ECE 462
Object-Oriented Programming using C++ and Java

Flickering and Double Buffering

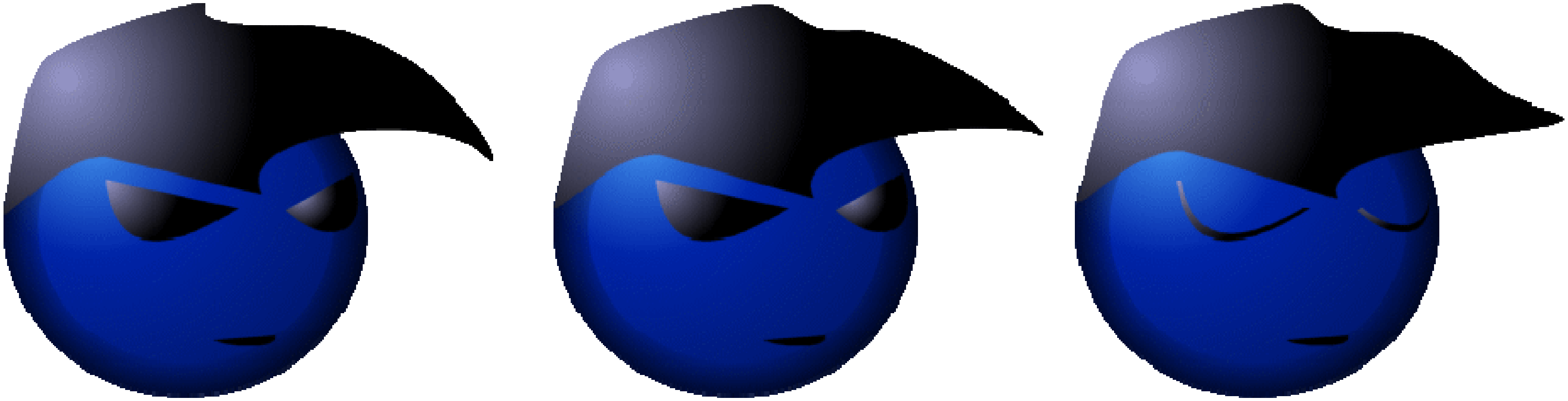
Yung-Hsiang Lu
yunglu@purdue.edu

Flickering

No Flickering

Flickering

- Goal: continuously iterate through the three images
- Approach: draw background first then draw an image
- Problem: occasionally, only the background is shown on the screen without any of the three images
- Result: the character sometimes disappears



Interleaving of Drawing and Display

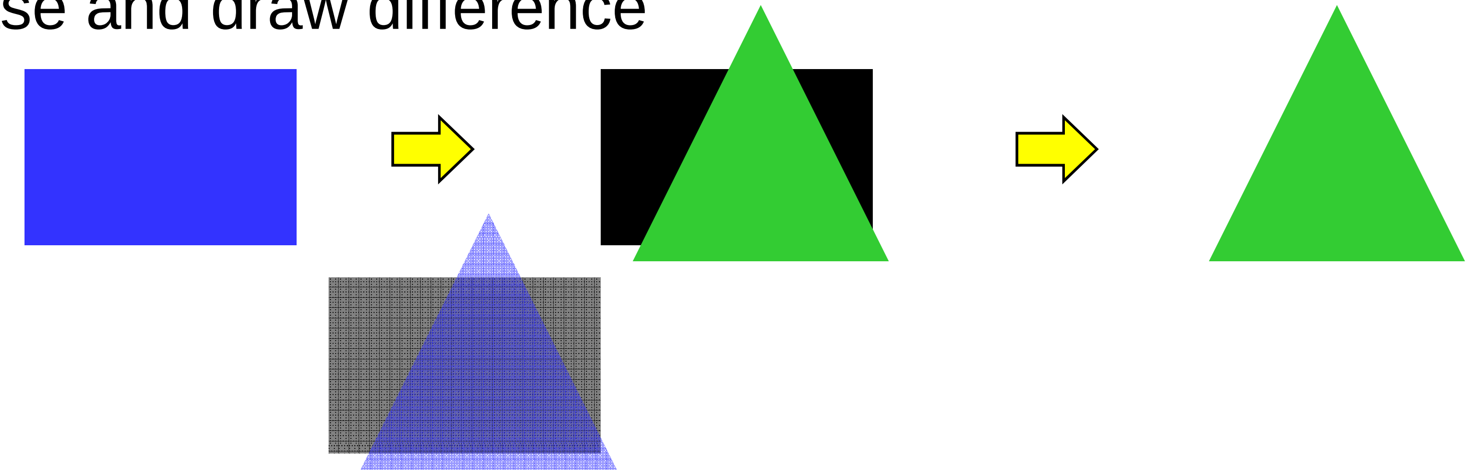
```
public void draw(Graphics g) {
      // draw background
      g.drawImage(bgImage, 0, 0, null);

      // draw image
      g.drawImage(anim.getImage(), 0, 0, null);
   }
```

➡ **sent to screen**

Possible Solutions

- erase and draw difference



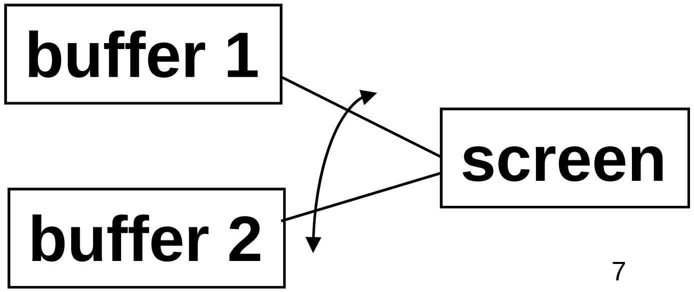
⇒ find the differences between **each pair** of images is not trivial. Interleaving is still a problem.

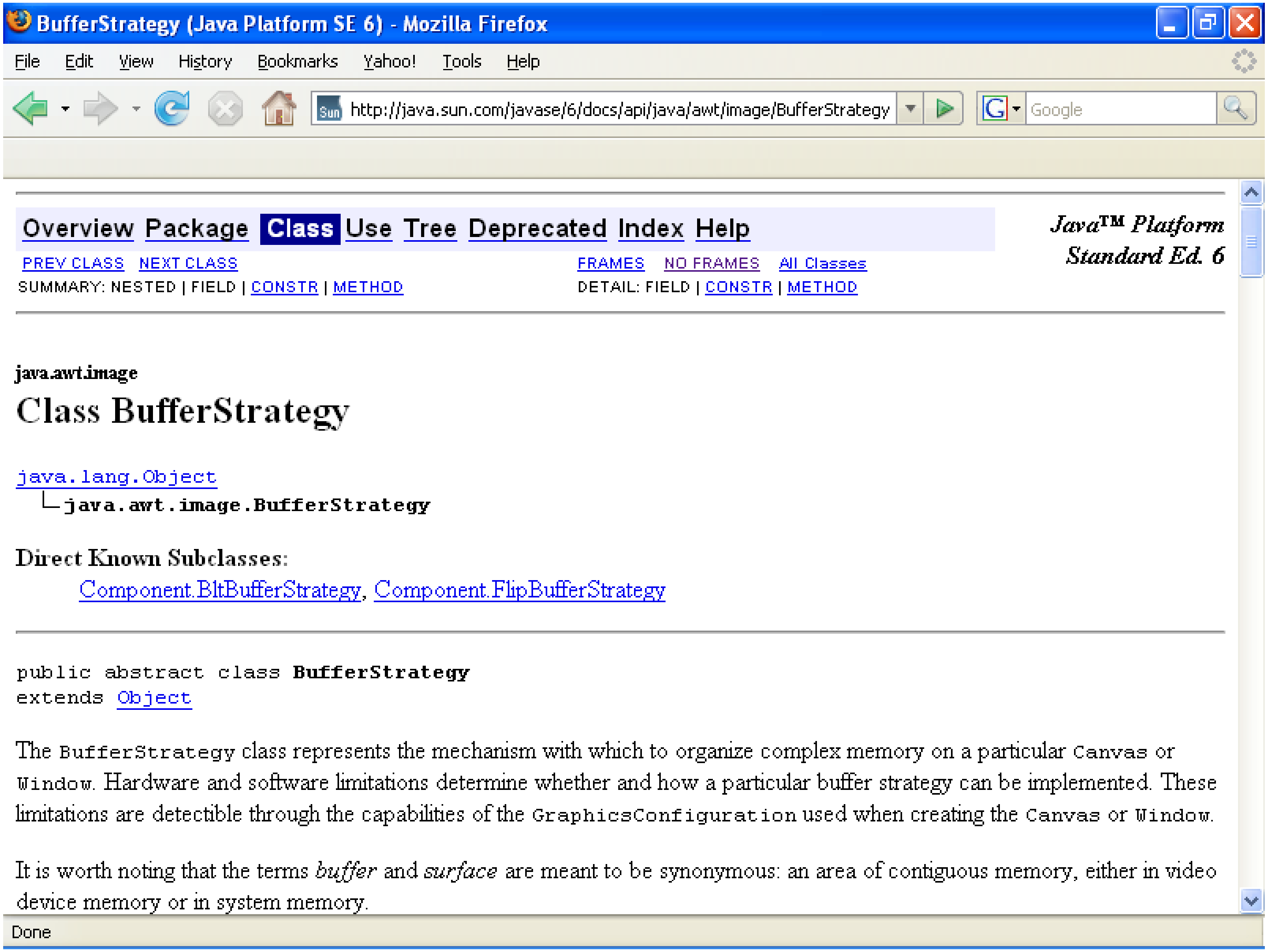
- make draw atomic (i.e. cannot interleave)

⇒ When the screen refreshes and drawing is incomplete, the screen will appear black.

Double Buffering + Page Flipping

- double buffering
  - buffer 1: working buffer for drawing, incomplete, invisible to user
  - buffer 2: completed, shown on screen
  - switching between the two buffers for frame updates
- page flipping
  - the pixels are not copied
  - instead, a pointer switching between the two buffers
  - flipping between monitor refresh




BufferStrategy (Java Platform SE 6) - Mozilla Firefox
File Edit View History Bookmarks Yahoo! Tools Help
http://java.sun.com/javase/6/docs/api/java/awt/image/BufferStrategy
Google
Overview Package Class Use Tree Deprecated Index Help
Java™ Platform
Standard Ed. 6
PREV CLASS NEXT CLASS
FRAMES NO FRAMES All Classes
SUMMARY: NESTED | FIELD | CONSTR | METHOD
DETAIL: FIELD | CONSTR | METHOD
Done

java.awt.image

Class BufferStrategy

```
java.lang.Object
  └java.awt.image.BufferStrategy
```

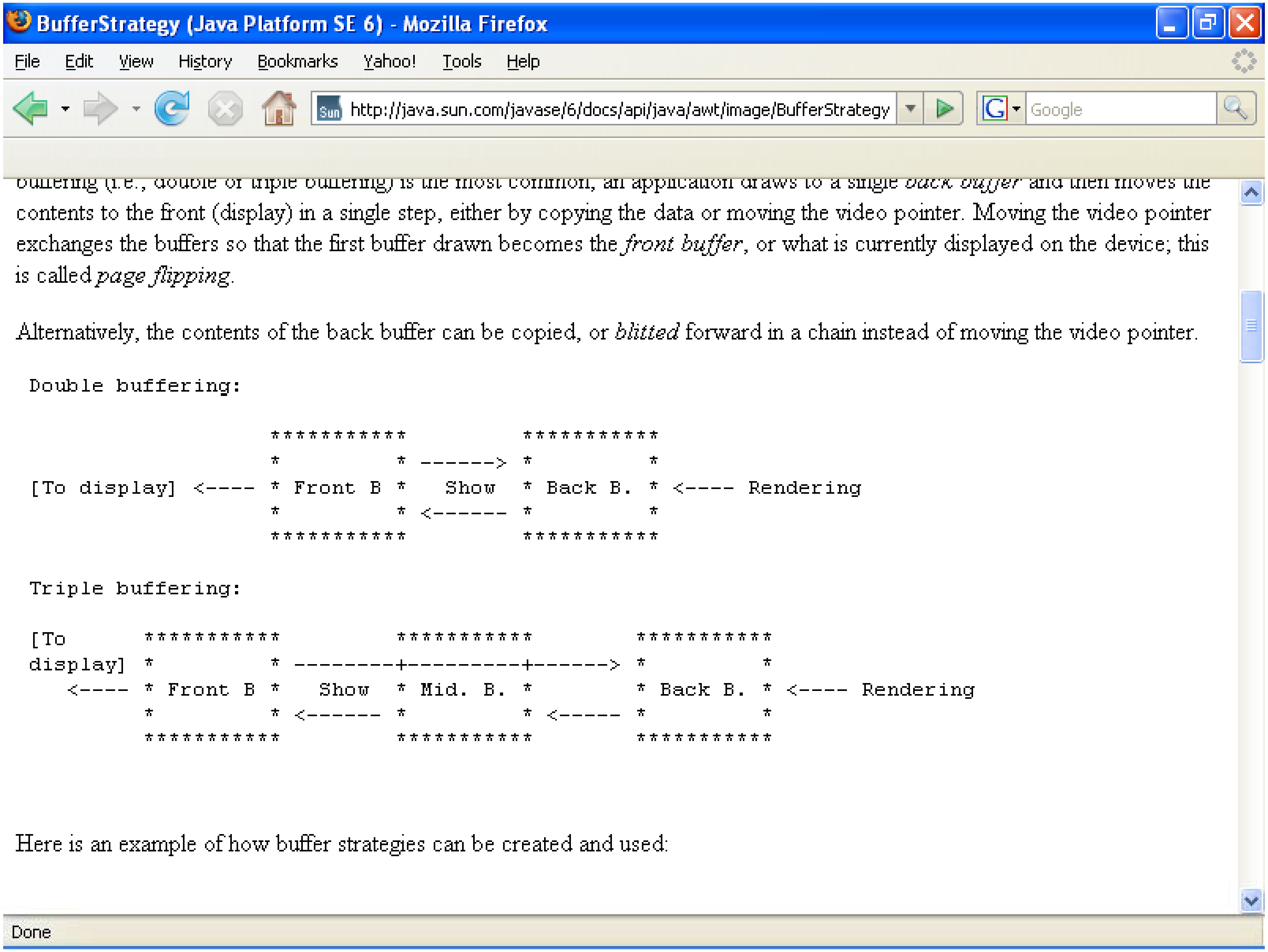
Direct Known Subclasses:

Component.BltBufferStrategy, Component.FlipBufferStrategy

```
public abstract class BufferStrategy
extends Object
```

The `BufferStrategy` class represents the mechanism with which to organize complex memory on a particular `Canvas` or `Window`. Hardware and software limitations determine whether and how a particular buffer strategy can be implemented. These limitations are detectible through the capabilities of the `GraphicsConfiguration` used when creating the `Canvas` or `Window`.

It is worth noting that the terms *buffer* and *surface* are meant to be synonymous: an area of contiguous memory, either in video device memory or in system memory.


BufferStrategy (Java Platform SE 6) - Mozilla Firefox
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Bookmarks
Yahoo!
Tools
Help
http://java.sun.com/javase/6/docs/api/java/awt/image/BufferStrategy
Google
Done

buffering (i.e., double or triple buffering) is the most common, an application draws to a single *back buffer* and then moves the contents to the front (display) in a single step, either by copying the data or moving the video pointer. Moving the video pointer exchanges the buffers so that the first buffer drawn becomes the *front buffer*, or what is currently displayed on the device; this is called *page flipping*.

Alternatively, the contents of the back buffer can be copied, or *blitted* forward in a chain instead of moving the video pointer.

