Data Structures in Java

Session 6

Instructor: Bert Huang

http://www1.cs.columbia.edu/~bert/courses/3134

Announcements

- Homework 2 released on website
  - Due Oct. 6th at 5:40 PM (12 days)

Review

- List code study
  - MyArrayList
  - MyLinkedList
- The Iterable interface
- Definition of Stack ADT

Today's Plan

- Homework advice
- Review of **scope** and recursion
- Stack applications examples
- Stack implementation (easy)

Test First

- Incrementally test your code
  - avoid having to debug too many moving parts at once
- 1st step, make it compile (have methods return garbage)
- 2nd step, make methods pass tests

Scope

-
  ```
  public int x = 200;

  public void mystery() {
      int x = 100;
      System.out.println(x);
  }
  ```

-
  ```
  int i = 200;
  for (int i=0; i<10; i++)
      System.out.println(“i = “+i);
  System.out.println(“i = “+i);
  ```

Generics and Scope

-
  ```
  public class Collection<String> {
      String whatIsThis;
  }
  Collection<Integer> myCollection =
        new Collection<Integer>();
  ```
- whatIsThis is an Integer
- So be careful with naming your generic placeholders

Stack Definition

- Essentially a very restricted List
- Two (main) operations:
  - Push(AnyType x)
  - Pop()
- Analogy – Cafeteria Trays, PEZ

Stack Applications

- Recursion
- Parsing text: infix vs. postfix
- Syntax checking ( ), { }, “”

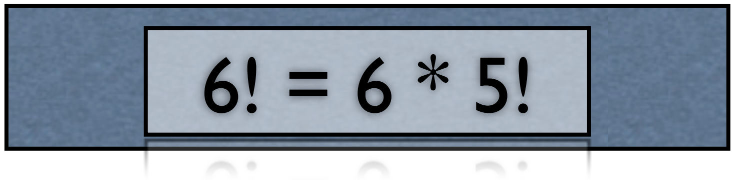
Evaluating Recursion

- Push recursive calls onto a Stack, evaluate top
- Consider computing factorials:
  - N! = N * (N-1)!
  - 1! = 1
- (Note: O(N!) is REALLY bad)

Stack Animation

Stack Animation

Stack Animation



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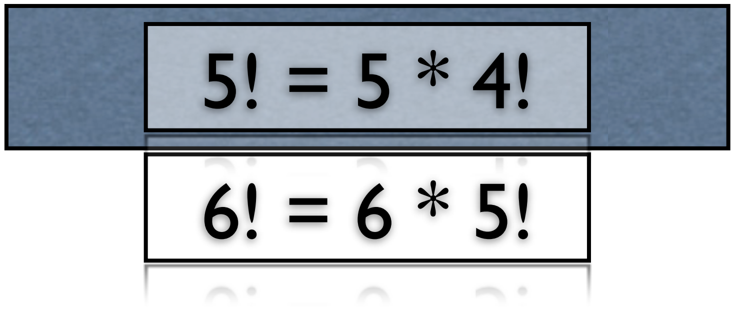

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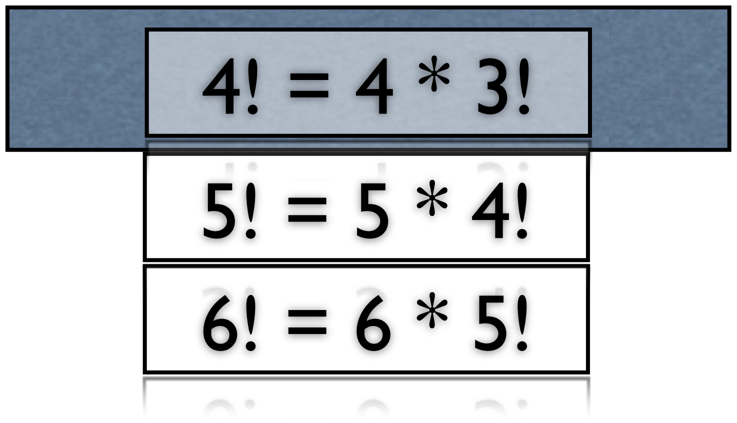

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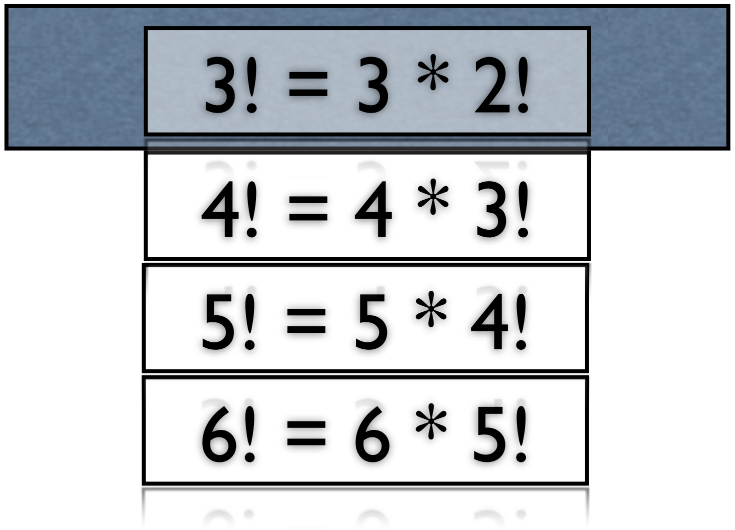

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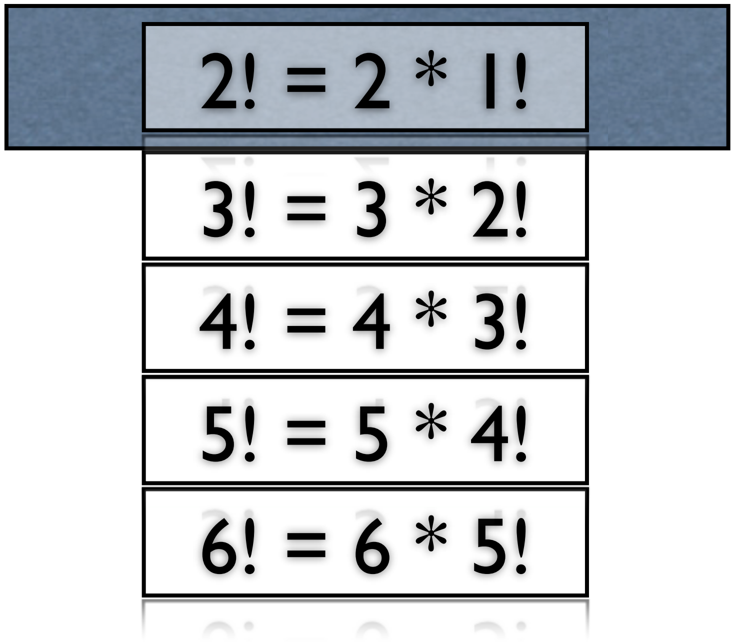

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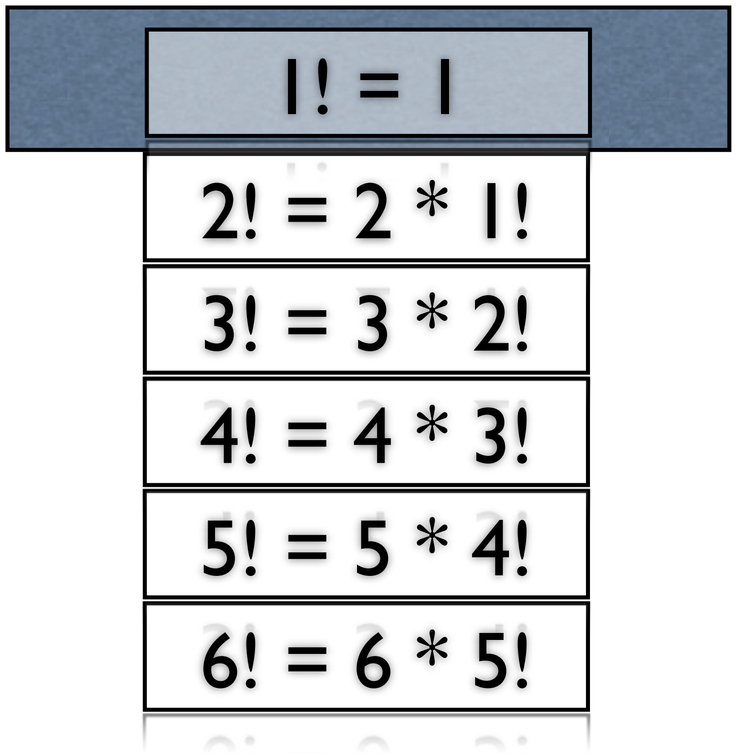

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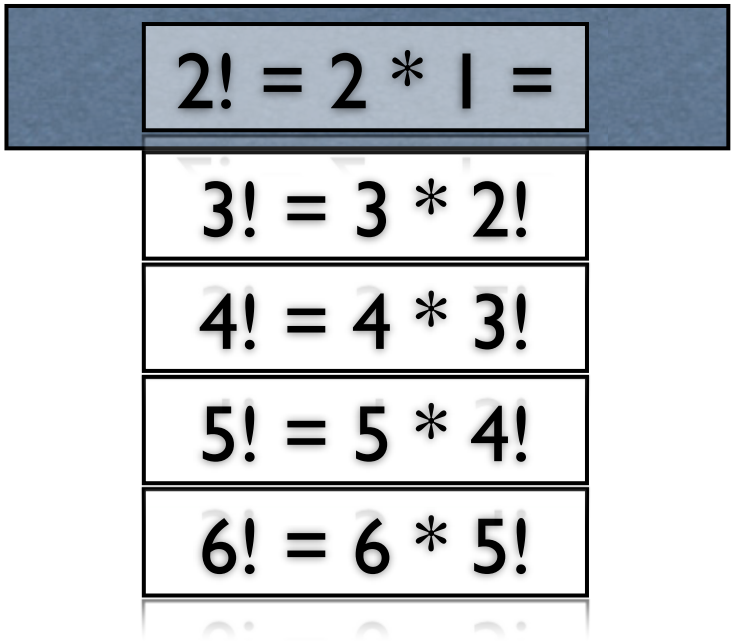

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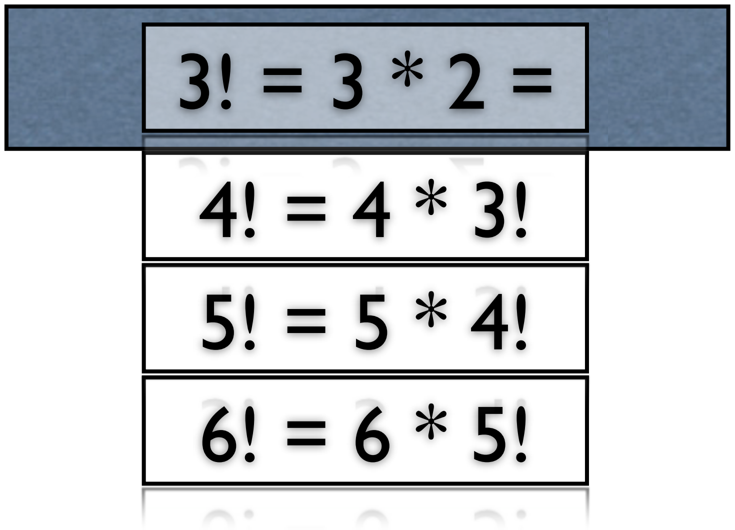

