LEC 08

CSE 123

Recursion

BEFORE WE START

Talk to your neighbors:

What's your favorite icebreaker question? 🫣

Instructors: Brett Wortzman, Miya Natsuhara

TAs:

Arohan	Neha	Rushil	Johnathan	Nicholas
Sean	Hayden	Srihari	Benoit	Isayiah
Audrey	Chris	Andras	Jessica	Kavya
Cynthia	Shreya	Kieran	Rohan	Eeshani
Amy	Packard	Cora	Dixon	Nichole
Trien	Lawrence	Liza	Helena	

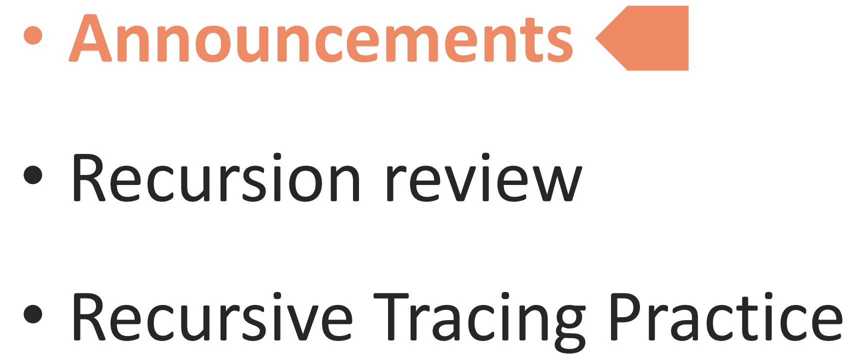
Music: CSE 123 25wi Lecture Tunes

Questions during Class?

Raise hand or send here

sli.do #cse123

Lecture Outline



- **Announcements**
- Recursion review
- Recursive Tracing Practice

Announcements

- Snow day!
  - Virtual lectures, virtual office hours, lighter IPL staffing today (Wed, Feb 5)
  - As of now, Thursday operations are expected to be "as usual"
- Quiz 1 Tuesday (Feb 11)!
  - Topics: ListNodes, LinkedIntList, Runtime analysis
  - Topics not on Quiz: Recursion
  - Practice quiz and reference sheet for Quiz 1 will be posted soon!
  - Quiz 0 feedback will be released before Quiz 1
- Programming Assignment 1 due in one week (Feb 12) @ 11:59pm
- Creative Project 1 and Resubmission Cycle 1 grades released later today
- Resubmission Period 3 closes this Friday (Feb 7) @ 11:59pm
  - Available assignments: ***C0***, P0, C1
  - ***Last opportunity to resubmit C0***
- Reminder: Grade guarantee calculator

Lecture Outline

- Announcements
- **Recursion review**
- Recursive Tracing Practice

Recursion (1)

“The repeated application of a recursive procedure or definition”

- Oxford Languages

- Real-world definition: defining a problem in terms of itself
  - Case in point: above definition
  - Further natural examples:

Recursion (2)

“The repeated application of a recursive procedure or definition”

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Recursion (3)

“The repeated application of a recursive procedure or definition”

