



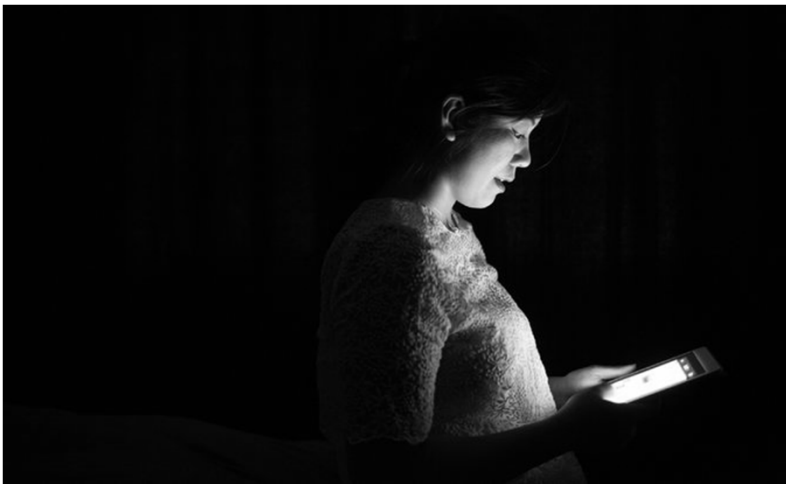
The Beauty and Joy of Computing

Lecture #10 Recursion II



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PUBLIC TO PRIVATE FORUMS IN CHINA



Censorship and detainment for many posters on China's public forum Weibo (like Twitter) has led to its descent with the rise of a competitor: WeChat (like Facebook) which is more private in its postings. Effects on freedom of speech and social activism is still to be seen.

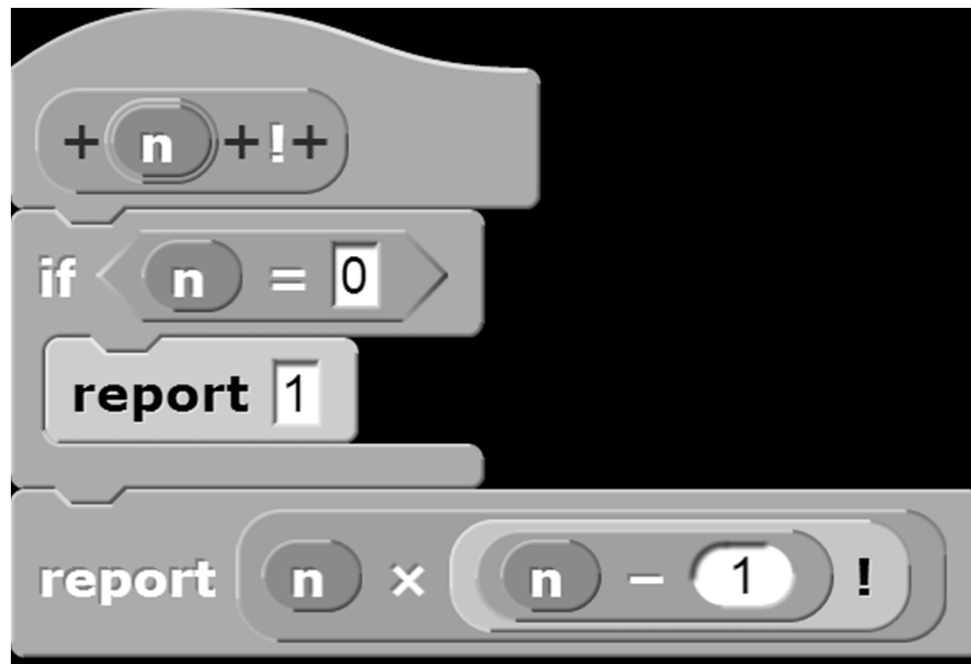
<http://www.nytimes.com/2014/07/05/world/asia/an-online-shift-in-china-muffles-an-open-forum.html?ref=technology>



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...**
 - “contractor” model
 - **5!**

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





Order of growth of # of calls of n !