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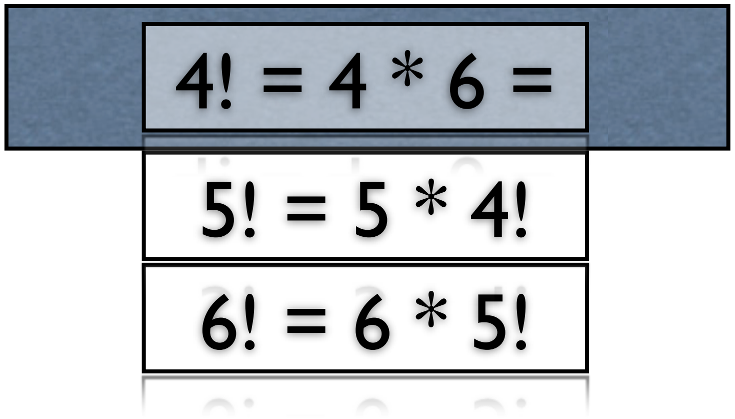

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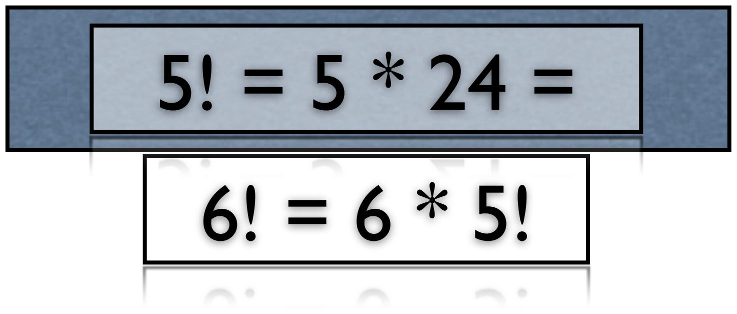

Stack Animation

6! = 6 * 120 = 720

Evaluating Postfix

- Postfix notation places operator after operands
  - Ambiguous Infix: 3 + 2 * 10 ((3+2) * 10)
  - Postfix: 3 2 + 10 * ((3 2 +) 10 *)

(As opposed to) 3 2 10 * + (3 (2 10 *) +)

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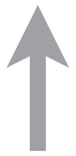

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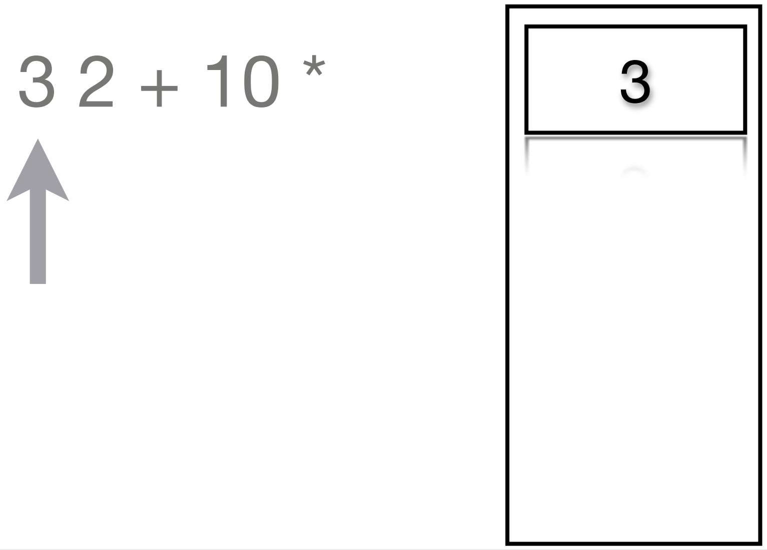

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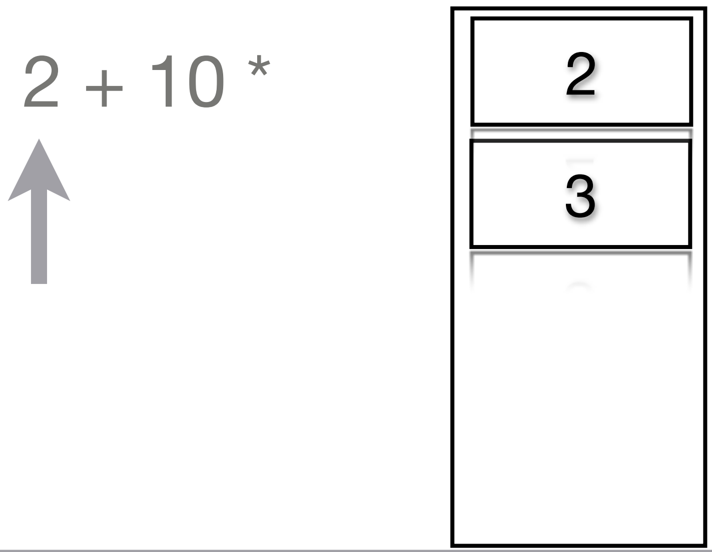

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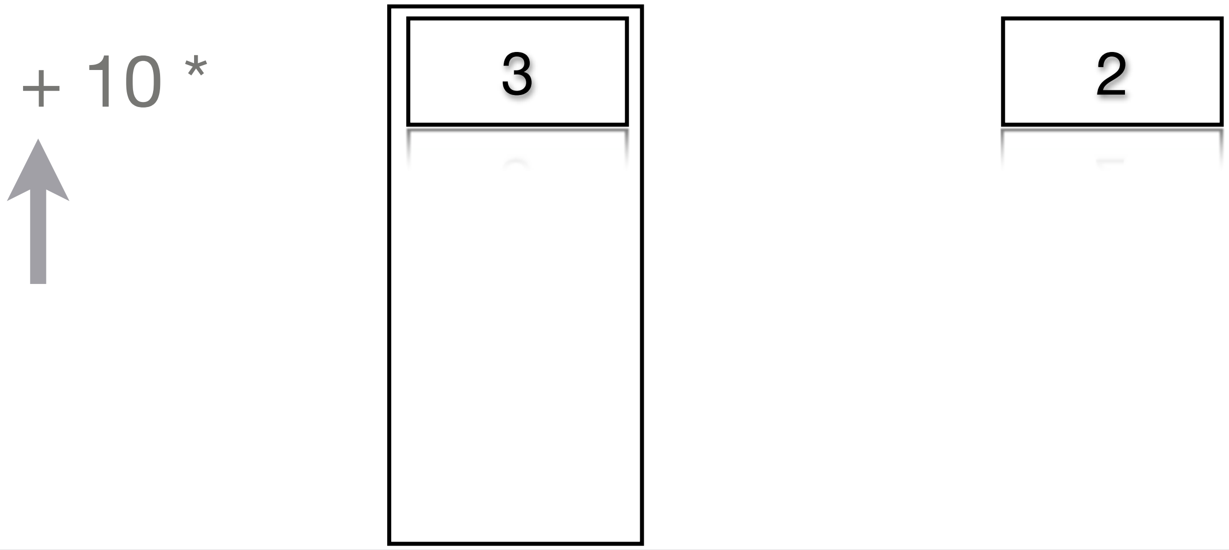

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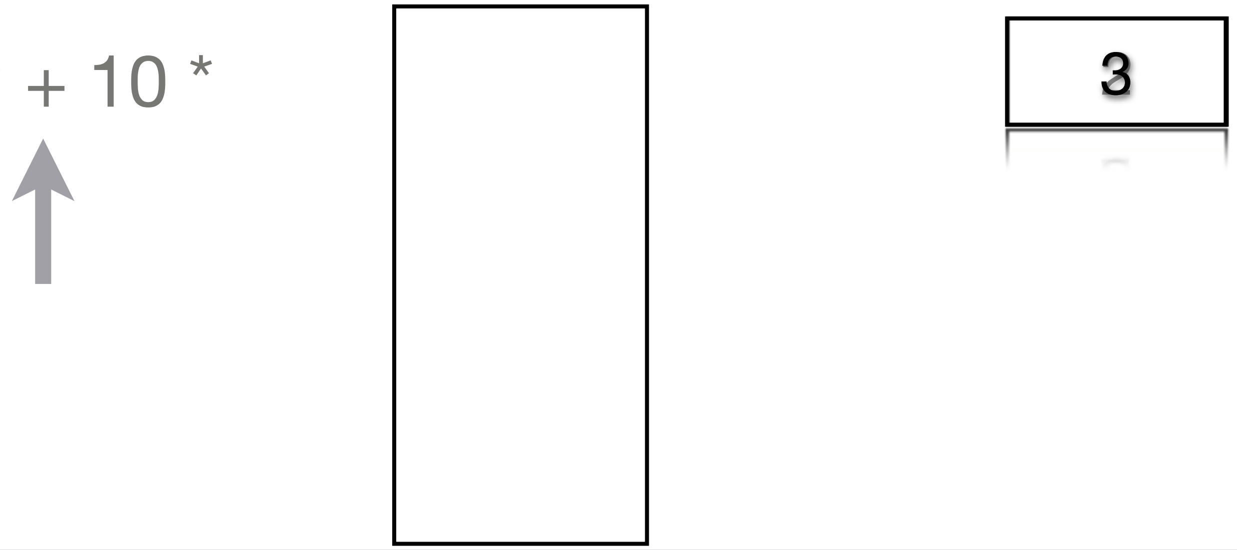

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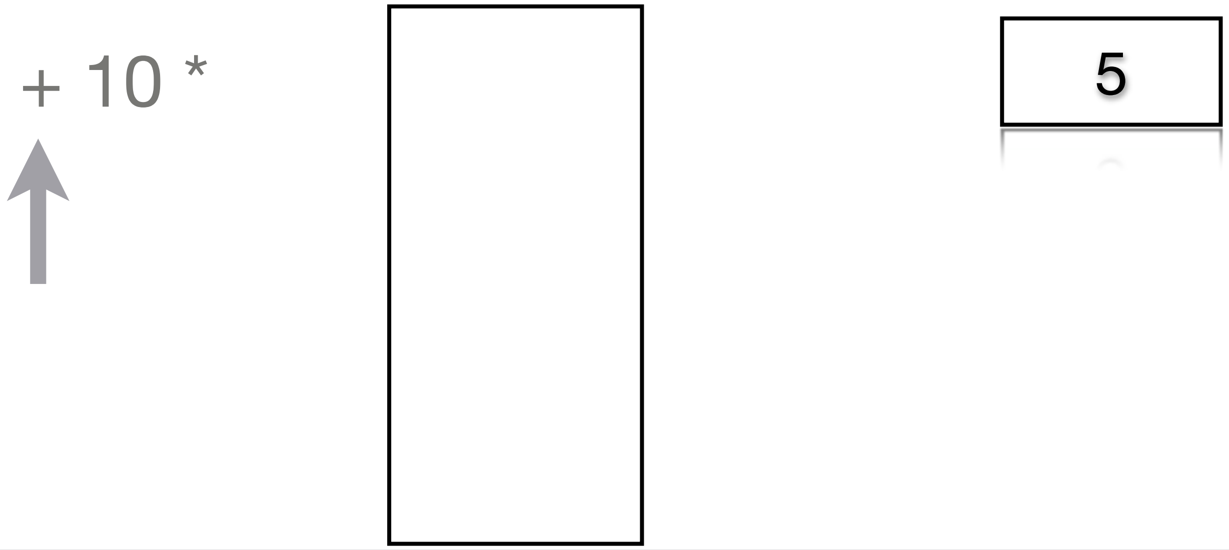

