core WEB programming

# Applets and Basic Graphics

## Agenda

- Applet restrictions
- Basic applet and HTML template
- The applet life-cycle
- Customizing applets through HTML parameters
- Methods available for graphical operations
- Loading and drawing images
- Controlling image loading
- Java Plug-In and HTML converter

## Security Restrictions: Applets Cannot…

- **Read from the local (client) disk**
  - Applets cannot read arbitrary files
  - They can, however, instruct the browser to display pages that are generally accessible on the Web, which might include some local files
- **Write to the local (client) disk**
  - The browser may choose to cache certain files, including some loaded by applets, but this choice is not under direct control of the applet
- **Open network connections other than to the server from which the applet was loaded**
  - This restriction prevents applets from browsing behind network firewalls

## Applets Cannot…

- **Link to client-side C code or call programs installed on the browser machine**
  - Ordinary Java applications can invoke locally installed programs (with the exec method of the Runtime class) as well as link to local C/C++ modules (“native” methods)
  - These actions are prohibited in applets because there is no way to determine whether the operations these local programs perform are safe
- **Discover private information about the user**
  - Applets should not be able to discover the username of the person running them or specific system information such as current users, directory names or listings, system software, and so forth
  - However, applets *can* determine the name of the host they are on; this information is already reported to the HTTP server that delivered the applet

# Applet Template

```
import java.applet.Applet;
import java.awt.*;

public class AppletTemplate extends Applet {

  // Variable declarations.

  public void init() {
    // Variable initializations, image loading, etc.
  }

  public void paint(Graphics g) {
    // Drawing operations.
  }
}
```

- **Browsers cache applets: in Netscape, use Shift-RELOAD to force loading of new applet. In IE, use Control-RELOAD**
- **Can use appletviewer for initial testing**

# Applet HTML Template

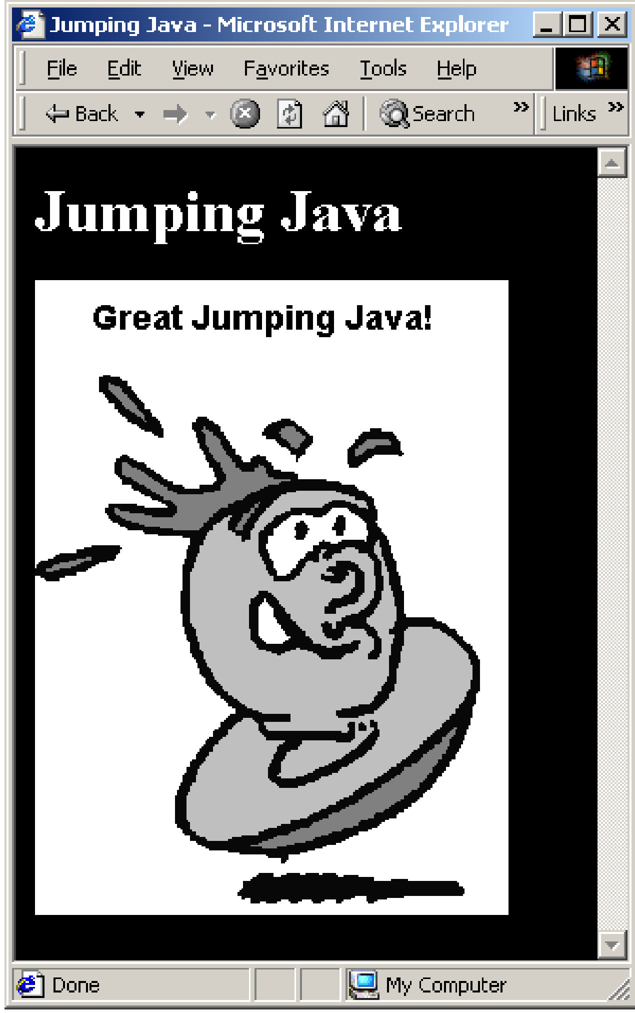
```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Transitional//EN">
<HTML>
<HEAD>
  <TITLE>A Template for Loading Applets</TITLE>
</HEAD>

<BODY>
<H1>A Template for Loading Applets</H1>
<P>
<APPLET CODE="AppletTemplate.class" WIDTH=120 HEIGHT=60>
  <B>Error! You must use a Java-enabled browser.</B>
</APPLET>

</BODY>
</HTML>
```

# Applet Example

```
import java.applet.Applet;
import java.awt.*;

/** An applet that draws an image. */

public class JavaJump extends Applet {
  private Image jumpingJava; // Instance var declarations here

  public void init() {         // Initializations here
    setBackground(Color.white);
    setFont(new Font("SansSerif", Font.BOLD, 18));
    jumpingJava = getImage(getDocumentBase(),
                           "images/Jumping-Java.gif");
    add(new Label("Great Jumping Java!"));
    System.out.println("Yow! I'm jiving with Java.");
  }

  public void paint(Graphics g) {  // Drawing here
    g.drawImage(jumpingJava, 0, 50, this);
  }
}
```

