

What is Java?

- **“.. A simple, pure object-oriented, distributed, interpreted, robust, secure, architecture neutral, portable, high-performance, multi-threaded, and dynamic language.”**

[Sun Microsystems, Summer 1995]

Two Application Styles

- **Application:**
Program that executes using the java interpreter.
- **Applet:**
 1. Program that runs in –
 - a. **appletviewer** (test utility for applets).
 - b. Web browser (IE, NSCP Communicator).
 2. Executes when HTML (HyperText Markup Language) document containing applet is opened and downloaded.

Applications vs Applets

- Applications are **more** robust:
 1. Applications do not have the same security restrictions that applets have.
 2. Applications can be compiled with JIT (Just-In-Time) and then execute as fast as C++.
 3. Applications can do RMI, JDBC, JavaBeans.

Applications vs Applets (cont)

- Applets give life to Web pages:
 1. Applets have a large library of AWT classes available.
 2. Applets provide the function of an application **without** using disk space.
 3. Applets do **not** have a “**main**” method.

Running Java Programs

- **Java Virtual Machine (JVM)**
 - Program running on computer.
 - Simulates a virtual computer running Java.
- **JVM loads classes dynamically**
 - Upon first reference to class in program.
 - Looks at directory / jar files in **CLASSPATH**.
- **CLASSPATH**
 - **Colon** separated list of names.
 - Example:
CLASSPATH = . : \$HOME/Java

Jar Files

- Zip file containing 1 or more **.class** files.
- Useful for bundling many Java files.
- Treated by JVM as an entire **directory**.
- Create using:
jar cf [filename] [files / directories to put in jar]

Java vs C++

- Java = C++
 - { struct, union, pointer, operator overloading, multiple inheritance, ... }
 - + { strict type checking, automatic garbage collection, ... }

Procedural Programming in Java

- *public class HelloWorld {*

```
    public static void main(String [] args) {  
        System.out.println("Welcome to Java" + args[0]);  
    } // end method main
```

```
} // end class HelloWorld
```

- All programs are placed inside a 'class'.
- Class names start with an **upper-case** letter.
- Java is case sensitive (capitalization matters).

Example Program (2)

- The code is placed in a file called *HelloWorld.java*.
- The program is always called *main*.
- The class is delimited by braces { ... }
- Java is free format – spaces, tabs & blank lines ignored.
- The program – *main* – is enclosed within braces { ... }
- Character strings enclosed between quote marks “...”.

Example Program (3)

- *System.out* refers to *stdout*.
- *println* is a method (procedure) to output to the screen.
- Text following *//* is comment & ignored by compiler.
- As a parameter to *main*, *args* holds command-line arguments.
- *args[0]* refers to the first element of the array of strings.
- *+* represents string concatenation.

Compile and Execute

- Creating source file – *HelloWorld.java*
Use vi, emacs, or other text-editor
- Compiling program – to create **bytecode** file
HelloWorld.class
javac HelloWorld.java
- Running program
java HelloWorld

Static Variable Initialization

- **Initialization Order**

1. Static initializations
2. Initialization block
3. Constructor

- **Example**

```
class Foo {  
    static Integer A = new Integer (1);    // static init  
    { A = new Integer (2); }              // init block  
    public Foo( ) { A = new Integer (3); } // constructor  
}
```

Static Variable Initialization Example

```
class Foo {  
    static Integer A = new Integer (1);    // 1) static init  
    { A = new Integer (2); }              // 2) init block  
    public Foo( ) { A = new Integer (3); } // 3) constructor  
  
    public static void main (String args[]) {  
        System.out.print("A=" + A + "\n"); // prints A=1  
        Foo f = new Foo();  
        System.out.print("A=" + A + "\n"); // prints A=3  
    }  
}
```

Strings in Java

- Creating string variables:
String greeting = “Hello”;
String text; text = args[0];
- Comparing strings:
text.equals(“Hello”)
text.compareTo(args[1])
- Determining the length of strings:
int len = text.length();
- Concatenating strings:
String message = text + ‘-’ + args[1];

Strings in Java (cont)

- Picking off parts of a string:
char ch = text.charAt(0);
message = text.substring(3, 6);
- Changing case:
String big = text.toUpperCase();
- The **String** class has 48 methods. Take a careful look at these by reference to
java.lang -> String

Basic Data Types in Java

- Integer (whole number) types:

byte tiny; // 8 bits, range -128 .. +127

short x, y = 5, z; // 16 bits, range -32768 .. +32767

int count = 0;

// 32 bits, range approx +-2000,000,000

long dist = -53; // 64 bits, range approx +-10 zillion

- Fractional values (floating-point) types:

float height = -3.4e22; // 32 bits, 7 significant digits

double fine = 123.5; // 64 bits, 15 significant digits

Basic Data Types (cont)

- Single characters:
char ch = 'X'; // 16 bits - Unicode character
- Logical (truth) values:
boolean ok = true; // 1 bit - constants - true, false
- Conversion (casting) between types:
Automatic if no loss of info,
e.g. *count = tiny; fine = dist;*
Explicit otherwise,
e.g. *tiny = (byte)count; dist = (long)fine;*

Command-Line Arguments

- Determining number of arguments:

int numberOfArgs = args.length;

// Note - **no** brackets

For any array, *arrayName.length* gives length.