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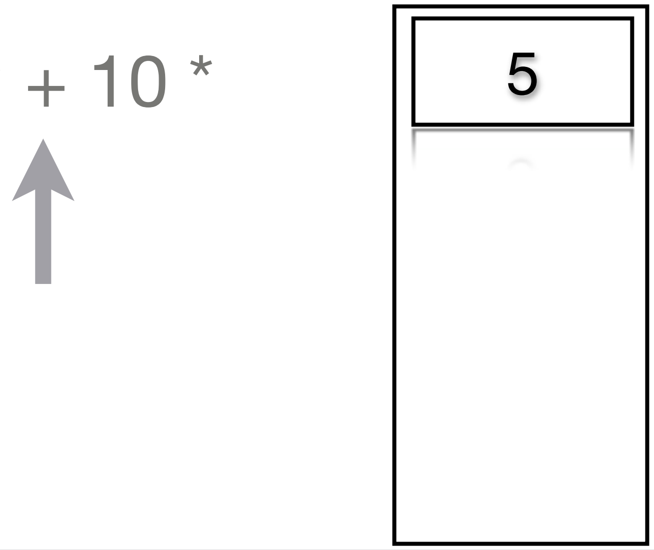

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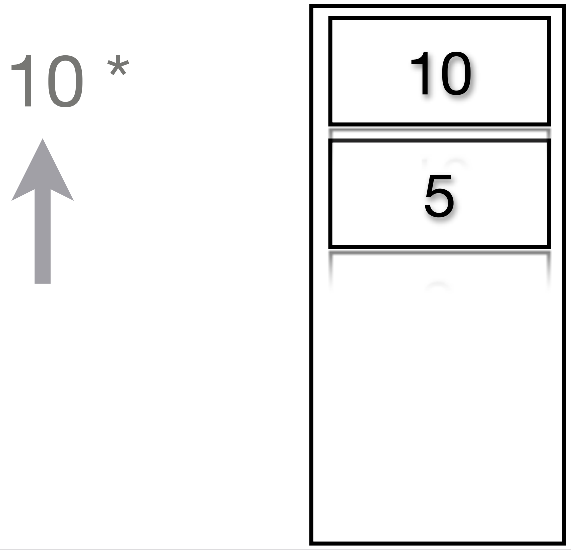

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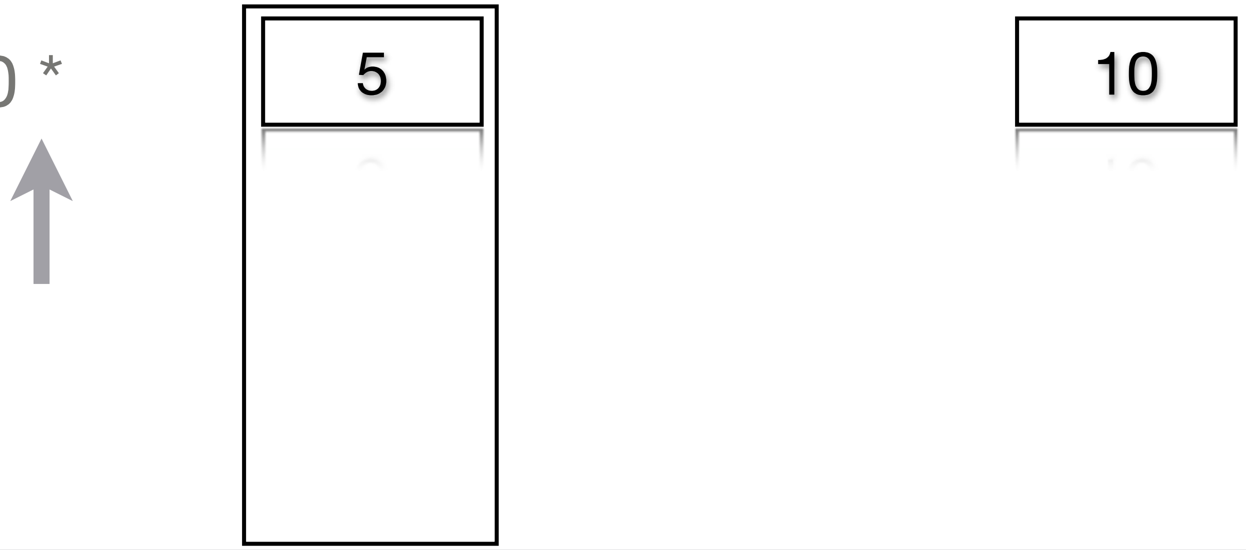

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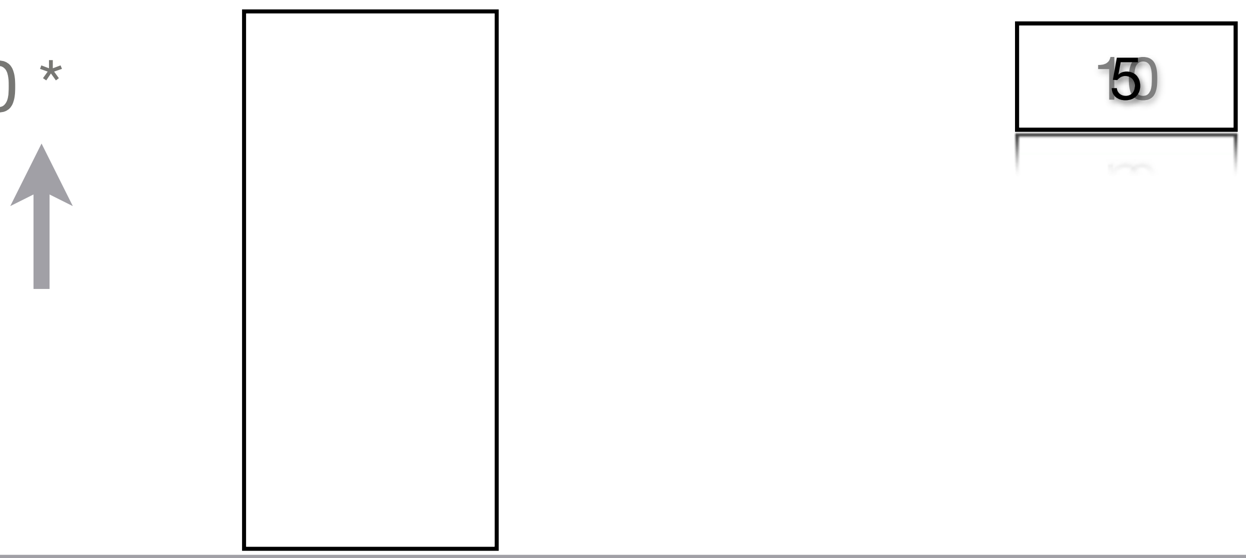

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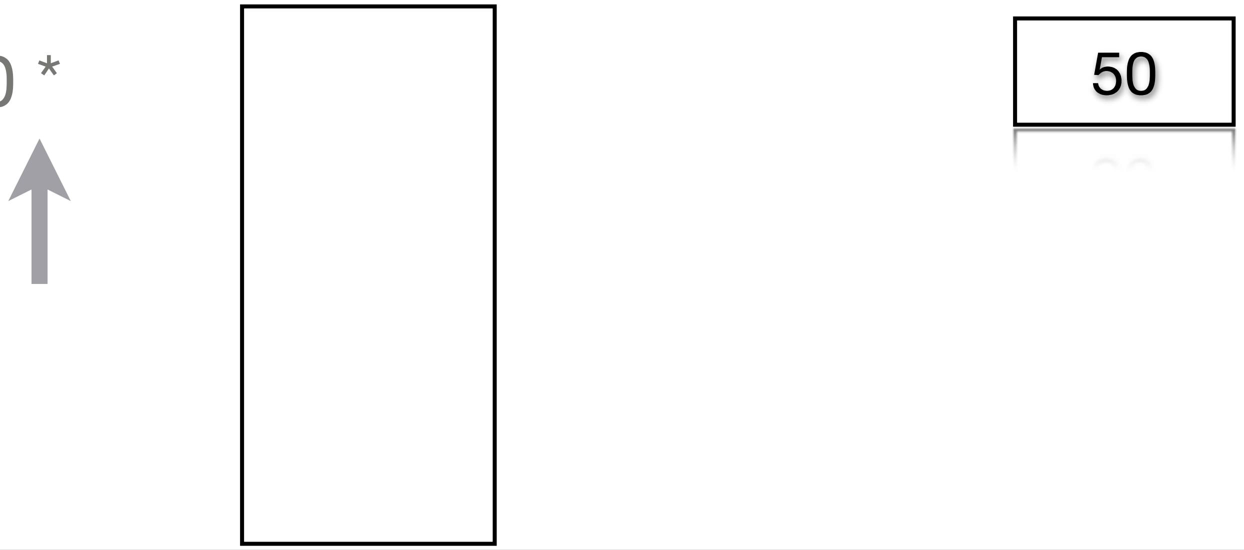

Syntax Checking

- Check for matching parenthesis ( ), braces { }, brackets [ ], etc.
- Sweep through code
  - If we see an opening symbol, push onto stack
  - If we see a closing symbol, pop from stack and compare

Syntax Checking

-
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  ( theItems.length == size( ) ) ensureCapacity( size ( )
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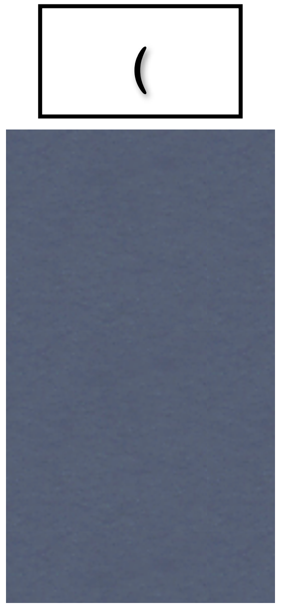

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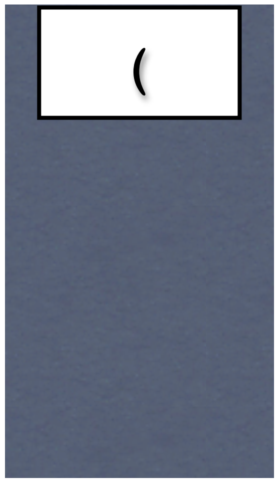

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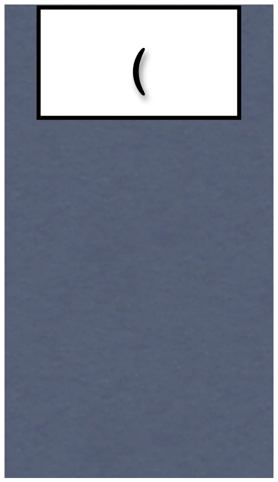

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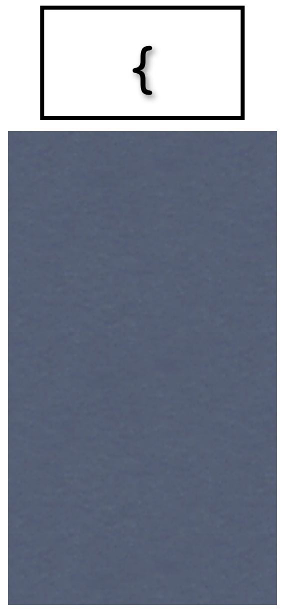