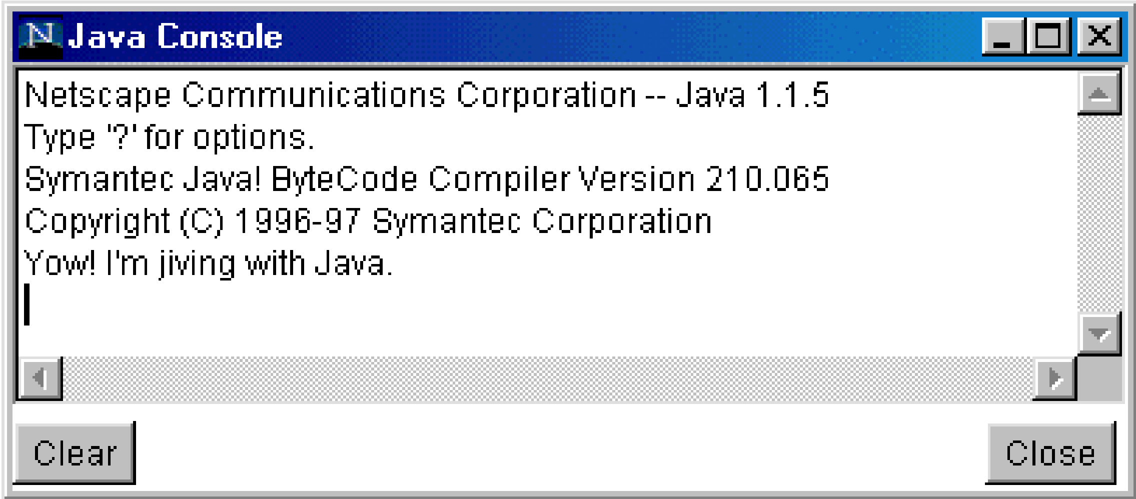
# Applet Example: Result

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Transitional//EN">
<HTML>
<HEAD>
  <TITLE>Jumping Java</TITLE>
</HEAD>
<BODY BGCOLOR="BLACK" TEXT="WHITE">
<H1>Jumping Java</H1>
<P>
<APPLET CODE="JavaJump.class"
        WIDTH=250
        HEIGHT=335>
  <B>Sorry, this example requires
  Java.</B>
</APPLET>
</BODY>
</HTML>
```


Jumping Java - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Links
Jumping Java
Great Jumping Java!
Done
My Computer

# Debugging Applets: The Java Console

- **Standard output (from System.out.println) is sent to the Java Console**
  - Navigator: open from `Window` menu
  - Communicator: open from `Communicator` ... `Tools`
  - IE 4: open from `View` menu (enable from `Tools` ... `Internet Options` ... `Advanced` screen)
  - IE 5/6 with Java plugin: go to Control Panel, click on Java Plugin, and select "Show Console" option.



```
Netscape Communications Corporation -- Java 1.1.5
Type '?' for options.
Symantec Java! ByteCode Compiler Version 210.065
Copyright (C) 1996-97 Symantec Corporation
Yow! I'm jiving with Java.
```

# The Applet Life Cycle

- **public void init()**
  - Called when applet is first loaded into the browser.
  - *Not* called each time the applet is executed
- **public void start()**
  - Called immediately after init initially
  - Reinvoked each time user returns to page after having left it
  - Used to start animation threads
- **public void paint(Graphics g)**
  - Called by the browser after init and start
  - Reinvoked whenever the browser redraws the screen (typically when part of the screen has been obscured and then reexposed)
  - This method is where user-level drawing is placed

## The Applet Life Cycle (Continued)

- **public void stop()**
  - Called when the user leaves the page
  - Used to stop animation threads
- **public void destroy()**
  - Called when applet is killed by the browser
- **Note nonstandard behavior**
  - In some versions of Internet Explorer, and later versions of Netscape, init is called each time the user returns to the same page, and destroy is called whenever the user leaves the page containing the applet. I.e., applet is started over each time (incorrect behavior!).

## Useful Applet Methods

- **getCodeBase, getDocumentBase**
  - The URL of the:

    Applet file - **`getCodeBase`**

    HTML file - **`getDocumentBase`**
- **getParameter**
  - Retrieves the value from the associated HTML `PARAM` element
- **getSize**
  - Returns the `Dimension` (width, height) of the applet
- **getGraphics**
  - Retrieves the current `Graphics` object for the applet
  - The `Graphics` object does not persist across `paint` invocations

# Useful Applet Methods (Continued)

- **showDocument (AppletContext method)**

  ```
  getAppletContext().showDocument(...)
  ```

  - Asks the browser to retrieve and a display a Web page
  - Can direct page to a named `FRAME` cell
- **showStatus**
  - Displays a string in the status line at the bottom of the browser
- **getCursor, setCursor**
  - Defines the `Cursor` for the mouse, for example, `CROSSHAIR_CURSOR`, `HAND_CURSOR`, `WAIT_CURSOR`

## Useful Applet Methods (Continued)

- **getAudioClip, play**
  - Retrieves an audio file from a remote location and plays it
  - JDK 1.1 supports .au only.  Java 2 also supports MIDI, .aiff and .wav
- **getBackground, setBackground**
  - Gets/sets the background color of the applet
  - `SystemColor` class provides access to desktop colors
- **getForeground, setForeground**
  - Gets/sets foreground color of applet (default color of drawing operations)

# HTML APPLET Element

