

# Lecture 21: More Recursion

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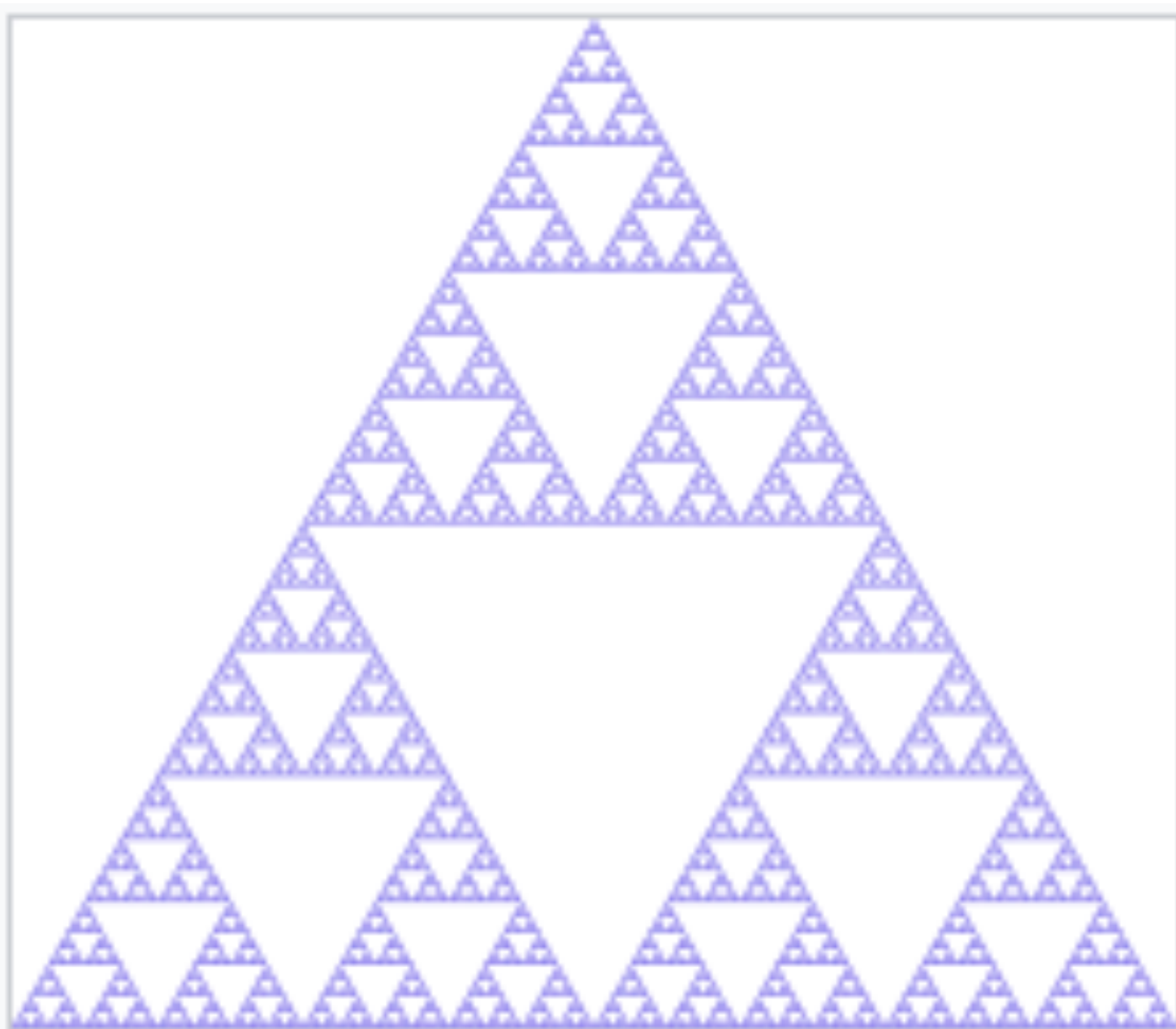
CS 51G  
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# Test Programs

- Questions on Test Programs

# Recursive objects

- Design recursive objects
  - Write type
  - Write base case (simplest — either object or class)
  - Write recursive case (instance variable has same type)
- Broccoli
  - <http://www.cs.pomona.edu/classes/cs051G/demos/Broccoli/>



Sierpinski triangle





HAPPY  
VALENTINE'S  
DAY.

-xkcd

# Recursive Methods

- Can have recursion on methods where it is just parameters that get simpler. Assume exponent is integer (or won't stop!!)

```
method simpleRecPower (base: Number, exponent: Number)
    -> Number {
  if (exponent == 0) then {
    1
  } else {
    base * simpleRecPower (base, exponent - 1)
  }
}
```

Call with simpler (smaller) exponent!

# More Power

- Can find even faster if use divide-and-conquer technique based on:
  - $b^0 = 1$
  - $b^{n+1} = b * b^n$
  - $(b^n)^m = b^{n*m}$
  - <http://www.cs.pomona.edu/classes/cs051G/demos/Powers/>

# Towers of Hanoi

- 3 diamond-tipped needles
- 64 golden disks to move
  - Start on needle one with lower disks larger than upper
  - Move to needle three
  - But can't put big disk on smaller disk
  - Can use 2nd needle to help
  - How many moves?
  - <http://www.cs.pomona.edu/classes/cs051G/demos/Hanoi/Hanoi.grace>



Questions?