Data Structures and Algorithms Laboratory		
Laboratory 6: Stacks	**School of Information Technology**	
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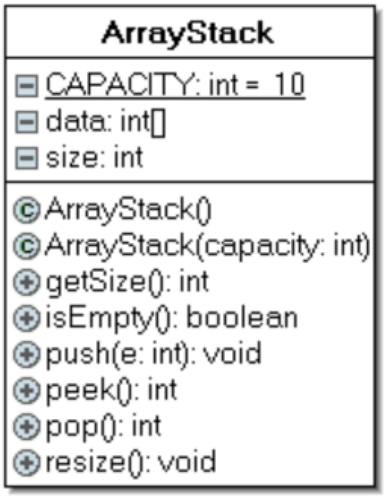
Objective

- To create a stack program based on an array
- To develop stack's methods such as push and pop
- To implement the Matching Parentheses
- To implement the Converting Infix to Postfix

Exercise 1(In-Class): From the given class diagram, create an array-based stack and complete the program to get the results as shown.

Diagram:



Expected result:

```
### Add Data to Empty stack ###
Stack empty: true
Stack push : 1 2 3 4 5
Stack top  : 5
Stack empty: false
Stack size : 5

++++++ Add more Data ++++++
Stack push :Double stack's size
 10 20 30 40 50
Stack size : 10
Stack top  : 50

------ Remove the Stack ------
Stack pop  : 50 40 30 20 10 5 4 3 2 1
Stack size : 0
Stack empty: true
```

ArrayStack:

```
class ArrayStack {
	//Note that this is only for an integer stack
	//------------ Data ------------------
	private final static int CAPACITY = 10;	//default size
	private int[] data;				//array for stack data
	private int size = 0;				//stack's size

	//------------ Method ------------------
	//constructor with default capacity
	public ArrayStack() {
		data = new int[CAPACITY];
	}

	//constructor with a given capacity
	public ArrayStack(int capacity) {
		data = new int[capacity];
	}

	//current stack's size, not a capacity
	public int getSize() {
		return size;
	}

	//empty?
	public boolean isEmpty() {

		if(size == 0)

{

return true;
```

```
}

else

{

return false;

}
```

```
        }


        //push
        public void push(int e) {

              if(size == data.length)

{

resize();

}

data[size] = e;

size++;
```

```
        }

        //peek
        public int peek() {

              if(size == 0)

{

return -999;

}
```

```
else

{

int element = data[size-1];

return element;

}
```

```
	}

	//pop
	public int pop() {

		if(size == 0)

{

return -999;

}

else

{

int element = data[size-1];

size--;

return element;

}
```

```
	}

	//resize
	public void resize() {
		System.out.println("Double stack's size");
		//create a new array of double size
		int[] temp = new int[2*data.length];
		//copy old array data to new array
		System.arraycopy(data, 0, temp, 0, data.length);
```

```
            //assign the stack to new array
            data = temp;
        }
}
```

MainClass

```
public class MainStack {
	public static void main(String[] args) {
	    ArrayStack stack = new ArrayStack(5);
	    System.out.println("### Add Data to Empty stack ###");      //Add data
	    System.out.println("Stack empty: "+stack.isEmpty());
	    System.out.print("Stack push :");
	    for(int i=1;i<=5;i++){
	      stack.push(i);                                           //push
	      System.out.print(" "+i);
	    }
	    System.out.println();

	    System.out.println("Stack top  : "+stack.peek());          //check Top
	    System.out.println("Stack empty: "+stack.isEmpty());      //check Empty
	    System.out.println("Stack size : "+stack.getSize());      //check Size

	    System.out.println("\n++++++ Add more Data ++++++");        //Add more data
	    System.out.print("Stack push :");
	    for(int j=10;j<=50;j+=10){
	      stack.push(j);                                           //push
	      System.out.print(" "+j);
	    }
	    System.out.println("\nStack size : "+stack.getSize());
	    System.out.println("Stack top  : "+stack.peek());

	    System.out.println("\n------ Remove the Stack ------");     //Remove Stack
	    System.out.print("Stack pop  :");
	    int s=stack.getSize();                                     //get Size
	    for(int k=1;k<=s;k++){
	      System.out.print(" "+stack.pop());                       //pop and display
	    }
	    System.out.println("\nStack size : "+stack.getSize());   //check Size
	    System.out.println("Stack empty: "+stack.isEmpty());      //check Empty
	}
}
```

Exercise 2(In-Class): Matching Parentheses

Modify the ArrayStack in Exercise 1 to become **a stack of character data type**. Write a new codes below.

