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Basic Java Syntax

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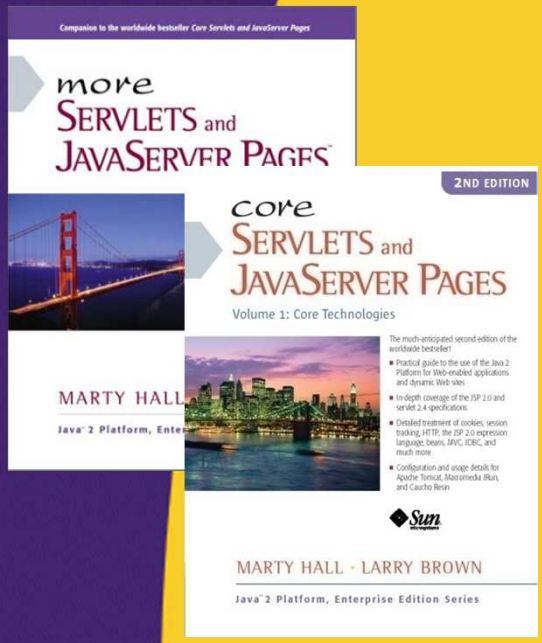

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Topics in This Section

- **Basics**
  - Creating, compiling, and executing simple Java programs
- **Accessing arrays**
- **Looping**
- **Indenting Code**
- **Using if statements**
- **Comparing strings**
- **Building arrays**
  - One-step process
  - Two-step process
  - Using multidimensional arrays
- **Performing basic mathematical operations**
- **Reading command-line input**

Basics

Getting Started: Syntax

- **Example**

```
public class HelloWorld {
  public static void main(String[] args) {
    System.out.println("Hello, world.");
  }
}
```

- **Details**
  - Processing starts in main
    - Routines usually called “methods,” not “functions.”
  - Printing is done with System.out.print...
    - System.out.println, System.out.print, System.out.printf

Getting Started: Execution

- **File: HelloWorld.java**

```
public class HelloWorld {
  public static void main(String[] args) {
    System.out.println("Hello, world.");
  }
}
```

- **Compiling**

```
> javac HelloWorld.java
```

- **Executing**

```
> java HelloWorld
Hello, world.
```

More Basics

- **Use + for string concatenation**
- **Arrays are accessed with [ ]**
  - Array indices are zero-based
  - The argument to **`main`** is an array of strings that correspond to the command line arguments
    - args[0] returns first command-line argument
    - args[1] returns second command-line argument, etc.
    - Error if you try to access more args than were supplied
- **The `length` field**
  - Gives the number of elements in *any* array
    - Thus, **`args.length`** gives the number of command-line arguments
    - Unlike in C/C++, the name of the program is not inserted into the command-line arguments

Command-line Arguments

- **Useful for learning and testing**
  - Command-line args are useful for practice

```
> java Classname arg1 arg2 ...
```

Example

- **File: ShowTwoArgs.java (naïve version)**

```
public class ShowTwoArgs {
  public static void main(String[] args) {
    System.out.println("First arg: " +
                       args[0]);
    System.out.println("Second arg: " +
                       args[1]);
  }
}
```

Oops! Crashes if there are not at least two command-line arguments. The code should have checked the length field, like this:

```
if (args.length > 1) {
  doThePrintStatements();
} else {
  giveAnErrorMessage();
}
```

Example (Continued)

- **Compiling**

```
> javac ShowTwoArgs.java
```

- **Executing**

```
> java ShowTwoArgs Hello Class
First args Hello
Second arg: Class

> java ShowTwoArgs
[Error message]
```

Loops

Looping Constructs

- **for/each**

```
for(variable: collection) {
  body;
}
```

- **for**

```
for(init; continueTest; updateOp) {
  body;
}
```

- **while**

```
while (continueTest) {
  body;
}
```

- **do**

```
do {
  body;
} while (continueTest);
```

For/Each Loops

```
public static void listEntries(String[] entries) {
  for(String entry: entries) {
    System.out.println(entry);
  }
}
```

- **Result**

```
String[] test = {"This", "is", "a", "test"};
listEntries(test);

This
is
a
test
```

For Loops

```
public static void listNums1(int max) {
  for(int i=0; i<max; i++) {
    System.out.println("Number: " + i);
  }
}
```

- **Result**

```
listNums1(4);

Number: 0
Number: 1
Number: 2
Number: 3
```

While Loops

```
public static void listNums2(int max) {
  int i = 0;
  while (i < max) {
    System.out.println("Number: " + i);
    i++; // "++" means "add one"
  }
}
```

- **Result**

```
listNums2(5);

Number: 0
Number: 1
Number: 2
Number: 3
Number: 4
```