```
<APPLET CODE="..." WIDTH=xxx HEIGHT=xxx ...>
...
</APPLET>
```

- **Required Attributes**
  - CODE
    - Designates the filename of the Java class file to load
    - Filename interpreted with respect to directory of current HTML page (default) unless `CODEBASE` is supplied
  - WIDTH and HEIGHT
    - Specifies area the applet will occupy
    - Values can be given in pixels or as a percentage of the browser window (width only). Percentages fail in appletviewer.

## HTML APPLET Element (Continued)

- **Other Attributes**
  - ALIGN, HSPACE, and VSPACE
    - Controls position and border spacing. Exactly the same as with the `IMG` element
  - ARCHIVE
    - Designates JAR file (zip file with .jar extension) containing all classes and images used by applet
    - Save considerable time when downloading multiple class files
  - NAME
    - Names the applet for interapplet and JavaScript communication
  - MAYSCRIPT (nonstandard)
    - Permits JavaScript to control the applet

## Setting Applet Parameters

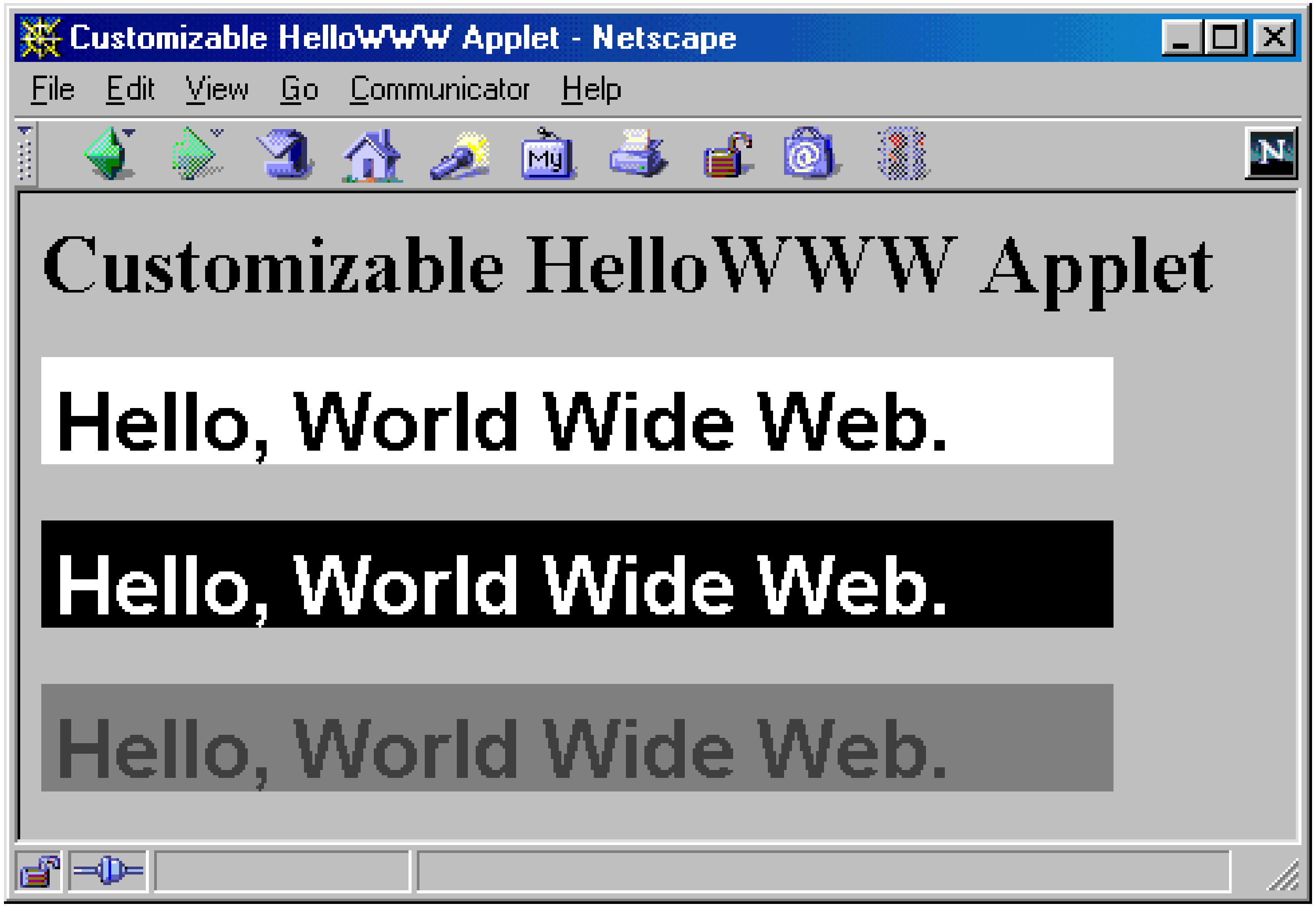
```
<H1>Customizable HelloWWW Applet</H1>

<APPLET CODE="HelloWWW2.class" WIDTH=400 HEIGHT=40>
  <PARAM NAME="BACKGROUND" VALUE="LIGHT">
  <B>Error! You must use a Java-enabled browser.</B>
</APPLET>

<APPLET CODE="HelloWWW2.class" WIDTH=400 HEIGHT=40>
  <PARAM NAME="BACKGROUND" VALUE="DARK">
  <B>Error! You must use a Java-enabled browser.</B>
</APPLET>

<APPLET CODE="HelloWWW2.class" WIDTH=400 HEIGHT=40>
  <B>Error! You must use a Java-enabled browser.</B>
</APPLET>
```

## Reading Applet Parameters

- Use getParameter(name) to retrieve the value of the PARAM element
- The name argument is case sensitive

```
public void init() {
  Color background = Color.gray;
  Color foreground = Color.darkGray;
  String backgroundType = getParameter("BACKGROUND");
  if (backgroundType != null) {
    if (backgroundType.equalsIgnoreCase("LIGHT")) {
      background = Color.white;
      foreground = Color.black;
    } else if (backgroundType.equalsIgnoreCase("DARK")) {
      background = Color.black;
      foreground = Color.white;
    }
  }
  ...
}
```

# Reading Applet Parameters: Result


Customizable HelloWWW Applet - Netscape
File Edit View Go Communicator Help

Customizable HelloWWW Applet

Hello, World Wide Web.

Hello, World Wide Web.

Hello, World Wide Web.

# Useful Graphics Methods

- **drawString(string, left, bottom)**
  - Draws a string in the current font and color with the *bottom left* corner of the string at the specified location
  - One of the few methods where the y coordinate refers to the bottom of shape, not the top. But y values are still with respect to the *top left* corner of the applet window
- **drawRect(left, top, width, height)**
  - Draws the outline of a rectangle (1-pixel border) in the current color
- **fillRect(left, top, width, height)**
  - Draws a solid rectangle in the current color
- **drawLine(x1, y1, x2, y2)**
  - Draws a 1-pixel-thick line from (x1, y1) to (x2, y2)

# Useful Graphics Methods (Continued)

- **drawOval, fillOval**
  - Draws an outlined and solid oval, where the arguments describe a rectangle that bounds the oval
- **drawPolygon, fillPolygon**
  - Draws an outlined and solid polygon whose points are defined by arrays or a `Polygon` (a class that stores a series of points)
  - By default, polygon is closed; to make an open polygon use the drawPolyline method
- **drawImage**
  - Draws an image
  - Images can be in JPEG or GIF (including GIF89A) format

## Drawing Color

- **setColor, getColor**
  - Specifies the foreground color prior to drawing operation
  - By default, the graphics object receives the foreground color of the window
  - AWT has 16 predefined colors (`Color.red`, `Color.blue`, etc.) or create your own color: `new Color(r, g, b)`
  - Changing the color of the `Graphics` object affects only the drawing that explicitly uses that `Graphics` object
    - To make permanent changes, call the *applet's* `setForeground` method.

## Graphics Font

- **setFont, getFont**
  - Specifies the font to be used for drawing text
  - Determine the size of a character through `FontMetrics` (in Java 2 use `LineMetrics`)
  - Setting the font for the `Graphics` object does not persist to subsequent invocations of `paint`
  - Set the font of the window (I.e., call the *applet's* `setFont` method) for permanent changes to the font
  - In JDK 1.1, only 5 fonts are available: `Serif` (aka `TimesRoman`), `SansSerif` (aka `Helvetica`), `Monospaced` (aka `Courier`), `Dialog`, and `DialogInput`

# Graphic Drawing Modes

- **setXORMode**
  - Specifies a color to XOR with the color of underlying pixel before drawing the new pixel
  - Drawing something twice in a row will restore the original condition
- **setPaintMode**
  - Set drawing mode back to normal (versus XOR)
  - Subsequent drawing will use the normal foreground color
  - Remember that the Graphics object is reset to the default each time. So, no need to call g.setPaintMode() in paint unless you do non-XOR drawing after your XOR drawing

# Graphics Behavior

- **Browser calls `repaint` method to request redrawing of applet**
  - Called when applet first drawn or applet is hidden by another window and then reexposed

$$\begin{tikzcd}
\texttt{repaint()} \arrow[d, dashed, "\text{``sets } \textit{flag}\text{''}"] \\
\texttt{update(Graphics g)} \arrow[d, "\text{Clears screen, calls } \texttt{paint}"] \\
\texttt{paint(Graphics g)}
\end{tikzcd}$$

# Drawing Images

- **Register the Image (from `init`)**

