Put your notes here

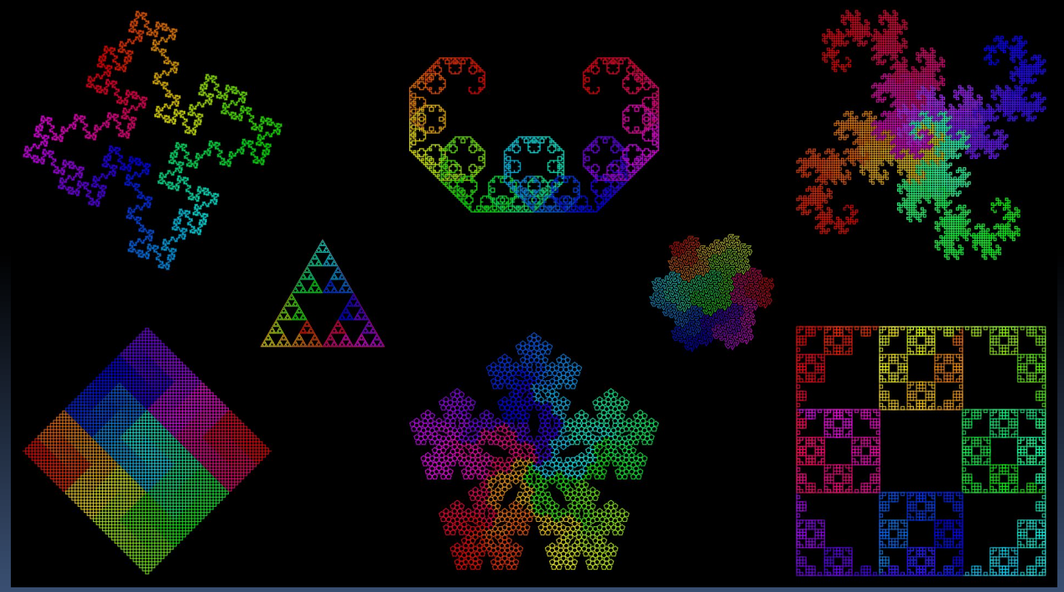
CS10 NEWS

UC Berkeley
Teaching Professor
Dan Garcia

The Beauty and Joy of Computing

Recursion III

elc.github.io/posts/plotting-fractals-step-by-step-with-python/



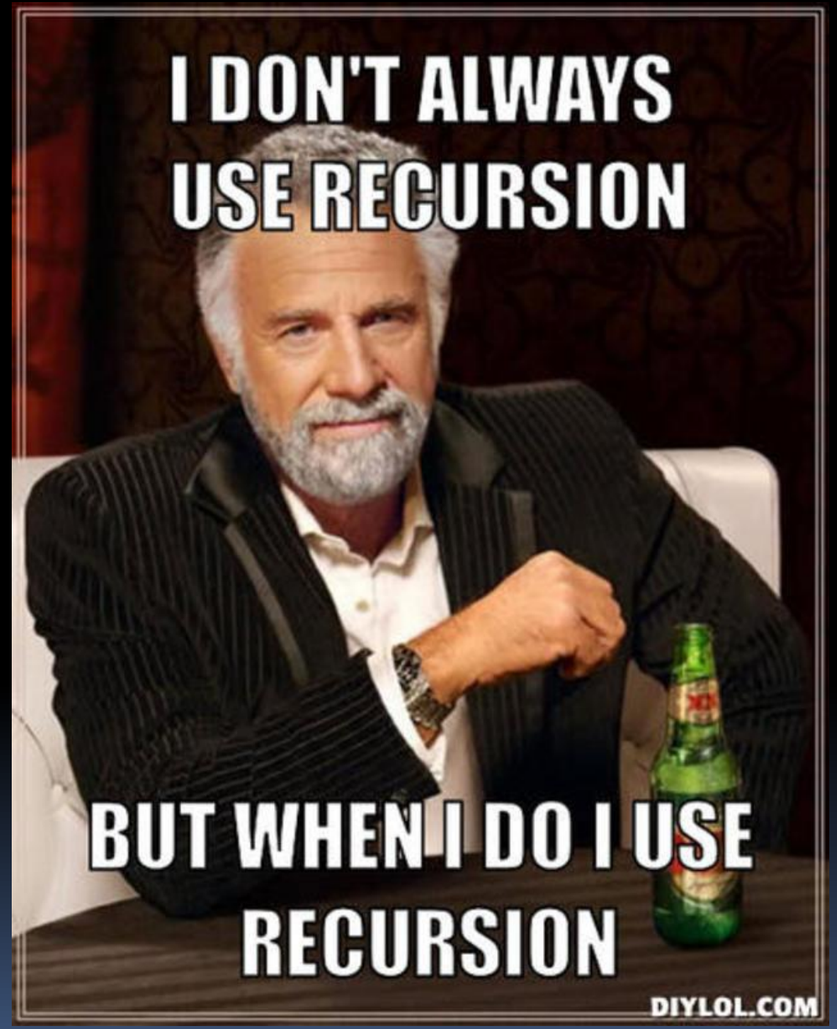
Runners Cyclists Use GPS Mapping to Make Art

