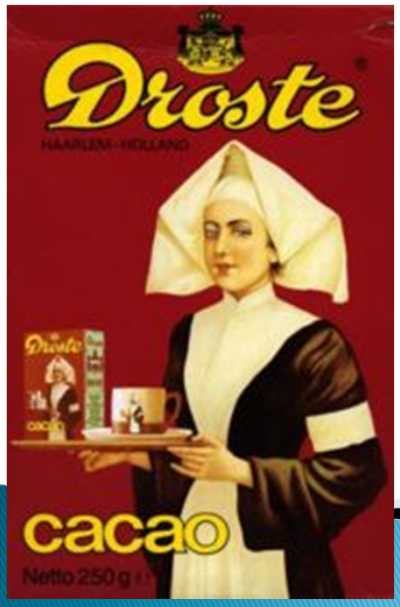


CSSE 220 Day 12

Recursion

Checkout *Recursion* project from SVN

Questions?

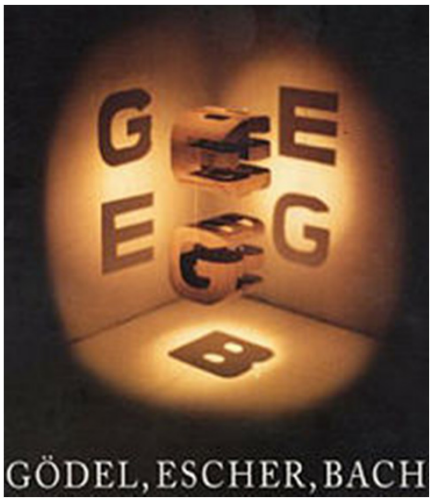
Announcement about ANGEL reading quizzes for HW 10 and HW 11:
Both are due Tuesday.
One should have been due today, but I did not get to change the schedule page.

Packages

- Let us group related classes
- We've been using them:
  - `javax.swing`
  - `java.awt`
  - `java.lang`
- Can (and should) group our own code into packages
  - Eclipse makes it easy…

Gödel, Escher, Bach

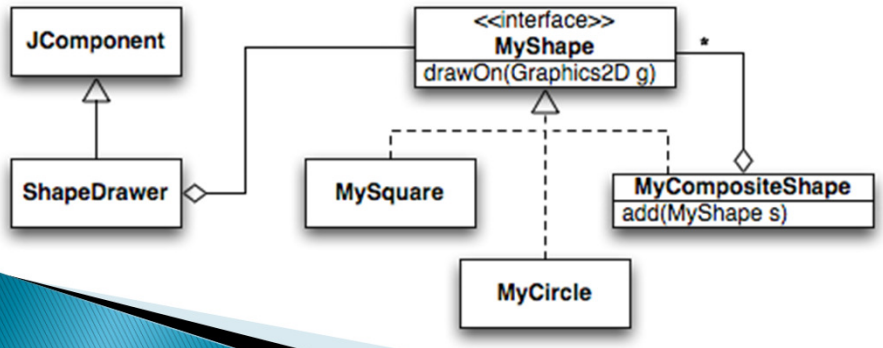
- By Douglas Hofstadter
- Argues that a major component of intelligence is **our ability to think about thinking**



Recursion

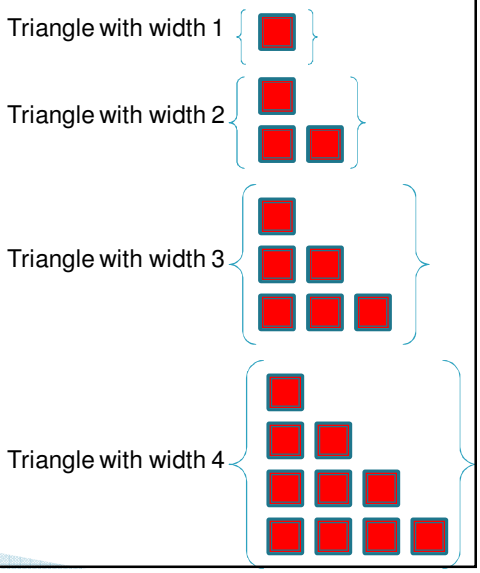
- A solution technique where the same computation **occurs repeatedly** as the problem is solved