```
Image image = getImage(getCodeBase(), "file");
Image image = getImage (url);
```

  - Loading is done in a separate thread
  - If URL is absolute, then `try/catch` block is required

- **Draw the image (from `paint`)**

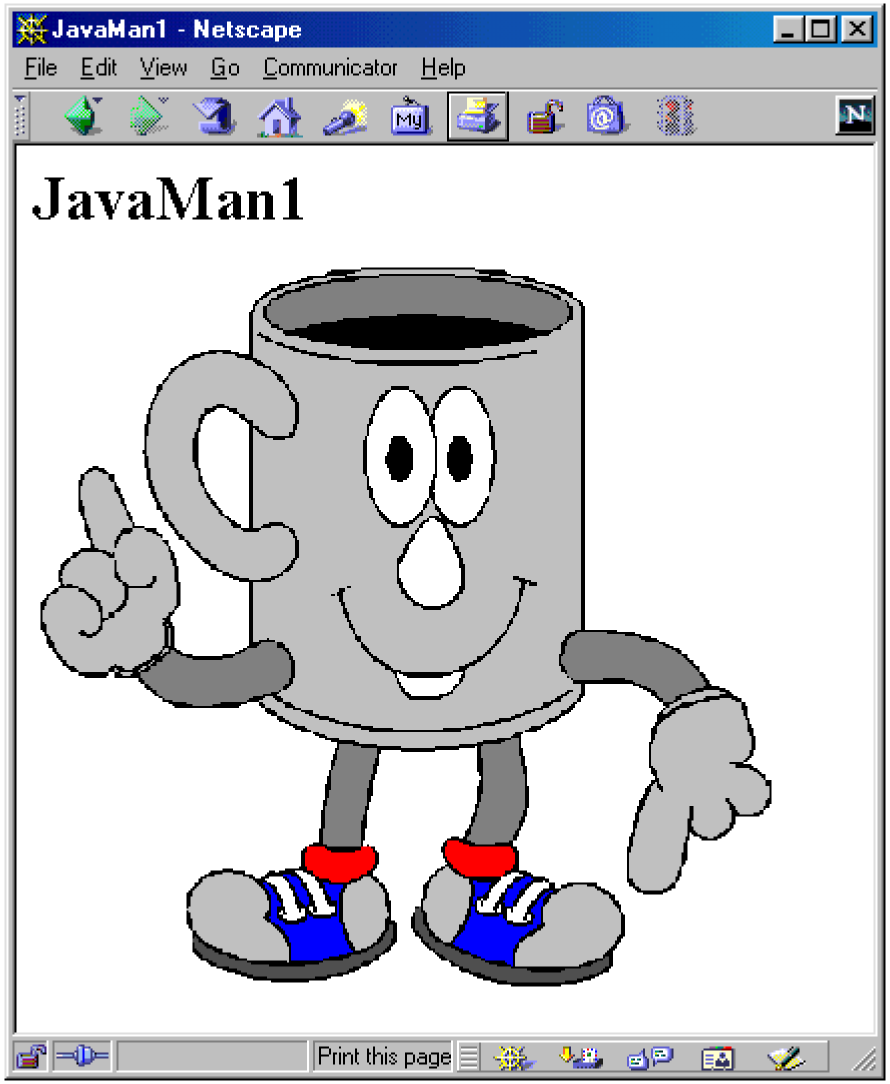
```
      g.drawImage(image, x, y, window);
      g.drawImage(image, x, y, w, h, window);
```

  - May draw partial image or nothing at all
  - Use the applet (`this`) for the `window` argument

## Loading Applet Image from Relative URL

```
import java.applet.Applet;
import java.awt.*;

/** An applet that loads an image from a relative URL. */

public class JavaMan1 extends Applet {
  private Image javaMan;

  public void init() {
    javaMan = getImage(getCodeBase(),
                       "images/Java-Man.gif");
  }

  public void paint(Graphics g) {
    g.drawImage(javaMan, 0, 0, this);
  }
}
```

# Image Loading Result



JavaMan1

# Loading Applet Image from Absolute URL

```
import java.applet.Applet;
import java.awt.*;
import java.net.*;
...
  private Image javaMan;