- Conversion to integer:

int value = Integer.parseInt(args[0]);

parseInt() raises *NumberFormatException* if a non-numeric value is entered.

- Conversion to float:

double volume = Double.parseDouble(args[1]);

Again this can raise *NumberFormatException*.

Command-Line Arguments (cont)

- Dealing with exceptions:

```
try {  
    value = Integer.parseInt(args[0]);  
} // end try  
catch(NumberFormatException nfe) {  
    System.err.println("Argument should be an  
        integer");  
    System.exit(-1);  
} //end catch
```

Boolean Variables

- Boolean variables contain truth values and can be used directly:

boolean ok = false;

text.length() < 10 && count < 25 && ok

// always evaluates to false

ok = count != 100 && ch != 'X';

// assigning a value

Sub-Programs in Java

- Called – **subroutines** (FORTRAN), **procedures** (PASCAL), **functions** (C) or **methods** (Java), but all refer to **sub-programs**.
- Subdivide a large program into smaller pieces – easier to understand.
- Allow several people to work on different parts of the program at once.
- Factor out commonly occurring pieces of code and write only once.

Sub-Programs (cont)

- Avoid repetition and hence changes only made in one place.
- Create sub-programs which can be re-used in other applications.
- Minimize the amount of re-compilation when changes are made.

Stream Input / Output

- Bytes: InputStream, OutputStream.
- Character: FileReader, PrintWriter.

Usage:

- ***import java.io.*;***
- **Open stream connection.**
- **Use stream -> read or/and write; catch exception if needed.**
- **Close stream.**

Standard Input / Output

- Standard I/O
 - Provided in **System** class in **java.lang**
 - **System.in**
 - An instance of `InputStream`
 - **System.out**
 - An instance of `PrintStream`
 - **System.err**
 - An instance of `PrintStream`

Prompted Keyboard Input

```
import java.io.*;           // provides visibility of I/O facilities
public class Greeting {
    public static void main(String [] args) {
        String name;
        try {
            InputStreamReader isr =
                new InputStreamReader(System.in);
            BufferedReader in = new BufferedReader(isr);
            System.out.print("Enter your name : ");
                // prompt for input
            name = in.readLine();           // get it
        } // end try
        catch(IOException ioe){}
        System.out.println("Welcome to Java - " + name);
    } // end main
} // end class Greeting
```

Reading Text Files

```
import java.io.*;  
public class FileReadDemo {  
  
    public static void main(String [] args)  
        throws IOException {  
        FileReader fr = null;  
        try {  
            fr = new FileReader(args[0]);  
        } // end try  
        catch(FileNotFoundException fnf) {  
            System.err.println("File does not exist");  
            System.exit(-1);  
        } // end catch
```

Reading Text Files (cont)

```
BufferedReader inFile = new BufferedReader(fr);  
String line;  
while (inFile.ready()) {  
    line = inFile.readLine();  
    System.out.println(line);  
} // end while  
inFile.close();  
} // end main  
  
} // end class FileReadDemo
```

Writing Text Files

```
import java.io.*;  
public class FileWriteDemo {  
  
    public static void main(String [] args) throws IOException {  
        FileOutputStream fos = new FileOutputStream(args[0]);  
        PrintWriter pr = new PrintWriter(fos);  
        for ( int i = 0; i < 20; i++)  
            pr.println("Demonstration of writing a text file");  
        pr.flush();  
        pr.close();  
    } // end main  
  
} // end class FileWriteDemo
```

Debugging

- **Process of finding and fixing software errors**
 - After testing detects error.
- **Goal**
 - Determine cause of **run-time** & **logic** errors.
 - Correct errors (without introducing new errors).
- **Similar to detective work**
 - Carefully inspect information in program
 - Code
 - Values of variables
 - Program behavior

Debugging – Approaches

- **Classic**
 - Insert debugging statements
 - Trace program control flow
 - Display value of variables
- **Modern**
 - IDE (integrated development environment)
 - Interactive debugger

Interactive Debugger

- Capabilities
 - Provides trace of program execution.
 - Shows location in code where error encountered.
 - Interactive program execution
 - **Single step** through code.
 - Run to **breakpoints**.
 - Displays values of variables
 - For current state of program.

Interactive Debugger (2)

- Single step
 - Execute single line of code at a time.
 - When executing **method**, can
 - Finish entire method.
 - Execute first line in method.
 - Tedious (or impractical) for long-running programs.

Interactive Debugger (3)

- Breakpoint
 - Specify location(s) in code.
 - Execute program until breakpoint encountered.
 - Can skip past uninteresting code.