# STACK OPERATIONS

CS212: Data Structure

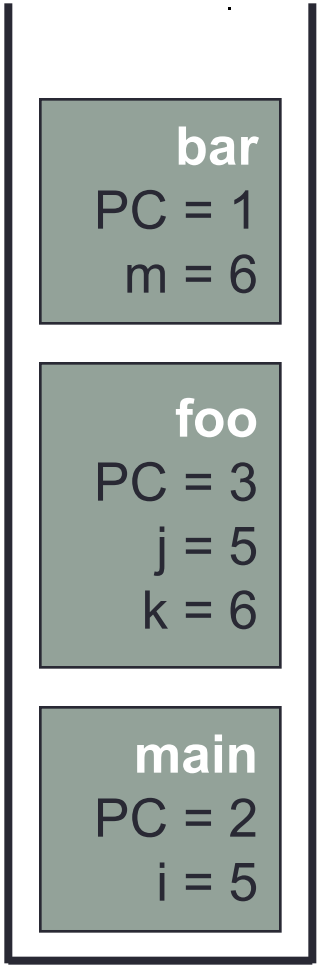
# Applications of Stacks

- Direct applications
  - Page-visited history in a Web browser
  - Undo sequence in a text editor
  - Chain of method calls in the Java Virtual Machine
- Indirect applications
  - Auxiliary data structure for algorithms
  - Component of other data structures → Ex. "Implement a stack of queue"

# Method Stack in the JVM

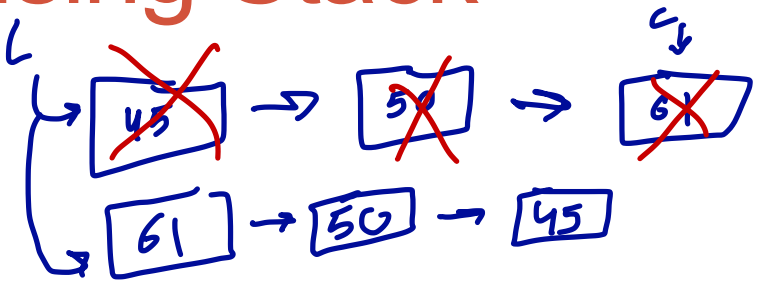
- The Java Virtual Machine (JVM) keeps track of the chain of active methods with a stack
- When a method is called, the JVM pushes on the stack a frame containing
  - Local variables and return value
  - Program counter, keeping track of the statement being executed
- When a method ends, its frame is popped from the stack and control is passed to the method on top of the stack
- Allows for recursion

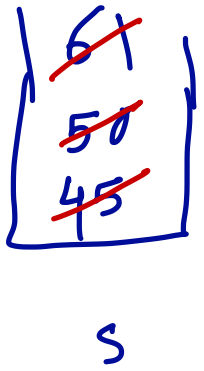
```
main() {
    int i = 5;
    foo(i);
}

foo(int j) {
    int k;
    k = j+1;
    bar(k);
}

bar(int m) {
    …
}
```



# Reverse a List using Stack

```
public class Tester {


   // … other methods here

   public void intReverse(List<Integer> l) {
        Stack<Integer> s = new Stack<Integer>();

        l.findFirst();
        while(!l.empty()) {
             s.push(l.retrieve());
             l.remove();
        }

        while(!s.empty())
             l.insert(s.pop());
    }
}
```



# Parentheses Matching

- Each “(”, “{”, or “[” must be paired with a matching “)”, “}”, or “]”
  - correct: ( )(( )){([( )])}
  - correct: ((( )(( )))){([( )])}
  - incorrect: )(( )){([( )])}
  - incorrect: ({[ ])}
  - incorrect: (

# Parentheses Matching Algorithm

```
Algorithm ParenMatch(X, n):
    Input: An array X of n tokens, each of which is either a grouping symbol,
    a variable, an arithmetic operator, or a number
    Output: true if and only if all the grouping symbols in X match
    Let S be an empty stack
    for i=0 to n-1 do
        if X[i] is an opening grouping symbol then
            S.push(X[i])
        else if X[i] is a closing grouping symbol then
            if S.isEmpty() then
                return false {nothing to match with}
            if S.pop() does not match the type of X[i] then
                return false {wrong type}
    if S.isEmpty() then
        return true {every symbol matched}
    else
        return false {some symbols were never matched}
```

# HTML Tag Matching

For fully-correct HTML, each <name> should pair with a matching </name>

```
<body>
  <center>
        <h1> The Little Boat </h1>
  </center>
  <p> The storm tossed the little
  boat like a cheap sneaker in an
  old washing machine. The three
  drunken fishermen were used to
  such treatment, of course, but
  not the tree salesman, who even as
  a stowaway now felt that he
  had overpaid for the voyage.</p>
  <ol>
        <li> Will the salesman die? </li>
        <li> What color is the boat? </li>
        <li> And what about Naomi? </li>
  </ol>
</body>
```

## The Little Boat

The storm tossed the little boat like a cheap sneaker in an old washing machine. The three drunken fishermen were used to such treatment, of course, but not the tree salesman, who even as a stowaway now felt that he had overpaid for the voyage.

1. Will the salesman die?
2. What color is the boat?
3. And what about Naomi?

# Evaluating Arithmetic Expressions

14 – 3 * 2 + 7 = (14 – (3 * 2) ) + 7

Operator precedence

* has precedence over +/–

Associativity

operators of the same precedence group
evaluated from left to right
Example: (x – y) + z rather than x – (y + z)

Idea: push each operator on the stack, but first pop and perform higher and *equal* precedence operations.

# Algorithm for Evaluating Expressions

Two stacks:

- opStk holds operators
- valStk holds values
- Use $ as special "end of input" token with lowest precedence

**Algorithm** doOp()

x ← valStk.pop();
y ← valStk.pop();
**op** ← opStk.pop();
valStk.push( y **op** x )

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**Algorithm** repeatOps( refOp ):

**while** ( valStk.size() > 1 ∧
prec(refOp) ≤ prec(opStk.top() )
doOp()

**Algorithm** EvalExp()

**Input:** a stream of tokens representing an arithmetic expression (with numbers)

**Output:** the value of the expression

**while** there's another token z
**if** isNumber(z) **then**
valStk.push(z)
**else**
repeatOps(z);
opStk.push(z)
repeatOps($);
**return** valStk.top()

# Algorithm on an Example Expression