ArrayStack and Stack Code:

```
package DSALab06;

public class ArrayStackChar {

private final static int CAPACITY = 10; //default size

private int[] data; //array for stack data

private int size = 0;

public ArrayStackChar()

{

data = new int[CAPACITY];

}

public ArrayStackChar(int capacity)

{

data = new int[capacity];

}

public int getSize()

{

return size;

}

public boolean isEmpty()

{

if(size == 0)

{

return true;
```

```
}
else
{
return false;
}
}
public void push (int e)
{
if(size == data.length)
{
resize();
}
data[size] = e;
size++;
}
public int peek()
{
if(size == 0)
{
return -999;
}
else
{
int element = data[size-1];
return element;
```

```
}

}

public int pop()

{

if(size == 0)

{

return -999;

}

else

{

int element = data[size-1];

size--;

return element;

}

}

//resize

public void resize()

{

System.out.println("Double stack's size");

//create a new array of double size

int[] temp = new int[2*data.length];

//copy old array data to new array

System.arraycopy(data, 0, temp, 0, data.length);

//assign the stack to new array

data = temp;
```

```
}

}
```

Then, complete the main class to complete the program to get the results as shown.

```
Expression: ()(()){([()])}

Input ..... (
Stack push : (

Input .... )
Stack pop : (
Matching ... ( with )
------------------------- delimiter matched!
Input ..... (
Stack push : (
Input ..... (
Stack push : (

Input .... )
Stack pop : (
Matching ... ( with )
------------------------- delimiter matched!

Input .... )
Stack pop : (
Matching ... ( with )
------------------------- delimiter matched!
Input ..... {
Stack push : {
Input ..... (
Stack push : (
Input ..... [
Stack push : [
Input ..... (
Stack push : (

Input .... )
Stack pop : (
Matching ... ( with )
------------------------- delimiter matched!

Input .... ]
Stack pop : [
Matching ... [ with ]
------------------------- delimiter matched!

Input .... )
Stack pop : (
Matching ... ( with )
------------------------- delimiter matched!

Input .... }
Stack pop : {
Matching ... { with }
------------------------- delimiter matched!

++++++++++++++++++++++++ ALL ARE MATCHED.
```

Main Class Source code:

```
package DSALab06;

public class MainMatching {

public static void main(String[] args) {

// TODO Auto-generated method stub

String opening="({[";

String closing=")}]";

String expression="()(()){([()])}";

//Show input message

System.out.print("Expression: "+expression);

System.out.println("\n");

ArrayStackChar stack = new ArrayStackChar(expression.length());

//split String to array of characters

char[] exp = expression.toCharArray();

//For each character in the array

for(char c:exp)

{

//is it opening delimiter?

//use indexOf() to find character in String, return -1 if not found, otherwise
return position

//if this opening delimiter is found

if(opening.indexOf(c) != -1)

{

//push to stack

System.out.println("Input ..... " + c);

System.out.println("Stack push : " + c);
```

```
stack.push(c);

}

else if(closing.indexOf(c) != -1)

{

//is stack empty? --> no matching opening delimiter

if(stack.isEmpty())

{

System.out.println("\n ***** MISMATCHED DELIMITER! ***** ");

//end the program

return;

}

//pop an element

System.out.println("\nInput .... " + c);

char p = (char) stack.pop(); ;

System.out.println("Stack pop : " + p);

System.out.println("Matching ... "+ p + " with "+ c);

//is the pop opening element is equal to the current closing delimiter?

//here the positions of both delimiters must be equal

if(opening.indexOf(p) == closing.indexOf(c))

{

System.out.println("------------ delimiter matched!");

}

else

{

System.out.println("\n ***** MISMATCHED DELIMITER! ***** ");
```

```
//end the program

return;

}

}

}

//---now all delimiters are checked---

//is there any delimiter left in stack?

//if stack is empty

if(stack.isEmpty())

{

System.out.println("\n++++++++++++++++++++++++++ ALL ARE MATCHED.");

}

else

{

System.out.println("\n ***** MISMATCHED DELIMITER! ***** ");

//end the program

return;

}

}

}
```