Fitness apps and the power of live satellite tracking have allowed runners, cyclists and others to draw hearts, animals, birthday wishes — and even homages to Vermeer — across their local landscapes.

www.nytimes.com/2022/09/24/techn

(Cal) Overview

- Recursion
  - Factorial Demo
  - Fibonacci Demo
  - Count Change

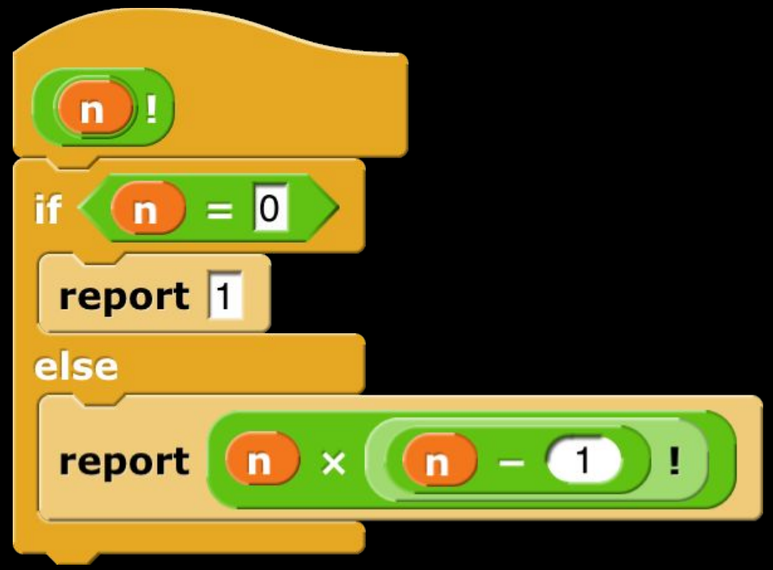


Recursion: Factorial

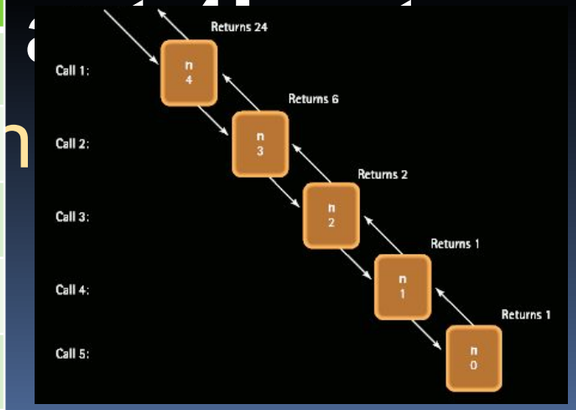
www.bogotobogo.com/cplusplus/images/quiz/recursion_factorial.png

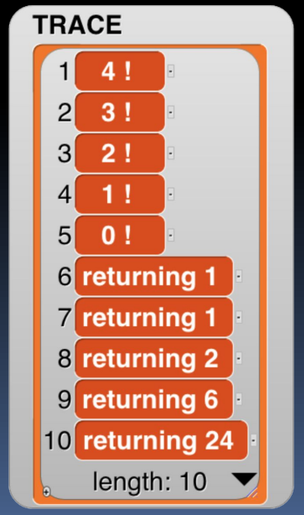
Recursion: Demonstrating n!

