



# CS10 The Beauty and Joy of Computing

## Lecture #11 : Recursion II

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Hello to Yue Li,  
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IPAD 2 ANNOUNCED TODAY

Will Apple continue to thrall its users  
with outstanding technology amidst  
tons of competition from its Android  
Rivals? Will Steve Jobs make an  
appearance? Will you buy one?

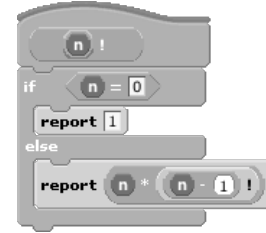


www.apple.com

## How the Computer Works ... n!

- Factorial(n) = n!
- Inductive definition:
  - $n! = 1$ ,  $n = 0$
  - $n! = n * (n-1)!$ ,  $n > 0$
- Let's act it out...
  - "Little people", or "subcontractor" model

n	n!
0	1
1	1
2	2
3	6
4	24
5	120



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## How the Computer Works ... fib(n)

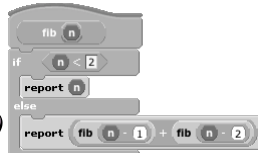
- Inductive definition:
  - $\text{fib}(n) = n$ ,  $n < 2$
  - $\text{fib}(n) = \text{fib}(n-1) + \text{fib}(n-2)$ ,  $n > 1$
- Let's act it out...
  - "contractor" model

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



Leonardo da Pisa  
aka, Fibonacci

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

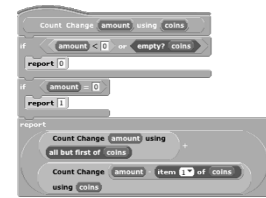


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## Counting Change (thanks to BH)

- Given coins {50, 25, 10, 5, 1} how many ways are there of making change?
  - 5: 2 (N, 5 P)
  - 10
  - 4 (D, 2N, N 5P, 10P)
  - 15
  - 6 (DN, D5P, 3N, 2N5P, 1N10P, 15P)
  - 100?



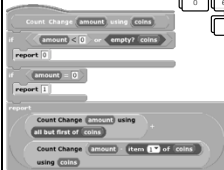
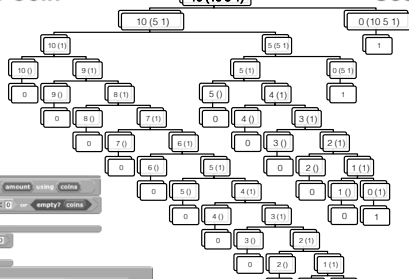
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## Call Tree for "Count Change 10 (10 5 1)"

Skip Coin

Use Coin

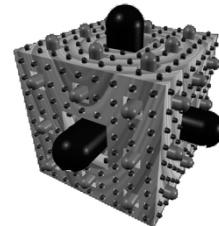


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## Summary

- It's important to understand the machine model
- Recursion is a very powerful idea, and one way to separate good from great

Menger Cube by Dan Garcia



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