  public void init() {
    try {
      URL imageFile =
        new URL("http://www.corewebprogramming.com" +
                "/images/Java-Man.gif");
      javaMan = getImage(imageFile);
    } catch(MalformedURLException mue) {
      showStatus("Bogus image URL.");
      System.out.println("Bogus URL");
    }
  }
```

# Loading Images in Applications

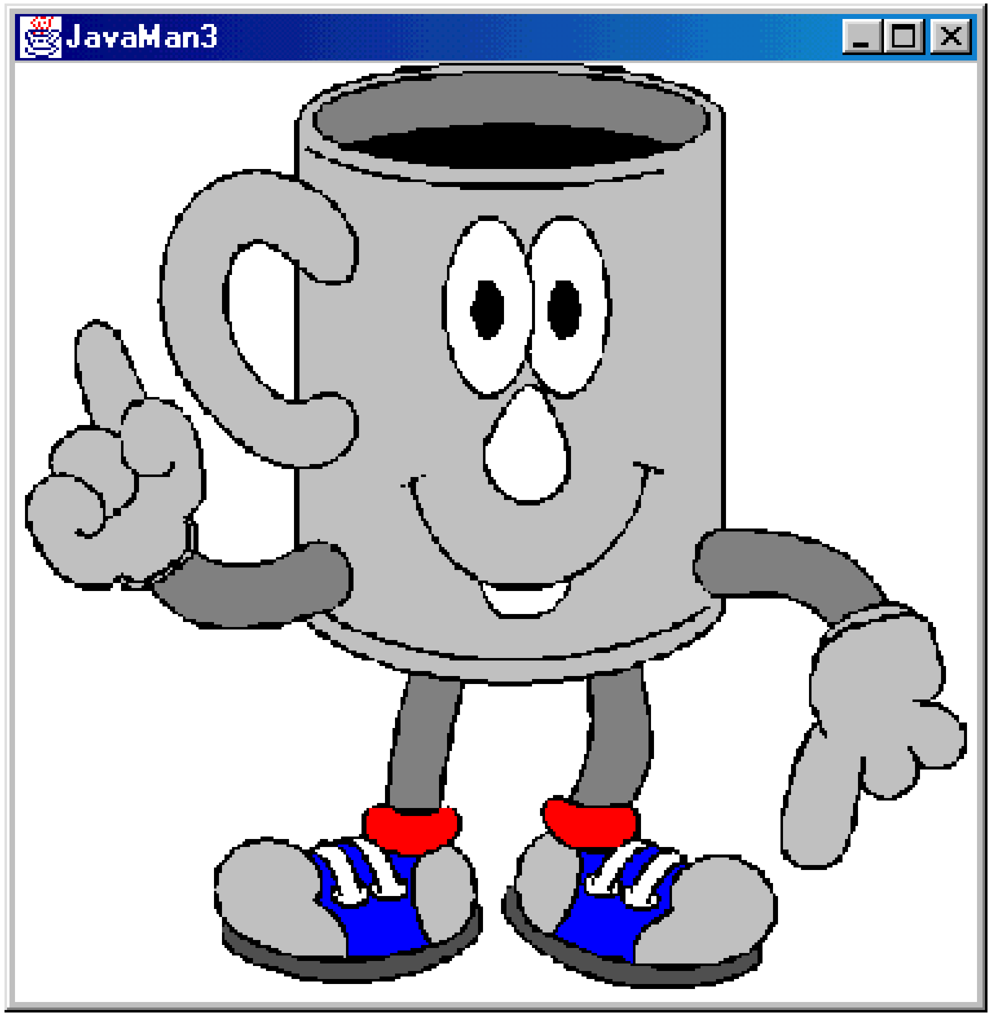
```
import java.awt.*;
import javax.swing.*;

class JavaMan3 extends JPanel {
  private Image javaMan;

  public JavaMan3() {
    String imageFile = System.getProperty("user.dir") +
                       "/images/Java-Man.gif";
    javaMan = getToolkit().getImage(imageFile);
    setBackground(Color.white);
  }

  public void paintComponent(Graphics g) {
    super.paintComponent(g);
    g.drawImage(javaMan, 0, 0, this);
  }
  ...
```

## Loading Images in Applications (Continued)

```
  ...

  public void paintComponent(Graphics g) {
    super.paintComponent(g);
    g.drawImage(javaMan, 0, 0, this);
  }

  public static void main(String[] args) {
    JPanel panel = new JavaMan3();
    WindowUtilities.setNativeLookAndFeel();
    WindowUtilities.openInJFrame(panel, 380, 390);
  }
}
```

- **See Swing chapter for `WindowUtilities`**

# Loading Images in Applications, Result



## Controlling Image Loading

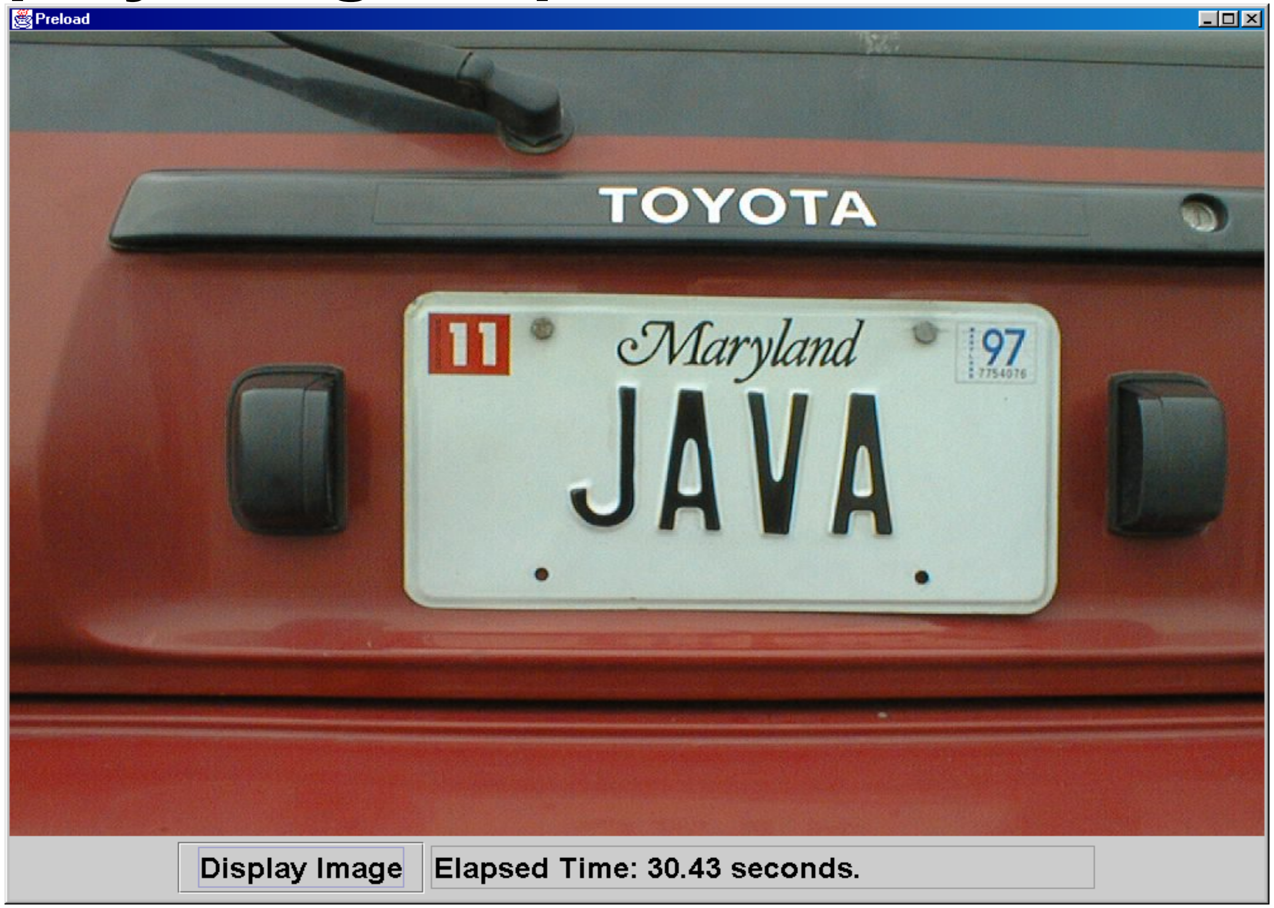
- **Use `prepareImage` to start loading image**