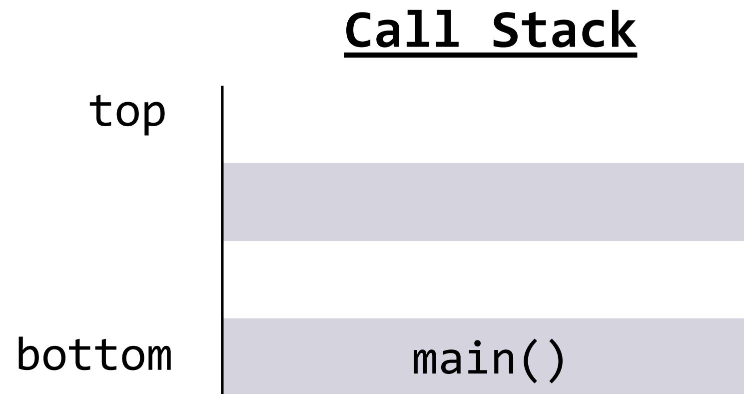
- Oxford Languages

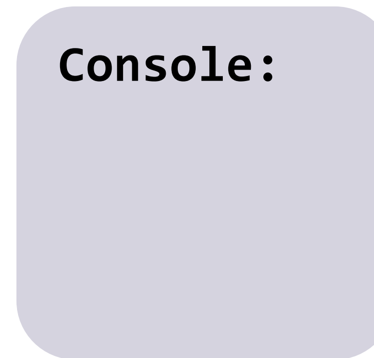
- Real-world definition: defining a problem in terms of itself
  - Case in point: above definition
- Computer science definition: when a method calls itself
  - “Alternative” to iteration (can combine for powerful results)
- 🤔 Wouldn’t that just lead to an infinite loop?
  - Yes! If you do things wrong…
  - Let’s review *how* method calls work

Method Calls

- Regardless how you use them, methods work the same way!
  - Pause execution, finish method, return where you left off
- How does Java keep track of the prior method?
  - Sort of like the "history" of the method calls it has paused… (LIFO)
  - Something called the **Call Stack**

Call Stack



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    mystery1();
    mystery2();
}

public static void mystery1() {
    System.out.println("One");
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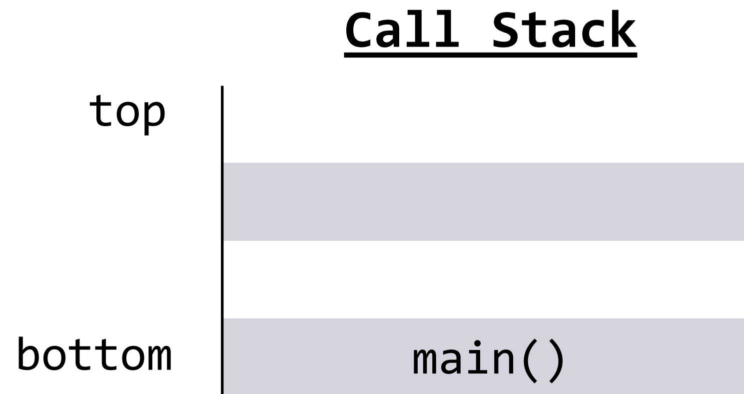

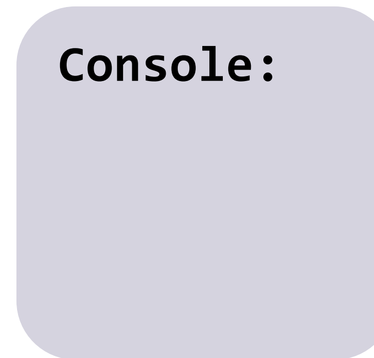


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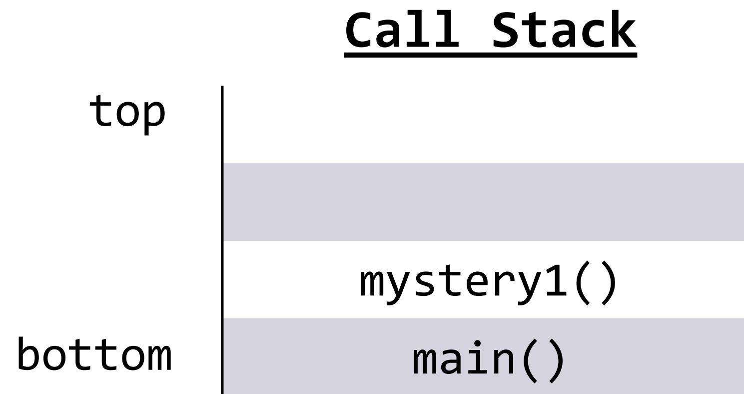