Do Loops

```
public static void listNums3(int max) {
  int i = 0;
  do {
    System.out.println("Number: " + i);
    i++;
  } while (i < max);
                    // ^ Don't forget semicolon
}
```

- **Result**

```
listNums3(3);
Number: 0
Number: 1
Number: 2
```

Class Structure and Formatting

Defining Multiple Methods in Single Class

```
public class LoopTest {
  public static void main(String[] args) {
    String[] test =
      { "This", "is", "a", "test"};
    listEntries(test);
    listNums1(5);
    listNums2(6);
    listNums3(7);
  }

  public static void listEntries(String[] entries) {…}
  public static void listNums1(int max) {…}
  public static void listNums2(int max) {…}
  public static void listNums3(int max) {…}
}
```

These methods say "static" because they are called directly from "main". In the next two sections on OOP, we will explain what "static" means and why most regular methods do not use "static". But for now, just note that methods that are directly called by "main" must say "static".

Indentation: blocks that are nested more should be indented more

- Yes

```
blah;
blah;
for(...) {
  blah;
  blah;
  for(...) {
    blah;
    blah;
  }
}
```

- No

```
blah;
blah;
for(...) {
blah;
blah;
for(...) {
blah;
blah;
}
}
```

Indentation: blocks that are nested the same should be indented the same

- Yes

```
blah;
blah;
for(...) {
  blah;
  blah;
  for(...) {
    blah;
    blah;
  }
}
```

- No

```
blah;
 blah;
for(...) {
   blah;
  blah;
  for(...) {
    blah;
     blah;
  }
  }
```

Indentation: Number of spaces and placement of braces is a matter of taste

- OK

```
blah;
blah;
for(...) {
  blah;
  blah;
  for(...) {
    blah;
    blah;
  }
}
```

- OK

```
blah;
blah;
for(...) {
    blah;
    blah;
    for(...) {
        blah;
        blah;
    }
}
```

- OK

```
blah;
blah;
for(...)
{
  blah;
  blah;
  for(...)
  {
    blah;
    blah;
  }
}
```

Conditionals and Strings

If Statements

- **Single Option**

```
if (boolean-expression) {
  statement;
}
```

- **Multiple Options**

```
if (boolean-expression) {
  statement1;
} else {
  statement2;
}
```

Boolean Operators

- **==, !=**
  - Equality, inequality. In addition to comparing primitive types, == tests if two objects are identical (the same object), not just if they appear equal (have the same fields). More details when we introduce objects.
- **<, <=, >, >=**
  - Numeric less than, less than or equal to, greater than, greater than or equal to.
- **&&, ||**
  - Logical AND, OR. Both use short-circuit evaluation to more efficiently compute the results of complicated expressions.
- **!**
  - Logical negation.

Example: If Statements

```
public static int max(int n1, int n2) {
  if (n1 >= n2) {
    return(n1);
  } else {
    return(n2);
  }
}
```

Strings

- **Basics**
  - String is a real class in Java, not an array of characters as in C and C++.
  - The String class has a shortcut method to create a new object: just use double quotes
    - This differs from normal objects, where you use the **new** construct to build an object
- **Use `equals` to compare strings**
  - Never use ==
- **Many useful builtin methods**
  - contains, startsWith, endsWith, indexOf, substring, split, replace, replaceAll
    - Note: can use regular expressions, not just static strings
  - toUpperCase, toLowerCase, equalsIgnoreCase

Common String Error: Comparing with ==

```
public static void main(String[] args) {
  String match = "Test";
  if (args.length == 0) {
    System.out.println("No args");
  } else if (args[0] == match) {
    System.out.println("Match");
  } else {
    System.out.println("No match");
  }
}
```

- **Prints "No match" for *all* inputs**
  - Fix:

```
if (args[0].equals(match))
```

String and ...

- **String → Immutable**
- **StringBuffer → Mutable, Synchronized**
- **StringBuilder → Mutable, Unsynchronized**

Arrays

Building Arrays: One-Step Process

- **Declare and allocate array in one fell swoop**

```
type[] var = { val1, val2, ... , valN };
```

- **Examples:**

```
int[] values = { 10, 100, 1000 };
String[] names = {"Joe", "Jane", "Juan"};
Point[] points = { new Point(0, 0),
                   new Point(1, 2),
                   new Point(3, 4) };
```

Building Arrays: Two-Step Process

- **Step 1: allocate an array of references:**

  type[] var = new *type*[size];

  – E.g.:

  ```
  int[] primes = new int[7];
  String[] names = new String[someArray.length];
  ```

- **Step 2: populate the array**

```
primes[0] = 2;          names[0] = "Joe";
primes[1] = 3;          names[1] = "Jane";
primes[2] = 5;          names[2] = "Juan";
primes[3] = 7;          names[3] = "John";
etc.
```

- **If you fail to populate an entry**
  – Default value is 0 for numeric arrays
  – Default value is **`null`** for object arrays