```
prepareImage(image, window)
prepareImage(image, width, height, window)
```

  – Starts loading image immediately (on separate thread), instead of when needed by `drawImage`
  – Particularly useful if the images will not be drawn until the user initiates some action such as clicking on a button or choosing a menu option
  – Since the applet thread immediately continues execution after the call to `prepareImage`, the image *may* not be completely loaded before `paint` is reached

# Controlling Image Loading, Case I: No prepareImage

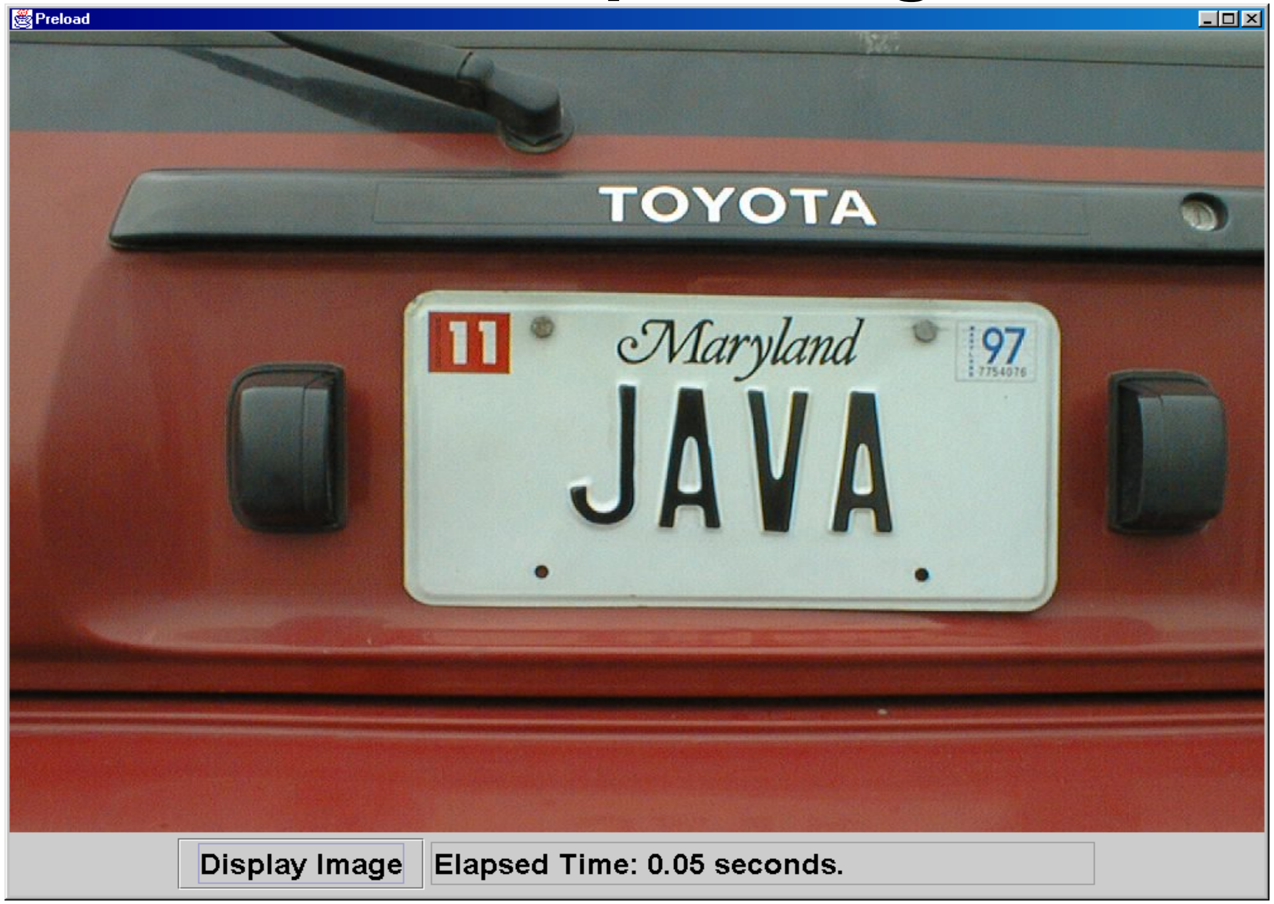
- Image is not loaded over network until after Display Image is pressed. 30.4 seconds.



Elapsed Time: 30.43 seconds.

# Controlling Image Loading, Case 2: With prepareImage

- Image loaded over network immediately. 0.05 seconds after pressing button.



Elapsed Time: 0.05 seconds.

# Controlling Image Loading: MediaTracker

- Registering images with a MediaTracker to control image loading

