OPERATORS

JAVA OPERATORS

- **Arithmetic Operators : +, -, *, /, %, ++,--**
- **Bitwise Operators : &, I, ^ , ~**
- **Relational Operators : >, >= , <, <=, ==, !=**
- **Logical Operators : && , II**

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Operators : Chapter - 4

Operators

CHAPTER

4

Operators

Java

The Complete Reference

Ninth Edition

Comprehensive Coverage of the Java Language

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Operators in Java

- Most of JAVA operators can be divided into the following four groups:
  - **Arithmetic : +, -, *, /, %, ++,--**
  - **Bitwise : &, I, ^ , ~**
  - **Relational : >, >= , <, <=, ==, !=**
  - **Logical : && , II**
- The **[ ]**, **( )**, and **.** can also act like operators for precedence purpose although they are technically separators.
- The arrow operator (->) is used in Lambda expression

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Java Operator : Unary, binary and ternary

Operator can be classified based on the operand they are operate.

- ✓ **Unary operator:** involve one operand e.g. ++,--,!,~, -

  Ex: x++, X--, !x, ~x
- ✓ **Binary operator:** involve two operand e.g. +,-,%,*

  Ex: x+y, x%y, x-y
- ✓ **Ternary operator:** involve three operand e.g. ? :

  Ex: ratio= denom==0 ? 0 : num/denom;

The minus (-) operator can both be Unary and Binary

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Java Unary Operator

The Java unary operators require only one operand. Unary operators are used to perform various operations i.e.:

- ✓ incrementing/decrementing a value by one
- ✓ negating an expression
- ✓ inverting the value of a boolean

```
class OperatorExample{
public static void main(String args[]){
int x=10;
System.out.println(x++);//10 (11)
System.out.println(++x);//12
System.out.println(x--);//12 (11)
System.out.println(--x);//10
}}
```

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=10;
System.out.println(a++ + ++a);//10+12=22
System.out.println(b++ + b++);//10+11=21

}}
```

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Java Unary Operator

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=-10;
boolean c=true;
boolean d=false;
System.out.println(~a);//-11 (minus of total positive value which starts from 0)
System.out.println(~b);//9 (positive of total minus, positive starts from 0)
System.out.println(!c);//false (opposite of boolean value)
System.out.println(!d);//true
}}
```

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Java Binary operators

The Java Binary operators require two operand. Binary operators are used to perform various operations

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=5;
System.out.println(a+b);//15
System.out.println(a-b);//5
System.out.println(a*b);//50
System.out.println(a/b);//2
System.out.println(a%b);//0
}}
```

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Java Ternary operators

The Java Ternary operators require three operand. The ***? :*** is referred as ternary operator and can be used as an alternative of if else.

```
i = 10;
k = i < 0 ? -i : i; // get absolute value of i
System.out.print("Absolute value of ");
System.out.println(i + " is " + k);

i = -10;
k = i < 0 ? -i : i; // get absolute value of i
System.out.print("Absolute value of ");
System.out.println(i + " is " + k);
```

The output generated by the program is shown here:

```
Absolute value of 10 is 10
Absolute value of -10 is 10
```

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Java Ternary Operator : Example

- Java Ternary operator is used as one liner replacement for if-then-else statement and used a lot in java programming. it is the only conditional operator which takes three operands.

Java Ternary Operator Example

```
class OperatorExample{
public static void main(String args[]){
int a=2;
int b=5;
int min=(a<b)?a:b;
System.out.println(min);
}}
```

Another Example:

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=5;
int min=(a<b)?a:b;
System.out.println(min);
}}
```

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Java Arithmetic operators

Arithmetic operators are used in mathematical expressions in the same way that they are used in algebra. The following table lists the arithmetic operators:

Operator	Result
+	Addition (also unary plus)
–	Subtraction (also unary minus)
*	Multiplication
/	Division
%	Modulus
++	Increment
+=	Addition assignment
– =	Subtraction assignment
*=	Multiplication assignment
/=	Division assignment
%=	Modulus assignment
– –	Decrement

The operands of the arithmetic operators must be of a numeric type. You cannot use them on **boolean** types, but you can use them on **char** types, since the **char** type in Java is, essentially, a subset of **int**.

ARITHMETIC operators: Example

Java arithmetic operators are used to perform addition, subtraction, multiplication, and division. They act as basic mathematical operations.