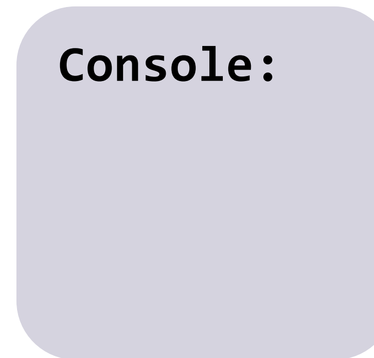


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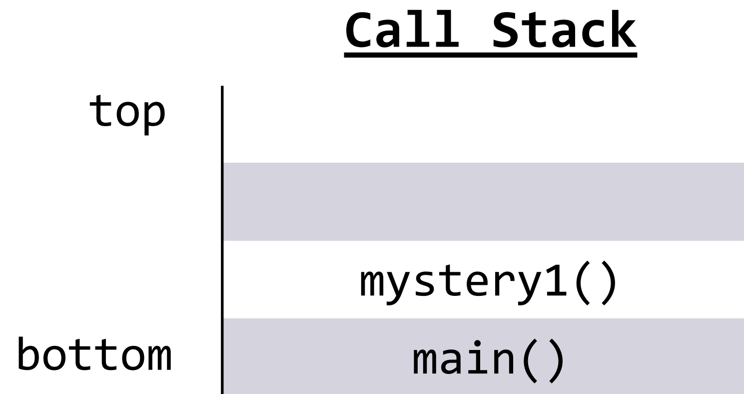

Console:

One

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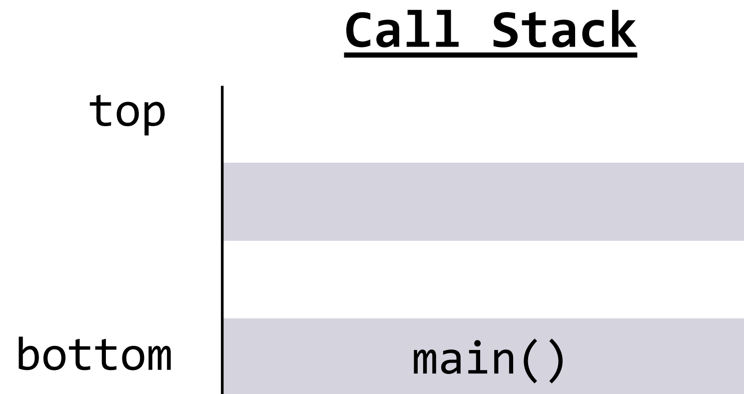

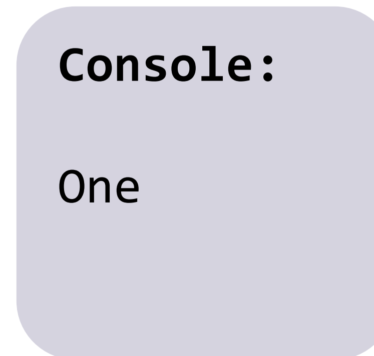


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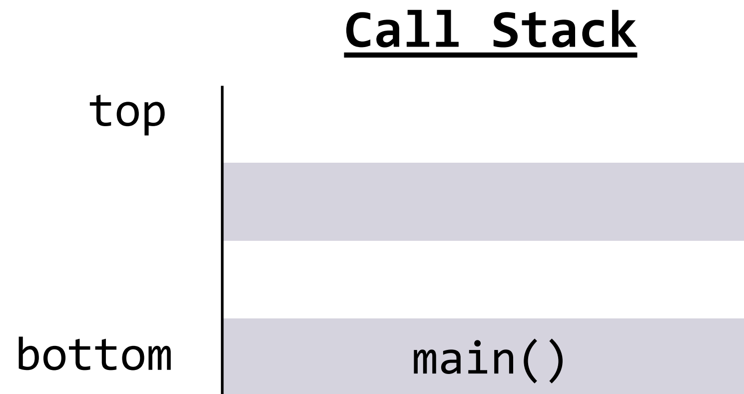