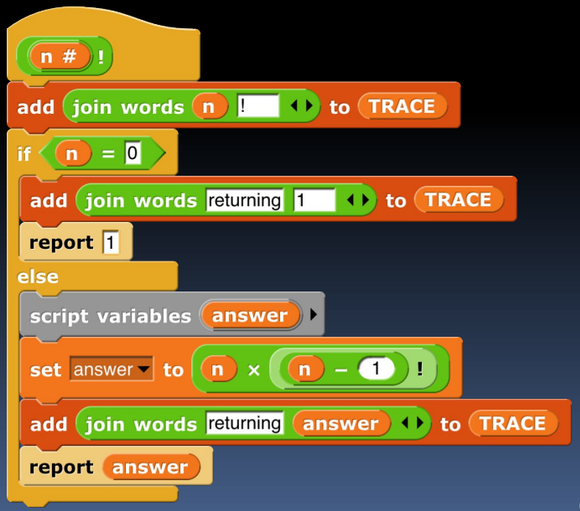
- **Factorial(n) = n! Inductive definition:**
  - n! = 1 , n = 0
  - n! = n * (n-1)! , n > 0
- **I**



n	n!
0	1
1	1
2	2
3	6
4	24







(Cal) Order of growth of # of calls of n!

a) Constant
b) Logarithmic
c) Linear
d) Quadratic
e) Exponential

(source: FallingFifth.com)

L12a Order of growth of # of calls of n!

Constant

Logarithmic

Linear

Quadratic

Cubic

Exponential

Recursion: Fibonacci

en.wikipedia.org/wiki/Fibonacci_number
www.ics.uci.edu/~eppstein/161/960109.html

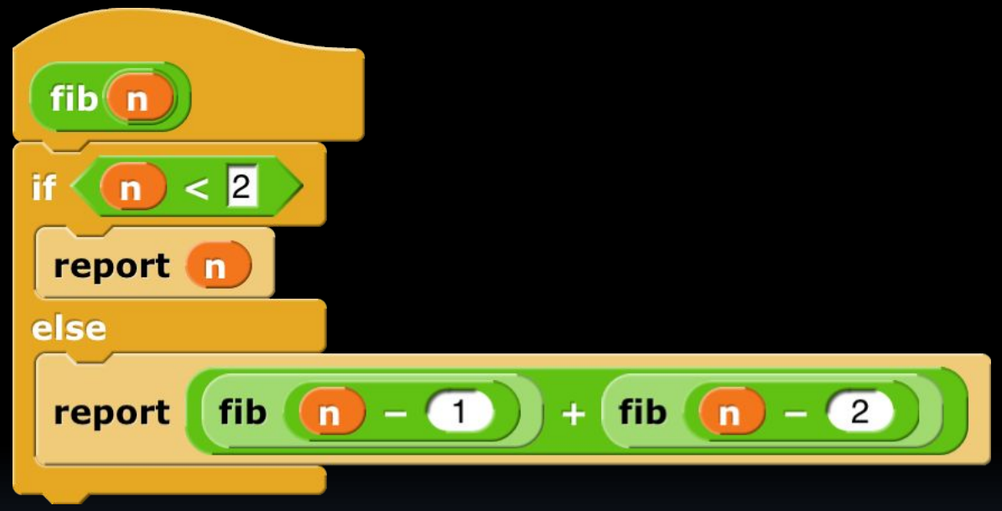
Recursion: Demonstrating fib(n)