Array Performance Problems

- **For very large arrays, undue paging can occur**
  - Array of references (pointers) allocated first
  - Individual objects allocated next
  - Thus, for very large arrays of objects, reference and object can be on different pages, resulting in swapping for each array reference
  - Example

```
String[] names = new String[10000000];
for(int i=0; i<names.length; i++) {
  names[i] = getNameFromSomewhere();
}
```

- **Problem does not occur with arrays of primitives**
  - I.e., with arrays of **`int`**, **`double`**, and other types that start with lowercase letter
  - Because system stores values directly in arrays, rather than storing references (pointers) to the objects

Multidimensional Arrays

- **Multidimensional arrays**
  - Implemented as arrays of arrays

```
int[][] twoD = new int[64][32];

String[][] cats = {{ "Caesar",  "blue-point" },
                  { "Heather", "seal-point" },
                  { "Ted",     "red-point"  }};
```

- **Note:**
  - Number of elements in each row need not be equal

```
int[][] irregular = { { 1 },
                      { 2, 3, 4},
                      { 5 },
                      { 6, 7 } };
```

TriangleArray: Example

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

    int[][] triangle = new int[10][];

    for(int i=0; i<triangle.length; i++) {
      triangle[i] = new int[i+1];
    }

    for (int i=0; i<triangle.length; i++) {
      for(int j=0; j<triangle[i].length; j++) {
        System.out.print(triangle[i][j]);
      }
      System.out.println();
    }
  }
}
```

TriangleArray: Result

```
> java TriangleArray

0
00
000
0000
00000
000000
0000000
00000000
000000000
0000000000
```

Math and Input

Basic Mathematical Routines

- **Very simplest routines use builtin operators**
  - +, -, *, /, ^, %
  - Be careful with / on **`int`** and **`long`** variables
- **Static methods in the Math class**
  - So you call Math.cos(...), Math.random(), etc.
    - Most operate on double precision floating point numbers
  - Simple operations: Math.pow(), etc.
    - pow (x^y), sqrt ($\sqrt{x}$), cbrt, exp (e^x), log ($\log_e$), log10
  - Trig functions: Math.sin(), etc.
    - sin, cos, tan, asin, acos, atan
      - Args are in radians, not degrees, (see toDegrees and toRadians)
  - Rounding and comparison: Math.round(), etc.
    - round/rint, floor, ceiling, abs, min, max
  - Random numbers: Math.random()
    - random (Math.random() returns from 0 inclusive to 1 exclusive).
    - See Random class for more control over randomization.

More Mathematical Routines

- **Special constants**
  - Double.POSITIVE_INFINITY
  - Double.NEGATIVE_INFINITY
  - Double.NAN
  - Double.MAX_VALUE
  - Double.MIN_VALUE
- **Unlimited precision libraries**
  - BigInteger, BigDecimal
    - Contain the basic operations, plus BigInteger has isPrime

Reading Simple Input

- **For simple testing, use standard input**
  - If you want strings, just use args[0], args[1], as before
    - To avoid errors, check args.length first
  - Convert if you want numbers. Two main options:
    - Use Scanner class
      - Note that you need import statement. See next slide!

```
Scanner inputScanner = new Scanner(System.in);
int i = inputScanner.nextInt();
double d = inputScanner.nextDouble();
```

    - Convert explicitly (Integer.parseInt, Double.parseDouble)

```
String seven = "7";
int i = Integer.parseInt(seven);
```

- **In real applications, use a GUI**
  - Collect input with textfields, sliders, combo boxes, etc.
    - Convert to numeric types with Integer.parseInt, Double.parseDouble, etc.

Example: Printing Random Numbers

```
import java.util.*;

public class RandomNums {
  public static void main(String[] args) {
    System.out.print("How many random nums? ");
    Scanner inputScanner = new Scanner(System.in);
    int n = inputScanner.nextInt();
    for(int i=0; i<n; i++) {
      System.out.println("Random num " + i +
                         " is " + Math.random());
    }
  }
}
How many random nums? 5
Random num 0 is 0.22686369670835704
Random num 1 is 0.0783768527137797
Random num 2 is 0.17918121951887145
Random num 3 is 0.3441924454634313
Random num 4 is 0.613105320317081 8
```

Wrap-Up

Summary

- **Basics**
  - Loops, conditional statements, and array access is similar to C and C++
    - But new for loop: for(String s: someStrings) { … }
  - Indent your code for readability
  - `String` is a real class in Java
    - Use **`equals`**, not ==, to compare strings
- **Allocate arrays in one step or in two steps**
  - If two steps, loop down array and supply values
- **Use Math.*blah*() for simple math operations**
- **Simple input from command window**
  - Use command line for strings supplied at program startup
  - Use Scanner to read values after prompts or to turn simple input into numbers