EASTERN WASHINGTON UNIVERSITY
start something big

Stack 1

Computer Science Department
Eastern Washington University
Yun Tian (Tony) Ph.D.

Last Class

- Algorithm Analysis

Today Class

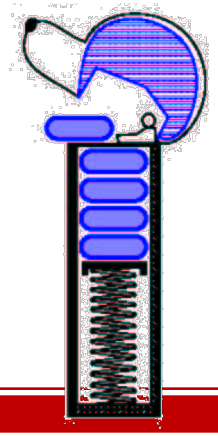
- Stack Data Structure

Abstract Data Types (ADT)

- An abstract data type (ADT) is an abstraction of a data structure.
- An ADT specifies:
  - Data stored
  - Operations on the data
  - Error conditions associated with operations.

The Stack ADT

- The Stack ADT stores arbitrary objects.
- Insertions and deletions follow the **last-in first-out** scheme.
- Think of a spring-loaded plate dispenser.
  - All operations are performed exclusively on the top end (**one end**) of the container.



The Stack ADT

- Main stack operations:
  - **push(object): inserts an element on the top**
  - **object pop(): removes and returns the last inserted element.**
  - object top(): returns the last inserted element without removing it.(in Java called peek())
  - integer size(): returns the number of elements stored.
  - boolean isEmpty(): indicates whether no elements are stored.

The Stack ADT

- In the Stack ADT, operations **pop** and **top** cannot be performed if the stack is empty.
  - We should throw an exception to indicate the error condition.
- Stack is linear in nature,
  - Grows in one direction as a sequence.

The Stack ADT

- Thus, underlying representation could be in two ways.
  - Array
  - Linked List
- Linked List representation is better
  - Dynamically shrink and expand.
  - Array is hard to expand,
    - have a limited capacity.

The Stack ADT

- All fundamental operations can be done **O(1)**.
  - Because we only care about the item on the top of the stack.
    - pop() removes the item on the top and return it.
    - push() inserts a item on the top of the stack.
    - top() or peek(), look at the item on the top, without removing it.
  - If we use linked list representation,
    - We use addFirst() and removeFirst() for push() and pop() respectively.

Applications of Stack

- 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.

Applications of Stack

- 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.

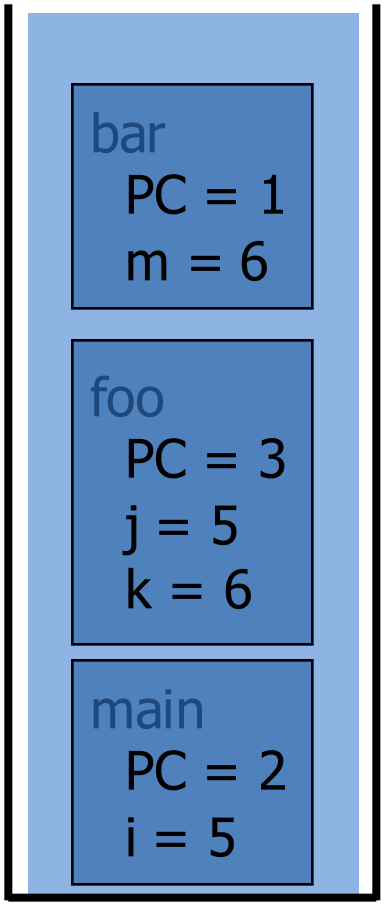
Applications of Stack

- Method Stack in the JVM
  - 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) {
    …
    }
```



Demo of Stack Implementation

Array based Stack

Linked List Stack

Summary Today

- Concept of Stack
  - Last-in First Out property
  - Operations restricted on one end of the container.
  - Two ways of representation.

Next Class

- More Applications of Stack