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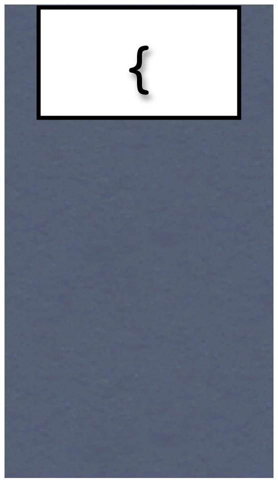

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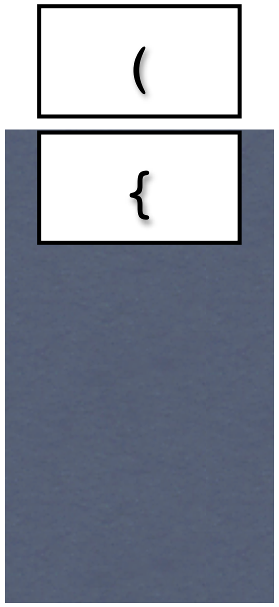

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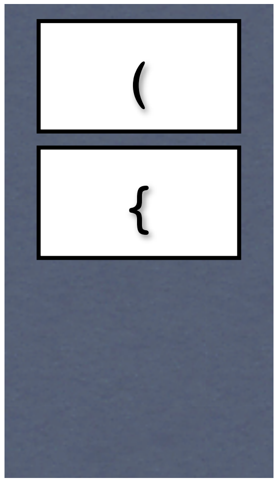

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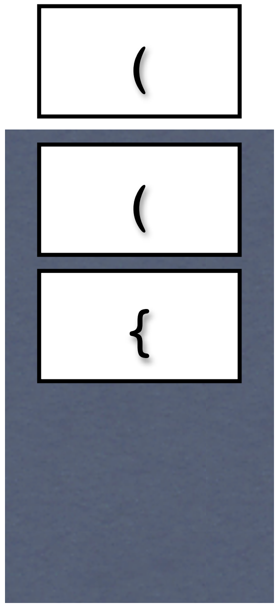

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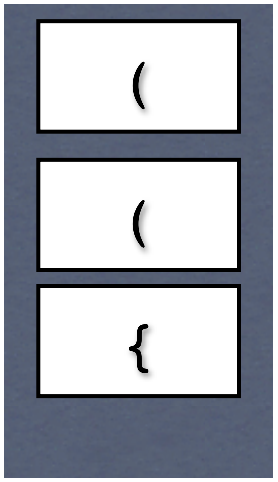

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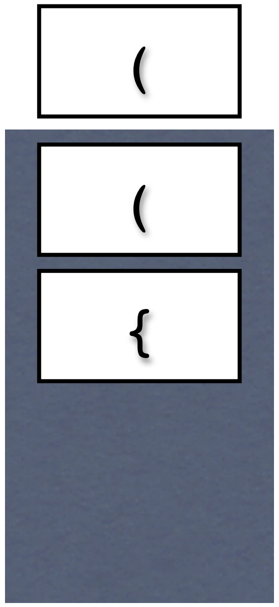

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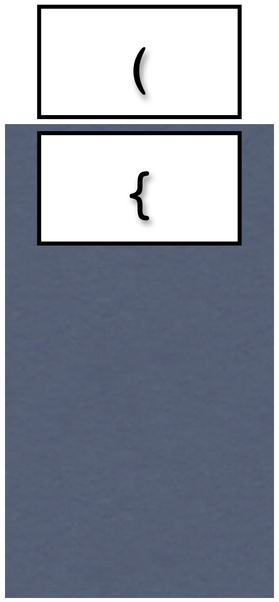

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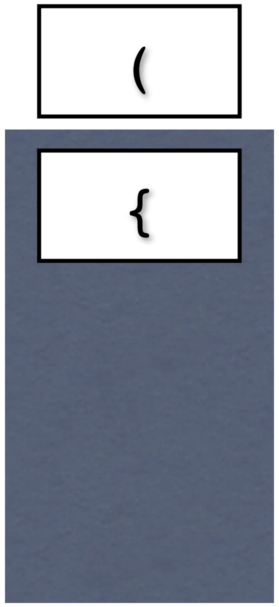

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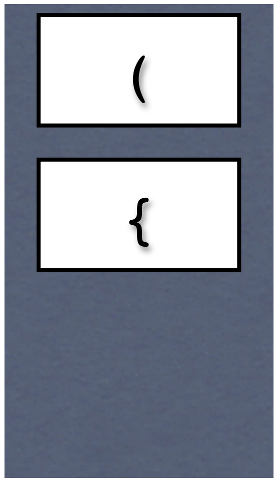

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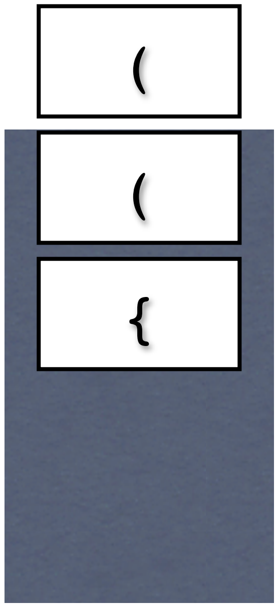

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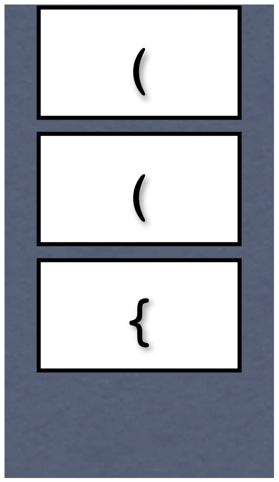

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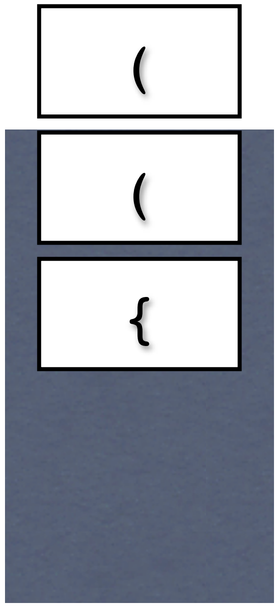

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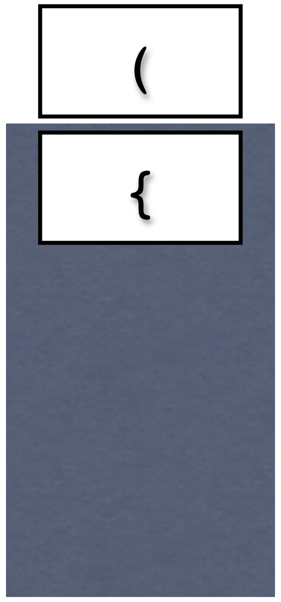

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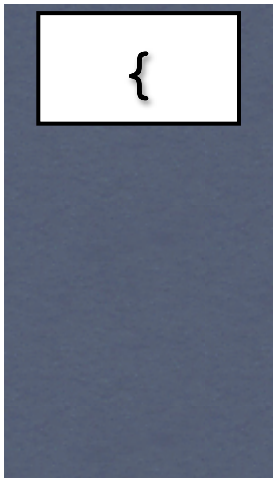

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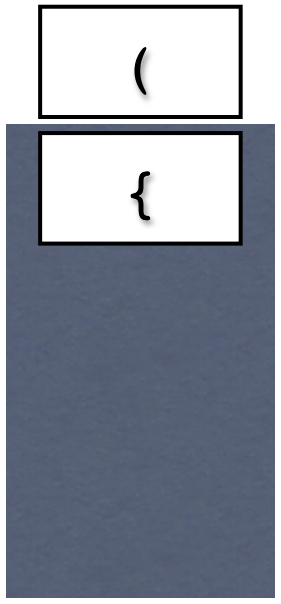

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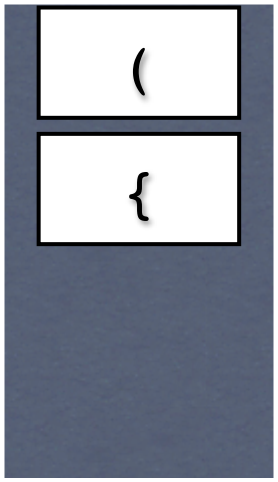

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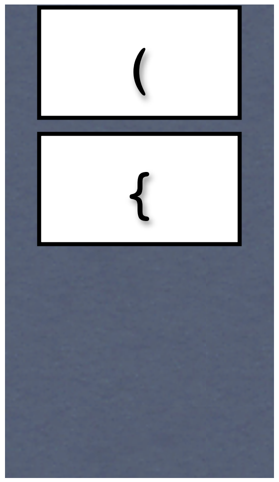

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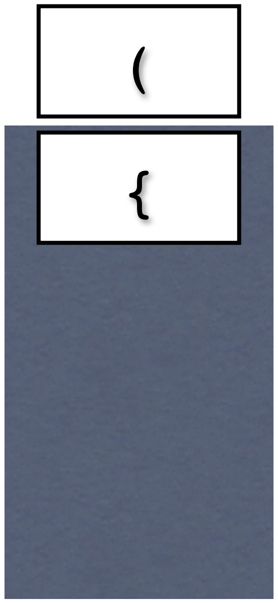

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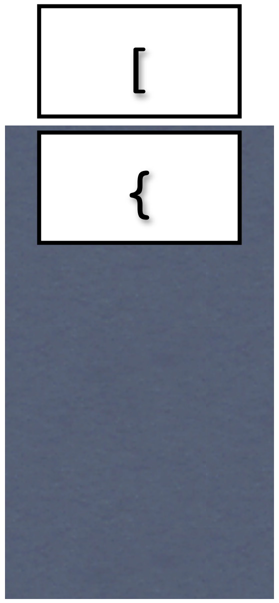

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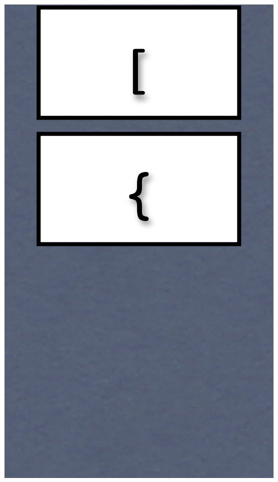
- `public void add( int idx, AnyType x) { if ( theItems.length == size( ) ) ensureCapacity( size ( ) * 2 + 1); for( int i=theSize; i > idx; i-- ) theItems [ i ] = theItems[ i - 1 ]; theItems[ idx ] = x; theSize++; }`



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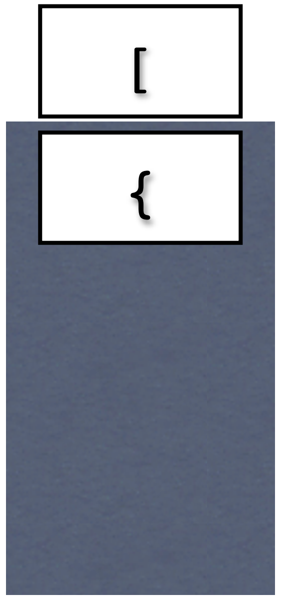

