Introduction to JAVA
CMSC 331
Fall 2000

Introduction
• Present the syntax of Java
• Introduce the Java API
• Demonstrate how to build
  – stand-alone Java programs
  – Java applets, which run within browsers e.g. Netscape
  – Java servlets, which run with a web server
• Example programs tested using Java on Windows 98 and/or Unix

Why Java?
• It’s the current “hot” language
• It’s almost entirely object-oriented
• It has a vast library of predefined objects
• It’s platform independent (except for J++)
  – this makes it great for Web programming
• It’s designed to support Internet applications
• It’s secure
• It isn’t C++

Important Features of Java
• Java is a simple language (compared to C++).
• Java is a completely object-oriented language.
• Java programs can be multi-threaded.
• Java programs automatically recycle memory.
• Java is a distributed and secure language.
• Java is robust (potential errors are often caught).
• To make Java portable, so that they run on a variety of hardware, programs are translated into byte code which is executing by a Java Virtual Machine.
Historical note

- In 1991, a group led by James Gosling and Patrick Naughton at Sun designed a language (code-named “Green”) for use in consumer devices such as intelligent TV “set-top” boxes and microwaves.
- The design choices made reflect the expectation that the language would be used to implement small, distributed, and necessarily robust programs on a variety of hardware.
- No customer was ever found for this technology.
- The language was renamed “Oak” (after a tree outside Gosling’s office) and was used to develop the HotJava browser, which had one unique property: it could dynamically download programs (“applets”) from the Web and run them.
- “Oak” was already taken as a name for a computer language, so Gosling thought of the name Java in a coffee shop.

Applets, Servlets and applications

- An applet is a program designed to be embedded in a Web page and run in a web browser
  - Applets run in a sandbox with numerous restrictions; for example, they can’t read files
- A servlet is a program which runs in a web server and typically generates a web page.
  - Dynamically generated web pages are important and Java servlets are an alternative to using Basic (ASP), Python, specialized languages (PHP), and vendor specific solutions (e.g., Oracle)
- An application is a conventional program
- Java isn’t a baby language anymore!

What is OOP?

- Object-oriented programming technology can be summarized by three key concepts:
  - Objects that provide encapsulation of procedures and data
  - Messages that support polymorphism across objects
  - Classes that implement inheritance within class hierarchies

Building Standalone JAVA Programs (on UNIX)

- Prepare the file myProgram.java using any editor
- Invoke the compiler: javac myProgram.java
- This creates myProgram.class
- Run the java interpreter: java myProgram
Java Virtual Machine

- The .class files generated by the compiler are not executable binaries
  - so Java combines compilation and interpretation
- Instead, they contain "byte-codes" to be executed by the Java Virtual Machine
  - other languages have done this, e.g. UCSD Pascal, Prolog
- This approach provides platform independence, and greater security

HelloWorld Application

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

- Note that String is built in
- println is a member function for the System.out class
- Every standalone Java application must have a main method like
  ```java
  public static void main(String[] args) {
  }
  ```

Java Applets

- The JAVA virtual machine may be executed under the auspices of some other program, e.g. a Web browser or server.
- Bytecodes can be loaded off the Web, and then executed locally.
- There are classes in Java to support this
Building Applets

- Prepare the file `myProgram.java`, and compile it to create `myProgram.class`
- Invoke an Applet Viewer, or a Java-aware browser such as Netscape, and open an HTML file such as `myProgram.html`
- Browser invokes the Java Virtual Machine

HelloWorld.java

```java
import java.applet.
public class HelloWorld extends Applet {
    public void init() {
        System.out.println("Hello, world!");
    }
}
```

hello.html

```html
<title>Hello, World</title>
<h1>Hello, World</h1>
<applet code="HelloWorld.class" width=100 height=140>
</applet>
```

Running the Applet

```
[3:43pm] linuxserver1 => pwd
/home/faculty4/finin/www/java
[3:43pm] linuxserver1 => ls
HelloWorld.java  hello.html
[3:43pm] linuxserver1 => javac HelloWorld.java
[3:43pm] linuxserver1 => ls
HelloWorld.class  HelloWorld.java  hello.html
```
Java Servlets

• Most interesting web applications provide services, which requires invoking programs.
• More and more of the web consists of pages that are not statically created by human editors, but dynamically generated when needed by programs.
• How do we invoke these programs and what programming languages should we use?
  – CGI: Common Gateway Interface
  – Web servers with built in support for servlets written in Python, Lisp, Tcl, Prolog, Java, Visual Basic, Perl, etc.
  – ASP (Active Server Pages) is a scripting environment for Microsoft Internet Information Server in which you can combine HTML, scripts and reusable ActiveX server components to create dynamic web pages.
  – ASP begat PHP, JSP, etc.
• Java turns out to be an excellent language for servlets

A Servlet’s Job

• Read any data sent by the user
  – From HTML form, applet, or custom HTTP client
• Look up HTTP request information
  – Browser capabilities, cookies, requesting host, etc.
• Generate the results
  – JDBC, RMI, direct computation, legacy app, etc.
• Format the results inside a document
  – HTML, Excel, etc.
• Set HTTP response parameters
  – MIME type, cookies, compression, etc.
• Send the document to the client

Why Build Web Pages Dynamically?

• The Web page is based on data submitted by the user
  – E.g., results page from search engines and order-confirmation pages at on-line stores
• The Web page is derived from data that changes frequently
  – E.g., a weather report or news headlines page
• The Web page uses information from databases or other server-side sources
  – E.g., an e-commerce site could use a servlet to build a Web page that lists the current price and availability of each item that is for sale.

The Advantages of Servlets Over “Traditional” CGI

• Efficient
  – Threads instead of OS processes, one servlet copy, persistence
• Convenient
  – Lots of high-level utilities
• Powerful
  – Sharing data, pooling, persistence
• Portable
  – Run on virtually all operating systems and servers
• Secure
  – No shell escapes, no buffer overflows
• Inexpensive
Simple Servlet Template

```java
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;

public class ServletTemplate extends HttpServlet {
    public void doGet(HttpServletRequest request,
                       HttpServletResponse response)
        throws ServletException, IOException{
        // Use "request" to read incoming HTTP headers
        // (e.g. cookies) and HTML form data (query data)
        // Use "response" to specify the HTTP response status
        // code and headers (e.g. the content type, cookies).
        PrintWriter out = response.getWriter();
        // Use "out" to send content to browser
    }
}
```

HelloWorld Servlet

```java
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;

public class HelloWorld extends HttpServlet {
    public void doGet(HttpServletRequest request,
                       HttpServletResponse response)
        throws ServletException, IOException {
        PrintWriter out = response.getWriter();
        out.println("Hello World");
    }
}
```

Summary

- Java is an object-oriented programming language.
- Java features make it ideally suited for writing network-oriented programs.
- Java class definitions and the programs associated with classes are compiled into byte code to facilitate program portability.
- Java class definitions and the programs associated with them can be loaded dynamically via a network.
- Java programs can be multithreaded, thereby enabling them to perform many tasks simultaneously.
- Java does automatic memory management, relieving you of tedious programming and frustrating debugging, thereby increasing your productivity.
- Java has syntactical similarities with the C and C++ languages.