```
 MediaTracker tracker = new MediaTracker(this);
  tracker.addImage(image1, 0);
  tracker.addImage(image2, 1);
  try {
    tracker.waitForAll();
  } catch(InterruptedException ie) {}
  if (tracker.isErrorAny()) {
    System.out.println("Error while loading image");
  }
```

  – Applet thread will block until all images are loaded
  – Each image is loaded in parallel on a separate thread

# Useful MediaTracker Methods

- **addImage**
  - Register a normal or scaled image with a given ID
- **checkAll, checkID**
  - Checks whether all or a particular registered image is done loading
- **isErrorAny, isErrorID**
  - Indicates if any or a particular image encountered an error while loading
- **waitForAll, waitForID**
  - Start loading all images or a particular image
  - Method does not return (blocks) until image is loaded
- **See `TrackerUtil` in book for simplified usage of `MediaTracker`**

# Loading Images, Case I: No MediaTracker

- Image size is wrong, since the image won't be done loading, and –1 will be returned

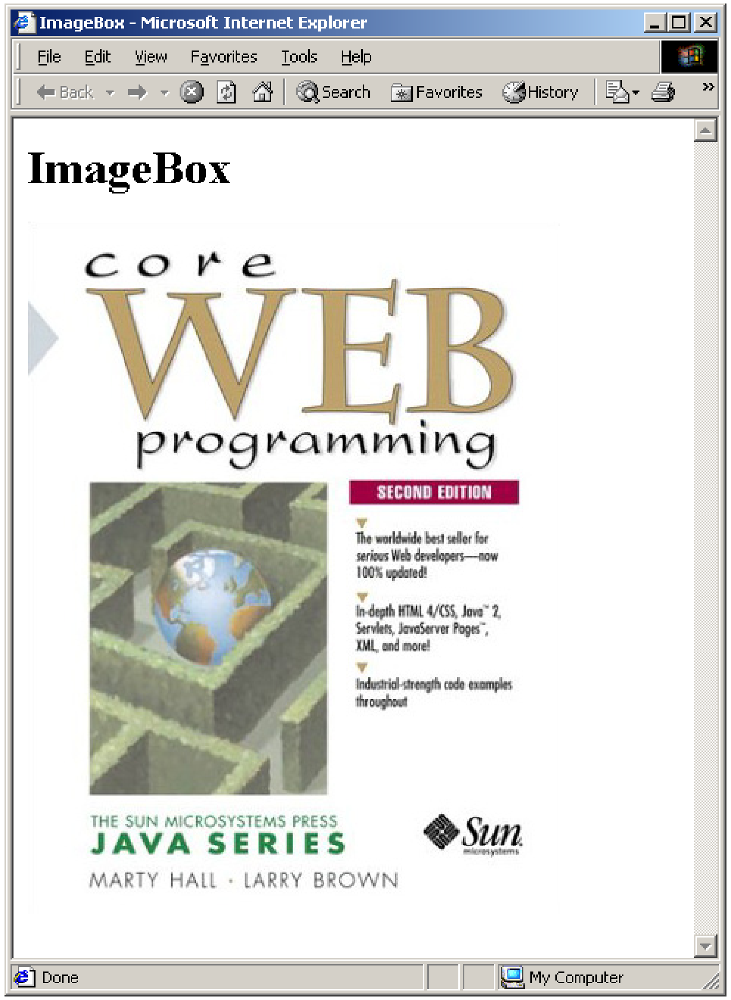
```
public void init() {
  image = getImage(getDocumentBase(), imageName);

  imageWidth = image.getWidth(this);
  imageHeight = image.getHeight(this);
}

public void paint(Graphics g) {
  g.drawImage(image, 0, 0, this);
  g.drawRect(0, 0, imageWidth, imageHeight);
}
```

## Loading Images, Case 2: With MediaTracker

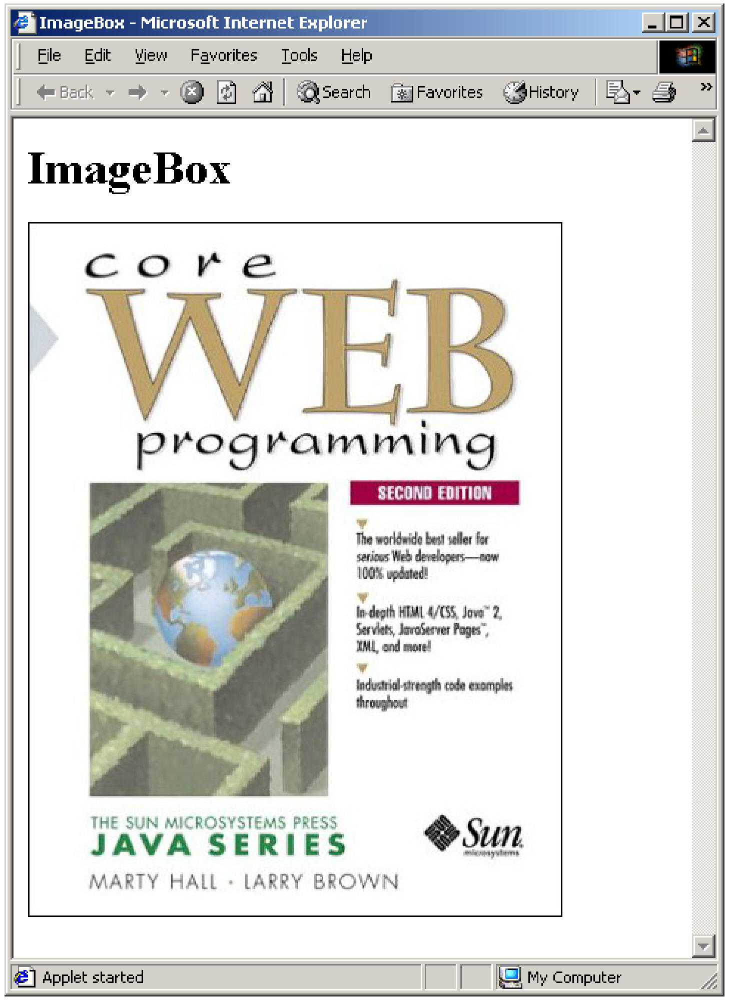
- Image is loaded before determining size

```
public void init() {
  image = getImage(getDocumentBase(), imageName);
  MediaTracker tracker = new MediaTracker(this);
  tracker.addImage(image, 0);
  try {
    tracker.waitForAll();
  } catch(InterruptedException ie) {}
  ...
  imageWidth = image.getWidth(this);
  imageHeight = image.getHeight(this);
}

