The Beauty and Joy of Computing

Lecture #10
Recursion II

Recursive Drawing

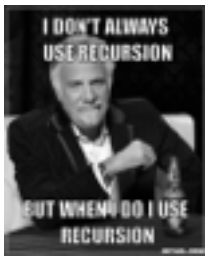
Toby Shachman created this amazing spatial programming language called "Recursive Drawing" that allows you to create drawings (even recursive ones!) without typing a line of code. It's a great example of a next-generation interface....

recursivedrawing.com

www.worldofescher.com/gallery/A13.html

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
- Let's act 4! out...
  - "contractor" model

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

4!

Order of growth of # of calls of n!

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

[source: FallingFifth.com]

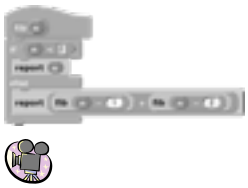
Recursion: Fibonacci

Recursion: Demonstrating fib(n)

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

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

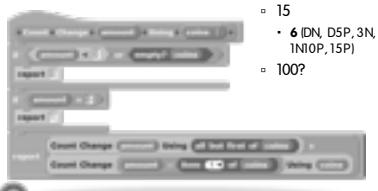
a) Constant
b) Logarithmic
c) Linear
d) Quadratic
e) Exponential

Chimney of Turku Energia, Turku, Finland featuring Fibonacci sequence in 2 mh, 3 mh, 5 mh, 8 mh, 13 mh, 21 mh. By Italian artist Mario Merz for an environmental art project. (Wikipedia)

Recursion: Count Change

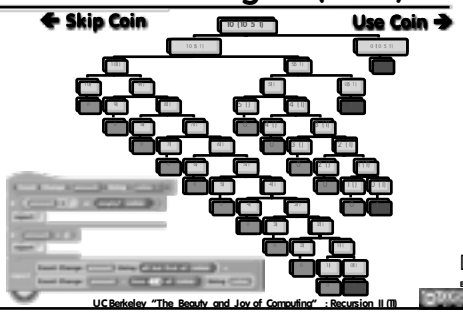
Counting Change (thanks to BH)

- Given coins {50, 25, 10, 5, 1} how many ways are there of making change?
  - 5
    - **2** (1N, 5P)
  - 10
    - **4** (1D, 2N, 1N5P, 10P)
  - 15
    - **6** (1DN, 1D5P, 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.nikkarth.com/my-uploads/2008/dactylifedall07.jpg

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