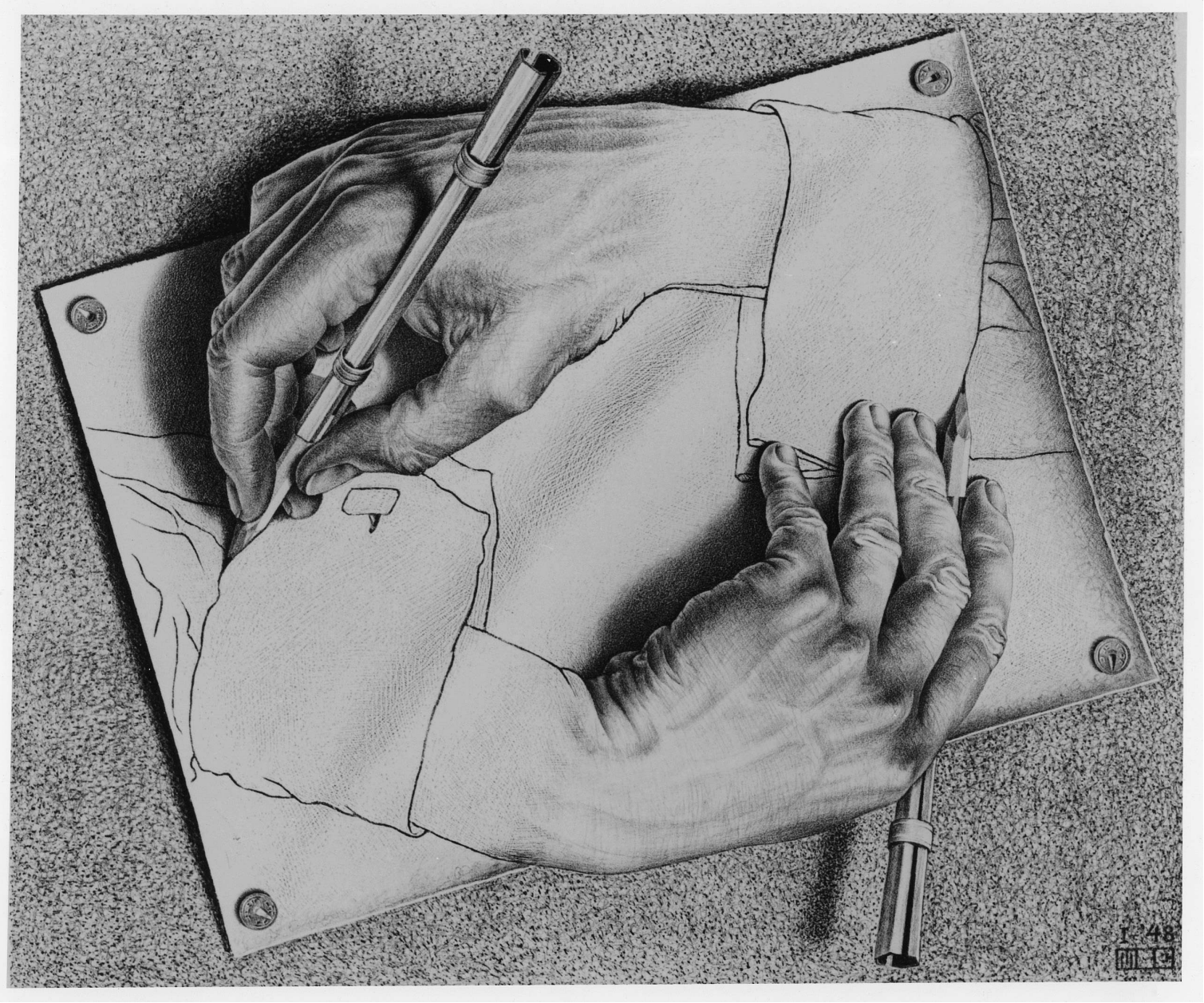
Computational Structures in Data Science

Lecture 5: Recursion

October 7, 2019

http://cs88.org

MC Escher “Drawing Hands” 1948



Administrative Issues

- **Midterm Next Week!**
- **7-9pm, Dwinelle 155**

Computational Concepts Toolbox

- Data type: values, literals, operations,
  - e.g., int, float, string
- Expressions, Call expression
- Variables
- Assignment Statement
- Sequences: tuple, list
  - indexing
- Data structures
- Tuple assignment
- Call Expressions
- Function Definition Statement
- Conditional Statement
- Iteration:
  - data-driven (list comprehension)
  - control-driven (for statement)
  - while statement
- Higher Order Functions
  - Functions as Values
  - Functions with functions as argument
  - Assignment of function values
- Higher order function patterns
  - Map, Filter, Reduce
- Recursion

Today: Recursion

re·cur·sion
/riˈkərZHən/

noun MATHEMATICS LINGUISTICS

the repeated application of a recursive procedure or definition.