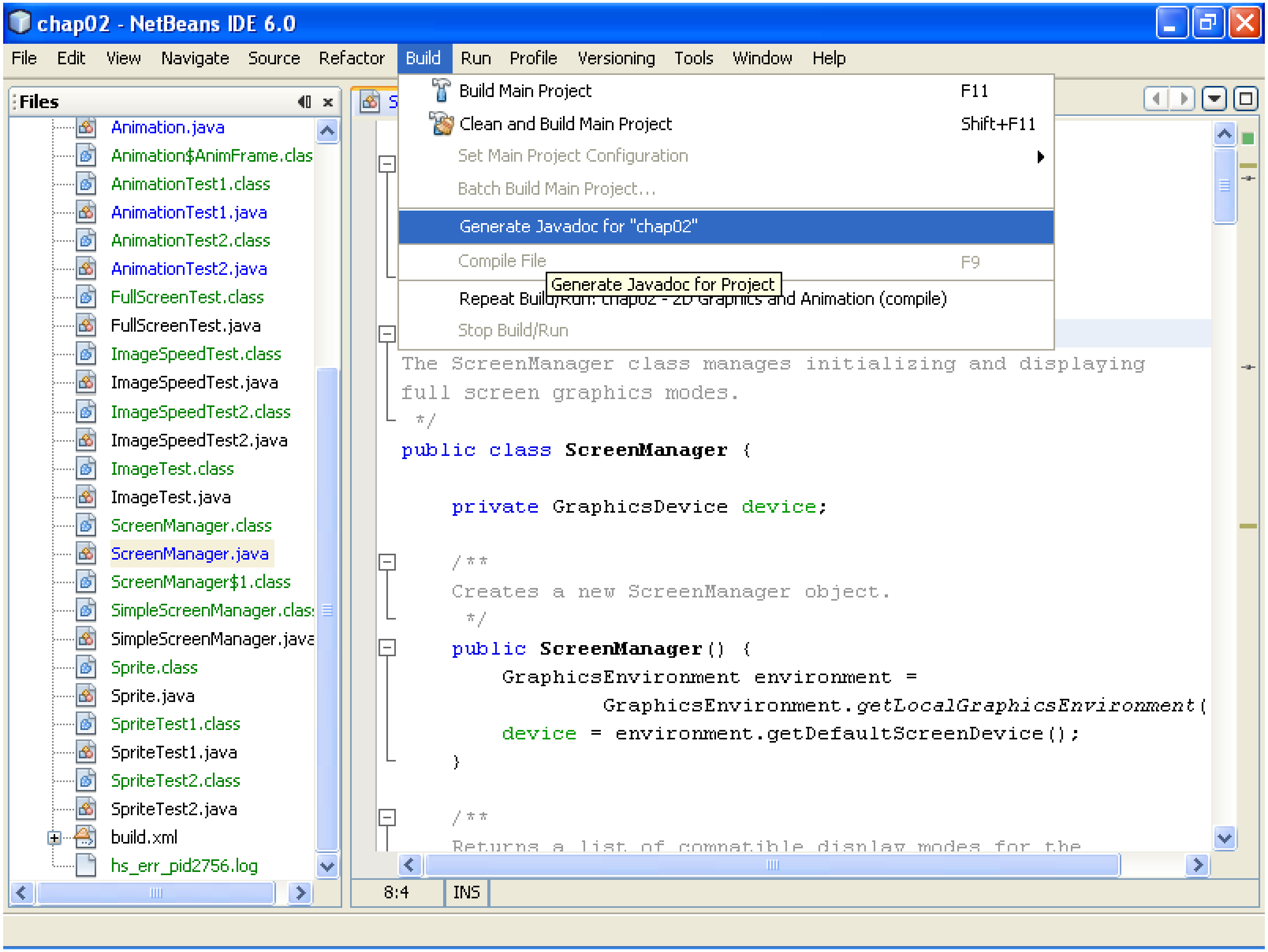
```
Double buffering:

                    ***********         ***********
                    *         * ------> *         *
[To display] <---- * Front B *   Show  * Back B. * <---- Rendering
                    *         * <------ *         *
                    ***********         ***********

Triple buffering:

[To       ***********         ***********        ***********
display] *         * ---------+---------+------> *         *
   <---- * Front B *   Show  * Mid. B. *        * Back B. * <---- Rendering
          *         * <------ *         * <----- *         *
          ***********         ***********        ***********
```

Here is an example of how buffer strategies can be created and used:

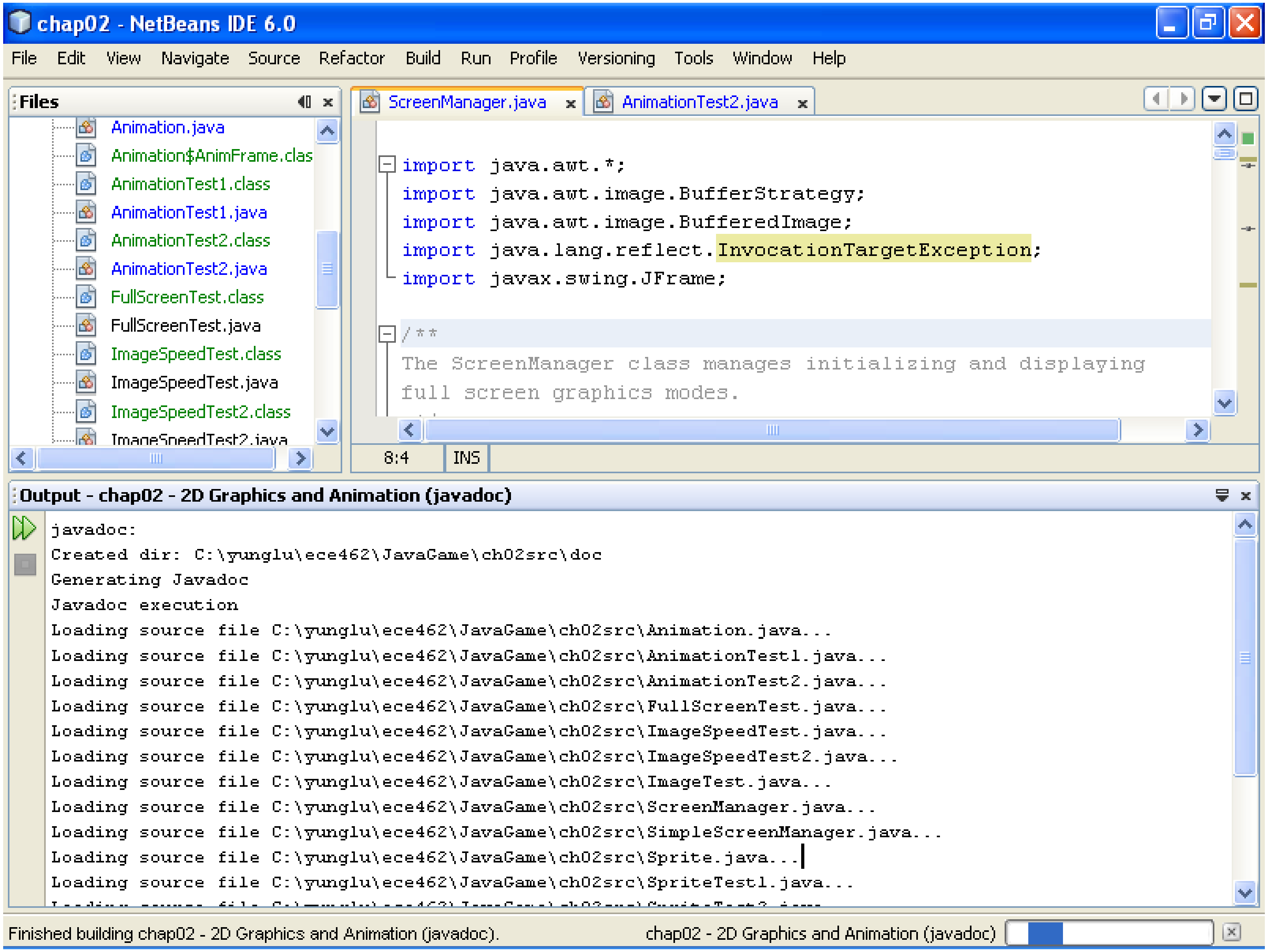
```
window.createBufferStrategy(2);
BufferStrategy strategy = window.getBufferStrategy();
Graphics g = strategy.getDrawGraphics();
draw(g);
g.dispose();
strategy.show();
```

Screen Manager with BufferStrategy

Automatic Document Generation using Javadoc



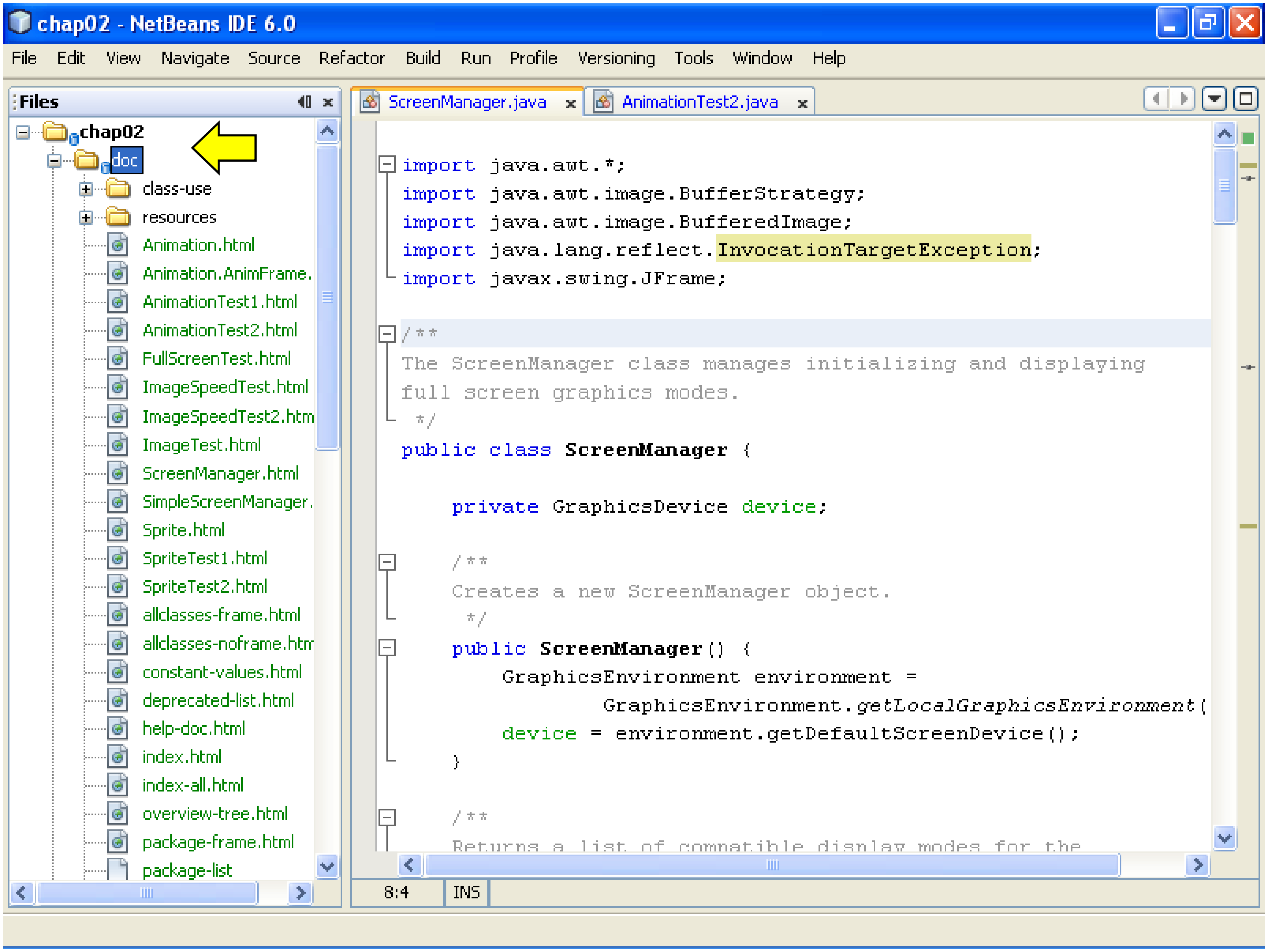
```
The ScreenManager class manages initializing and displaying
full screen graphics modes.
 */
public class ScreenManager {

    private GraphicsDevice device;

    /**
    Creates a new ScreenManager object.
     */
    public ScreenManager() {
        GraphicsEnvironment environment =
            GraphicsEnvironment.getLocalGraphicsEnvironment(
        device = environment.getDefaultScreenDevice();
    }

    /**
    Returns a list of compatible display modes for the
```



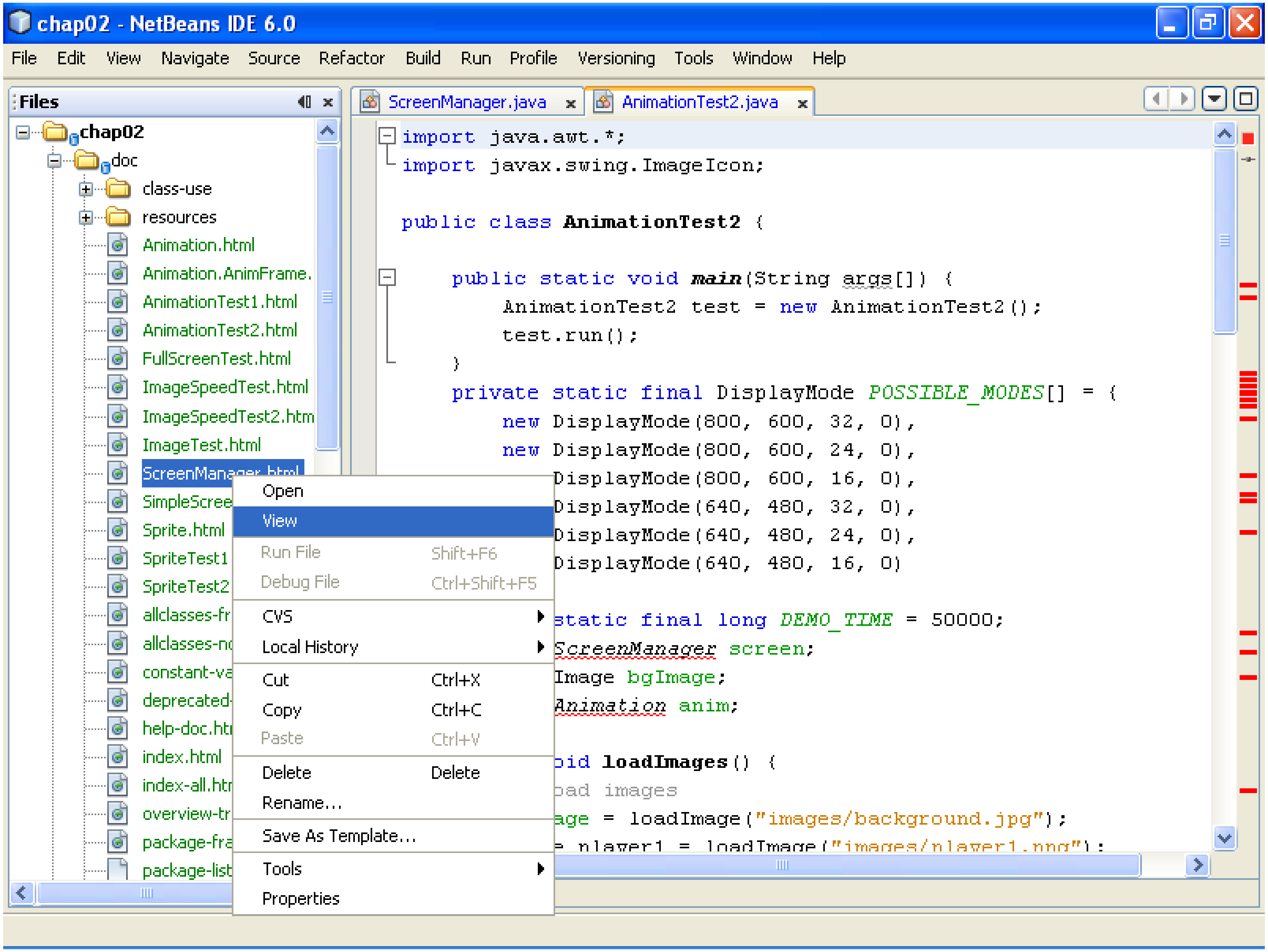
```java
import java.awt.*;
import java.awt.image.BufferStrategy;
import java.awt.image.BufferedImage;
import java.lang.reflect.InvocationTargetException;
import javax.swing.JFrame;

/**
The ScreenManager class manages initializing and displaying
full screen graphics modes.
```

```
javadoc:
Created dir: C:\yunglu\ece462\JavaGame\ch02src\doc
Generating Javadoc
Javadoc execution
Loading source file C:\yunglu\ece462\JavaGame\ch02src\Animation.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\AnimationTest1.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\AnimationTest2.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\FullScreenTest.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\ImageSpeedTest.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\ImageSpeedTest2.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\ImageTest.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\ScreenManager.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\SimpleScreenManager.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\Sprite.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\SpriteTest1.java...
Loading source file C:\yunglu\ece462\JavaGame\ch02src\SpriteTest2.java
```

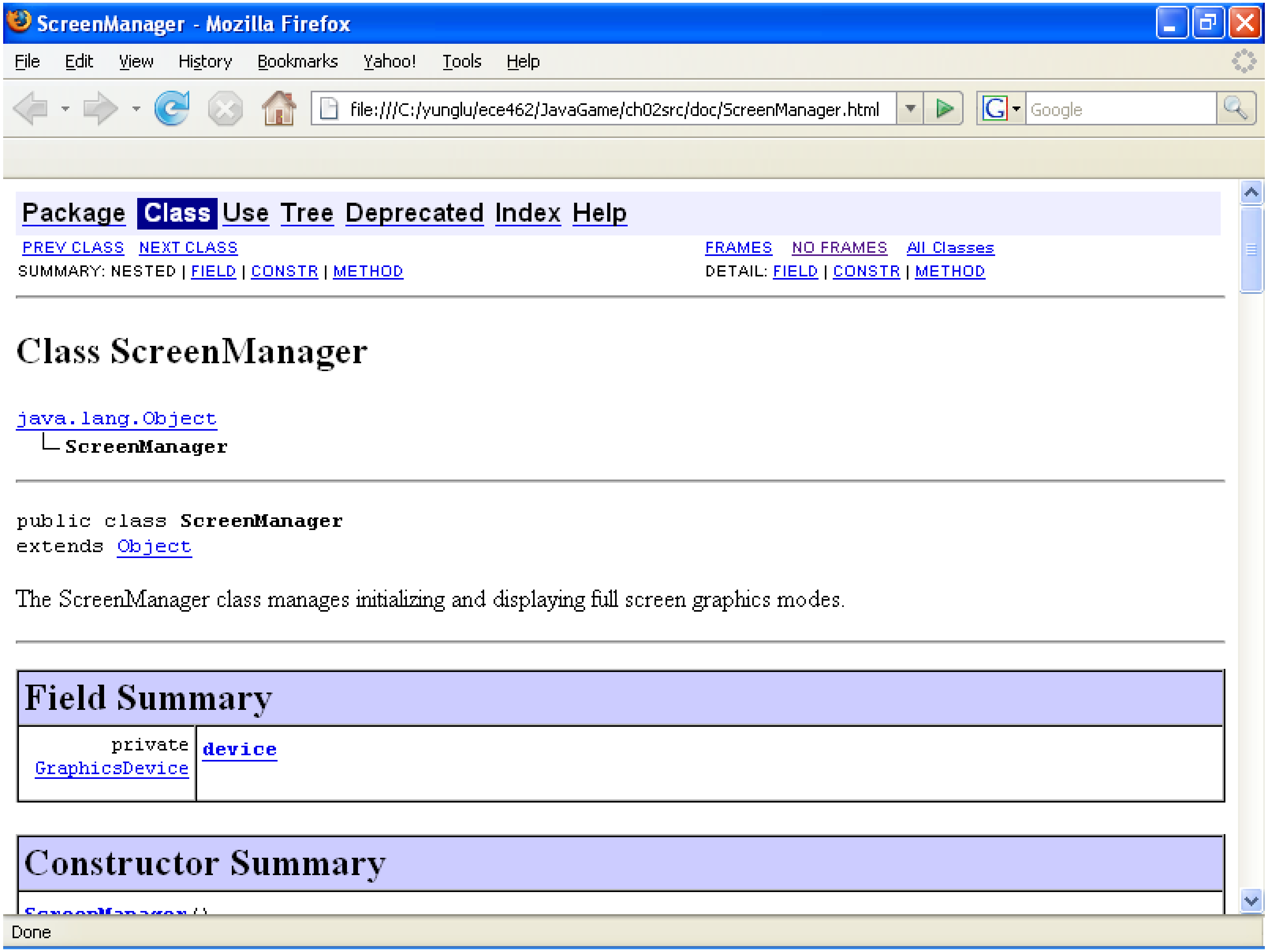
Finished building chap02 - 2D Graphics and Animation (javadoc).



```
import java.awt.*;
import java.awt.image.BufferStrategy;
import java.awt.image.BufferedImage;
import java.lang.reflect.InvocationTargetException;
import javax.swing.JFrame;

/**
The ScreenManager class manages initializing and displaying
full screen graphics modes.
 */
public class ScreenManager {

    private GraphicsDevice device;

    /**
    Creates a new ScreenManager object.
     */
    public ScreenManager() {
        GraphicsEnvironment environment =
                GraphicsEnvironment.getLocalGraphicsEnvironment(
        device = environment.getDefaultScreenDevice();
    }

    /**
    Returns a list of compatible display modes for the
```