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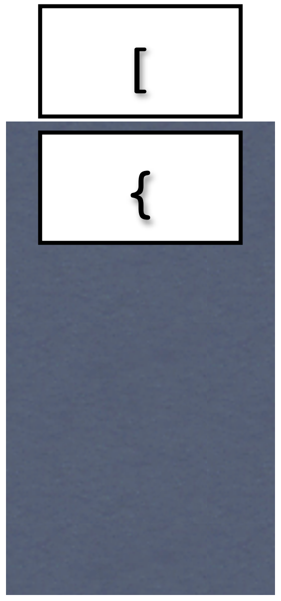

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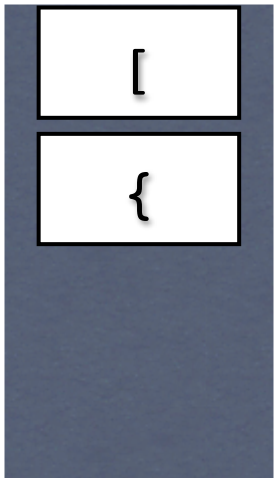

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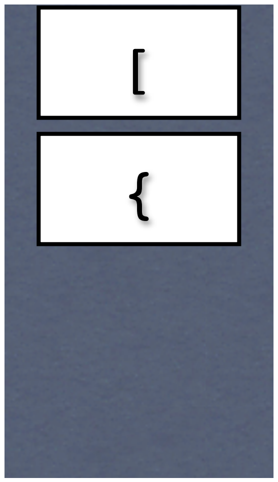

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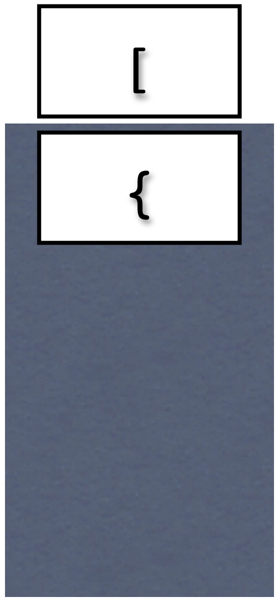

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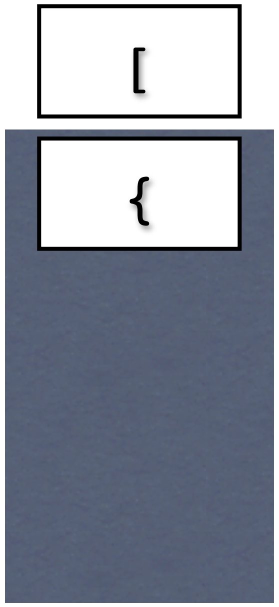

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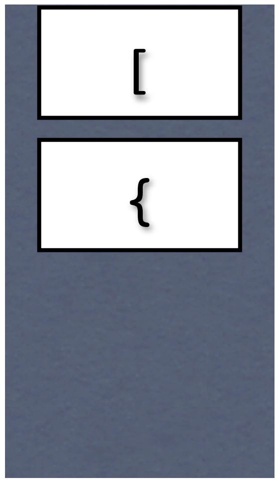

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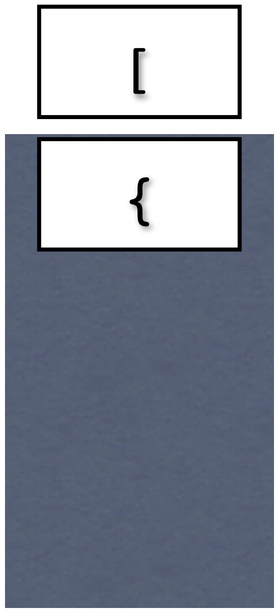

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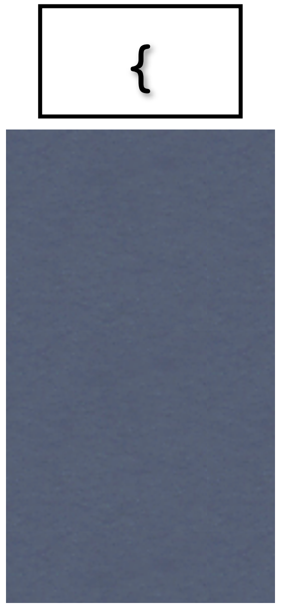


Stack Implementations

- Linked List:
  - Push(x) <-> add(x)   <->   add(x,0)
  - Pop() <-> remove(0)
- Array:
  - Push(x) <-> Array[k++] = x
  - Pop() <-> return Array[--k]

Queue ADT

- Stacks are **L**ast **I**n **F**irst **O**ut
- Queues are **F**irst **I**n **F**irst **O**ut, first-come first-served
- Operations: **enqueue** and **dequeue**
- Analogy: standing in line, garden hose, etc

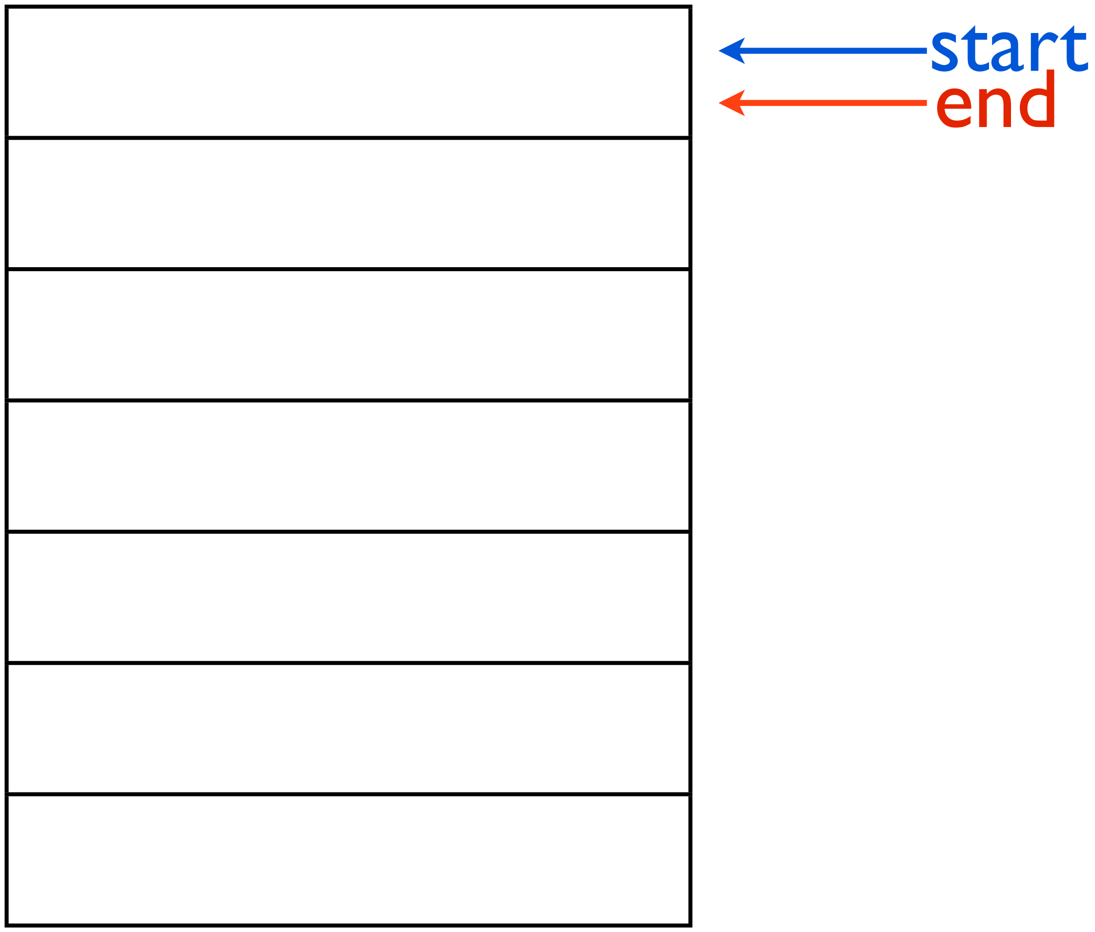
Queue Implementation

- Linked List
  - add(x,0) to enqueue, remove(N-1) to dequeue
- Array List won’t work well!
  - add(x,0) is expensive
  - Solution: use a circular array

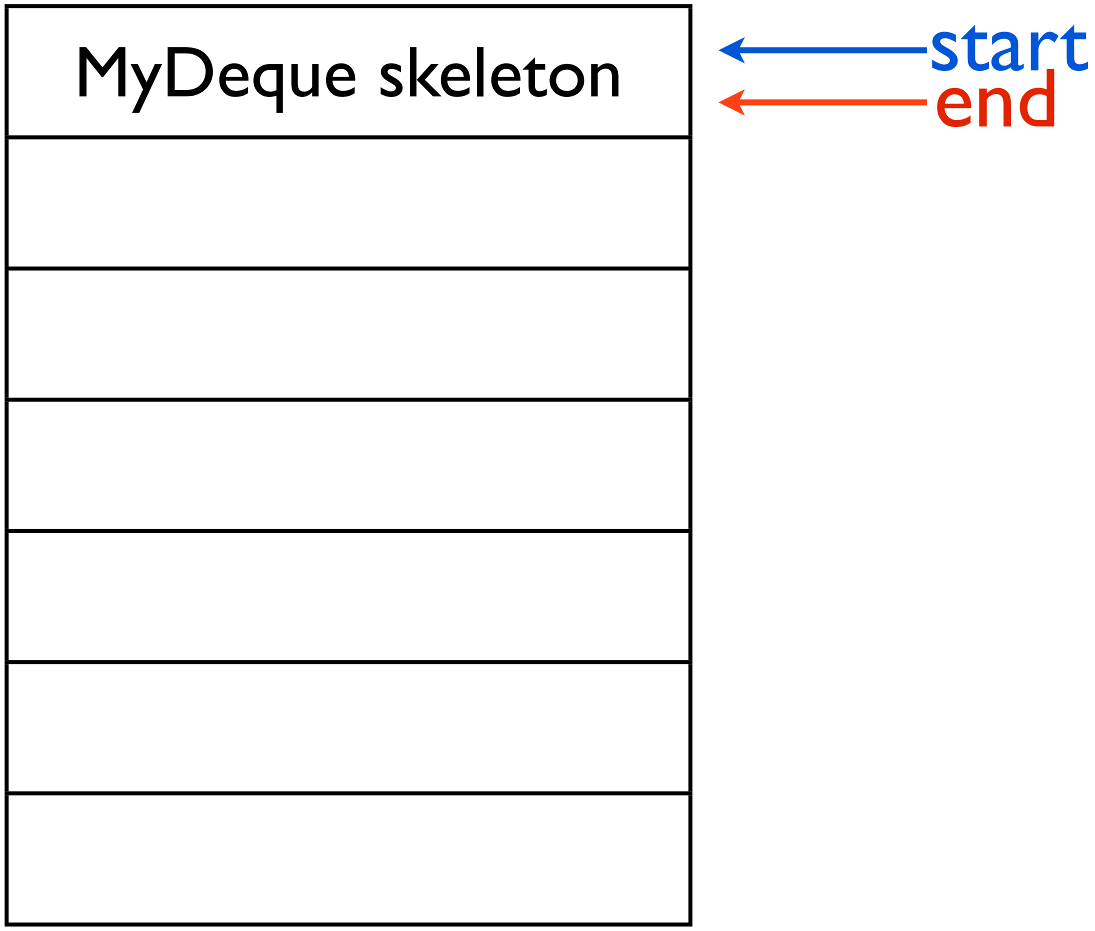
Circular Array

- Don’t shift after removing from array list
- Keep track of start and end of queue
- When run out of space, wrap around; modular arithmetic
- When array is full, increase size using list tactic