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=5;
System.out.println(a+b);//15
System.out.println(a-b);//5
System.out.println(a*b);//50
System.out.println(a/b);//2
System.out.println(a%b);//0
}}
```

```
class OperatorExample{
public static void main(String args[]){
System.out.println(10*10/5+3-1*4/2);
}}
```

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Java Modulus Operators

The Modulus Operator

The modulus operator, %, returns the remainder of a division operation. It can be applied to floating-point types as well as integer types. The following example program demonstrates the %:

```
// Demonstrate the % operator.
class Modulus {
  public static void main(String args[]) {
    int x = 42;
    double y = 42.25;

    System.out.println("x mod 10 = " + x % 10);
    System.out.println("y mod 10 = " + y % 10);
  }
}
```

When you run this program, you will get the following output:

```
x mod 10 = 2
y mod 10 = 2.25
```

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Arithmetic Compound Assignment Operators

```
// Demonstrate several assignment operators.
class OpEquals {
  public static void main(String args[]) {
    int a = 1;
    int b = 2;
    int c = 3;

    a += 5;
    b *= 4;
    c += a * b;
    c %= 6;
    System.out.println("a = " + a);
    System.out.println("b = " + b);
    System.out.println("c = " + c);
  }
}
```

The output of this program is shown here:

```
a = 6
b = 8
c = 3
```

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Java Bitwise Operators

Java defines several *bitwise operators* that can be applied to the integer types: **long**, **int**, **short**, **char**, and **byte**. These operators act upon the individual bits of their operands. They are summarized in the following table:

Operator	Result
~	Bitwise unary NOT
&	Bitwise AND
|	Bitwise OR
^	Bitwise exclusive OR
>>	Shift right
>>>	Shift right zero fill
<<	Shift left
&=	Bitwise AND assignment
|=	Bitwise OR assignment
^=	Bitwise exclusive OR assignment
>>=	Shift right assignment
>>>=	Shift right zero fill assignment
<<=	Shift left assignment

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Java Bitwise Operators

The bitwise logical operators are &, |, ^, and ~. The following table shows the outcome of each operation. In the discussion that follows, keep in mind that the bitwise operators are applied to each individual bit within each operand.

A	B	A | B	A & B	A ^ B	~A
0	0	0	0	0	1
1	0	1	0	1	0
0	1	1	0	1	1
1	1	1	1	0	0

The Bitwise NOT

Also called the *bitwise complement*, the unary NOT operator, ~, inverts all of the bits of its operand. For example, the number 42, which has the following bit pattern:

00101010

becomes

11010101

after the NOT oper

The Bitwise AND

The AND operator, &, produces a 1 bit if both operands are also 1. A zero is produced in all other cases. Here is an example:

```
 00101010   42
&00001111   15
 --------
 00001010   10
```

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Java Bitwise Operators

The Bitwise OR

The OR operator, |, combines bits such that if either of the bits in the operands is a 1, then the resultant bit is a 1, as shown here:

```
  00101010   42
| 00001111   15
  ----------
  00101111   47
```

The Bitwise XOR

The XOR operator, ^, combines bits such that if exactly one operand is 1, then the result is 1. Otherwise, the result is zero. The following example shows the effect of the ^. This example also demonstrates a useful attribute of the XOR operation. Notice how the bit pattern of 42 is inverted wherever the second operand has a 1 bit. Wherever the second operand has a 0 bit, the first operand is unchanged. You will find this property useful when performing some types of bit manipulations.

```
  00101010   42
^ 00001111   15
  ----------
  00100101   37
```

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Java Shift operators

Left Shift Operator

- The Java left shift operator << is used to shift all of the bits in a value to the left side of a specified number of times.

Right Shift Operator

- The Java right shift operator >> is used to move left operands value to right by the number of bits specified by the right operand.

Java Left Shift Operator Example

```
class OperatorExample{
public static void main(String args[]){
System.out.println(10<<2);//10*2^2=10*4=40
System.out.println(10<<3);//10*2^3=10*8=80
System.out.println(20<<2);//20*2^2=20*4=80
System.out.println(15<<4);//15*2^4=15*16=240
}}
```

Java Right Shift Operator Example

```
class OperatorExample{
public static void main(String args[]){
System.out.println(10>>2);//10/2^2=10/4=2
System.out.println(20>>2);//20/2^2=20/4=5
System.out.println(20>>3);//20/2^3=20/8=2
}}
```

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Java Shift Operator Example: >> vs >>>

```
class OperatorExample{
public static void main(String args[]){
    //For positive number, >> and >>> works same
    System.out.println(20>>2);
    System.out.println(20>>>2);
    //For negative number, >>> changes parity bit (MSB) to 0
    System.out.println(-20>>2);
    System.out.println(-20>>>2);
}}
```

Output:

```
5
5
-5
1073741819
```

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The Unsigned Right Shift

The following code fragment demonstrates the >>>. Here, a is set to –1, which sets all 32 bits to 1 in binary. This value is then shifted right 24 bits, filling the top 24 bits with zeros, ignoring normal sign extension. This sets a to 255.