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

public class AnimationTest2 {

    public static void main(String args[]) {
        AnimationTest2 test = new AnimationTest2();
        test.run();
    }
    private static final DisplayMode POSSIBLE_MODES[] = {
        new DisplayMode(800, 600, 32, 0),
        new DisplayMode(800, 600, 24, 0),
            DisplayMode(800, 600, 16, 0),
            DisplayMode(640, 480, 32, 0),
            DisplayMode(640, 480, 24, 0),
            DisplayMode(640, 480, 16, 0)

            static final long DEMO_TIME = 50000;
            ScreenManager screen;
            Image bgImage;
            Animation anim;

            oid loadImages() {
            oad images
            age = loadImage("images/background.jpg");
            = player1 = loadImage("images/player1.png");
```


ScreenManager - Mozilla Firefox
File
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file:///C:/yunglu/ece462/JavaGame/ch02src/doc/ScreenManager.html
Google
Package
Class
Use
Tree
Deprecated
Index
Help
PREV CLASS
NEXT CLASS
FRAMES
NO FRAMES
All Classes
SUMMARY: NESTED | FIELD | CONSTR | METHOD
DETAIL: FIELD | CONSTR | METHOD
Done

Class ScreenManager

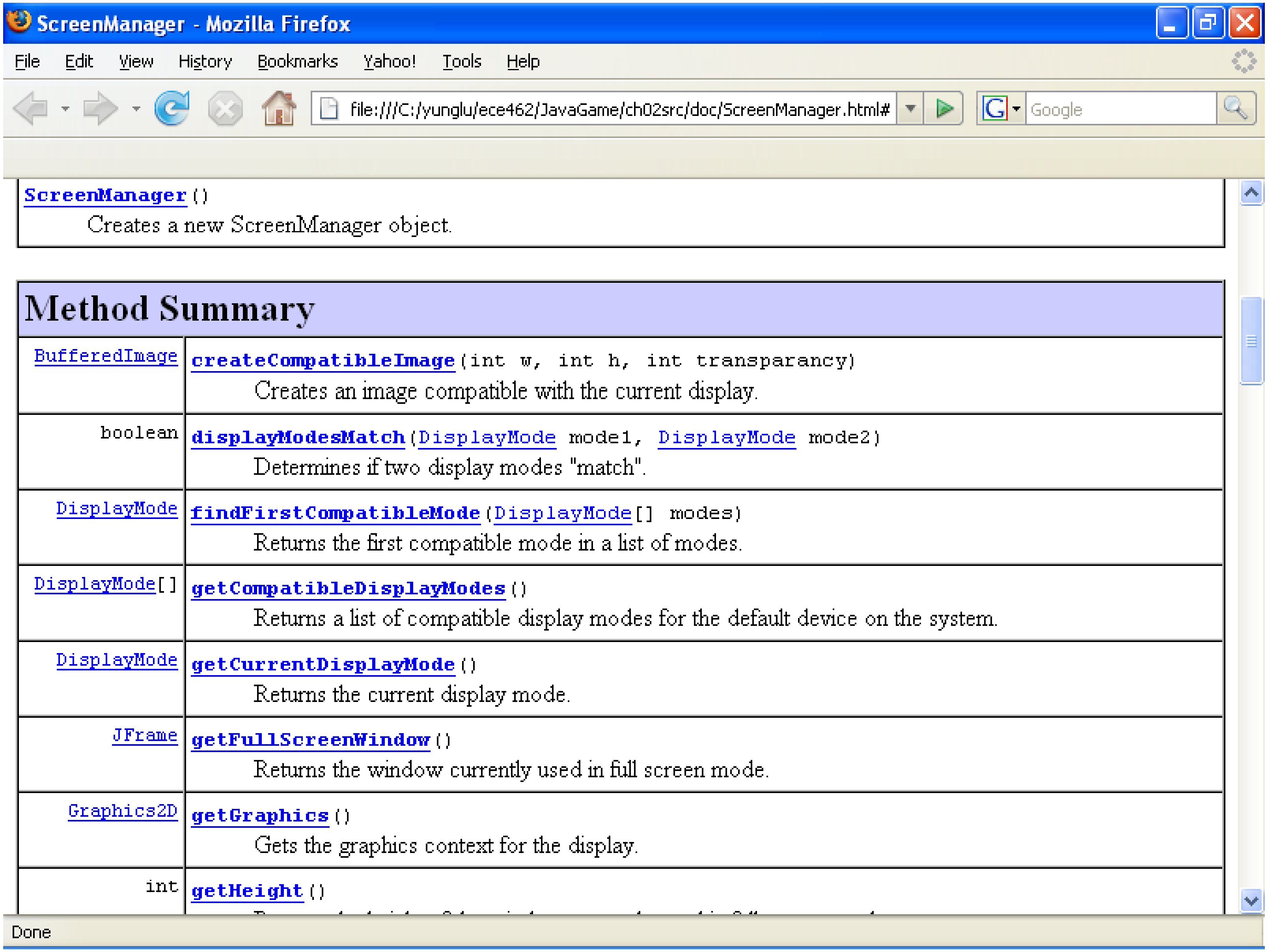
```
java.lang.Object
  └ ScreenManager
```

```
public class ScreenManager
extends Object
```

The ScreenManager class manages initializing and displaying full screen graphics modes.

Field Summary	
private GraphicsDevice	**device**

Constructor Summary
ScreenManager()


ScreenManager - Mozilla Firefox
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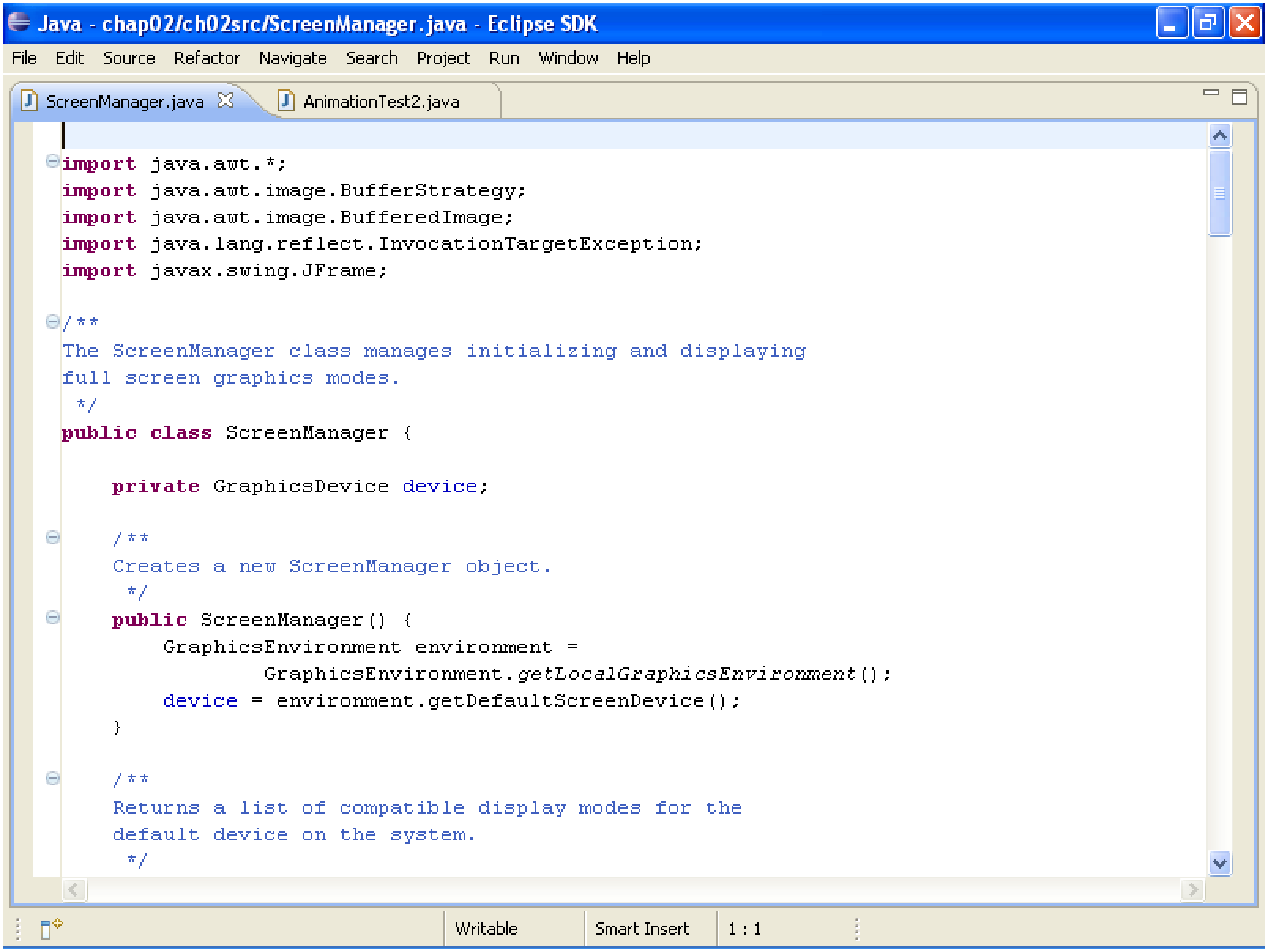
Help
file:///C:/yunglu/ece462/JavaGame/ch02src/doc/ScreenManager.html#
Google
Done

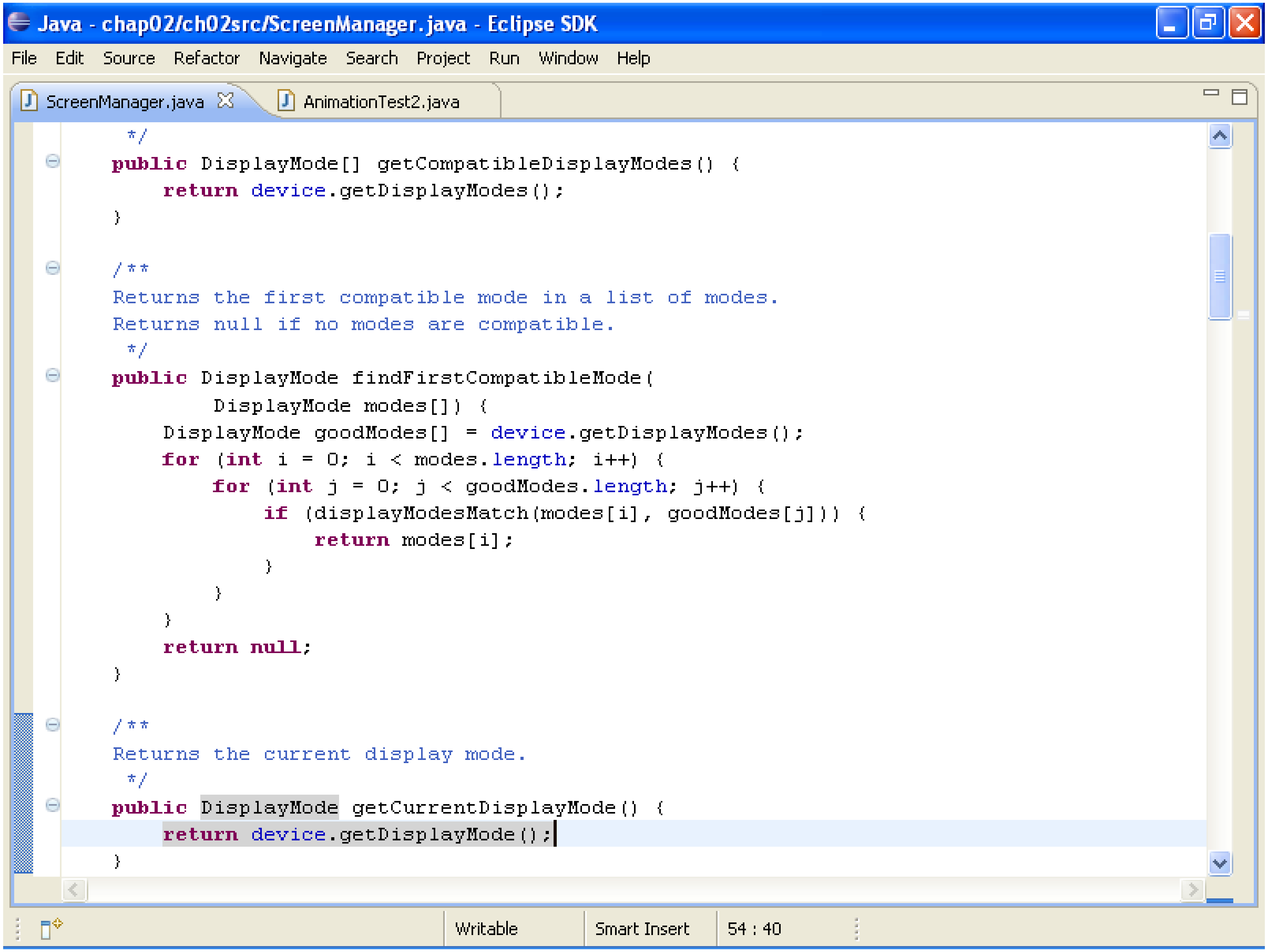
ScreenManager()
Creates a new ScreenManager object.

Method Summary

BufferedImage	**createCompatibleImage**(int w, int h, int transparancy) Creates an image compatible with the current display.
boolean	**displayModesMatch**(DisplayMode mode1, DisplayMode mode2) Determines if two display modes "match".
DisplayMode	**findFirstCompatibleMode**(DisplayMode[] modes) Returns the first compatible mode in a list of modes.
DisplayMode[]	**getCompatibleDisplayModes**() Returns a list of compatible display modes for the default device on the system.
DisplayMode	**getCurrentDisplayMode**() Returns the current display mode.
JFrame	**getFullScreenWindow**() Returns the window currently used in full screen mode.
Graphics2D	**getGraphics**() Gets the graphics context for the display.
int	**getHeight**()


Java - chap02/ch02src/ScreenManager.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
ScreenManager.java
AnimationTest2.java
Writable
Smart Insert
1 : 1

```java

import java.awt.*;
import java.awt.image.BufferStrategy;
import java.awt.image.BufferedImage;
import java.lang.reflect.InvocationTargetException;
import javax.swing.JFrame;

/**
The ScreenManager class manages initializing and displaying
full screen graphics modes.
 */
public class ScreenManager {

    private GraphicsDevice device;

    /**
    Creates a new ScreenManager object.
     */
    public ScreenManager() {
        GraphicsEnvironment environment =
                GraphicsEnvironment.getLocalGraphicsEnvironment();
        device = environment.getDefaultScreenDevice();
    }