- a recursive definition.
  plural noun: **recursions**

re·cur·sive
/riˈkərsiv/

adjective

characterized by recurrence or repetition, in particular.

- MATHEMATICS LINGUISTICS
  relating to or involving the repeated application of a rule, definition, or procedure to successive results.
- COMPUTING
  relating to or involving a program or routine of which a part requires the application of the whole, so that its explicit interpretation requires in general many successive executions.

- **Recursive function calls itself, directly or indirectly**

Why Recursion?

- "After Abstraction, Recursion is probably the 2nd biggest idea in this course"
- "It's tremendously useful when the problem is self-similar"
- "It's no more powerful than iteration, but often leads to more concise & better code"
- "It embodies the beauty and joy of computing"

Why Recursion? More Reasons

- **Recursive structures exist (sometimes hidden) in nature and therefore in data!**
- **It's mentally and sometimes computationally more efficient to process recursive structures using recursion.**

Function Review

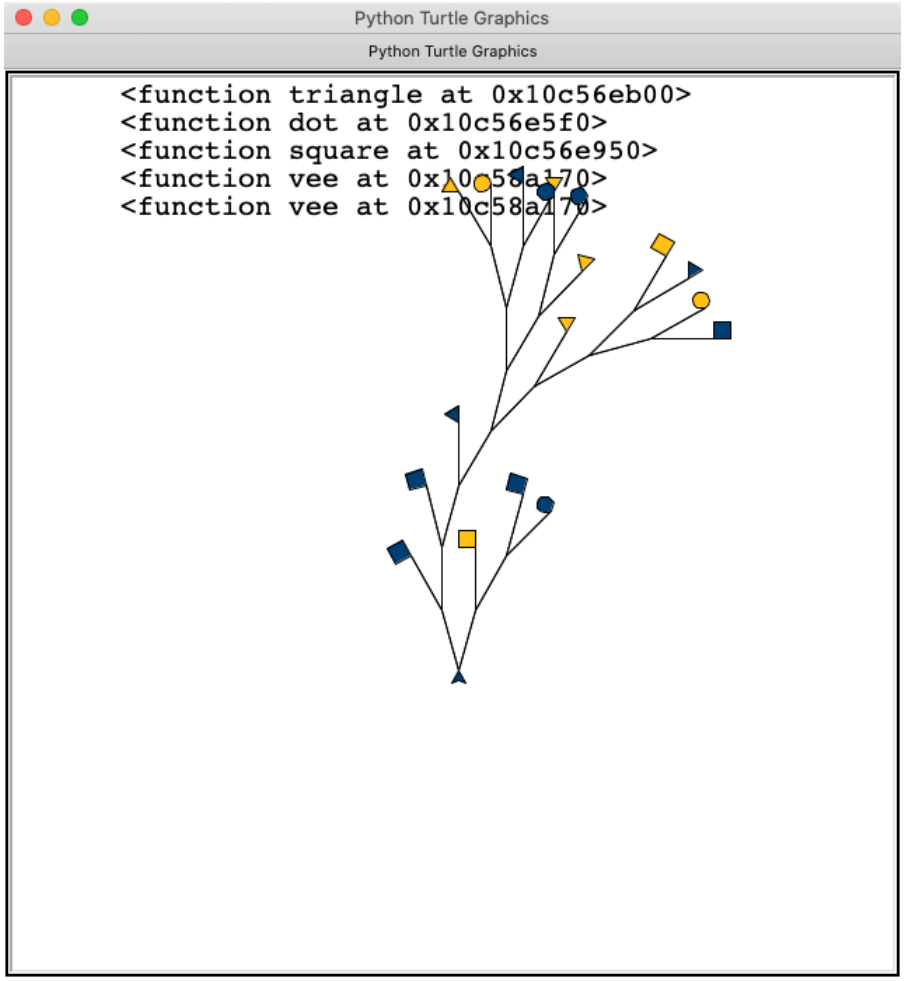
- A function cannot…

  A) have a function as argument
  B) define a function within itself
  C) return a function
  D) call itself
  E) None of the above.

Solution:
E) A, B, C, D are all possible!

Demo Time

- **Vee a randomly recursive fractal**



Recursion

- Recursion is…

A) Less powerful than a for loop
B) As powerful as a for loop
C) As powerful as a while loop
D) More powerful than a while loop
E) Just different but equally powerful as a for loop AND a while loop

Solution:
E) Different – it reads differently, but you can solve any problem with one of these techniques. (Some tools are better suited for some jobs though.)`

So far I feel…

- I "get" vee and countdown

  A) I am totally lost
  B) It's confusing, but I kinda get it
  C) Starting to make sense…
  D) I get it, but have questions
  E) No questions at all!