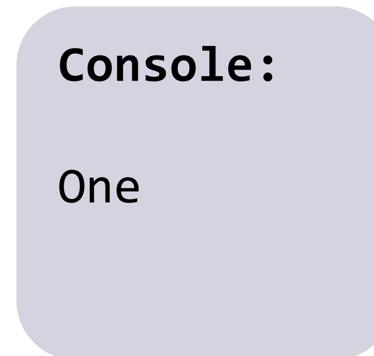


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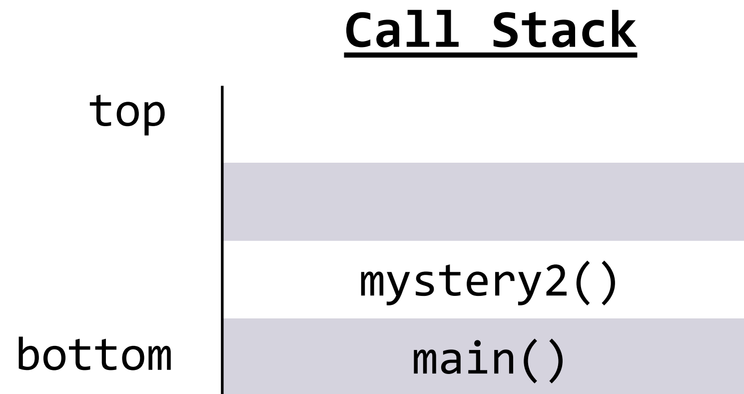

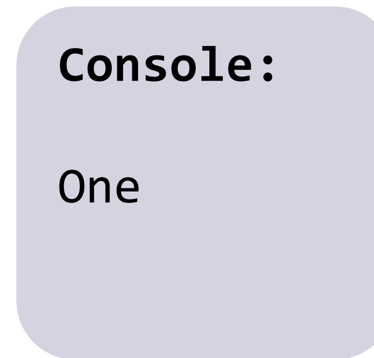


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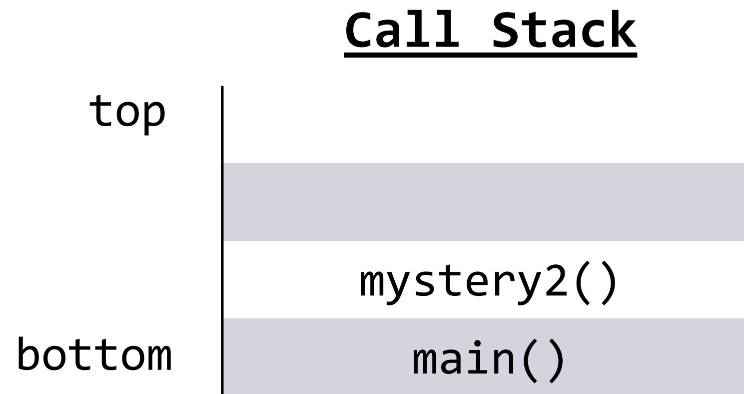

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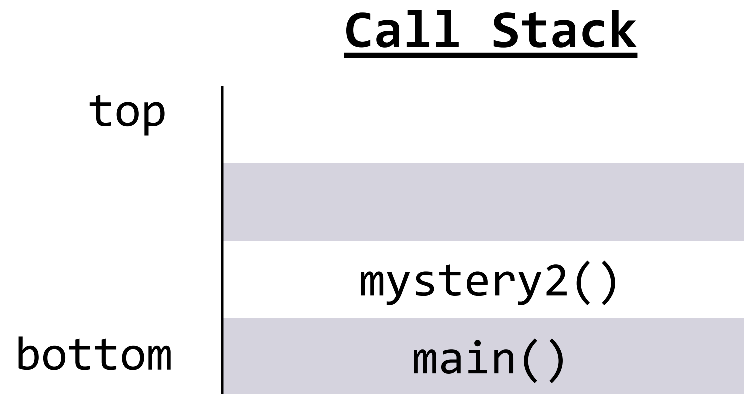

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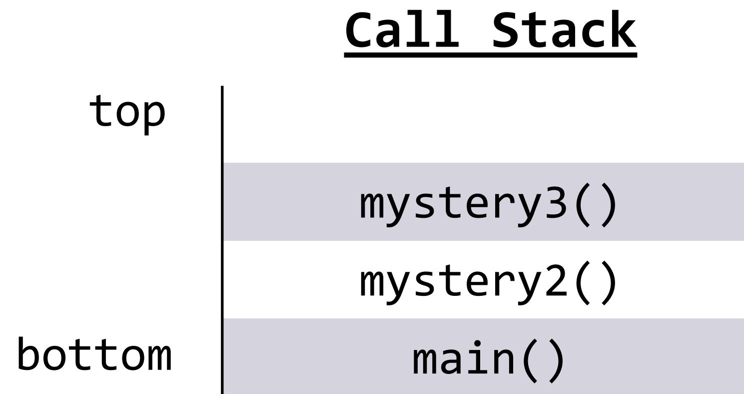