recurs

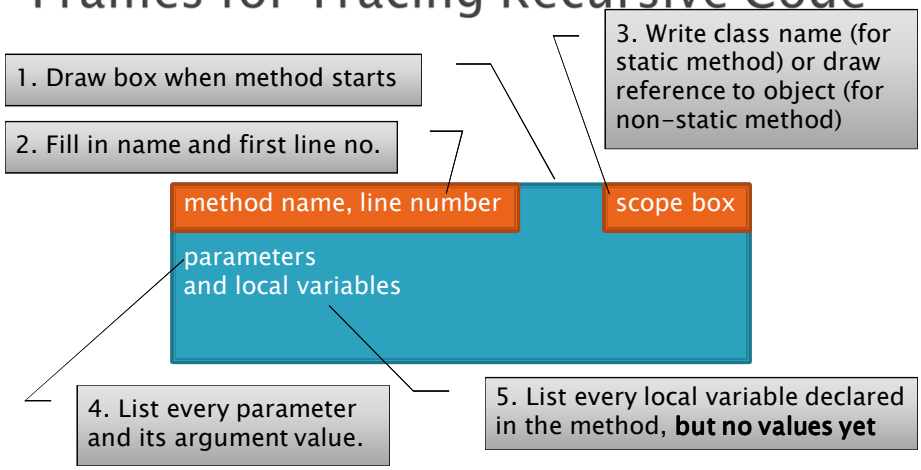


An example – Triangle Numbers

- If each red block has area 1, what is the ***area* A(n)** of the Triangle whose *width* is n?
  - Answer:
    A(n) = n + A(n-1)
- The above holds for which *n*? What is the answer for other *n*?
  - Answer: The recursive equation holds for n > 1.
    For n = 1, the area is 1.



Frames for Tracing Recursive Code



Thanks for David Gries for this technique

Q1–Q2

Suggested Practice

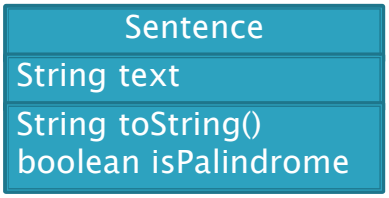
- Trace the **buildShape(MAX_DEPTH)** method call in **shapes.Main**'s **main** method

Key Rules to Using Recursion

- Always have a **base case** that **doesn't recurse**
- Make sure recursive case always makes **progress**, by **solving a smaller problem**
- **You gotta believe**
  - Trust in the recursive solution
  - Just consider one step at a time

Programming Problem

- Add a recursive method to Sentence for computing whether Sentence is a palindrome



Recursive Helpers

- Our isPalindrome() makes lots of new Sentence objects
- We can make it better with a "recursive helper method"
  - Many recursive problems require a helper method

```
public boolean isPalindrome() {
    return isPalindrome(0,  this.text.length() - 1);
}
```

Position of first letter of the remaining String to check

Position of last letter of the remaining String to check

Homework part 1

- Reverse a string…recursively!
- A recursive helper can make this really short!

Another Definition of Recursion

- "If you already know what recursion is, just remember the answer. Otherwise, find someone who is standing closer to Douglas Hofstadter than you are; then ask him or her what recursion is."

—Andrew Plotkin

Recursive Functions

- Factorial:

$$n! = \begin{cases} 1 & \text{if } n \leq 1 \\ n * (n-1)! & \text{otherwise} \end{cases}$$

Base Case

Recursive step

- Ackermann function:

$$A(m,n) = \begin{cases} n+1 & \text{if } m = 0 \\ A(m-1,1) & \text{if } m > 0 \text{ and } n = 0 \\ A(m-1, A(m,n-1)) & \text{otherwise} \end{cases}$$

Q3-Q5