    /**
    Returns a list of compatible display modes for the
    default device on the system.
     */
```



Java - chap02/ch02src/ScreenManager.java - Eclipse SDK
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ScreenManager.java
AnimationTest2.java
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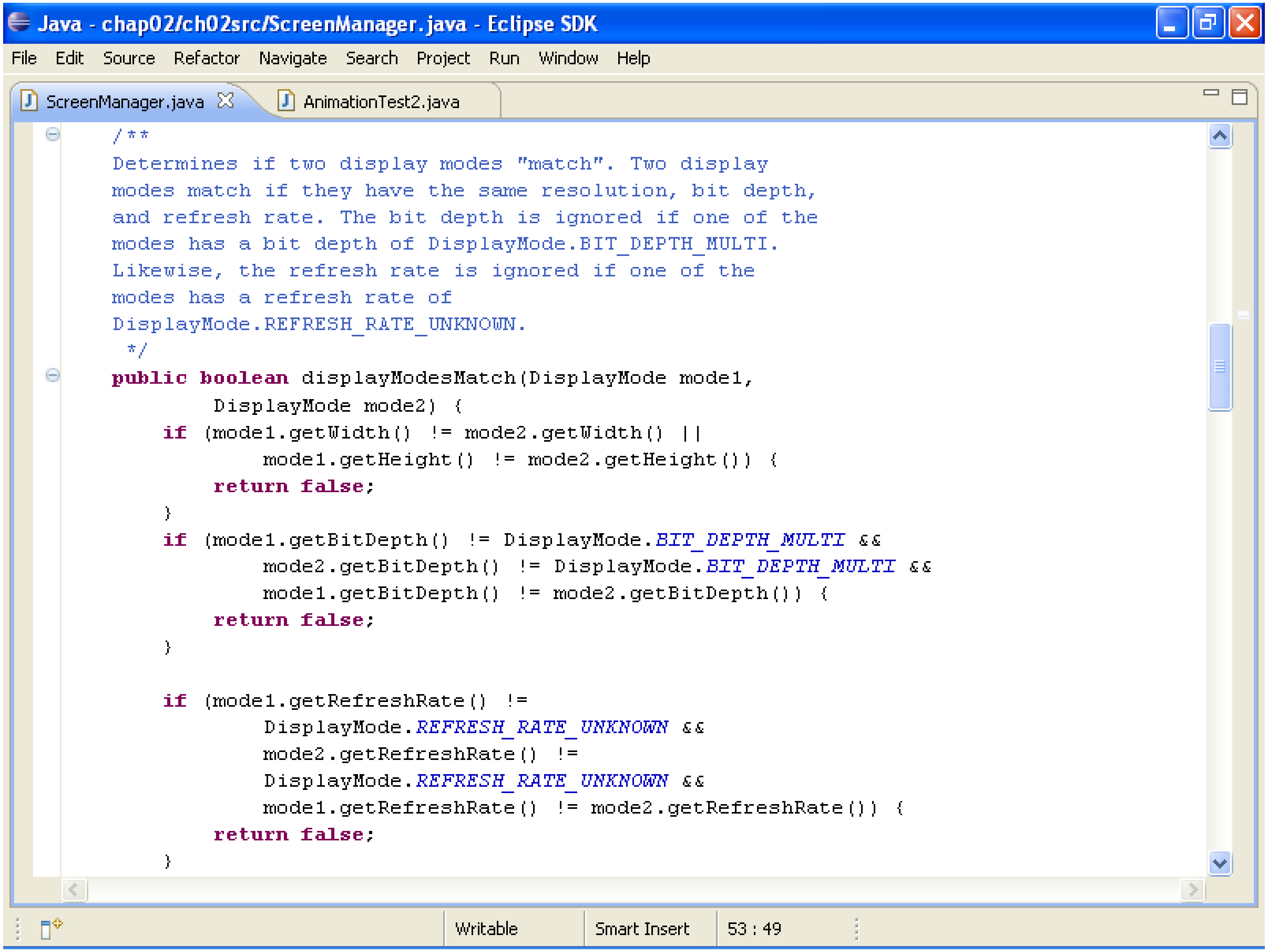
```
     */
    public DisplayMode[] getCompatibleDisplayModes() {
        return device.getDisplayModes();
    }

    /**
    Returns the first compatible mode in a list of modes.
    Returns null if no modes are compatible.
     */
    public DisplayMode findFirstCompatibleMode(
            DisplayMode modes[]) {
        DisplayMode goodModes[] = device.getDisplayModes();
        for (int i = 0; i < modes.length; i++) {
            for (int j = 0; j < goodModes.length; j++) {
                if (displayModesMatch(modes[i], goodModes[j])) {
                    return modes[i];
                }
            }
        }
        return null;
    }

    /**
    Returns the current display mode.
     */
    public DisplayMode getCurrentDisplayMode() {
        return device.getDisplayMode();
    }
```


Java - chap02/ch02src/ScreenManager.java - Eclipse SDK
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ScreenManager.java
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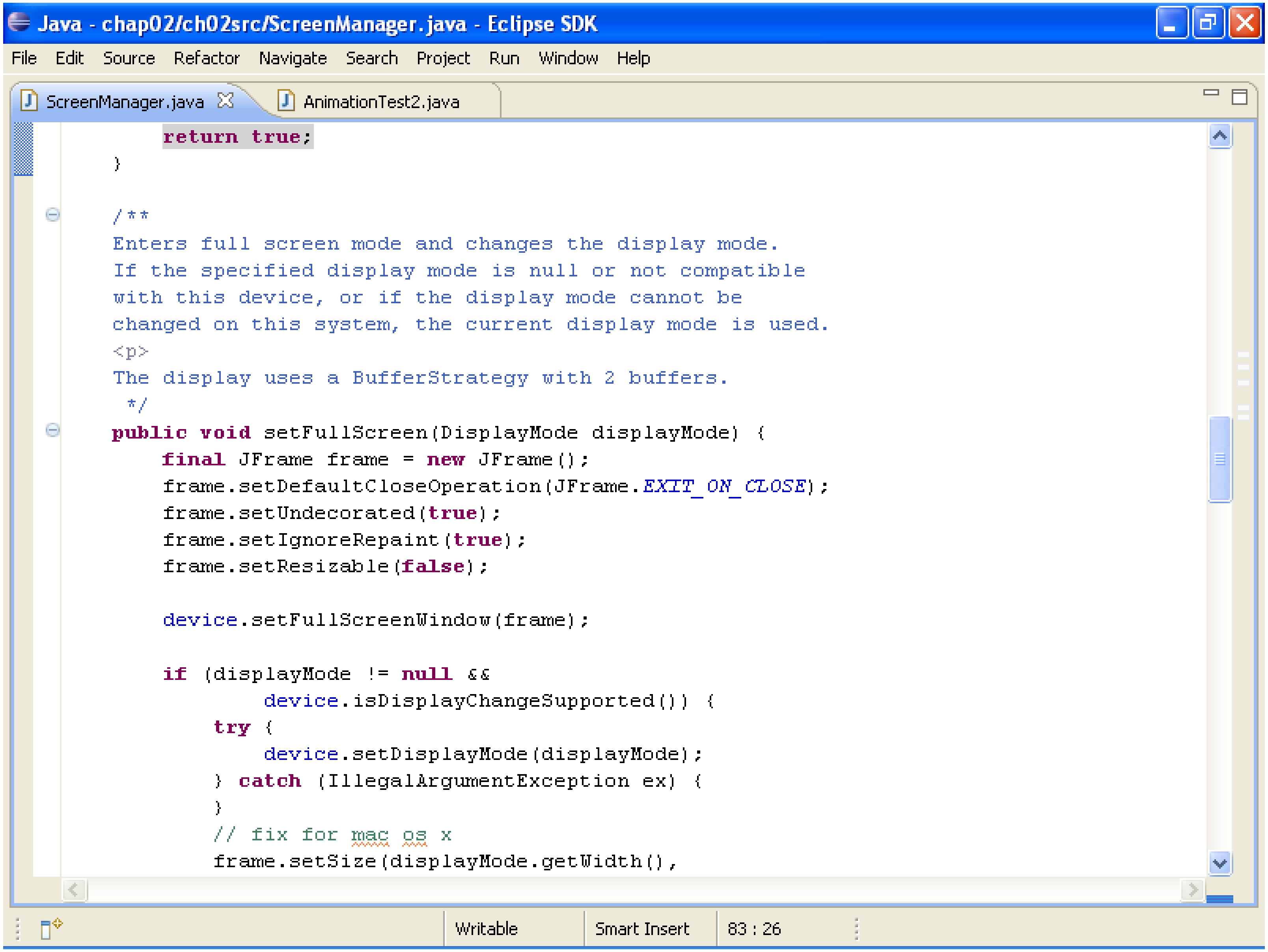
```
    /**
    Determines if two display modes "match". Two display
    modes match if they have the same resolution, bit depth,
    and refresh rate. The bit depth is ignored if one of the
    modes has a bit depth of DisplayMode.BIT_DEPTH_MULTI.
    Likewise, the refresh rate is ignored if one of the
    modes has a refresh rate of
    DisplayMode.REFRESH_RATE_UNKNOWN.
     */
    public boolean displayModesMatch(DisplayMode mode1,
            DisplayMode mode2) {
        if (mode1.getWidth() != mode2.getWidth() ||
                mode1.getHeight() != mode2.getHeight()) {
            return false;
        }
        if (mode1.getBitDepth() != DisplayMode.BIT_DEPTH_MULTI &&
                mode2.getBitDepth() != DisplayMode.BIT_DEPTH_MULTI &&
                mode1.getBitDepth() != mode2.getBitDepth()) {
            return false;
        }

        if (mode1.getRefreshRate() !=
                DisplayMode.REFRESH_RATE_UNKNOWN &&
                mode2.getRefreshRate() !=
                DisplayMode.REFRESH_RATE_UNKNOWN &&
                mode1.getRefreshRate() != mode2.getRefreshRate()) {
            return false;
        }
```



Java - chap02/ch02src/ScreenManager.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
ScreenManager.java
AnimationTest2.java
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Smart Insert
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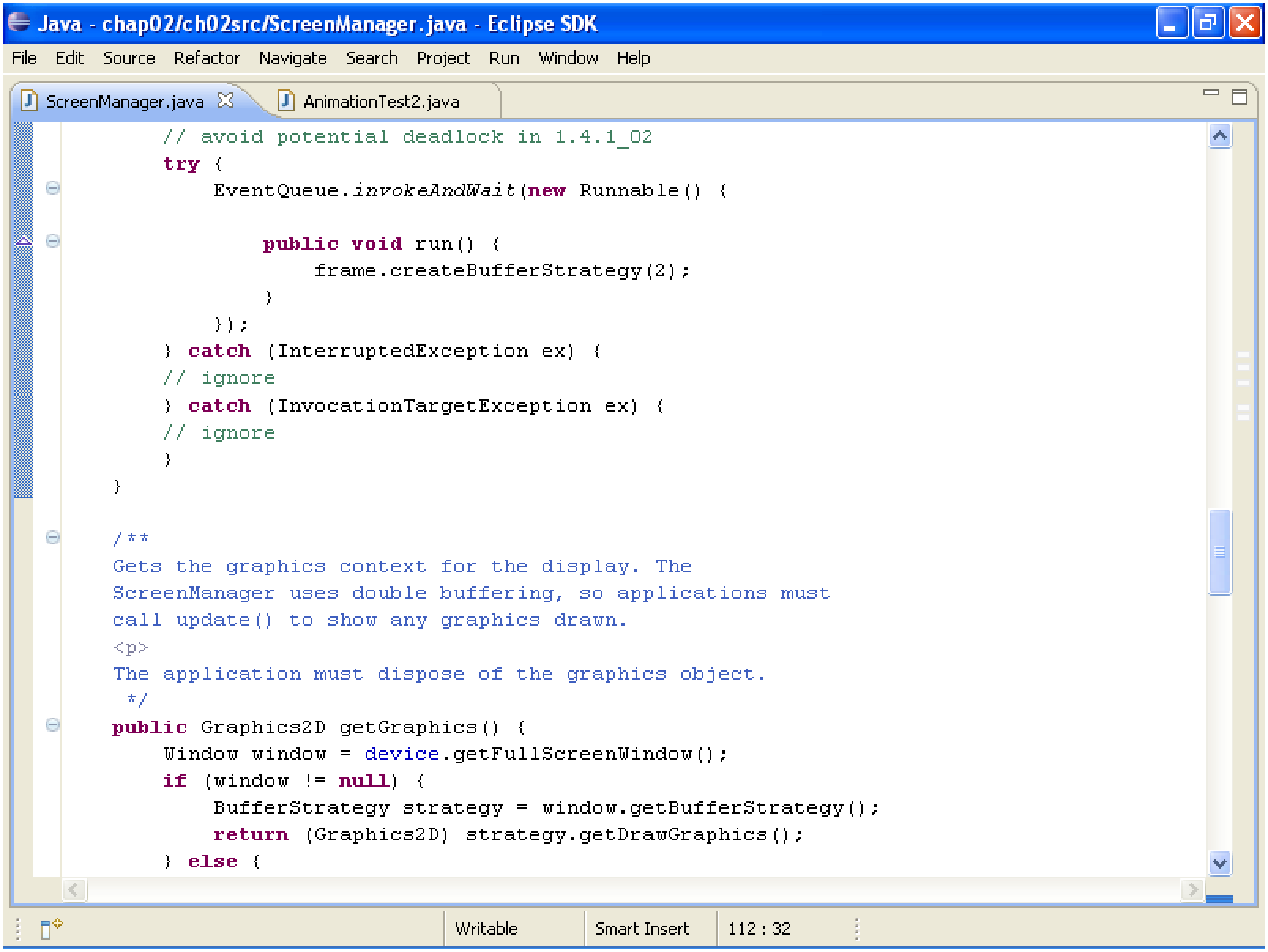
```
        return true;
    }

    /**
    Enters full screen mode and changes the display mode.
    If the specified display mode is null or not compatible
    with this device, or if the display mode cannot be
    changed on this system, the current display mode is used.
    <p>
    The display uses a BufferStrategy with 2 buffers.
     */
    public void setFullScreen(DisplayMode displayMode) {
        final JFrame frame = new JFrame();
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setUndecorated(true);
        frame.setIgnoreRepaint(true);
        frame.setResizable(false);

        device.setFullScreenWindow(frame);

        if (displayMode != null &&
                device.isDisplayChangeSupported()) {
            try {
                device.setDisplayMode(displayMode);
            } catch (IllegalArgumentException ex) {
            }
            // fix for mac os x
            frame.setSize(displayMode.getWidth(),
```


Java - chap02/ch02src/ScreenManager.java - Eclipse SDK
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ScreenManager.java
AnimationTest2.java
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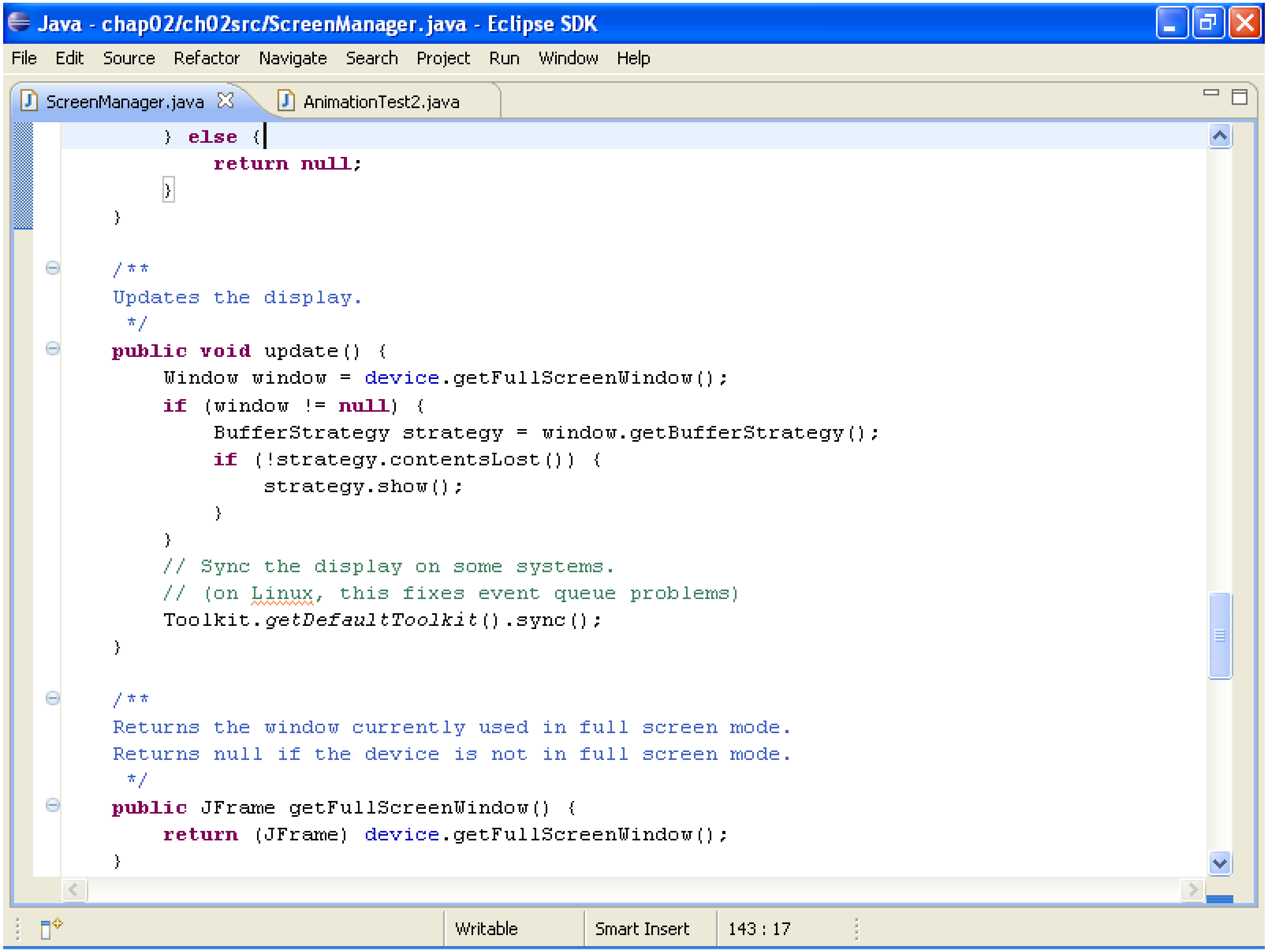
112 : 32

```
    // avoid potential deadlock in 1.4.1_02
    try {
        EventQueue.invokeAndWait(new Runnable() {

            public void run() {
                frame.createBufferStrategy(2);
            }
        });
    } catch (InterruptedException ex) {
    // ignore
    } catch (InvocationTargetException ex) {
    // ignore
    }
}