```
int a = -1;
a = a >>> 24;
```

Here is the same operation in binary form to further illustrate what is happening:

11111111 11111111 11111111 11111111 –1 in binary as an int
>>>24
00000000 00000000 00000000 11111111 255 in binary as an int

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Boolean Logical Operators

The Boolean logical operators shown here operate only on **boolean** operands. All of the binary logical operators combine two **boolean** values to form a resultant **boolean** value.

Operator	Result
&	Logical AND
|	Logical OR
^	Logical XOR (exclusive OR)
||	Short-circuit OR
&&	Short-circuit AND
!	Logical unary NOT
&=	AND assignment
|=	OR assignment
^=	XOR assignment
==	Equal to
!=	Not equal to
?:	Ternary if-then-else

The logical Boolean operators, **&**, **|**, and **^**, operate on **boolean** values in the same way that they operate on the bits of an integer. The logical **!** operator inverts the Boolean state: **!true == false** and **!false == true**. The following table shows the effect of each logical operation:

Boolean Logical Operators

The logical Boolean operators, &, |, and ^, operate on **boolean** values in the same way that they operate on the bits of an integer. The logical ! operator inverts the Boolean state: **!true == false** and **!false == true**. The following table shows the effect of each logical operation:

A	B	A | B	A & B	A ^ B	!A
False	False	False	False	False	True
True	False	True	False	True	False
False	True	True	False	True	True
True	True	True	True	False	False

Here is a program that is almost the same as the **BitLogic** example shown earlier, but it operates on **boolean** logical values instead of binary bits:

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Short-Circuit Logical Operators

- These are secondary versions of the Boolean AND and OR operators, and are commonly known as *short-circuit* logical operators.
- The AND operator results in **false** when **A** is **false**, no matter what **B** is. If you use the **||** and **&&** forms, rather than the **|** and **&** forms of these operators, Java will not bother to evaluate the right hand operand when the outcome of the expression can be determined by the left operand alone.

```
if (denom != 0 && num / denom > 10)
```

Since the short-circuit form of AND (**&&**) is used, there is no risk of causing a run-time exception when **denom** is zero. If this line of code were written using the single **&** version of AND, both sides would be evaluated, causing a run-time exception when **denom** is zero.

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Java AND Operator : Logical && and Bitwise &

- The logical && operator doesn't check second condition if first condition is false. It checks second condition only if first one is true.
- The bitwise & operator always checks both conditions whether first condition is true or false.

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=5;
int c=20;
System.out.println(a<b&&a<c);//false && true = false
System.out.println(a<b&a<c);//false & true = false
}}
```

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Java AND Operator : Logical && and Bitwise &

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=5;
int c=20;
System.out.println(a<b&&a++<c);//false && true = false
System.out.println(a);//10 because second condition is not checked
System.out.println(a<b&a++<c);//false && true = false
System.out.println(a);//11 because second condition is checked
}}
```

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Java OR Operator Example: Logical || and Bitwise |

- The logical || operator doesn't check second condition if first condition is true. It checks second condition only if first one is false.
- The bitwise | operator always checks both conditions whether first condition is true or false.

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=5;
int c=20;
System.out.println(a>b||a<c);//true || true = true
System.out.println(a>b|a<c);//true | true = true
//|| vs |
System.out.println(a>b||a++<c);//true || true = true
System.out.println(a);//10 because second condition is not checked
System.out.println(a>b|a++<c);//true | true = true
System.out.println(a);//11 because second condition is checked
}}
```

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Relational Operators

The *relational operators* determine the relationship that one operand has to the other. Specifically, they determine equality and ordering. The relational operators are shown here:

Operator	Result
==	Equal to
!=	Not equal to
>	Greater than
<	Less than
>=	Greater than or equal to
<=	Less than or equal to

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Relational Operators

As stated, the result produced by a relational operator is a **boolean** value. For example, the following code fragment is perfectly valid:

```
int a = 4;
int b = 1;
boolean c = a < b;
```

In this case, the result of **a<b** (which is **false**) is stored in **c**.

