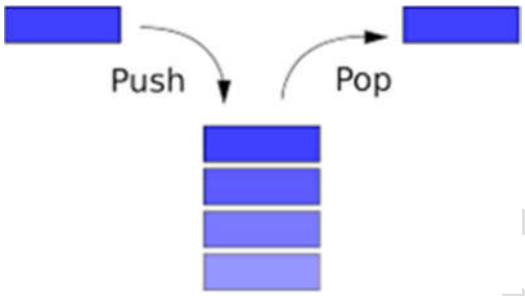
Stacks

Stack is an abstract data type that serves as a collection of elements, with two principal operations:

- **push** adds an element to the collection;
- **pop** removes the last element that was added.



- **Last In, First Out ➔ LIFO**

ABSTRACT DATA TYPE: STACK

DATA

- A collection of objects in reverse chronological order and having the same data type

OPERATIONS

PSEUDOCODE	UML	DESCRIPTION
`push(newEntry)`	`+push(newEntry: T): void`	Task: Adds a new entry to the top of the stack. Input: `newEntry` is the new entry. Output: None.
`pop()`	`+pop(): T`	Task: Removes and returns the stack's top entry. Input: None. Output: Returns the stack's top entry. Throws an exception if the stack is empty before the operation.
`peek()`	`+peek(): T`	Task: Retrieves the stack's top entry without changing the stack in any way. Input: None. Output: Returns the stack's top entry. Throws an exception if the stack is empty.
`isEmpty()`	`+isEmpty(): boolean`	Task: Detects whether the stack is empty. Input: None. Output: Returns true if the stack is empty.
`clear()`	`+clear(): void`	Task: Removes all entries from the stack. Input: None. Output: None.

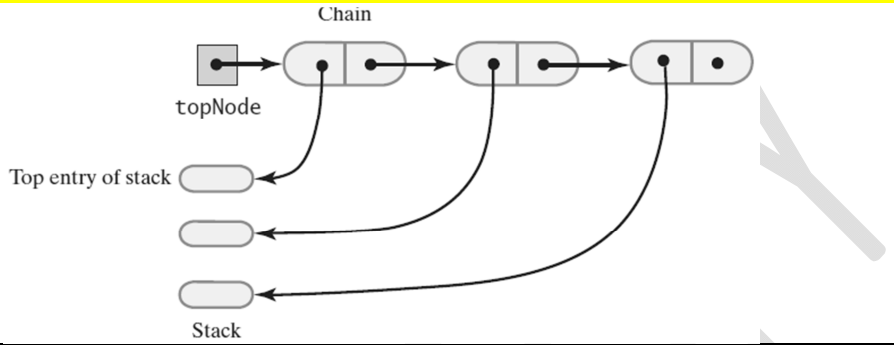
Single Linked List Implementation:

Each of the following operation involves top of stack

- **push**
- **pop**
- **peek**

Head or Tail for topNode??

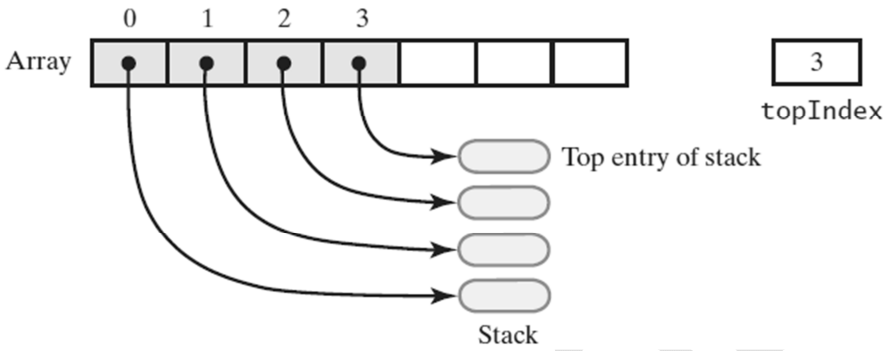
Head of linked list easiest, fastest to access ➔ Let this be the top of the stack




```
public class LinkedStack<T extends Comparable<T>> {
   private Node<T> topNode;

   public void push(T data) {
      Node<T> newNode = new Node<T>(data);
      newNode.setNext(topNode);
      topNode = newNode;
   }

   public Node<T> pop() {
      Node<T> toDel = topNode;
      if(topNode != null)
         topNode = topNode.getNext();
      return toDel;
   }

   public Node<T> peek() {   return topNode; }

   public int length() {
      int length = 0;
      Node<T> curr = topNode;
      while (curr != null) {
         length++;
         curr = curr.getNext();
      }
      return length;
   }

   public boolean isEmpty() {    return (topNode == null);    }

   public  void clear() {  topNode = null;  }
}
```