- **Inductive definition:**
  - fib(n) = n , n < 2
  - fib(n) = fib(n-1)+fib(n-2) , n ≥ 2

$$F(n) := \begin{cases} 0 & \text{if } n = 0; \\ 1 & \text{if } n = 1; \\ F(n-1) + F(n-2) & \text{if } n > 1. \end{cases}$$

- **Let's act it out…**
  - "contractor" model
  - fib(5)

n	fib(n)
0	0
1	1
2	1
3	2
4	3
5	5



Let's now: trace… (gif from Ybungalobill@wikimedia)

Order of growth of # of calls of fib(n)

a) Constant
b) Logarithmic
c) Linear
d) Quadratic
e) Exponential

Chimney of Turku Energia, Turku, Finland featuring Fibonacci sequence in 2m high neon lights. By Italian artist Mario Merz for an environmental art project. (Wikipedia)

L12b Order of growth of # of calls of fib(n)

Constant

Logarithmic

Linear

Quadratic

Cubic

Exponential

Recursion: Count Change

Counting Change (thanks to BH)

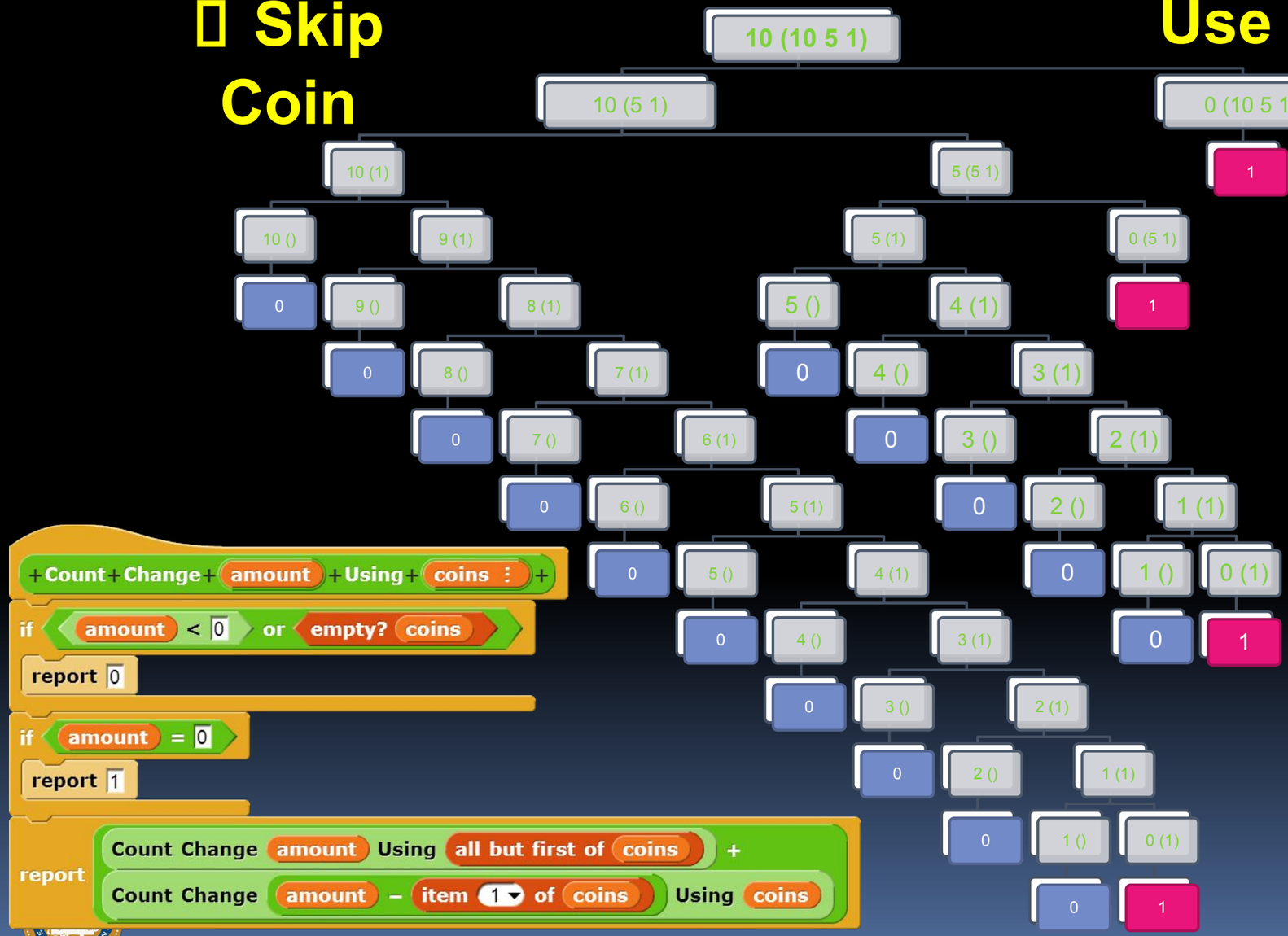
- Given coins {50, 25, 10, 5, 1} how many ways are there of making change?