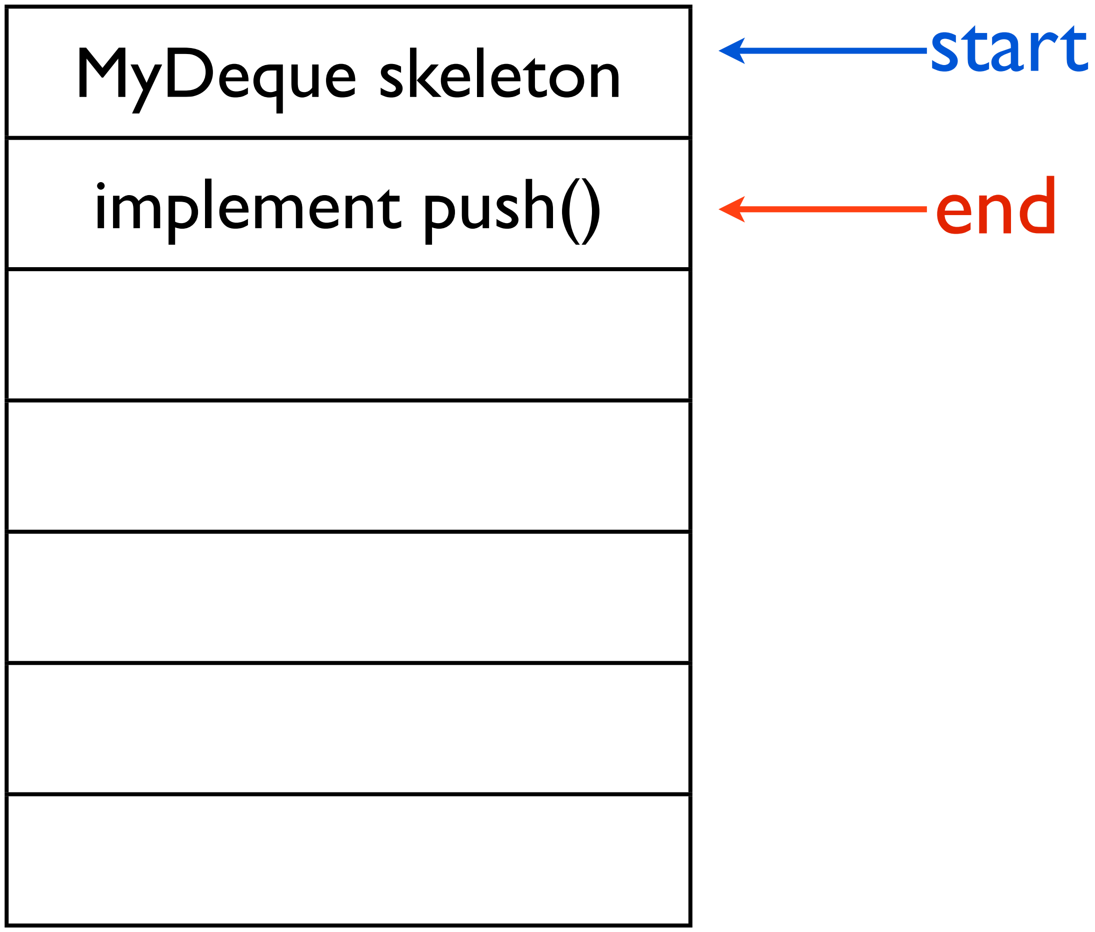
Circular Array Example



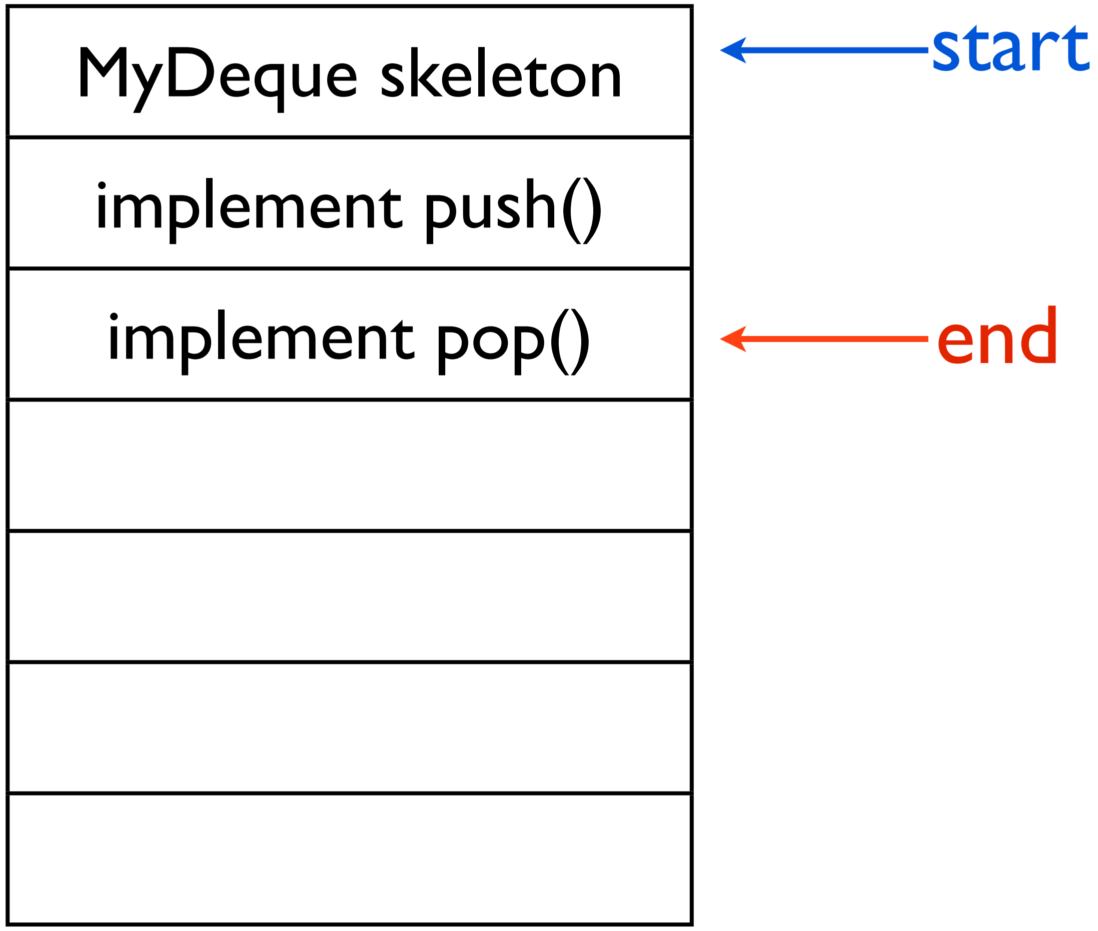
Circular Array Example



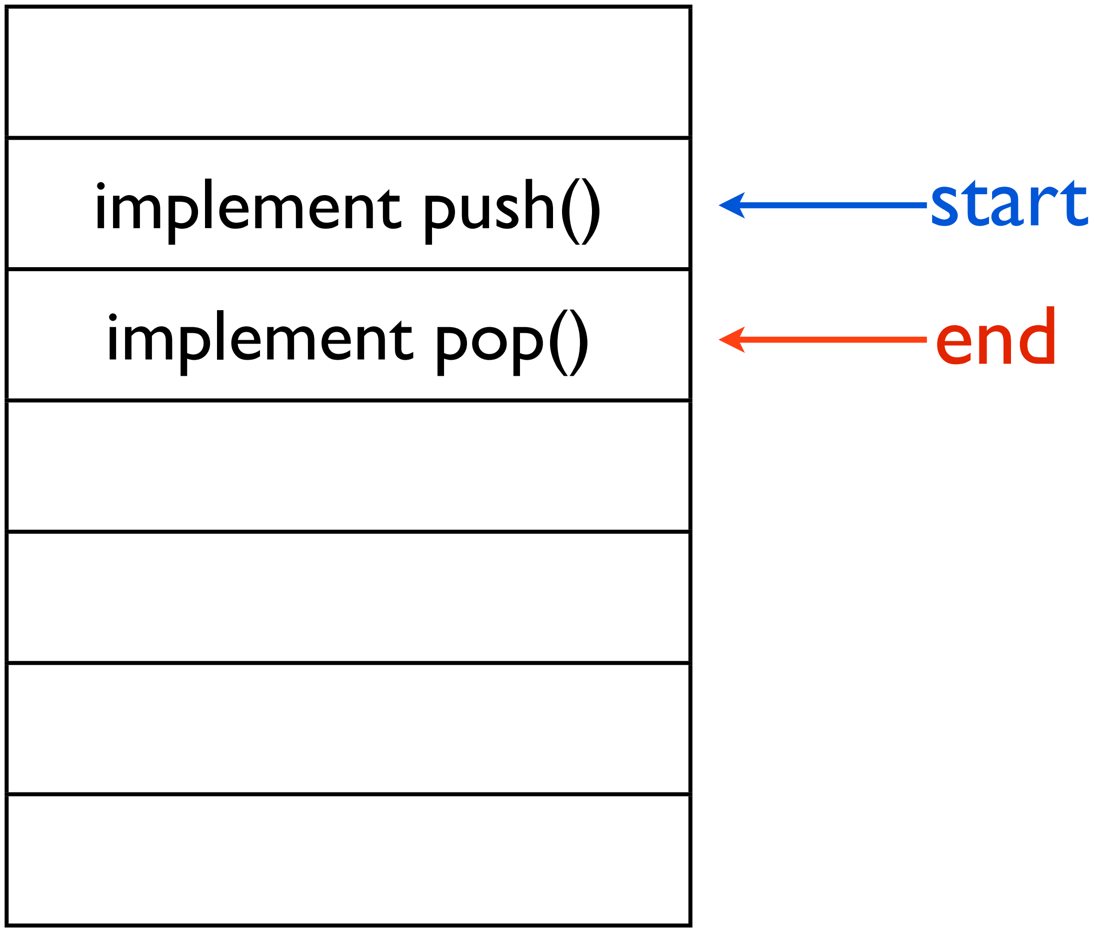
Circular Array Example



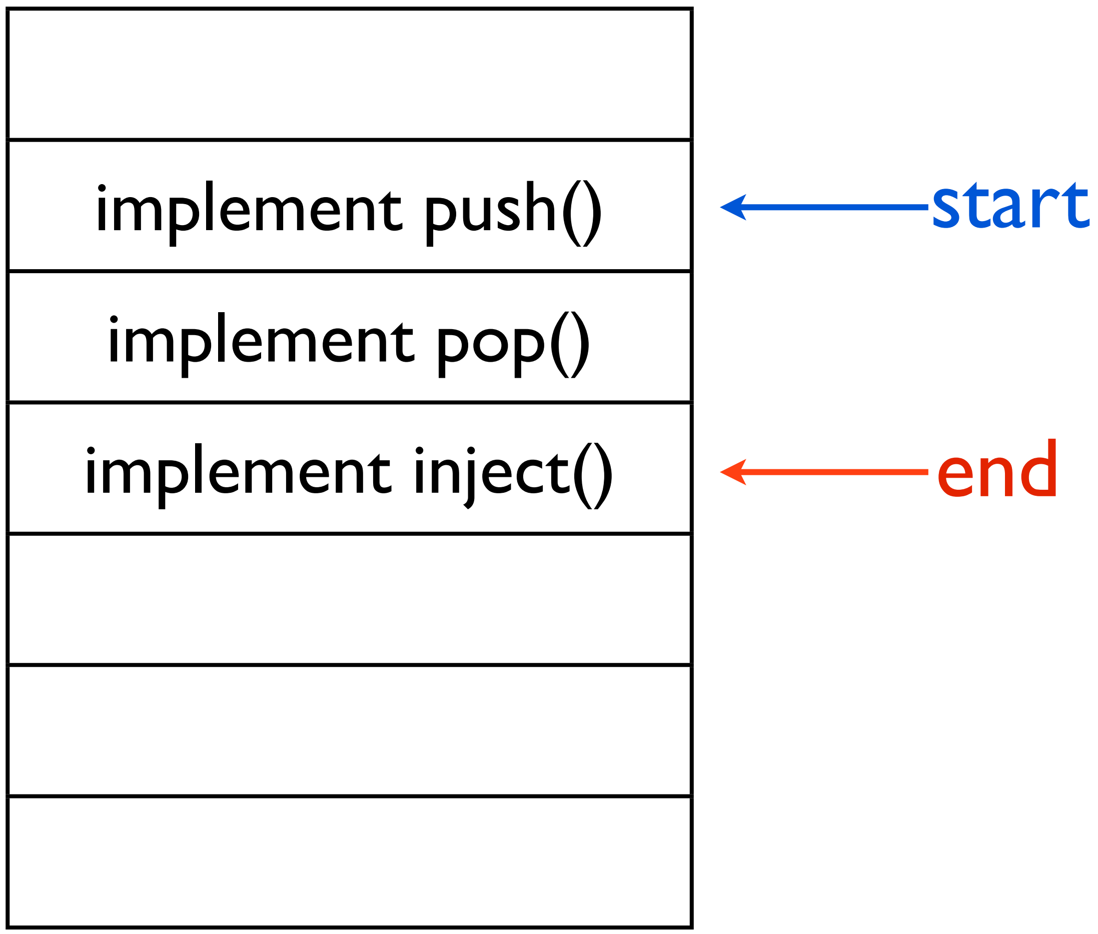
Circular Array Example