Question: What is the maximum number of parentheses that can be pushed to the stack AT ANY TIME when the algorithm runs? What are they?

The maximum number of parentheses that can be pushed to the stack AT ANY TIME is 4.They are `{([(.`

Exercise 3 (Homework): Converting Infix to Postfix.

Write a program to convert the given infix expression to become the postfix expression.

Expression: (a+b-c)*d–(e+f)

Expected output:

```
Infix: (a+b-c)*d-(e+f)

Postfix: ab+c-d*ef+-
```

ArrayStack and Stack Code:

```
package DSALab06;

public class ArrayStackChar {

private final static int CAPACITY = 10; //default size

private int[] data; //array for stack data

private int size = 0;

public ArrayStackChar()

{

data = new int[CAPACITY];

}

public ArrayStackChar(int capacity)

{

data = new int[capacity];

}

public int getSize()

{

return size;

}

public boolean isEmpty()
```

```
{
if(size == 0)
{
return true;
}
else
{
return false;
}
}
public void push (int e)
{
if(size == data.length)
{
resize();
}
data[size] = e;
size++;
}
public int peek()
{
if(size == 0)
{
return -999;
}
```

```
else

{

int element = data[size-1];

return element;

}

}

public int pop()

{

if(size == 0)

{

return -999;

}

else

{

int element = data[size-1];

size--;

return element;

}

}

//resize

public void resize()

{

System.out.println("Double stack's size");

//create a new array of double size

int[] temp = new int[2*data.length];
```

```
//copy old array data to new array

System.arraycopy(data, 0, temp, 0, data.length);

//assign the stack to new array

data = temp;

}

}
```

Main Class Source code:

```
package DSALab06;

public class MainInfix2Postfix {

public static void main(String[] args) {

// TODO Auto-generated method stub

String operator = "+-*/";

String expression = "(a+b-c)*d-(e+f)";

System.out.println("Infix: " + expression);

//Create a char stack

ArrayStackChar stack = new ArrayStackChar();

//split String to array of characters

char[] exp = expression.toCharArray();

char[] postfix = new char[expression.length()];

int size = 0;

System.out.print("\nPostfix: ");

//For each character in the array

for(char c:exp)
```

```
{
if(c == '(')
{
stack.push(c);
}
else if(operator.indexOf(c)!= -1)
{
if(operator.indexOf(stack.peek())!= -1)
{
postfix[size] = (char) stack.pop();
size++;
stack.push(c);
}
else
{
stack.push(c);
}
}
else if(c == ')')
{
while(stack.peek() != '(')
{
if(!stack.isEmpty())
{
postfix[size] = (char) stack.pop();
```

```
size++;

}

else

{

System.out.println("expression is not matched");

}

}

stack.pop();

}

else

{

postfix[size] = c;

size++;

}

}

// now all operators and operands are checked

// is there any operator left in stack?

// if stack is NOT empty

if (!stack.isEmpty())

{

if(operator.indexOf(stack.peek())!=-1)

{

postfix[size]= (char) stack.pop();

size++;

}
```

```
else if(stack.peek() == '(')

{

System.out.println("expression is not matched");

}

}//end if stack is NOT empty

for(char b:postfix)

{

System.out.print(b);

}

}

}
```

Question: What is the maximum number of symbols that will be pushed to the stack AT ONE TIME during the conversion of this expression? What are they?

The maximum number of symbols that will be pushed to the stack AT ONE TIME is 3. They are - , (and +.