



Lecture 3: Operators

Kenya 2005

Lecture Outline

- What operators are
- Arithmetic Operators such as +, -
- Assignment Operator
- Increment/Decrement Operators e.g i++
- Relational Operators
- Conditional Operators



What are Operators?

- Operators are special symbols used for:
 - mathematical functions
 - assignment statements
 - logical comparisons

- Examples of operators:

$3 + 5$ // uses + operator

$14 + 5 - 4 * (5 - 3)$ // uses +, -, * operators

- *Expressions* can be combinations of variables, primitives and operators that result in a value



The Operator Groups

- There are 5 different groups of operators:
 - Arithmetic Operators
 - Assignment Operator
 - Increment / Decrement Operators
 - Relational Operators
 - Conditional Operators
- The following slides will explain the different groups in more detail.



Arithmetic Operators

- Java has 6 basic arithmetic operators :

+	add
-	subtract
*	multiply
/	divide
%	modulo (remainder)
^	exponent (to the power of)

- The order of operations (or precedence) when evaluating an expression can be summarized in the acronym PEMDAS.



Order Of Operations

- Order of Operations (**PEMDAS**)
 1. **P**arentheses
 2. **E**xponents
 3. **M**ultiplication and **D**ivision from left to right
 4. **A**ddition and **S**ubtraction from left to right

- An easy way to remember this is:
“**P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally” !



Order of Operations (Cont'd)

- Example: $10 + 15 / 5;$
- The result is different depending on whether the addition or division is performed first

$$(10 + 15) / 5 = 5$$

$$10 + (15 / 5) = 13$$

Without parentheses, Java will choose the second case

- Note: you should be explicit and use parentheses to avoid confusion



Integer Division

- In the previous example, we were lucky that $(10 + 15) / 5$ gives an exact integer answer (5).
- But what if we divide 63 by 35?
- Depending on the data types of the variables that store the numbers, we will get different results.



Integer Division (Cont'd)

- ```
int i = 63;
int j = 35;
System.out.println(i / j);
```

Output: 1
- ```
double x = 63;  
double y = 35;  
System.out.println(x / y);
```

Output: 1.8
- The result of integer division is just the integer part of the quotient!



Assignment Operator

- The basic assignment operator (=) assigns the value of `expr` to `var`

`var = expr ;`

- Java allows you to combine arithmetic and assignment operators into a single operator

- Examples:

`x = x + 5 ;` is equivalent to

`x += 5 ;`

`y = y * 7 ;` is equivalent to

`y *= 7 ;`



Increment/Decrement Operators

- `++` is called the increment operator. It is used to increase the value of a variable by 1.

For example:

`i = i + 1;` can be written as:
`++i;` or `i++;`

- `--` is called the decrement operator. It is used to decrease the value of a variable by 1.

`i = i - 1;` can be written as:
`--i;` or `i--;`



Increment Operators (cont'd)

- The increment / decrement operator has two forms :
 - Prefix Form e.g `++i;` `--i;`
 - Postfix Form e.g `i++;` `i--;`



Prefix increment /decrement

- The prefix form first adds/ subtracts 1 from the variable and then continues to any other operator in the expression
- Example:

```
int numOranges = 5;  
int numApples = 10;  
int numFruit;  
numFruit = ++numOranges + numApples;
```

numFruit has value 16

numOranges has value 6



Postfix Increment/ Decrement

- The postfix form `i++`, `i--` first evaluates the entire expression and then adds 1 to the variable
- Example:

```
int numOranges = 5;  
int numApples = 10;  
int numFruit;  
numFruit = numOranges++ + numApples;
```

`numFruit` has value 15

`numOranges` has value 6



Relational (Comparison) Operators

- Relational operators compare two values
- They Produce a boolean value (**true** or **false**) depending on the relationship

OperationIs true when
$a > b$	a is greater than b
$a \geq b$	a is greater than or equal to b
$a == b$	a is equal to b
$a \neq b$	a is not equal to b
$a \leq b$	a is less than or equal to b
$a < b$	a is less than b

Note: == sign!