Array-Based Implementation:

- End of the array easiest to access
  - Let this be top of stack
  - Let first entry be bottom of stack




```
public class ArrayStack <T> {
   private Object[] s;
   private int n=-1;

   public ArrayStack(int capacity){
      s = new Object[capacity];
   }

   public boolean isEmpty(){ return n ==-1;}
   public int getN(){ return n;}

   public void push(T data){
      s[++n] = data;
   }

   public Object pop(){
      if(!isEmpty())
         return s[n--];
      return null;
   }

   public String toString() {
      String res = "Top-->";
      for(int i=n; i>=0;i--)
         res+="["+s[i]+"]-->";
      return res+"Null";
   }
}
```

Iteration (Optional)

Design challenge: Support iteration over stack items by client, without revealing the internal representation of the stack.

- **Java solution**. Make stack implement the **java.lang.Iterable** interface.

Q. What is an `Iterable`?
A. Has a method that returns an `Iterator`.

Iterable interface

```
public interface Iterable<Item> {
   Iterator<Item> iterator();
}
```

Q. What is an `Iterator` ?
A. Has methods `hasNext()` and `next()`.
Q. Why make data structures `Iterable` ?
A. Java supports elegant client code.

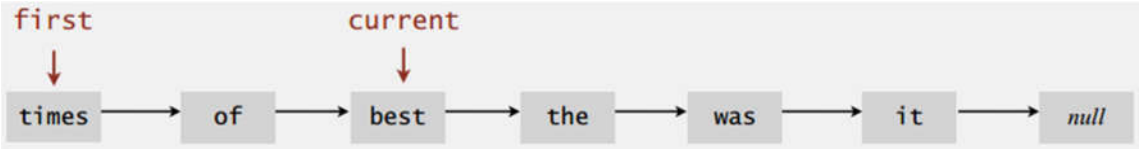
Iterator interface

```
public interface Iterator<Item> {
   boolean hasNext();
   Item next();
   void remove();   <-- optional; use at your own risk
}
```

```
import java.util.Iterator;
public class LinkedStack<T extends Comparable<T>> implements Iterable<T> {
   :
   public Iterator<T> iterator(){
      return new ListIterator();
   }

   private class ListIterator implements Iterator<T>{
      private Node<T> curr = topNode;
      public boolean hasNext(){return curr!=null;}
      public void remove(){}
      public T next(){
         T t = curr.data;
         curr = curr.next;
         return t;
      }
   }
}
```

```
Iterator<String> itt = ls.iterator();
while (itt.hasNext())
   System.out.println(itt.next());
```

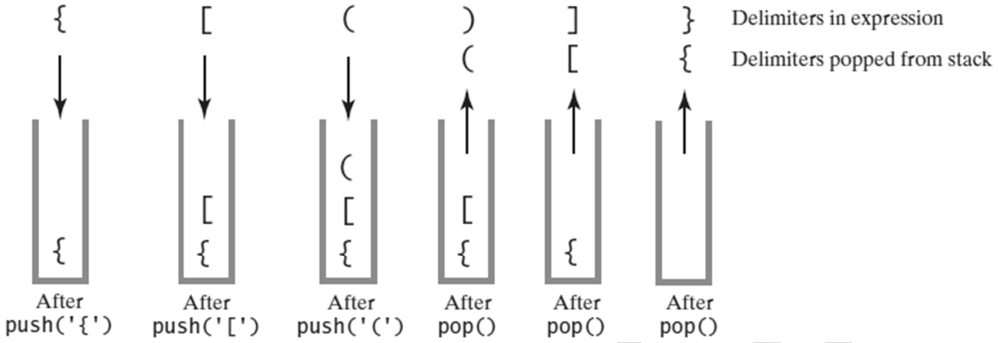
```
for(String s: ls)
   System.out.println(s);
```