- 5
  - **2** (N, 5P)
- 10
  - **4** (D, 2N, N5P, 10P)
- 15
  - **6** (DN, D5P, 3N, 2N5P, 1N10P, 15P)
- 100?

Call Tree for “Count Change 10 (10 5 1)”

Skip Coin

Use Coin



“I understood Count Change”

a) Strongly agree
b) Agree
c) Neutral
d) Disagree
e) Strongly disagree

www.nilkanth.com/my-uploads/200508/dactylfractal107.jpg

When poll is active, respond at **pollev.com/ddg**

Text **DDG** to **22333** once to join

L12c "I understood Count Change"

Strongly agree

Agree

Neutral

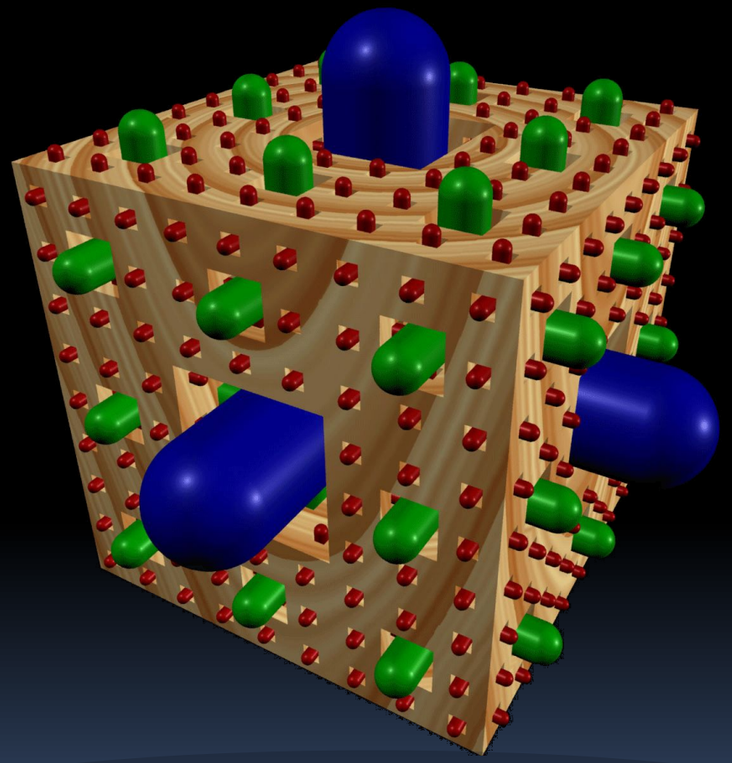
Disagree

Strongly disagree

Summary

- It's important to understand the machine model
- It's often the simplest way to solve many problems
  - Esp if recursive in nature!
- Remember, trust it!
- Recursion is a very powerful idea, often separates good from great (you're great!)

Menger Cube by Dan Garcia



Garcia