/**
Gets the graphics context for the display. The
ScreenManager uses double buffering, so applications must
call update() to show any graphics drawn.
<p>
The application must dispose of the graphics object.
 */
public Graphics2D getGraphics() {
    Window window = device.getFullScreenWindow();
    if (window != null) {
        BufferStrategy strategy = window.getBufferStrategy();
        return (Graphics2D) strategy.getDrawGraphics();
    } else {
```


Java - chap02/ch02src/ScreenManager.java - Eclipse SDK
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ScreenManager.java
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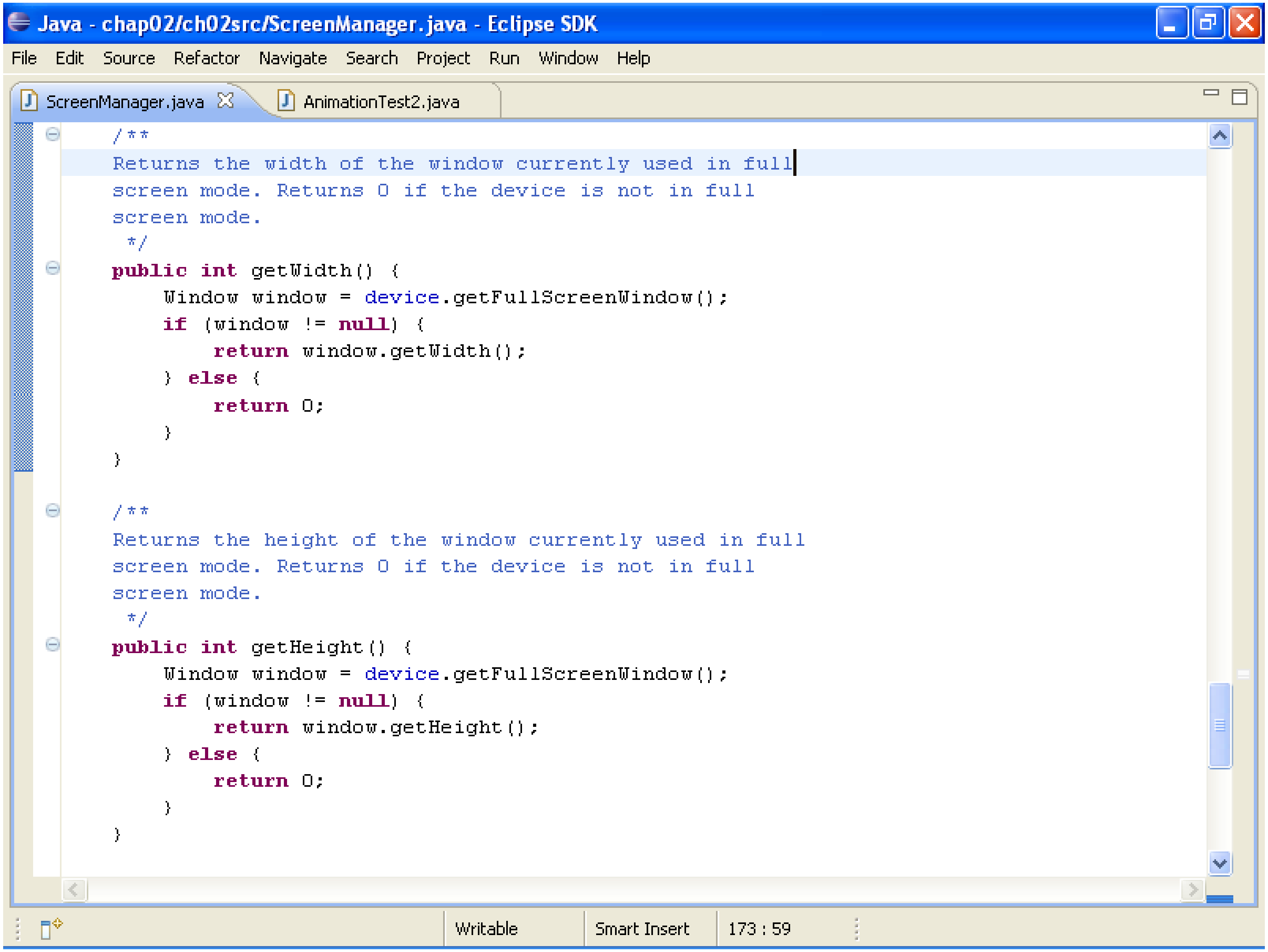
143 : 17

```java
        } else {
            return null;
        }
    }

    /**
    Updates the display.
     */
    public void update() {
        Window window = device.getFullScreenWindow();
        if (window != null) {
            BufferStrategy strategy = window.getBufferStrategy();
            if (!strategy.contentsLost()) {
                strategy.show();
            }
        }
        // Sync the display on some systems.
        // (on Linux, this fixes event queue problems)
        Toolkit.getDefaultToolkit().sync();
    }

    /**
    Returns the window currently used in full screen mode.
    Returns null if the device is not in full screen mode.
     */
    public JFrame getFullScreenWindow() {
        return (JFrame) device.getFullScreenWindow();
    }
```


Java - chap02/ch02src/ScreenManager.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
ScreenManager.java
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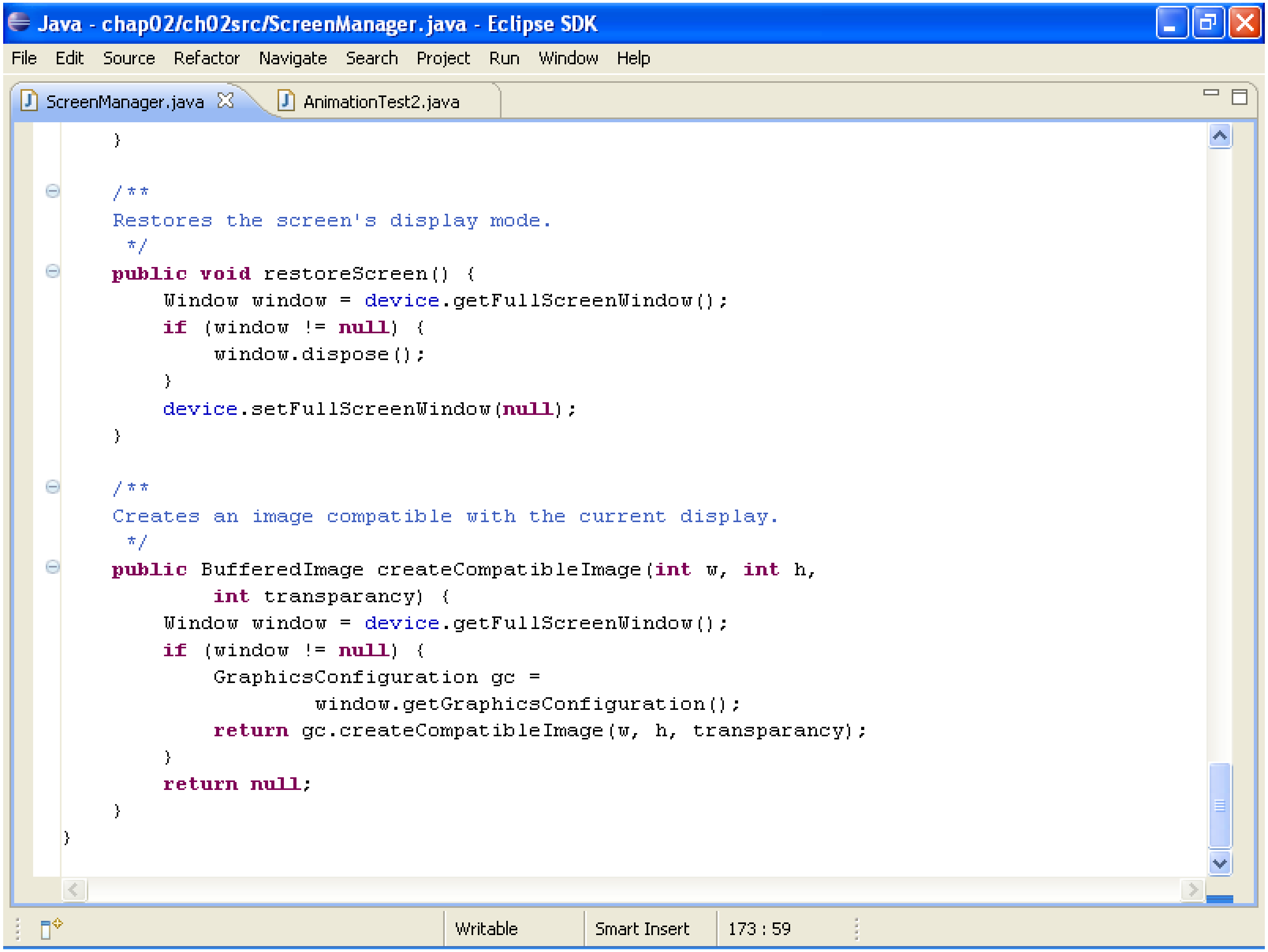
```
/**
Returns the width of the window currently used in full
screen mode. Returns 0 if the device is not in full
screen mode.
 */
public int getWidth() {
    Window window = device.getFullScreenWindow();
    if (window != null) {
        return window.getWidth();
    } else {
        return 0;
    }
}

/**
Returns the height of the window currently used in full
screen mode. Returns 0 if the device is not in full
screen mode.
 */
public int getHeight() {
    Window window = device.getFullScreenWindow();
    if (window != null) {
        return window.getHeight();
    } else {
        return 0;
    }
}
```



Java - chap02/ch02src/ScreenManager.java - Eclipse SDK
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ScreenManager.java
AnimationTest2.java
Writable
Smart Insert
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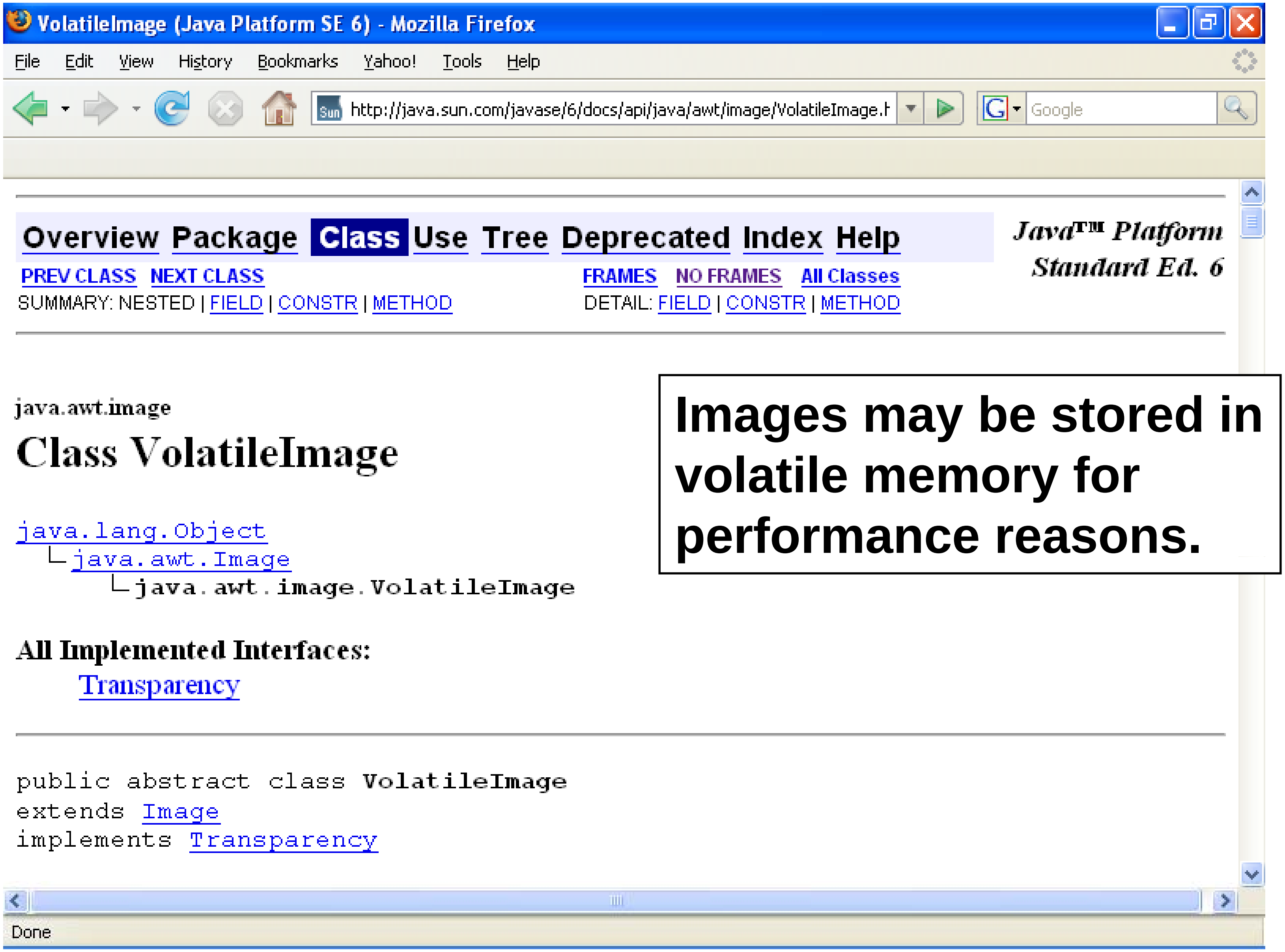
```
    }

    /**
    Restores the screen's display mode.
     */
    public void restoreScreen() {
        Window window = device.getFullScreenWindow();
        if (window != null) {
            window.dispose();
        }
        device.setFullScreenWindow(null);
    }

    /**
    Creates an image compatible with the current display.
     */
    public BufferedImage createCompatibleImage(int w, int h,
            int transparancy) {
        Window window = device.getFullScreenWindow();
        if (window != null) {
            GraphicsConfiguration gc =
                    window.getGraphicsConfiguration();
            return gc.createCompatibleImage(w, h, transparancy);
        }
        return null;
    }
}
```


VolatileImage (Java Platform SE 6) - Mozilla Firefox
File Edit View History Bookmarks Yahoo! Tools Help
http://java.sun.com/javase/6/docs/api/java/awt/image/VolatileImage.h
Google
Overview Package Class Use Tree Deprecated Index Help
PREV CLASS NEXT CLASS
FRAMES NO FRAMES All Classes
SUMMARY: NESTED | FIELD | CONSTR | METHOD
DETAIL: FIELD | CONSTR | METHOD
Done

Java™ Platform Standard Ed. 6

java.awt.image

Class VolatileImage