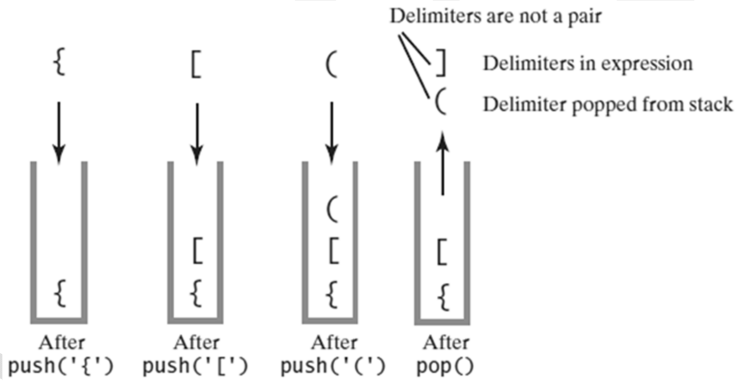
Balanced Delimiters

Problem: Find out if delimiters ("[{(]})") are paired correctly ➔ Compilers

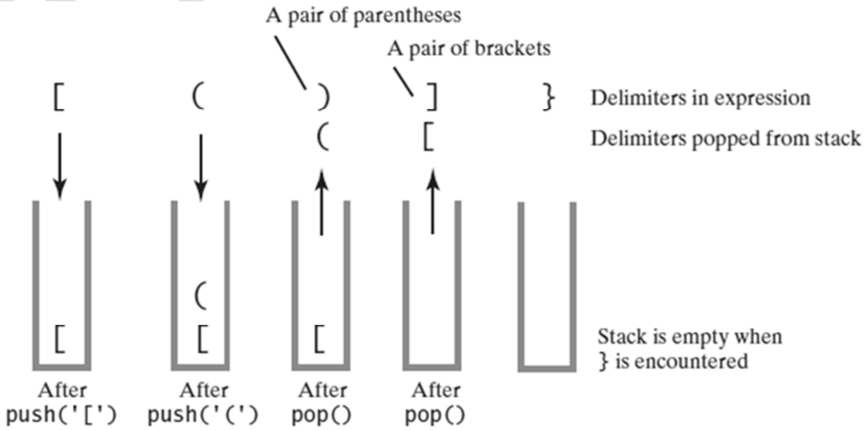
Example 1: The contents of a stack during the scan of an expression that contains the **balanced delimiters { [( )] }**



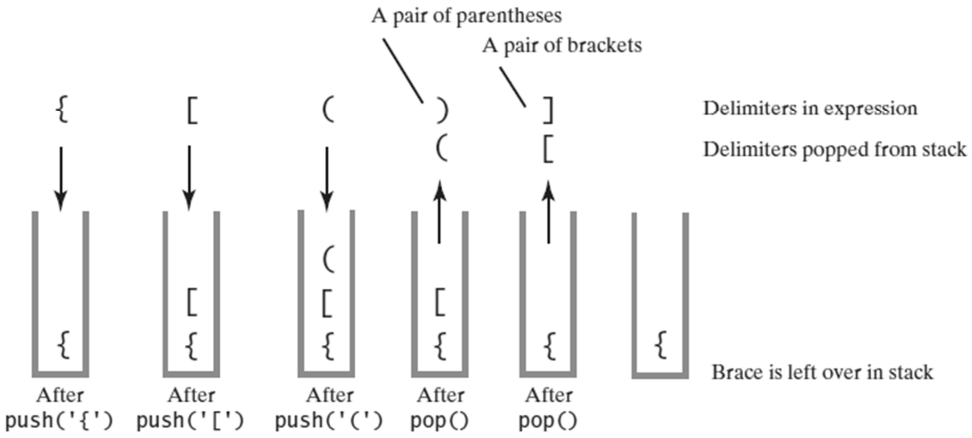
Example 2: The contents of a stack during the scan of an expression that contains the **unbalanced delimiters { [( ]) }**



Example 3: The contents of a stack during the scan of an expression that contains the **unbalanced delimiters [( )] }**



Example 4: The contents of a stack during the scan of an expression that contains the **unbalanced delimiters { [( )]**



Algorithm to process balanced expression:

```
Algorithm checkBalance(expression)
// Returns true if the parentheses, brackets,
// and braces in an expression are paired correctly.
isBalanced = true
while ((isBalanced == true) and not at end of expression) {
   nextCharacter = next character in expression
   switch (nextCharacter) {
      case '(': case '[': case '{':
         Push nextCharacter onto stack
         break

      case ')': case ']': case '}':
         if (stack is empty)
            isBalanced = false
         else {
             openDelimiter = top entry of stack
             Pop stack
             isBalanced = true or false according to whether openDelimiter
                          and nextCharacter are a pair of delimiters
          }
          break
   }
}
if (stack is not empty)  isBalanced = false
return isBalanced
```

H.W. implement check balance algorithm using linked list/array stacks