public void paint(Graphics g) {
  g.drawImage(image, 0, 0, this);
  g.drawRect(0, 0, imageWidth, imageHeight);
}
```

# Loading Images: Results


ImageBox - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
ImageBox
core WEB programming
SECOND EDITION
The worldwide best seller for serious Web developers—now 100% updated!
In-depth HTML 4/CSS, Java 2, Servlets, JavaServer Pages, XML, and more!
Industrial-strength code examples throughout
THE SUN MICROSYSTEMS PRESS JAVA SERIES
MARTY HALL · LARRY BROWN
Done
My Computer

Case 1

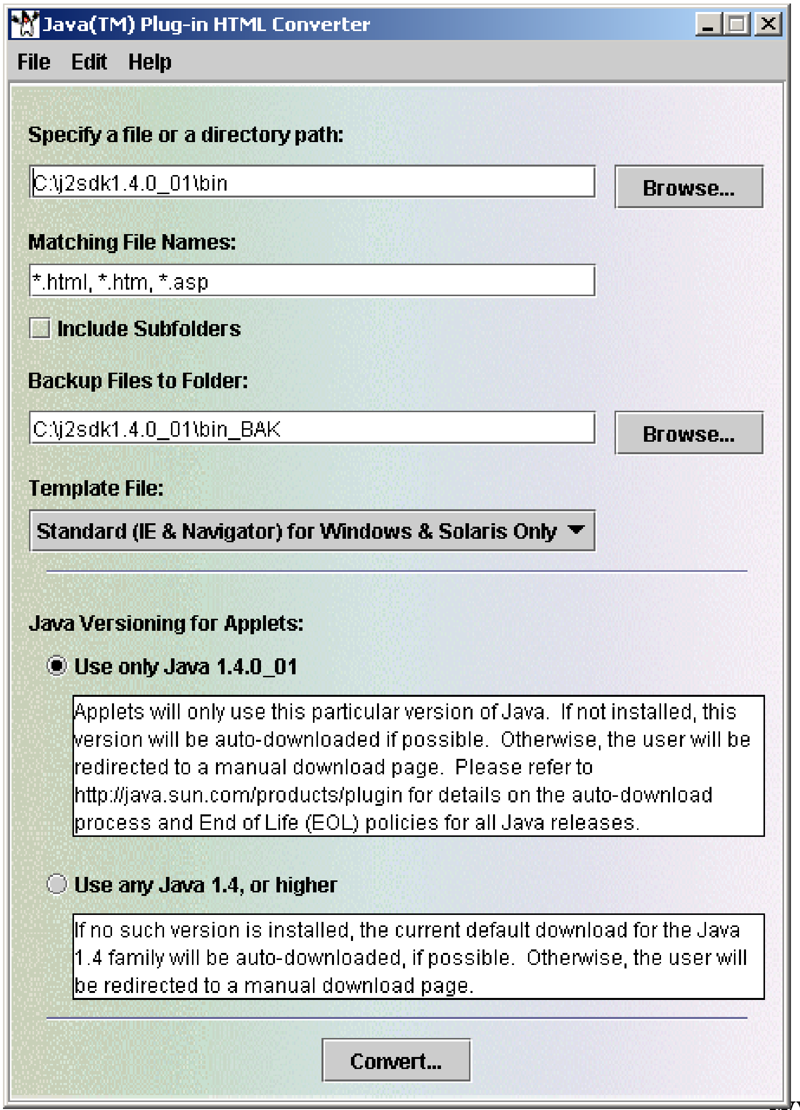

ImageBox - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
ImageBox
core WEB programming
SECOND EDITION
The worldwide best seller for serious Web developers—now 100% updated!
In-depth HTML 4/CSS, Java 2, Servlets, JavaServer Pages, XML, and more!
Industrial-strength code examples throughout
THE SUN MICROSYSTEMS PRESS JAVA SERIES
MARTY HALL · LARRY BROWN
Applet started
My Computer

Case 2

# Java Plug-In

- **Internet Explorer and Netscape (except Version 6 and 7) only support JDK 1.1**
- **Plugin provides support for the latest JDK**
  - http://java.sun.com/products/plugin/
  - Java 2 Plug-In > 5 Mbytes
  - Installing JDK 1.4 installs plugin automatically
- **Older browsers require modification of APPLET element to support OBJECT element (IE) or EMBED element (Netscape)**
  - Use HTML Converter to perform the modification

# Java Plug-In HTML Converter



Specify a file or a directory path: C:\j2sdk1.4.0_01\bin

Matching File Names: *.html, *.htm, *.asp

☐ Include Subfolders

Backup Files to Folder: C:\j2sdk1.4.0_01\bin_BAK

Template File: Standard (IE & Navigator) for Windows & Solaris Only

Java Versioning for Applets:

● Use only Java 1.4.0_01

Applets will only use this particular version of Java. If not installed, this version will be auto-downloaded if possible. Otherwise, the user will be redirected to a manual download page. Please refer to http://java.sun.com/products/plugin for details on the auto-download process and End of Life (EOL) policies for all Java releases.

○ Use any Java 1.4, or higher

If no such version is installed, the current default download for the Java 1.4 family will be auto-downloaded, if possible. Otherwise, the user will be redirected to a manual download page.

# Java Plug-In HTML Converter

- “Navigator for Windows Only” conversion

```
<EMBED type="application/x-java-applet;version=1.4"
   CODE = "HelloWWW.class" CODEBASE = "applets"
   WIDTH = 400 HEIGHT = 40
   BACKGROUND = "LIGHT"
   scriptable=false
   pluginspage="http://java.sun.com/products/plugin/
       index.html#download"
>
   <NOEMBED>
     <B>Error! You must use a Java-enabled browser.</B>
   </NOEMBED>
</EMBED>
```

# Java Plug-In HTML Converter

- "Internet Explorer for Windows and Solaris" conversion

```
<OBJECT classid="clsid:8AD9C840-044E-11D1-B3E9-00805F499D93"
   WIDTH = 400 HEIGHT = 40
   codebase="http://java.sun.com/products/plugin/autodl/
       jinstall-1_4-win.cab#Version=1,4,0,0"
>
   <PARAM NAME = CODE VALUE = "HelloWWW.class" >
   <PARAM NAME = CODEBASE VALUE = "applets" >
   <PARAM NAME="type"
          VALUE="application/x-java-applet;version=1.4">
   <PARAM NAME="scriptable" VALUE="false">
   <PARAM NAME = "BACKGROUND" VALUE ="LIGHT">
   <B>Error! You must use a Java-enabled browser.</B>
</OBJECT>
```

## Summary

- **Applet operations are restricted**
  - Applet cannot read/write local files, call local programs, or connect to any host other than the one from which it was loaded
- **The init method**
  - Called only when applet loaded, not each time executed
  - This is where you use getParameter to read PARAM data
- **The paint method**
  - Called each time applet is displayed
  - Coordinates in drawing operations are wrt top-left corner
- **Drawing images**
  - getImage(getCodeBase(), "imageFile") to “load”
  - drawImage(image, x, y, this) to draw

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## Questions?