```
java.lang.Object
  └java.awt.Image
      └java.awt.image.VolatileImage
```

All Implemented Interfaces:

Transparency

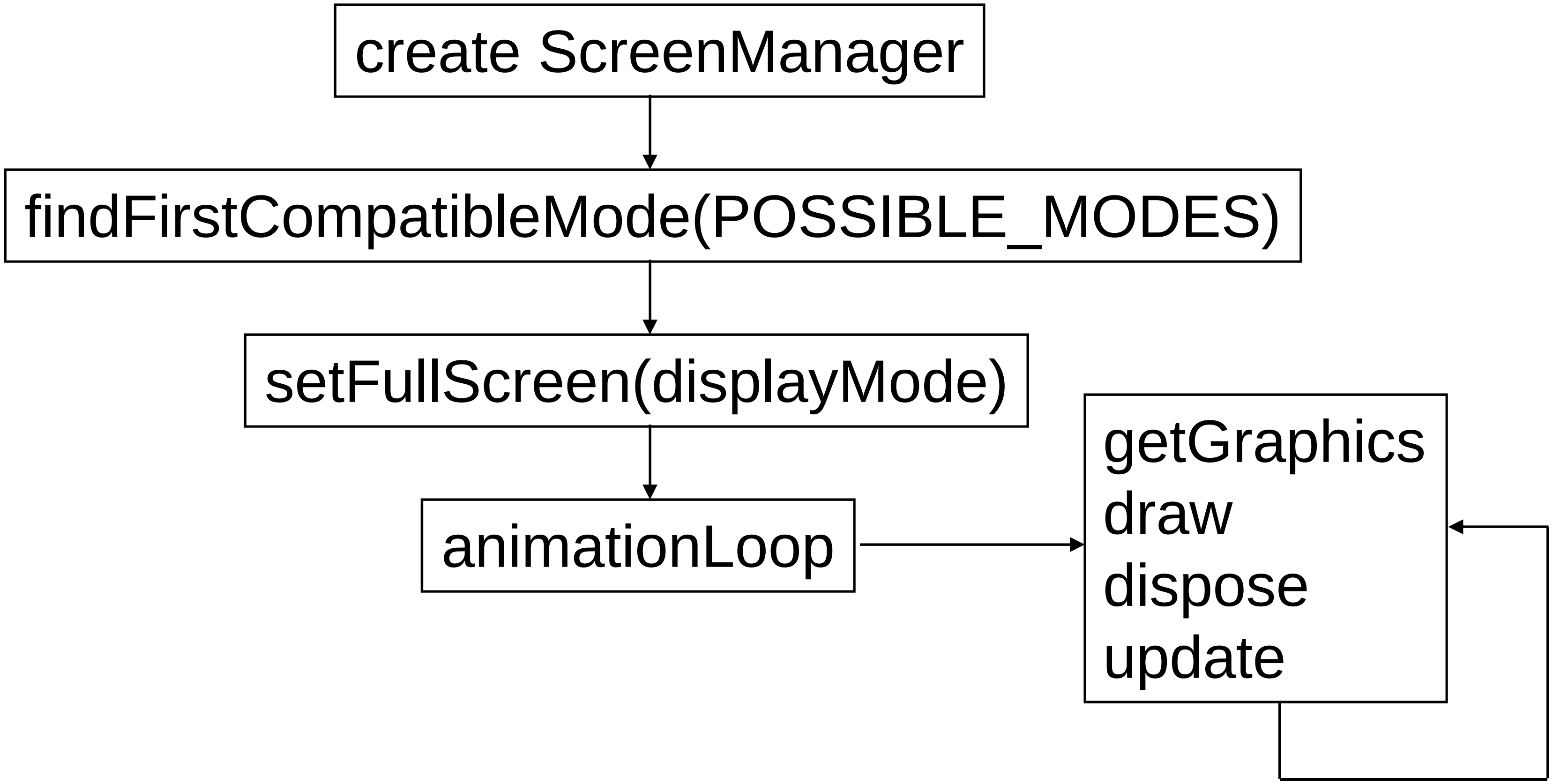
```
public abstract class VolatileImage
extends Image
implements Transparency
```

Images may be stored in volatile memory for performance reasons.

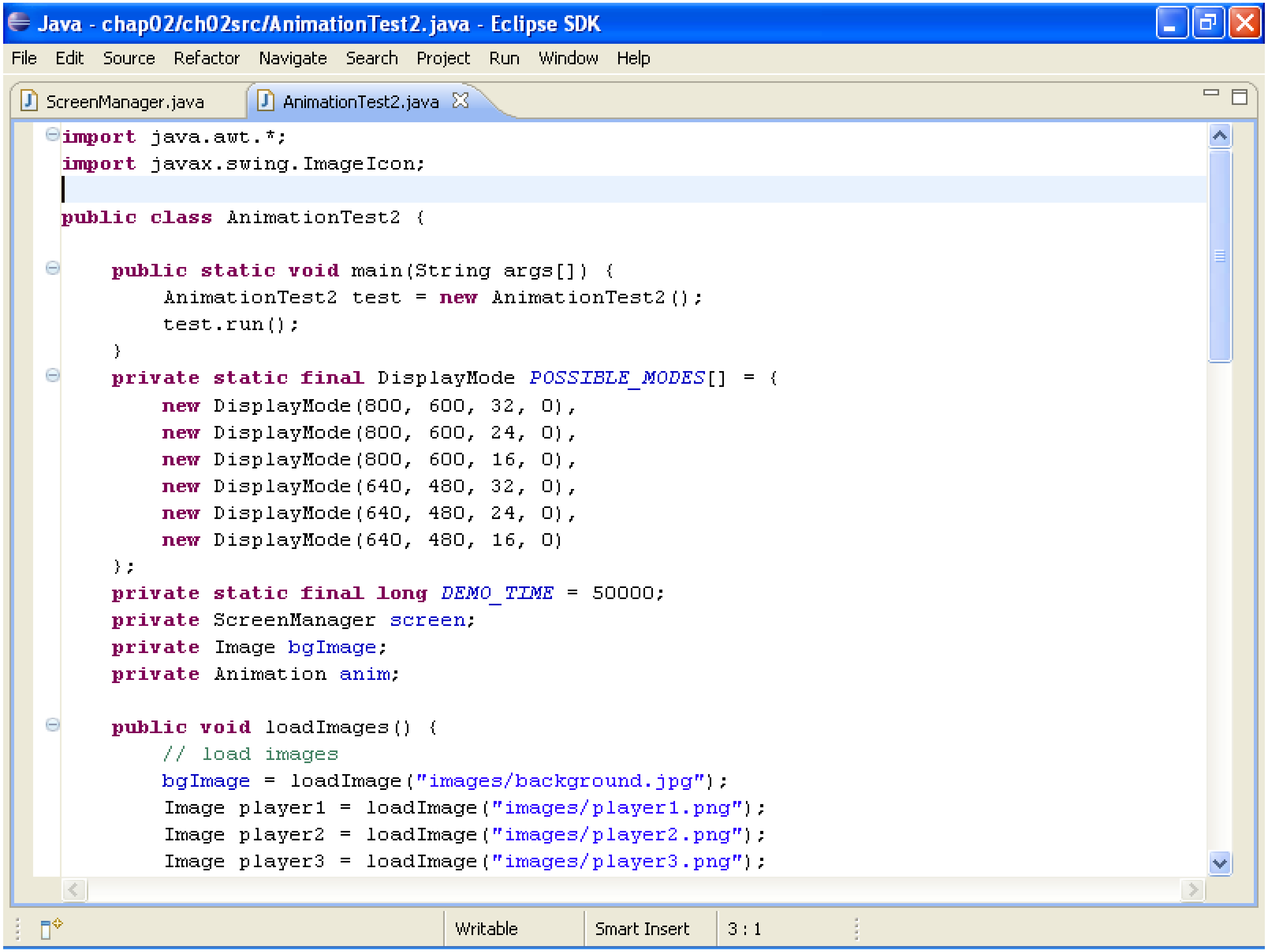
AnimationTest2
Using ScreenManager

Using ScreenManager

POSSIBLE_MODES: an array of different DisplayMode



create ScreenManager
findFirstCompatibleMode(POSSIBLE_MODES)
setFullScreen(displayMode)
animationLoop
getGraphics
draw
dispose
update


Java - chap02/ch02src/AnimationTest2.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
ScreenManager.java
AnimationTest2.java
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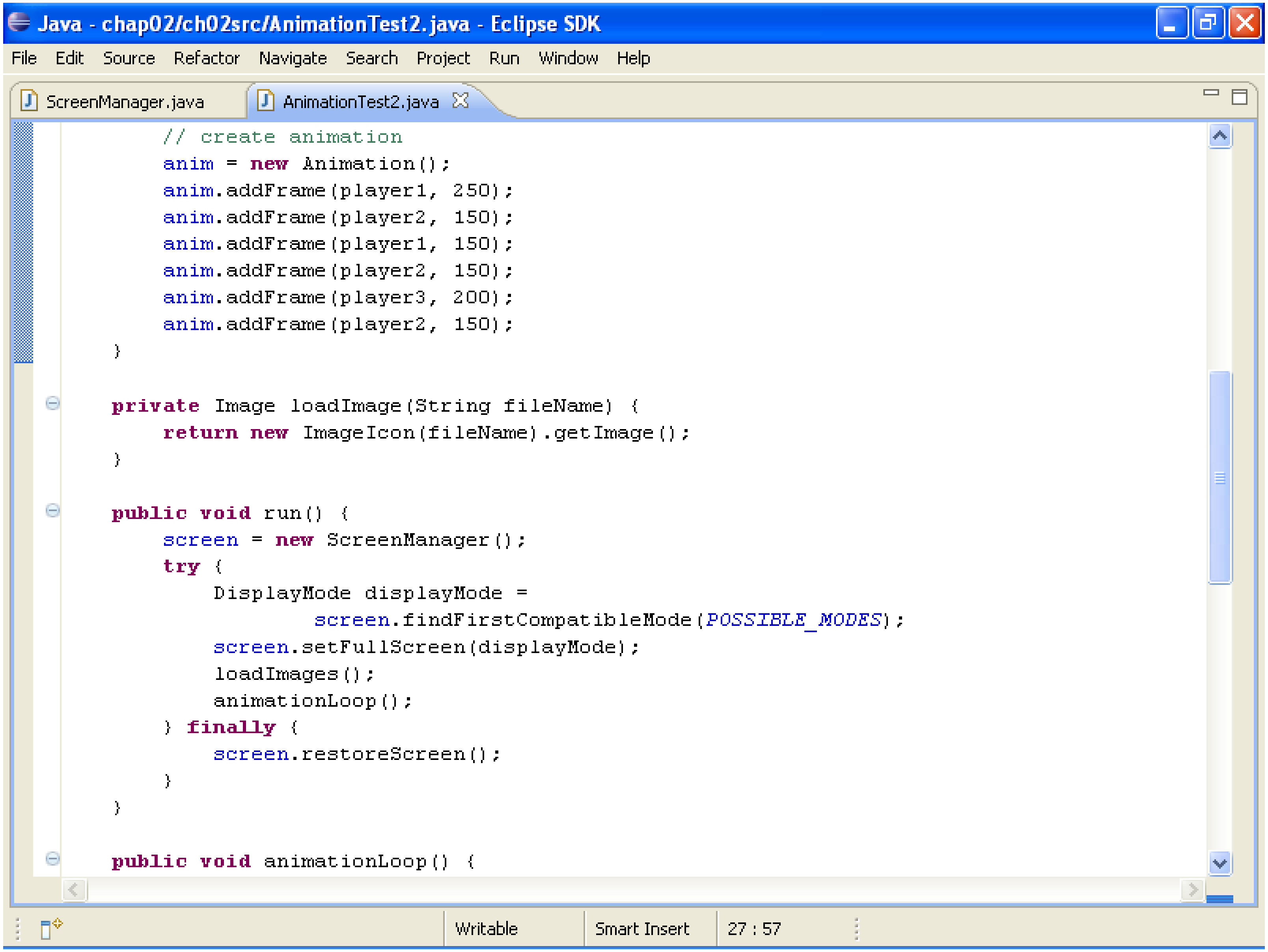
```java
import java.awt.*;
import javax.swing.ImageIcon;

public class AnimationTest2 {

    public static void main(String args[]) {
        AnimationTest2 test = new AnimationTest2();
        test.run();
    }
    private static final DisplayMode POSSIBLE_MODES[] = {
        new DisplayMode(800, 600, 32, 0),
        new DisplayMode(800, 600, 24, 0),
        new DisplayMode(800, 600, 16, 0),
        new DisplayMode(640, 480, 32, 0),
        new DisplayMode(640, 480, 24, 0),
        new DisplayMode(640, 480, 16, 0)
    };
    private static final long DEMO_TIME = 50000;
    private ScreenManager screen;
    private Image bgImage;
    private Animation anim;

    public void loadImages() {
        // load images
        bgImage = loadImage("images/background.jpg");
        Image player1 = loadImage("images/player1.png");
        Image player2 = loadImage("images/player2.png");
        Image player3 = loadImage("images/player3.png");
```


Java - chap02/ch02src/AnimationTest2.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
ScreenManager.java
AnimationTest2.java
Writable
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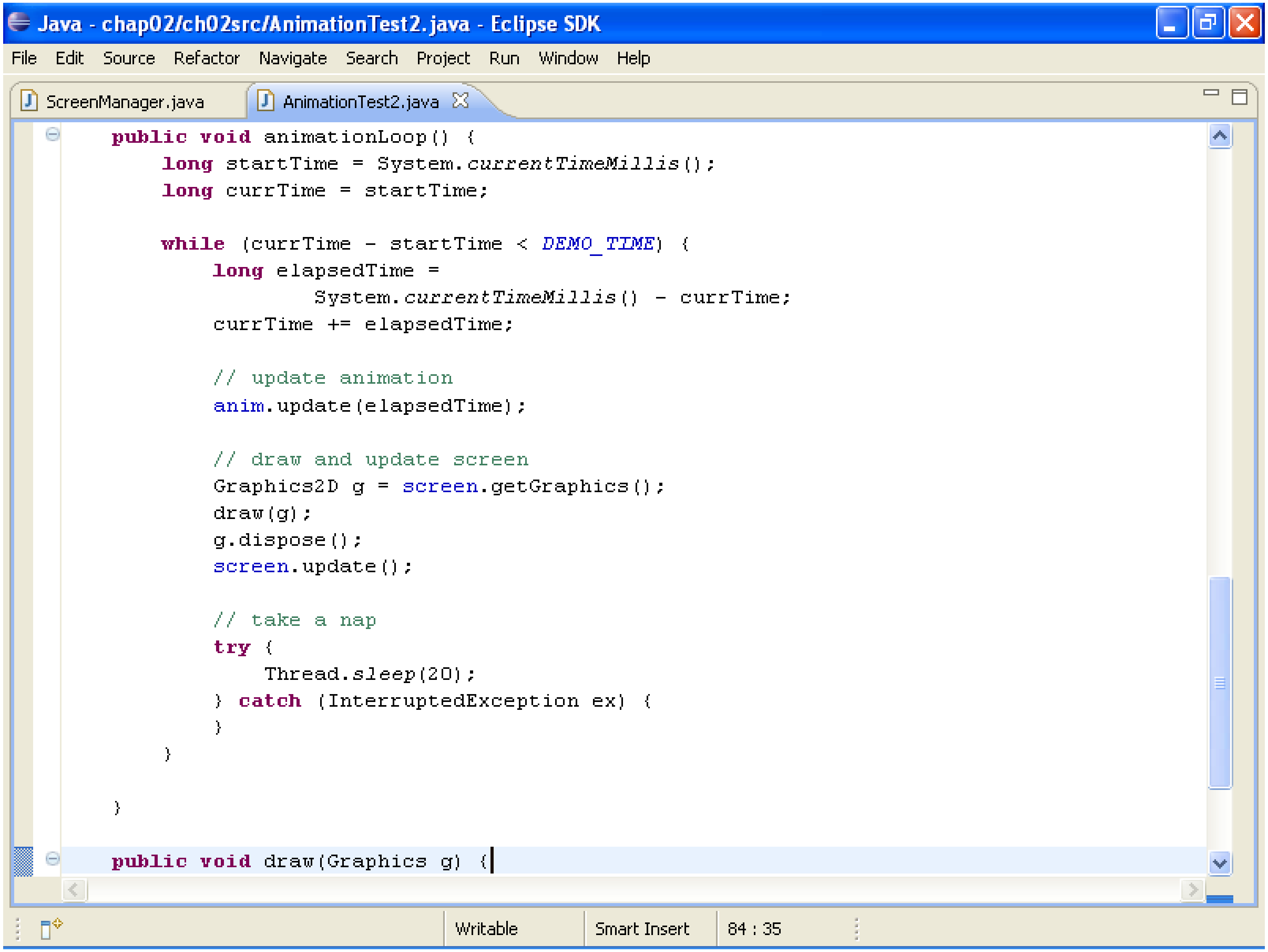
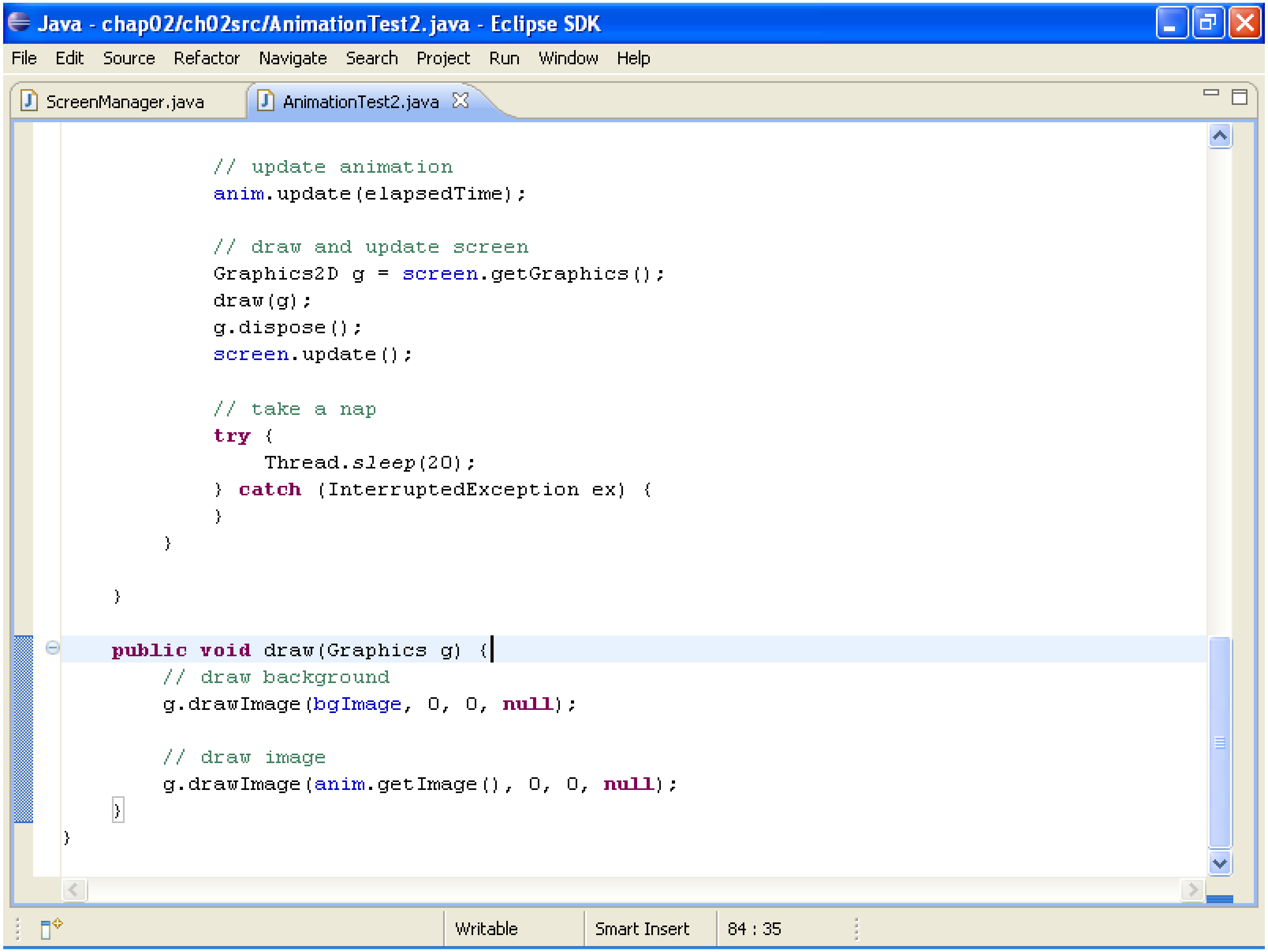
```
        // create animation
        anim = new Animation();
        anim.addFrame(player1, 250);
        anim.addFrame(player2, 150);
        anim.addFrame(player1, 150);
        anim.addFrame(player2, 150);
        anim.addFrame(player3, 200);
        anim.addFrame(player2, 150);
    }

    private Image loadImage(String fileName) {
        return new ImageIcon(fileName).getImage();
    }

    public void run() {
        screen = new ScreenManager();
        try {
            DisplayMode displayMode =
                    screen.findFirstCompatibleMode(POSSIBLE_MODES);
            screen.setFullScreen(displayMode);
            loadImages();
            animationLoop();
        } finally {
            screen.restoreScreen();
        }
    }

    public void animationLoop() {
```


Java - chap02/ch02src/AnimationTest2.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
ScreenManager.java
AnimationTest2.java

```
    public void animationLoop() {
        long startTime = System.currentTimeMillis();
        long currTime = startTime;

        while (currTime - startTime < DEMO_TIME) {
            long elapsedTime =
                    System.currentTimeMillis() - currTime;
            currTime += elapsedTime;