(source: FallingFifth.com)

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



PIE-EATING CONTEST





How the Computer Works ... fib(n)

- Inductive definition:

- $\text{fib}(n) = n$, $n < 2$
- $\text{fib}(n) = \text{fib}(n-1) + \text{fib}(n-2)$, $n > 1$

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

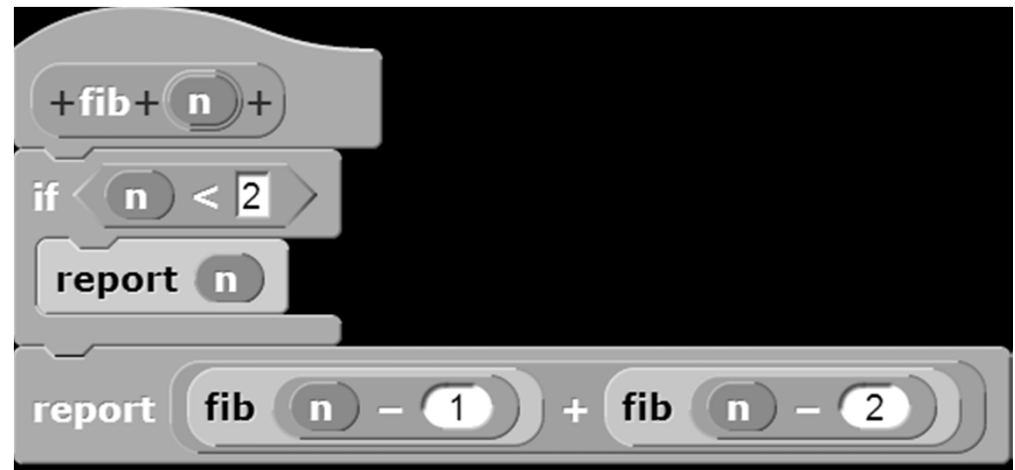
- Let's act it out...

- “contractor” model
- $\text{fib}(5)$

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



Leonardo de Pisa
aka, Fibonacci



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.

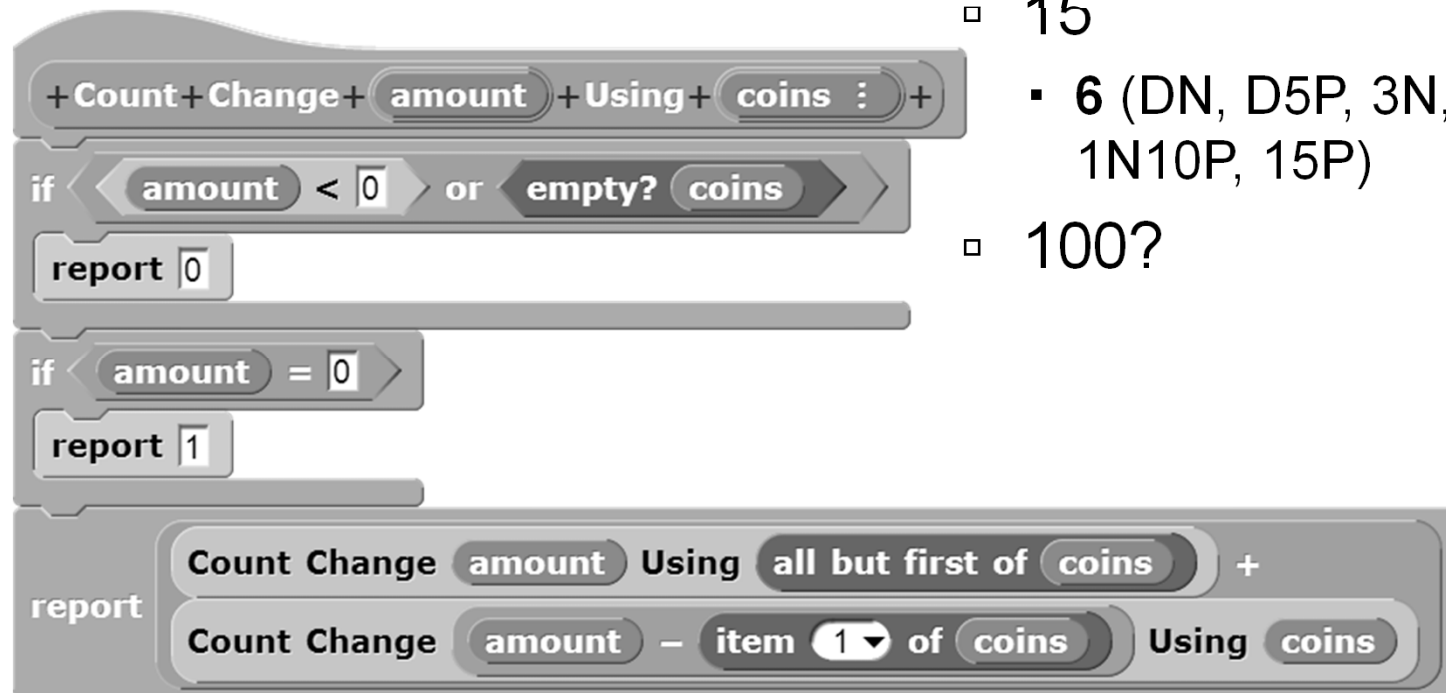
(Wikipedia)





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?