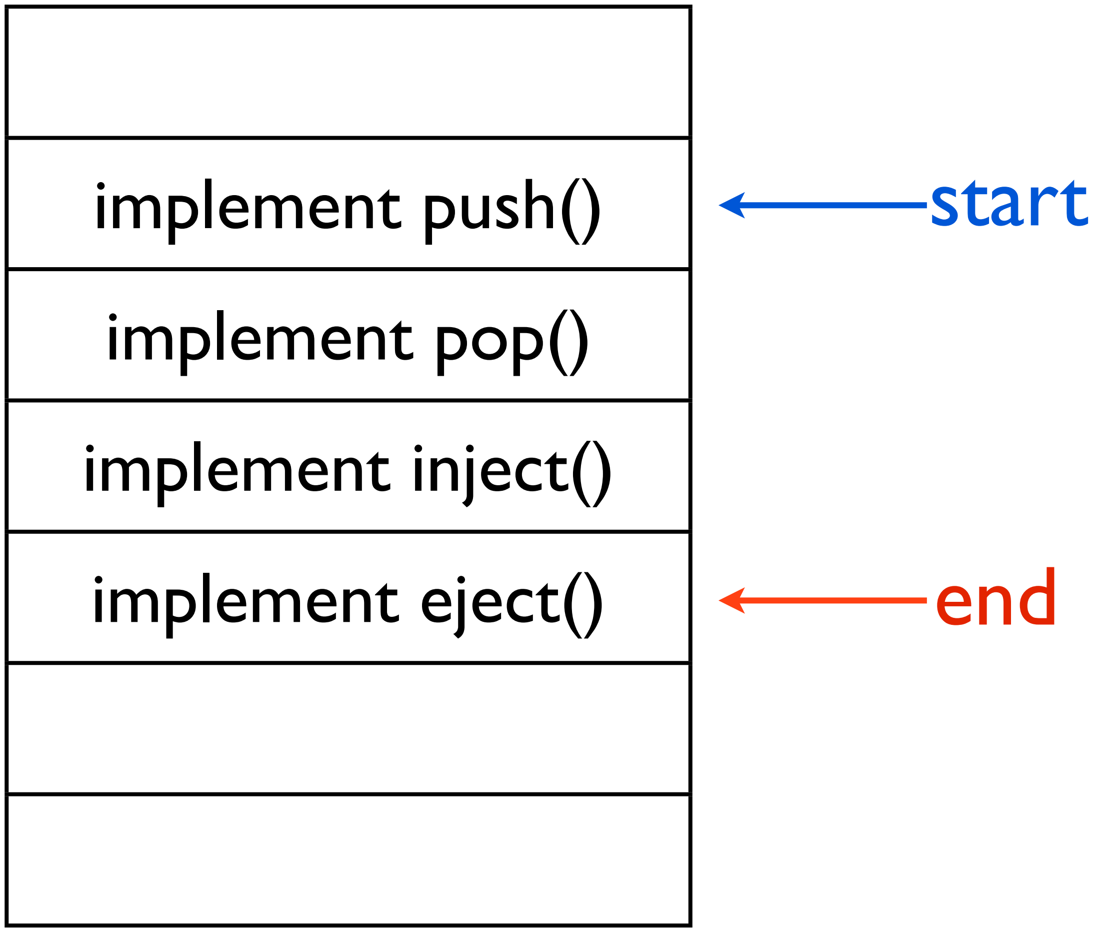
Circular Array Example



Circular Array Example



Circular Array Example



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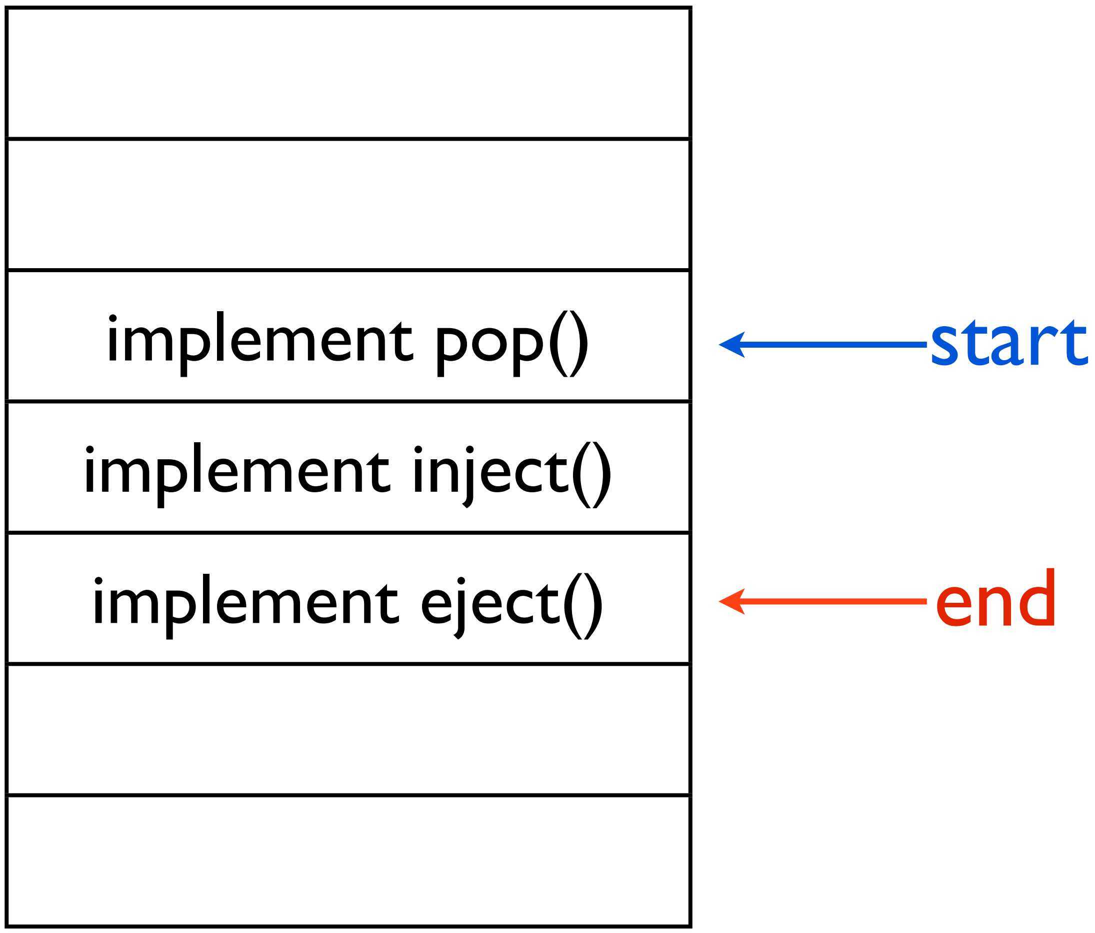

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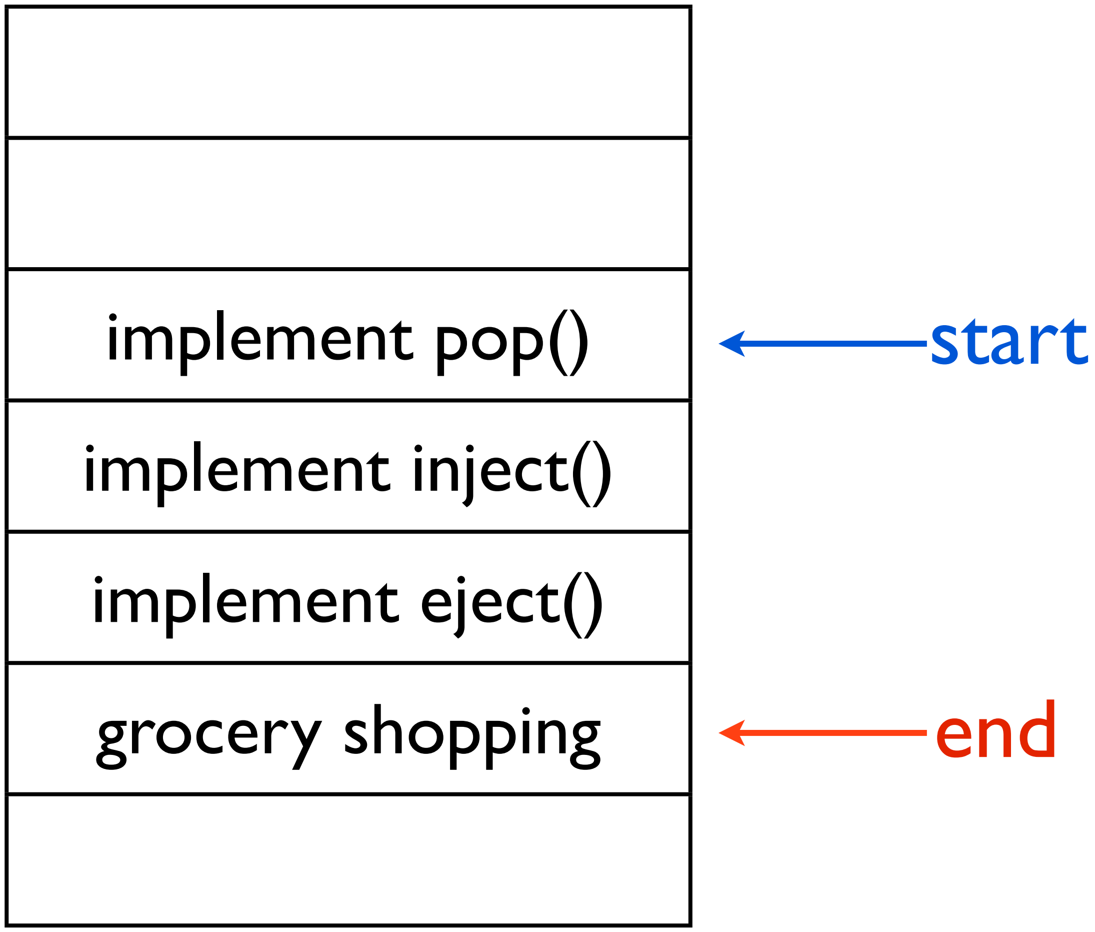