            // update animation
            anim.update(elapsedTime);

            // draw and update screen
            Graphics2D g = screen.getGraphics();
            draw(g);
            g.dispose();
            screen.update();

            // take a nap
            try {
                Thread.sleep(20);
            } catch (InterruptedException ex) {
            }
        }

    }

    public void draw(Graphics g) {
```



```
            // update animation
            anim.update(elapsedTime);

            // draw and update screen
            Graphics2D g = screen.getGraphics();
            draw(g);
            g.dispose();
            screen.update();

            // take a nap
            try {
                Thread.sleep(20);
            } catch (InterruptedException ex) {
            }
        }

    }

    public void draw(Graphics g) {
        // draw background
        g.drawImage(bgImage, 0, 0, null);

        // draw image
        g.drawImage(anim.getImage(), 0, 0, null);
    }
}
```

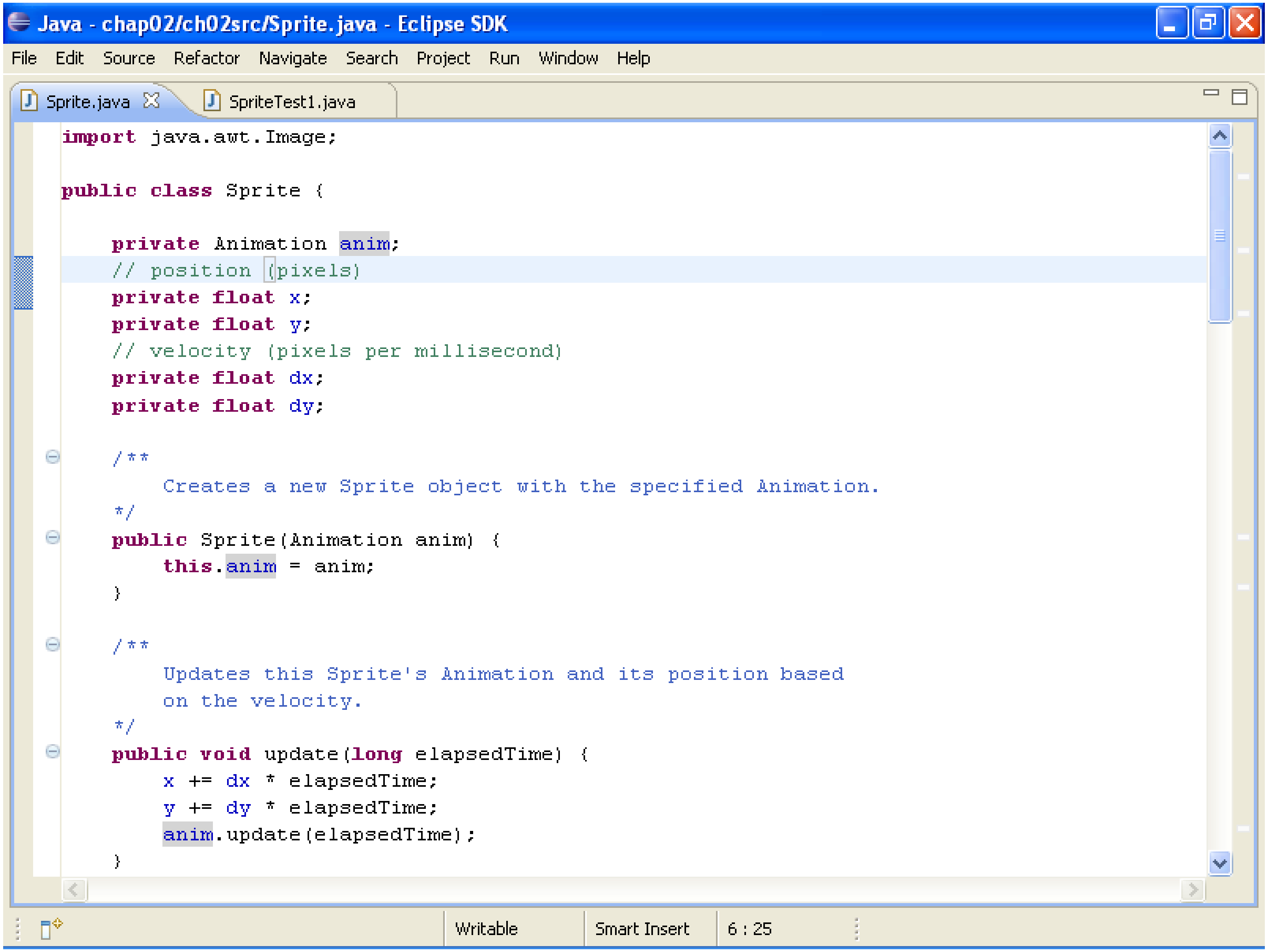
ECE 462
Object-Oriented Programming using C++ and Java

Moving Image: Sprite

Yung-Hsiang Lu

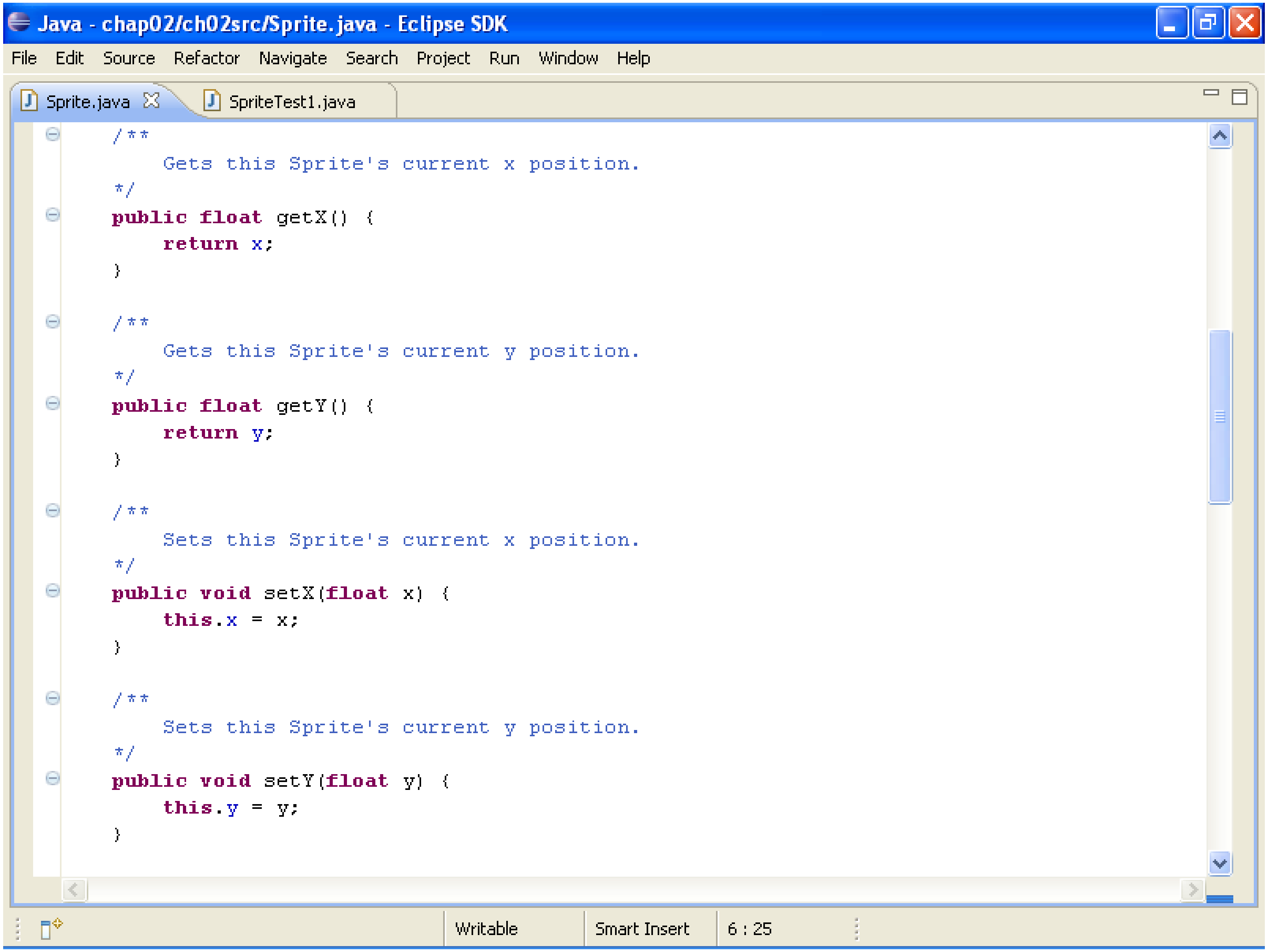
yunglu@purdue.edu

Sprite

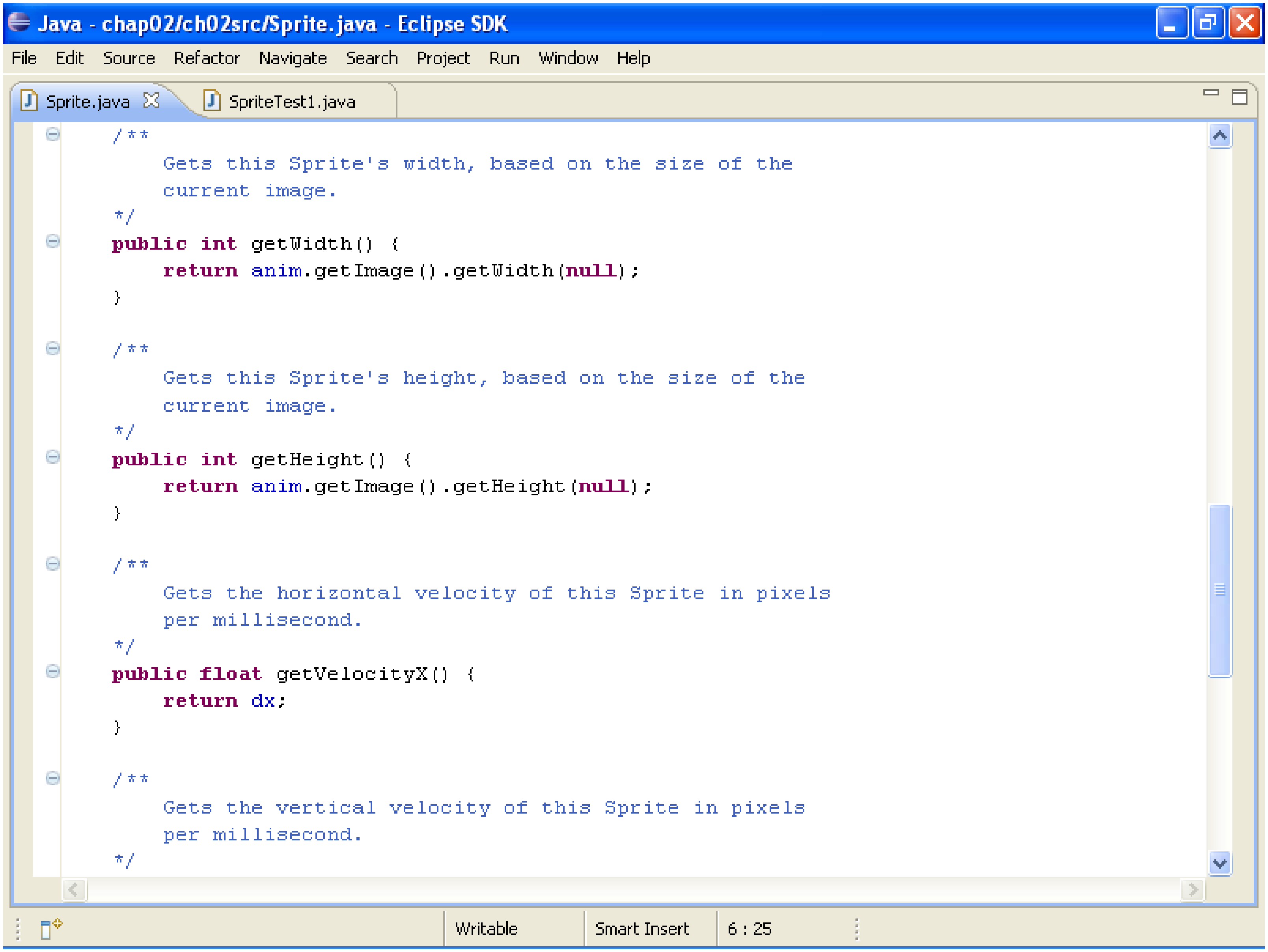


Java - chap02/ch02src/Sprite.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
Sprite.java
SpriteTest1.java
Writable
Smart Insert
6 : 25

```java
import java.awt.Image;

public class Sprite {

    private Animation anim;
    // position (pixels)
    private float x;
    private float y;
    // velocity (pixels per millisecond)
    private float dx;
    private float dy;

    /**
        Creates a new Sprite object with the specified Animation.
    */
    public Sprite(Animation anim) {
        this.anim = anim;
    }

    /**
        Updates this Sprite's Animation and its position based
        on the velocity.
    */
    public void update(long elapsedTime) {
        x += dx * elapsedTime;
        y += dy * elapsedTime;
        anim.update(elapsedTime);
    }
```

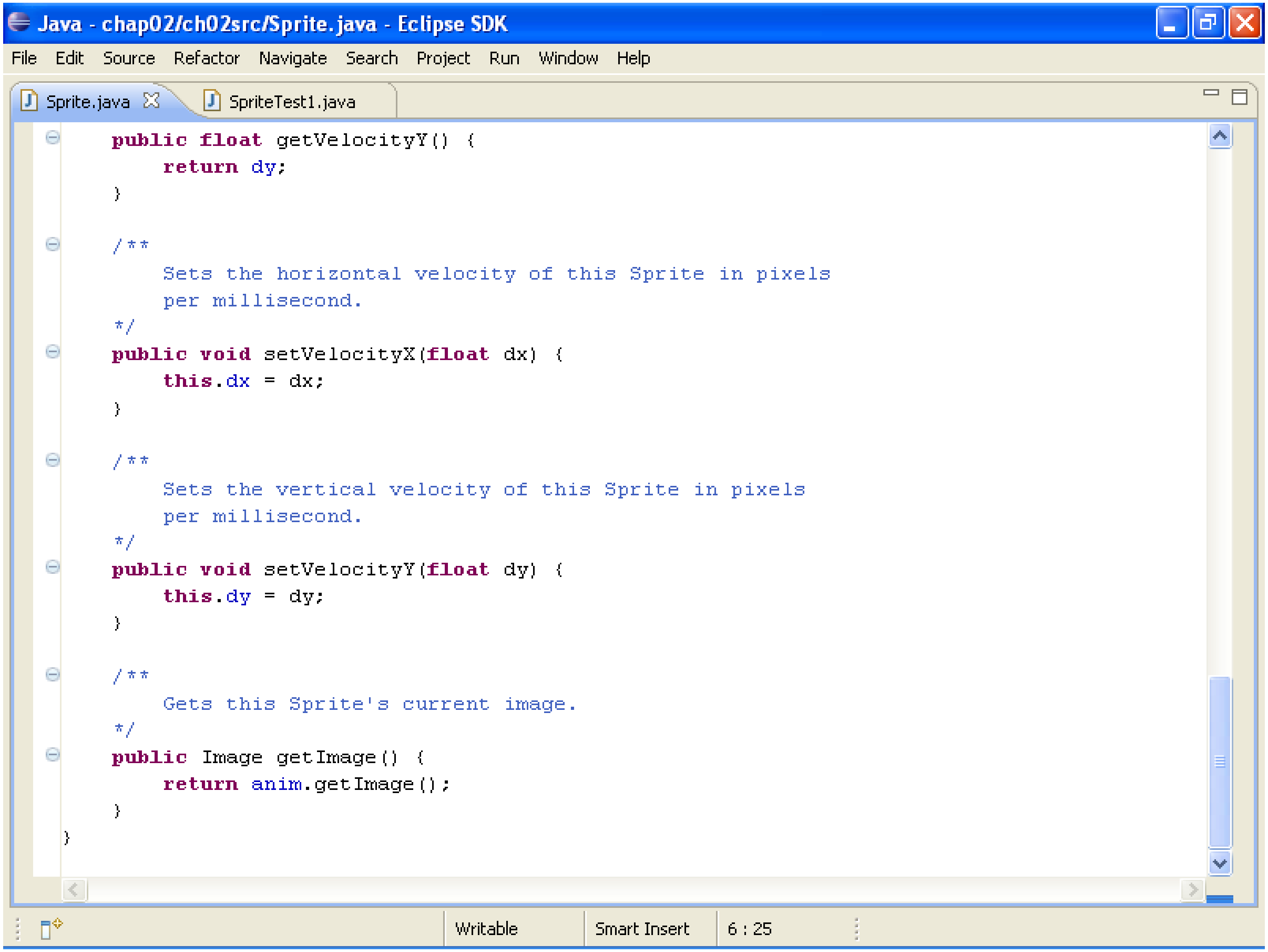

Java - chap02/ch02src/Sprite.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
Sprite.java
SpriteTest1.java
Writable
Smart Insert
6 : 25

```
    /**
        Gets this Sprite's current x position.
    */
    public float getX() {
        return x;
    }

    /**
        Gets this Sprite's current y position.
    */
    public float getY() {
        return y;
    }

    /**
        Sets this Sprite's current x position.
    */
    public void setX(float x) {
        this.x = x;
    }