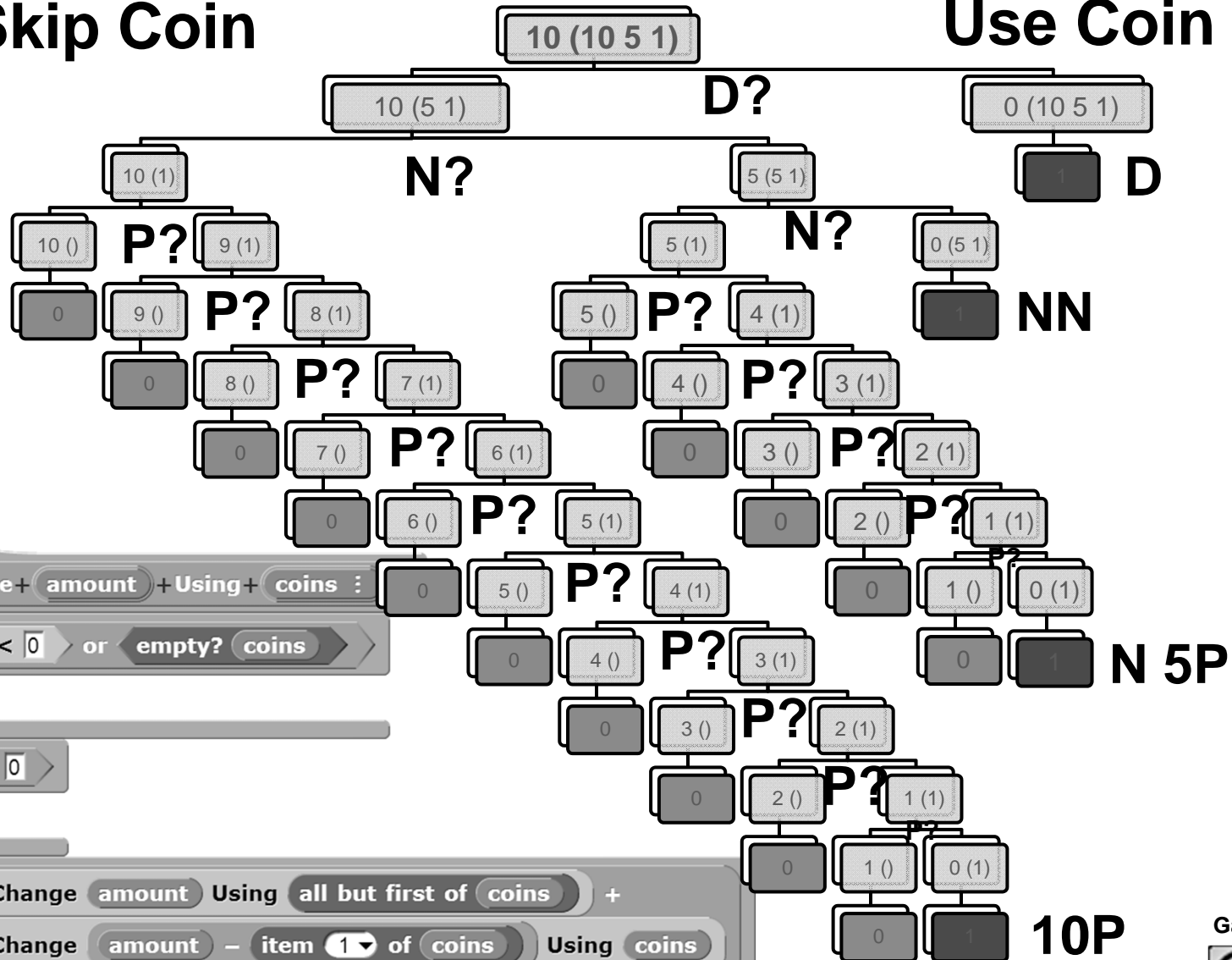


bjc

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

← Skip Coin

Use Coin →



```

+Count+Change+ amount +Using+ coins :
if amount < 0 or empty? coins
  report 0
if amount = 0
  report 1
report
  Count Change amount Using all but first of coins +
  Count Change amount - item 1 of coins Using coins
  
```



“I understood Count Change”

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



img4.joyreactor.com/pics/post/drawing-recursion-girl-275624.jpeg





Summary

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

Menger Cube by Dan Garcia