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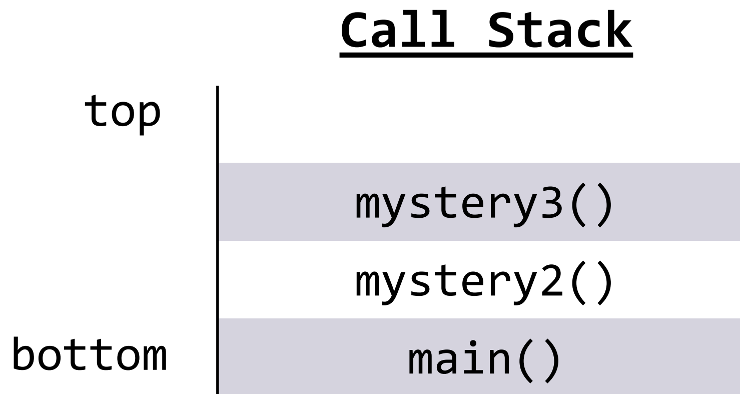

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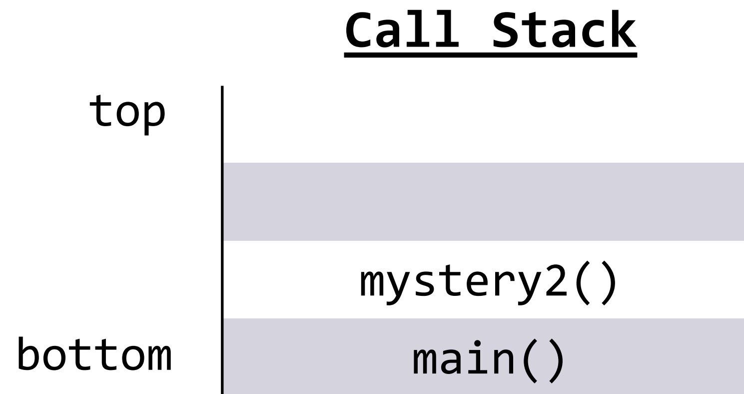

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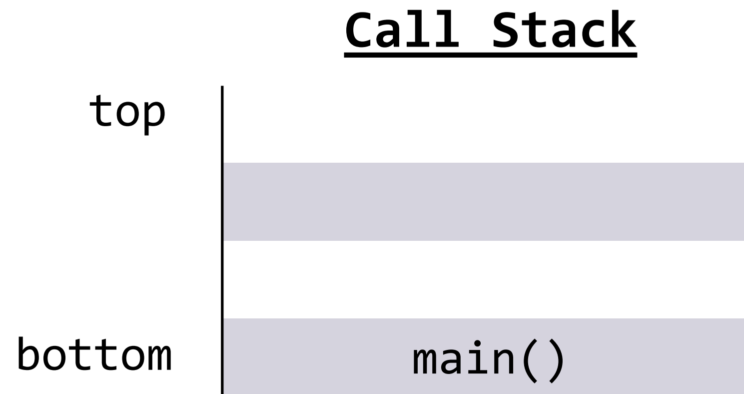

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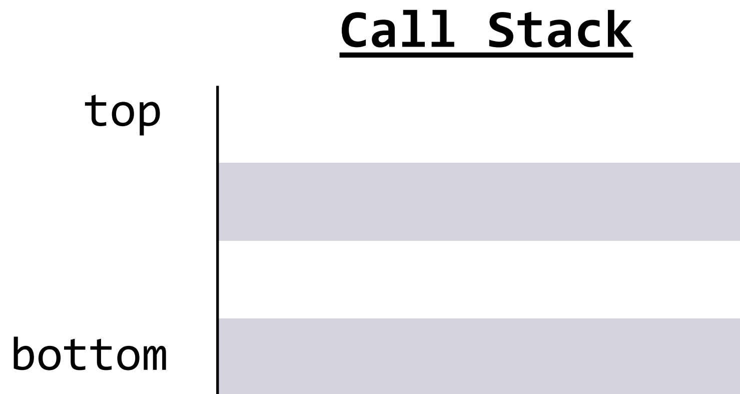