If you are coming from a C/C++ background, please note the following. In C/C++, these types of statements are very common:

```
int done;
//...
if(!done)... // Valid in C/C++
if(done)...  // but not in Java.
```

In Java, these statements must be written like this:

```
if(done == 0)... // This is Java-style.
if(done != 0)...
```

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Java assignment operator

Java assignment operator is one of the most common operator. It is used to assign the value on its right to the operand on its left.

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=20;
a+=4;//a=a+4 (a=10+4)
b-=4;//b=b-4 (b=20-4)
System.out.println(a);
System.out.println(b);
}}
```

```
class OperatorExample{
public static void main(String[] args){
int a=10;
a+=3;//10+3
System.out.println(a);
a-=4;//13-4
System.out.println(a);
a*=2;//9*2
System.out.println(a);
a/=2;//18/2
System.out.println(a);
}}
```

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Java Assignment Operator Example: Adding short

```
class OperatorExample{
public static void main(String args[]){
short a=10;
short b=10;
//a+=b;//a=a+b internally so fine
a=a+b;//Compile time error because 10+10=20 now int
System.out.println(a);
}}
```

After type cast:

```
class OperatorExample{
public static void main(String args[]){
short a=10;
short b=10;
a=(short)(a+b);//20 which is int now converted to short
System.out.println(a);
}}
```

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Java Operator Precedence

Highest						
++ (postfix)	-- (postfix)					
++ (prefix)	-- (prefix)	~	!	+ (unary)	- (unary)	(*type-cast*)
*	/	%				
+	-					
>>	>>>	<<				
>	>=	<	<=	instanceof		
==	!=					
&						
^						
|						
&&						
||						
?:						
->						
=	op=					
Lowest						

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Java Operator Precedence

Parentheses raise the precedence of the operations that are inside them. This is often necessary to obtain the result you desire. For example, consider the following expression:

```
a >> b + 3
```

This expression first adds 3 to **b** and then shifts **a** right by that result. That is, this expression can be rewritten using redundant parentheses like this:

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

However, if you want to first shift **a** right by **b** positions and then add 3 to that result, you will need to parenthesize the expression like this:

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

In addition to altering the normal precedence of an operator, parentheses can sometimes be used to help clarify the meaning of an expression. For anyone reading your code, a complicated expression can be difficult to understand. Adding redundant but clarifying parentheses to complex expressions can help prevent confusion later. For example, which of the following expressions is easier to read?

```
a | 4 + c >> b & 7
(a | (((4 + c) >> b) & 7))
```

One other point: parentheses (redundant or not) do not degrade the performance of your program. Therefore, adding parentheses to reduce ambiguity does not negatively affect your program.

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Control Statements

JAVA Control Statements

- Selection – if and switch
- Iteration – for(for each), while and do-while
- Jump – break, continue and return

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Control Statement

CHAPTER

5

Control Statements

Java

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Java Control statements

Java's program control statements can be put into the following categories:

- **Selection – if and switch**

  Selection statements allow your program to choose different paths of execution based upon the outcome of an expression or the state of a variable.

- **iteration – for, while and do-while**

  Iteration statements enable program execution to repeat one or more statements (that is, iteration statements form loops).

- **Jump – break, continue and return**

  Jump statements allow your program to execute in a nonlinear fashion

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Control Statement :Selection

- **If: Nested if, the if – else-if ladder**

  - same as C/C++

- **Switch**

  - Java's multiday branch statement

  - expression must be of type *byte, short, int, char or enumeration*

  - expression *(case value)* can also be of type string (beginning with JDK 7)

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Selection: Switch example

```
// Use a string to control a switch statement.

class StringSwitch {
  public static void main(String args[]) {

    String str = "two";

    switch(str) {
      case "one":
        System.out.println("one");
        break;
      case "two":
        System.out.println("two");
        break;
      case "three":
        System.out.println("three");
        break;
      default:
        System.out.println("no match");
        break;
    }
  }
}
```

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Switch summery

In summary, there are three important features of the **switch** statement to note:

- The **switch** differs from the **if** in that **switch** can only test for equality, whereas **if** can evaluate any type of Boolean expression. That is, the **switch** looks only for a match between the value of the expression and one of its **case** constants.
- No two **case** constants in the same **switch** can have identical values. Of course, a **switch** statement and an enclosing outer **switch** can have **case** constants in common.
- A **switch** statement is usually more efficient than a set of nested **ifs**.

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Java Control Statement: Iteration

- **While**
  - **same as C/C++**
- **Do – while**
  - **same as C/C++**
- **For**
  - **for: same as C/C++**
  - **-*For each version* of for loop : new**

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Iteration: The for each version of For

The general form of the for-each version of the **for** is shown here:

for (*type itr-var* : *collection*) *statement-block*