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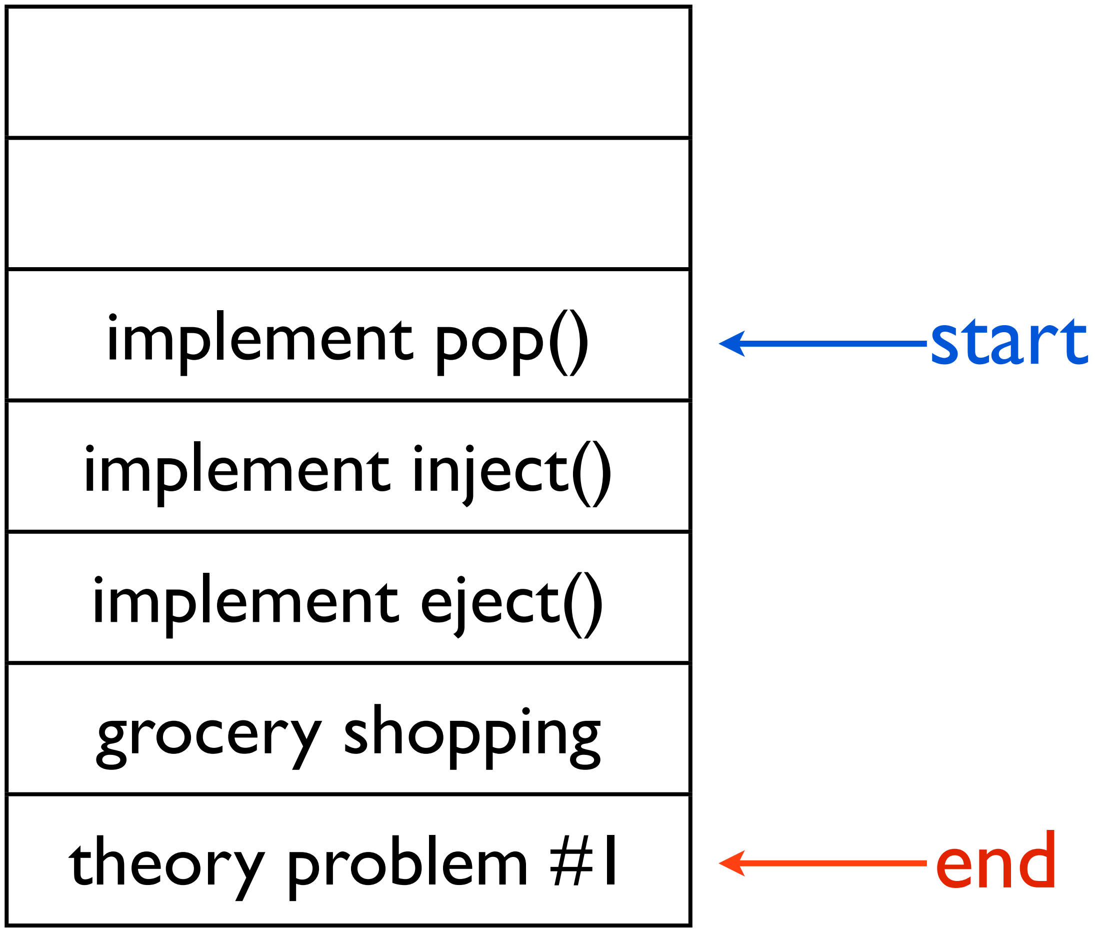

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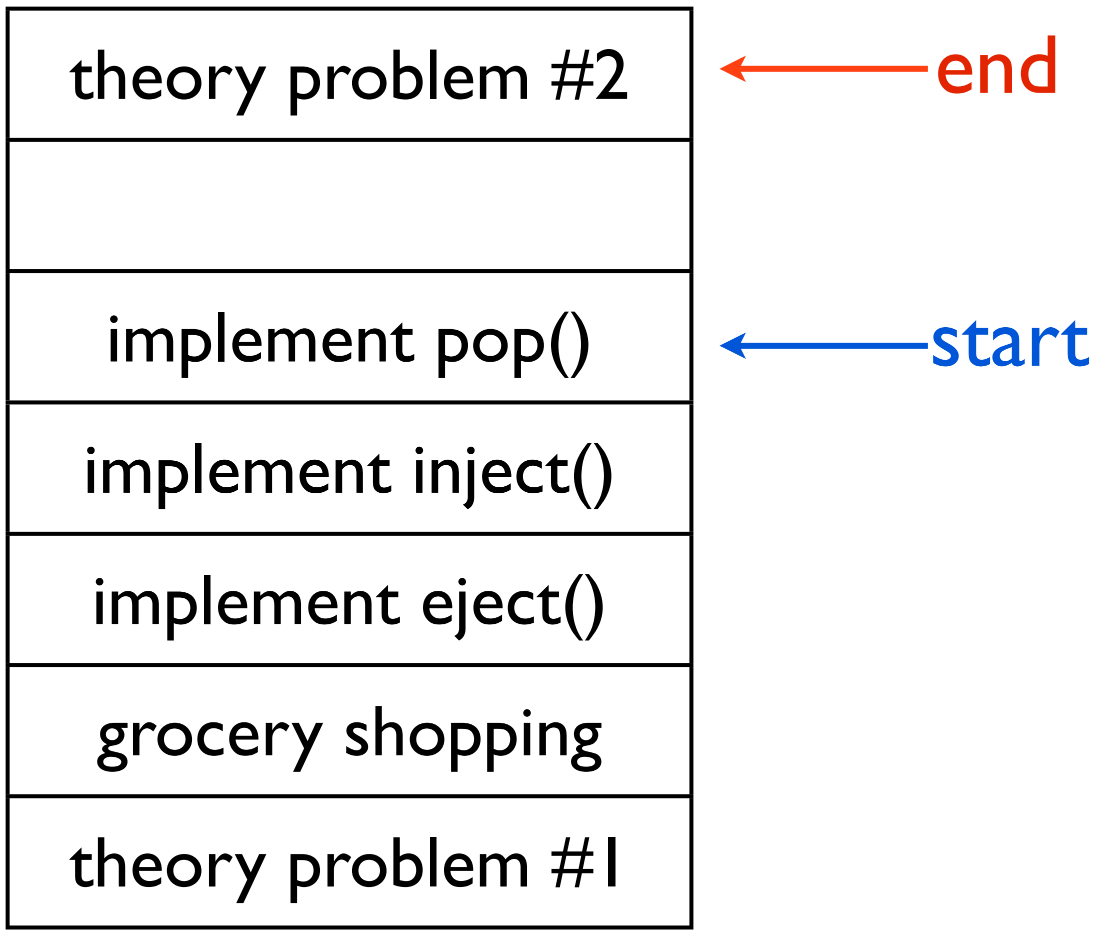

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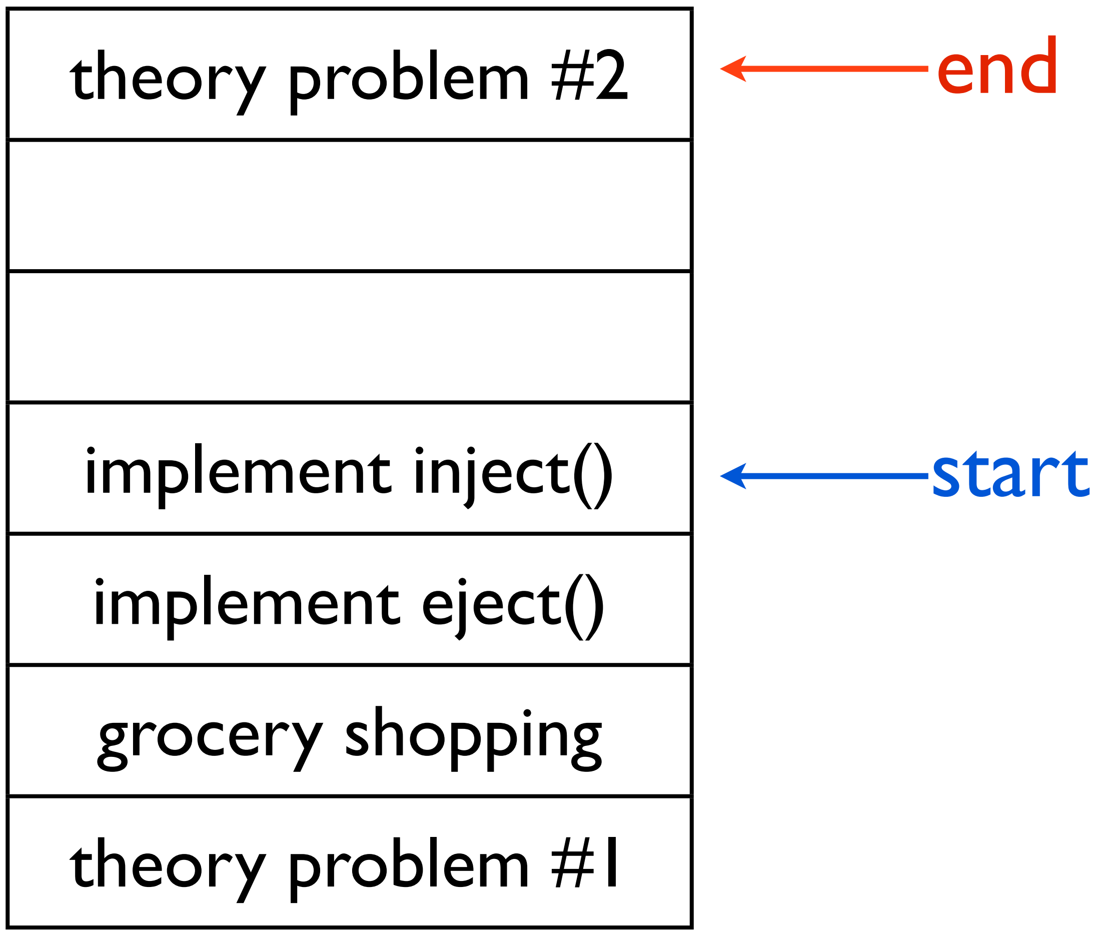

Reading

- Stacks and Queues: Weiss 3.6-3.7