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Method Calls

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  - Pause execution, finish method, return where you left off
- How does Java keep track of the prior method (LIFO)?
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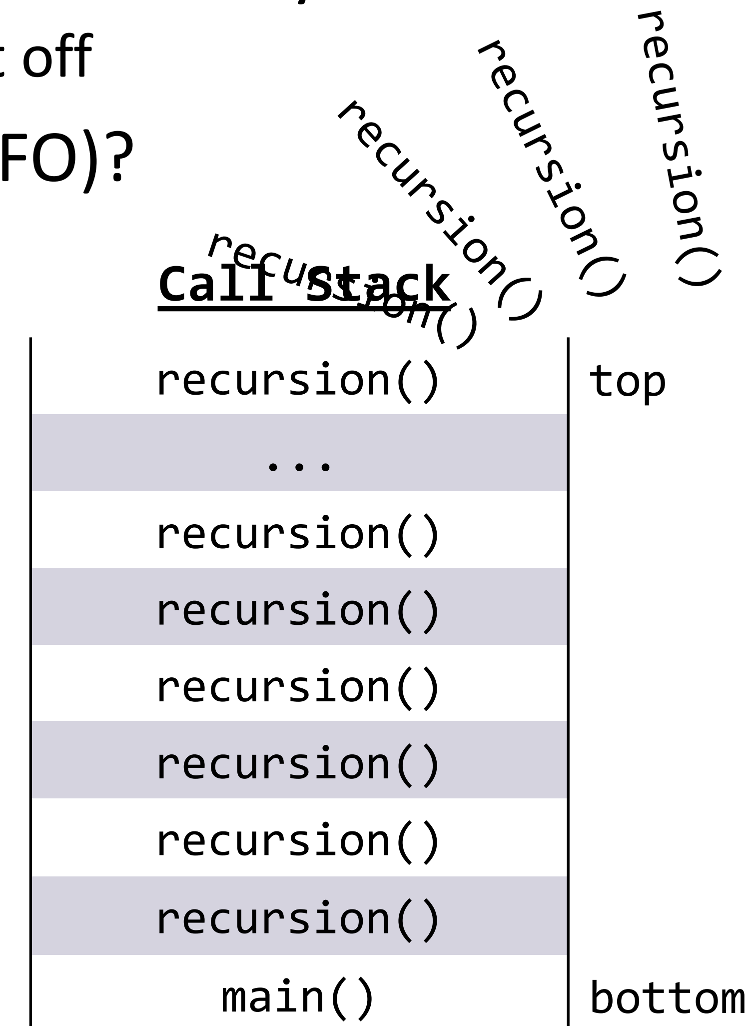
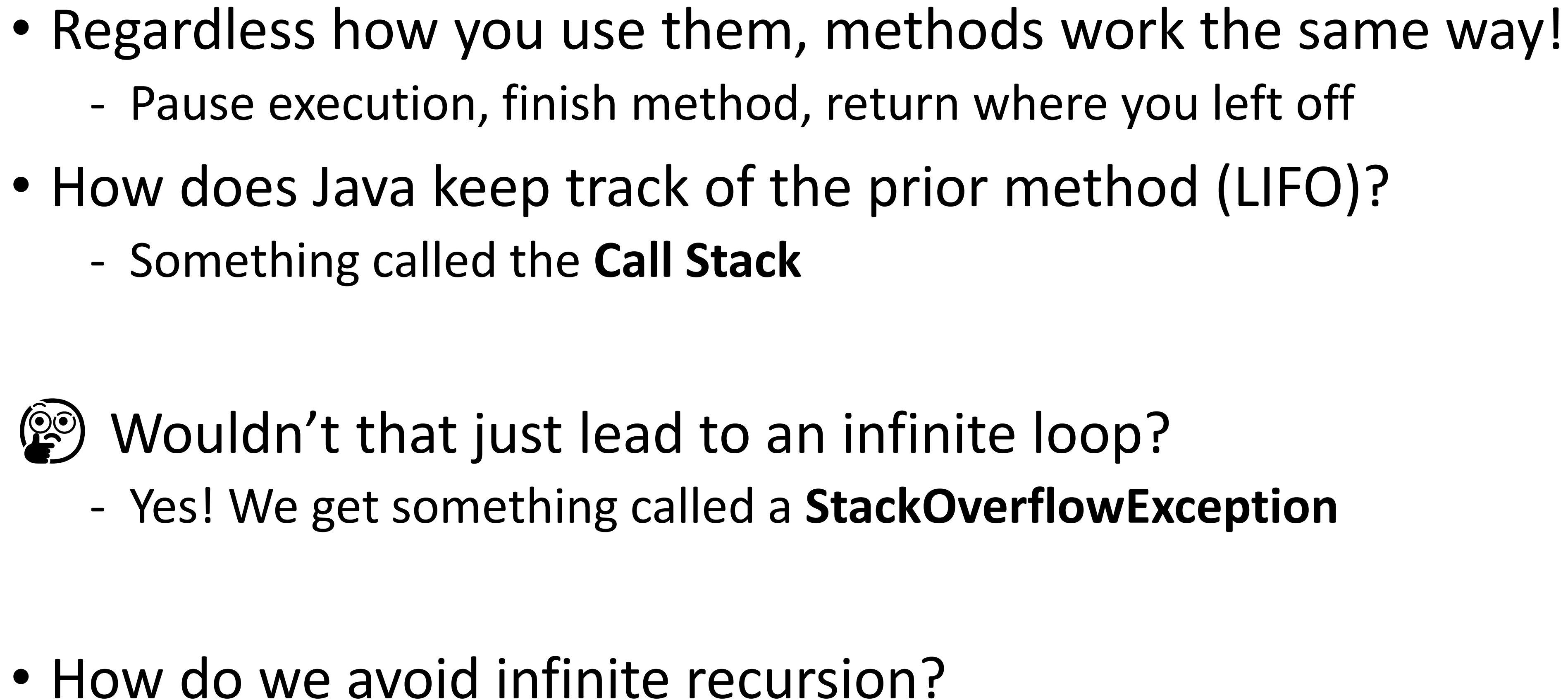