```
int nums[] = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 };
int sum = 0;

for(int x: nums) sum += x;
```

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The for each version :Example

```
// Use a for-each style for loop.
class ForEach {
  public static void main(String args[]) {
    int nums[] = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 };
    int sum = 0;

    // use for-each style for to display and sum the values
    for(int x : nums) {
      System.out.println("Value is: " + x);
      sum += x;
    }

    System.out.println("Summation: " + sum);
  }
}
```

```
Value is: 1
Value is: 2
Value is: 3
Value is: 4
Value is: 5
Value is: 6
Value is: 7
Value is: 8
Value is: 9
Value is: 10
Summation: 55
```

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The *for each version* : Example

```
// The for-each loop is essentially read-only.
class NoChange {
  public static void main(String args[]) {
    int nums[] = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 };

    for(int x: nums) {
      System.out.print(x + " ");
      x = x * 10; // no effect on nums
    }

    System.out.println();

    for(int x : nums)
      System.out.print(x + " ");

    System.out.println();
  }
}
```

```
1 2 3 4 5 6 7 8 9 10
1 2 3 4 5 6 7 8 9 10
```

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for each : Example

```
// Use for-each style for on a two-dimensional array.
class ForEach3 {
  public static void main(String args[]) {
    int sum = 0;
    int nums[][] = new int[3][5];

    // give nums some values
    for(int i = 0; i < 3; i++)
      for(int j = 0; j < 5; j++)
        nums[i][j] = (i+1)*(j+1);

    // use for-each for to display and sum the values
    for(int x[] : nums) {
      for(int y : x) {
        System.out.println("Value is: " + y);
        sum += y;
      }
    }
    System.out.println("Summation: " + sum);
  }
}
```

```
Value is: 1
Value is: 2
Value is: 3
Value is: 4
Value is: 5
Value is: 2
Value is: 4
Value is: 6
Value is: 8
Value is: 10
Value is: 3
Value is: 6
Value is: 9
Value is: 12
Value is: 15
Summation: 90
```

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Java Jump statements

- **Break Statement**
- **Continue Statement**
- **Return Statement**

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The Break Statement

The break statement has three uses.

- **First**, as you have seen, it terminates a statement sequence in a switch statement.
- **Second,** it can be used to exit a loop.
- **Third,** it can be used as a “civilized” form of goto.

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Jumping Statement: Break

```
// Using break as a civilized form of goto.
class Break {
  public static void main(String args[]) {
    boolean t = true;

    first: {
      second: {
        third: {
          System.out.println("Before the break.");
          if(t) break second; // break out of second block
          System.out.println("This won't execute");
        }
        System.out.println("This won't execute");
      }
      System.out.println("This is after second block.");
    }
  }
}
```

```
Before the break.
This is after second block.
```

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Jumping Statement: Continue

```
// Using continue with a label.
class ContinueLabel {
  public static void main(String args[]) {
outer: for (int i=0; i<10; i++) {
         for(int j=0; j<10; j++) {
           if(j > i) {
             System.out.println();
             continue outer;
           }
           System.out.print(" " + (i * j));
         }
       }
       System.out.println();
  }
}
```

```
0
0 1
0 2 4
0 3 6 9
0 4 8 12 16
0 5 10 15 20 25
0 6 12 18 24 30 36
0 7 14 21 28 35 42 49
0 8 16 24 32 40 48 56 64
0 9 18 27 36 45 54 63 72 81
```

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Jumping Statement: Return

```
// Demonstrate return.
class Return {
  public static void main(String args[]) {
    boolean t = true;

    System.out.println("Before the return.");

    if(t) return; // return to caller

    System.out.println("This won't execute.");
  }
}
```

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Java Control statements: Summary

Java's program control statements can be put into the following categories:

- **Selection – if and switch**

  Selection statements allow your program to choose different paths of execution based upon the outcome of an expression or the state of a variable.

- **iteration – for, while and do-while**

  Iteration statements enable program execution to repeat one or more statements (that is, iteration statements form loops).

- **Jump – break, continue and return**

  Jump statements allow your program to execute in a nonlinear fashion

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Java POP Summary

JAVA POP Features

- History, Features and Environment
- Lexical Issues
- Variable, Array and Data Type
- Operators
- Control Statements

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It is not enough just to write code that works. It is as important-perhaps more important to write code well; not merely code that works, but code that is legible, maintainable, reusable, fast, and efficient.