Examples of Relational Operations

```
int x = 3;  
int y = 5;  
boolean result;
```

1) `result = (x > y);`

now `result` is assigned the value `false` because 3 is `not greater` than 5

2) `result = (15 == x*y);`

now `result` is assigned the value `true` because the product of 3 and 5 `equals` 15

3) `result = (x != x*y);`

now `result` is assigned the value `true` because the product of `x` and `y` (15) is `not equal` to `x` (3)



Conditional Operators

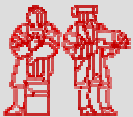
Symbol	Name
&&	AND
	OR
!	NOT

- Conditional operators can be referred to as `boolean` operators, because they are only used to combine expressions that have a value of `true` or `false`.



Truth Table for Conditional Operators

x	y	x && y	x y	!x
True	True	True	True	False
True	False	False	True	False
False	True	False	True	True
False	False	False	False	True



Examples of Conditional Operators

```
boolean x = true;
```

```
boolean y = false;
```

```
boolean result;
```

1. Let `result = (x && y);`

now `result` is assigned the value `false`
(see truth table!)

2. Let `result = ((x || y) && x);`

<code>(x y)</code>	evaluates to <code>true</code>
<code>(true && x)</code>	evaluates to <code>true</code>

now `result` is assigned the value `true`



Using && and ||

- Java performs **short-circuit evaluation**: By this we mean that it evaluates && and || expressions from left to right and *once it finds the result, it stops*.
- Examples:
 - (a && (b++ > 3))
 - (x || y)
- Java will evaluate these expressions from left to right and so will evaluate
 - a before (b++ > 3)
 - x before y



Short-Circuit Evaluation

```
( a && ( b++ > 3 ) ) ;
```

What happens if `a` is `false`?

- Java will not evaluate the right-hand expression `(b++ > 3)` if the left-hand operator `a` is `false`, since the result is already determined in this case to be `false`. This means `b` will not be incremented!

```
( x || y ) ;
```

What happens if `x` is `true`?

- Similarly, Java will not evaluate the right-hand operator `y` if the left-hand operator `x` is `true`, since the result is already determined in this case to be `true`.



POP QUIZ

1) What is the value of `number`?

```
int number = 5 * 3 - 3 / 6 - 9 * 3;
```

2) What is the value of `result`?

```
int x = 8;
```

```
int y = 2;
```

```
boolean result = (15 == x * y);
```

3) What is the value of `result`?

```
boolean x = 7;
```

```
boolean result = (x < 8) && (x > 4);
```

4) What is the value of `numCars`?

```
int numBlueCars = 5;
```

```
int numGreenCars = 10;
```

```
int numCars = numGreenCars++ +
```

```
numBlueCars + ++numGreenCars;
```



POP Quiz Solutions

1) What is the value of `number`? `-12`

```
int number = 5 * 3 - 3 / 6 - 9 * 3;
```

2) What is the value of `result`? `false`

```
int x = 8;
```

```
int y = 2;
```

```
boolean result = (15 == x * y);
```

3) What is the value of `result`? `true`

```
boolean x = 7;
```

```
boolean result = (x < 8) && (x > 4);
```

4) What is the value of `numCars`? `27`

```
int numBlueCars = 5;
```

```
int numGreenCars = 10;
```

```
int numCars = numGreenCars++ + numBlueCars +  
              ++numGreenCars;
```



Reference

- Summary of Java operators

<http://java.sun.com/docs/books/tutorial/java/nutsandbolts/opsummary.html>



This Lecture Covered....

- What Operators are
- The different types of operators
- The order of Operations for arithmetic operators
- Prefix and Postfix operators
- Short Circuit Evaluation



MIT OpenCourseWare
<http://ocw.mit.edu>

EC.S01 Internet Technology in Local and Global Communities
Spring 2005-Summer 2005

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.