🤔 Wouldn't that just lead to an infinite loop?

```
public static void recursion() {
    System.out.println("Woah");
    recursion();
}
```

StackOverflowException!

Method Calls



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  - Pause execution, finish method, return where you left off
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Wouldn’t that just lead to an infinite loop?

  - Yes! We get something called a **StackOverflowException**

- How do we avoid infinite recursion?

Recursion (4)

"The repeated application of a recursive procedure or definition"

- Oxford Languages

- Why do we care?
  - It's a fundamental Computer Science topic
  - Some things are easier to describe with recursion than with loops
  - There are some problems that lend themselves more easily to a recursive solution than an iterative (loop-y) solution
    - Though all problems that can be solved with recursion can be solved with loops, and vice versa

Recursive Methods

- 2 components of every recursive method:

- Recursive case
  - Decompose problem into subproblem
  - Make the actual recursive call
  - Combine results meaningfully

- Base case
  - Simplest version of the problem
  - No subproblems to break into
  - Return known answer

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If decomposing moves you closer to the base, no infinite recursion!

Math Examples

n! or factorial(n) = product of all positive integers <= n

- Two ways of viewing this idea:

- $n! = n * (n-1) * (n-2) * \cdots * 2 * 1$
  - Iterative approach - loop through all values and multiply together

- $n! = n * (n-1)!$
  - Recursive approach – decompose into subproblem and combine
  - What would our base case / simplest input (n) be?

Math Examples

n! / factorial(n) = product of all positive integers <= n

- Reminder, recursive approach: $n! = n * (n-1)!$
  - Let's trace through with a simple example 3!

$4! = 4 * 3!$

$3! = 3 * 2!$

$2! = 2 * 1!$

$1! = 1 * 0!$

$0! = 1$

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$4! = 4 * 3!$

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$4! = 4 * 3!$

$3! = 6$

Math Examples

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- Reminder, recursive approach: $n! = n * (n-1)!$
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$4! = 4 * 6$

Math Examples

n! / factorial(n) = product of all positive integers <= n

- Reminder, recursive approach: $n! = n * (n-1)!$
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$4! = 24$