    /**
        Sets this Sprite's current y position.
    */
    public void setY(float y) {
        this.y = y;
    }
```



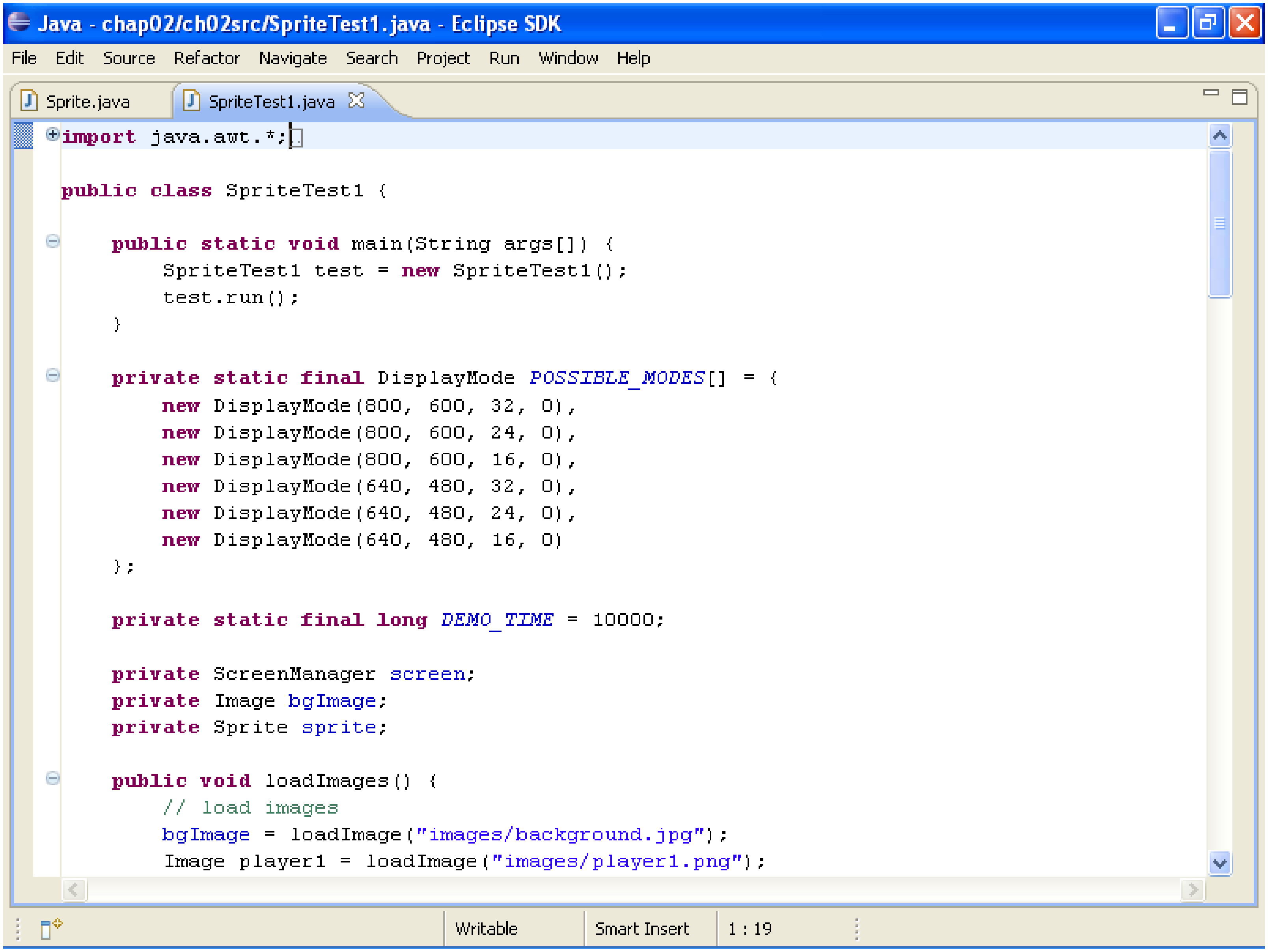
Java - chap02/ch02src/Sprite.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
Sprite.java
SpriteTest1.java
Writable
Smart Insert
6 : 25

```
    /**
        Gets this Sprite's width, based on the size of the
        current image.
    */
    public int getWidth() {
        return anim.getImage().getWidth(null);
    }

    /**
        Gets this Sprite's height, based on the size of the
        current image.
    */
    public int getHeight() {
        return anim.getImage().getHeight(null);
    }

    /**
        Gets the horizontal velocity of this Sprite in pixels
        per millisecond.
    */
    public float getVelocityX() {
        return dx;
    }

    /**
        Gets the vertical velocity of this Sprite in pixels
        per millisecond.
    */
```

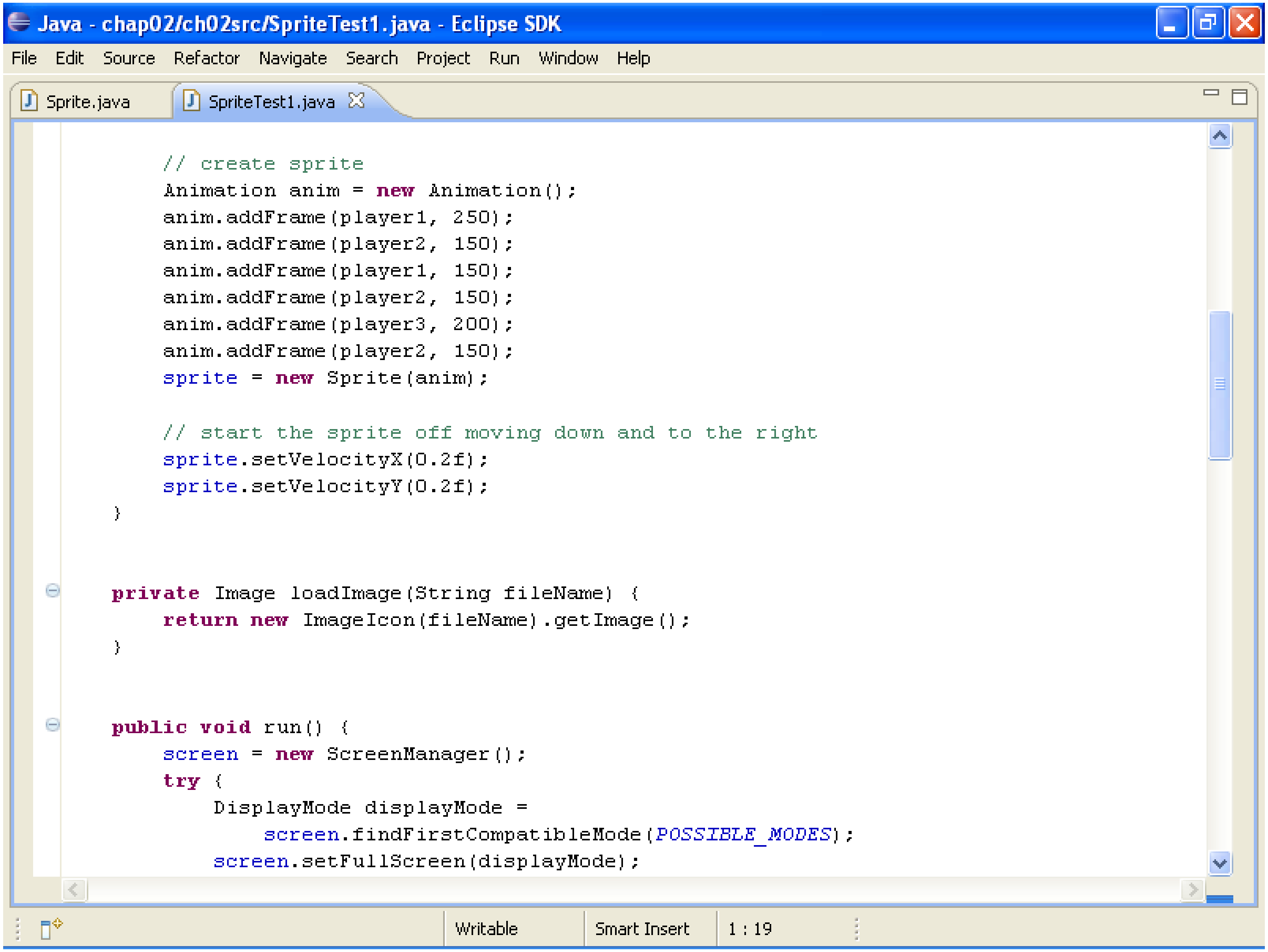

Java - chap02/ch02src/Sprite.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
Sprite.java
SpriteTest1.java
Writable
Smart Insert
6 : 25

```
    public float getVelocityY() {
        return dy;
    }

    /**
        Sets the horizontal velocity of this Sprite in pixels
        per millisecond.
    */
    public void setVelocityX(float dx) {
        this.dx = dx;
    }

    /**
        Sets the vertical velocity of this Sprite in pixels
        per millisecond.
    */
    public void setVelocityY(float dy) {
        this.dy = dy;
    }

    /**
        Gets this Sprite's current image.
    */
    public Image getImage() {
        return anim.getImage();
    }
}
```

SpriteTest1

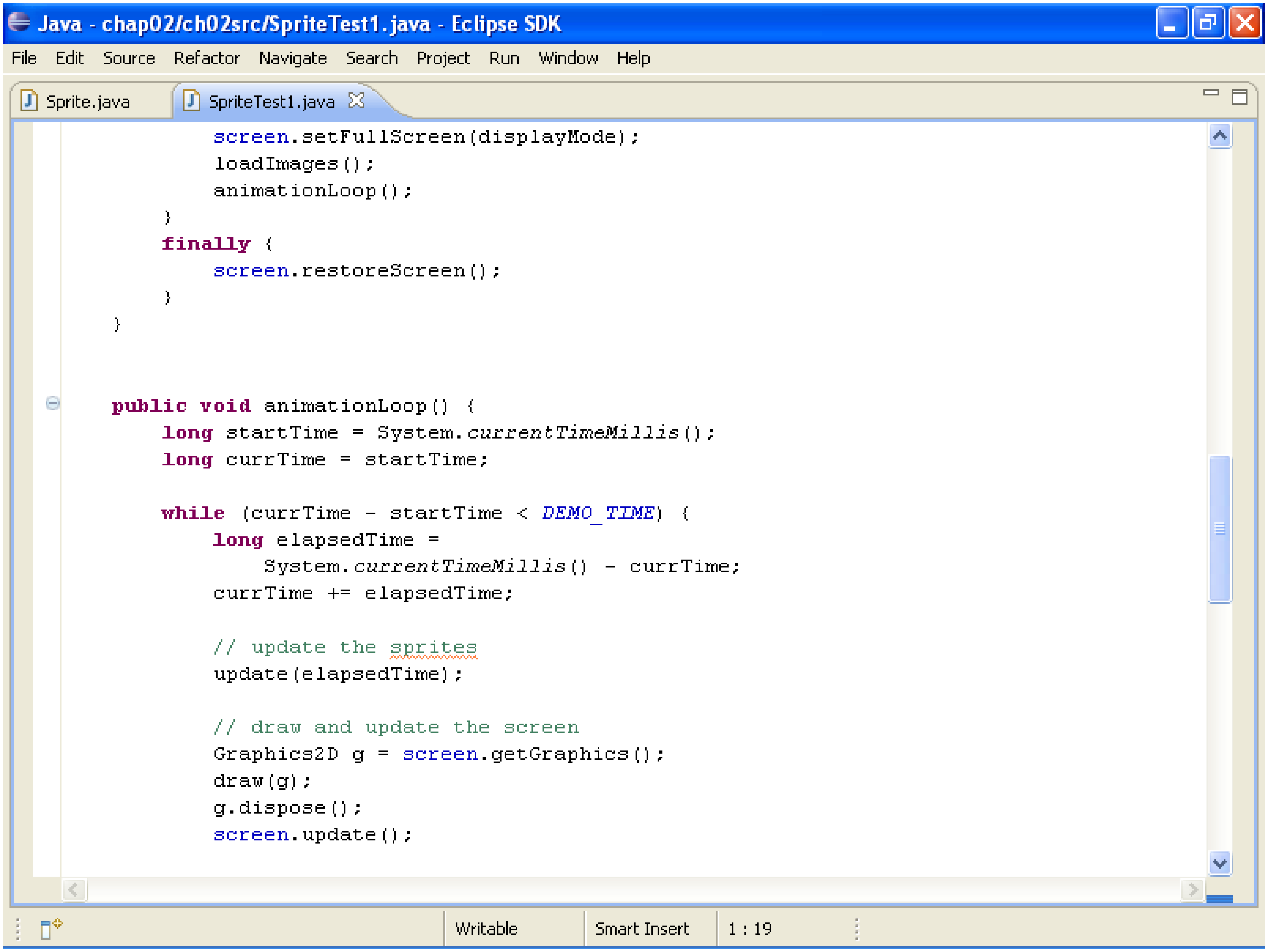


```
import java.awt.*;

public class SpriteTest1 {

    public static void main(String args[]) {
        SpriteTest1 test = new SpriteTest1();
        test.run();
    }

    private static final DisplayMode POSSIBLE_MODES[] = {
        new DisplayMode(800, 600, 32, 0),
        new DisplayMode(800, 600, 24, 0),
        new DisplayMode(800, 600, 16, 0),
        new DisplayMode(640, 480, 32, 0),
        new DisplayMode(640, 480, 24, 0),
        new DisplayMode(640, 480, 16, 0)
    };

    private static final long DEMO_TIME = 10000;

    private ScreenManager screen;
    private Image bgImage;
    private Sprite sprite;

    public void loadImages() {
        // load images
        bgImage = loadImage("images/background.jpg");
        Image player1 = loadImage("images/player1.png");
```



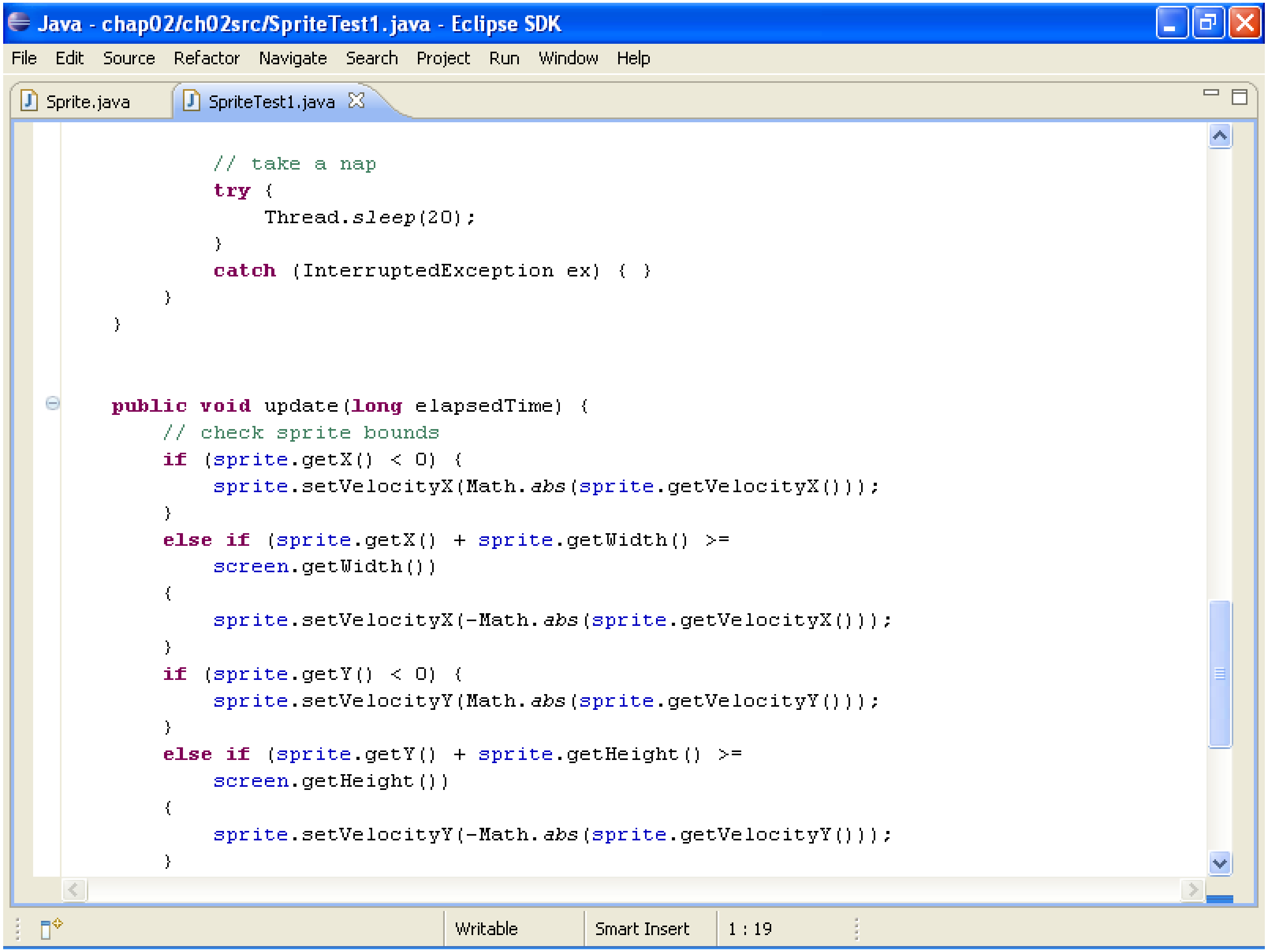
Java - chap02/ch02src/SpriteTest1.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
Sprite.java
SpriteTest1.java
Writable
Smart Insert
1 : 19

```
        // create sprite
        Animation anim = new Animation();
        anim.addFrame(player1, 250);
        anim.addFrame(player2, 150);
        anim.addFrame(player1, 150);
        anim.addFrame(player2, 150);
        anim.addFrame(player3, 200);
        anim.addFrame(player2, 150);
        sprite = new Sprite(anim);

        // start the sprite off moving down and to the right
        sprite.setVelocityX(0.2f);
        sprite.setVelocityY(0.2f);
    }


    private Image loadImage(String fileName) {
        return new ImageIcon(fileName).getImage();
    }


    public void run() {
        screen = new ScreenManager();
        try {
            DisplayMode displayMode =
                screen.findFirstCompatibleMode(POSSIBLE_MODES);
            screen.setFullScreen(displayMode);
```

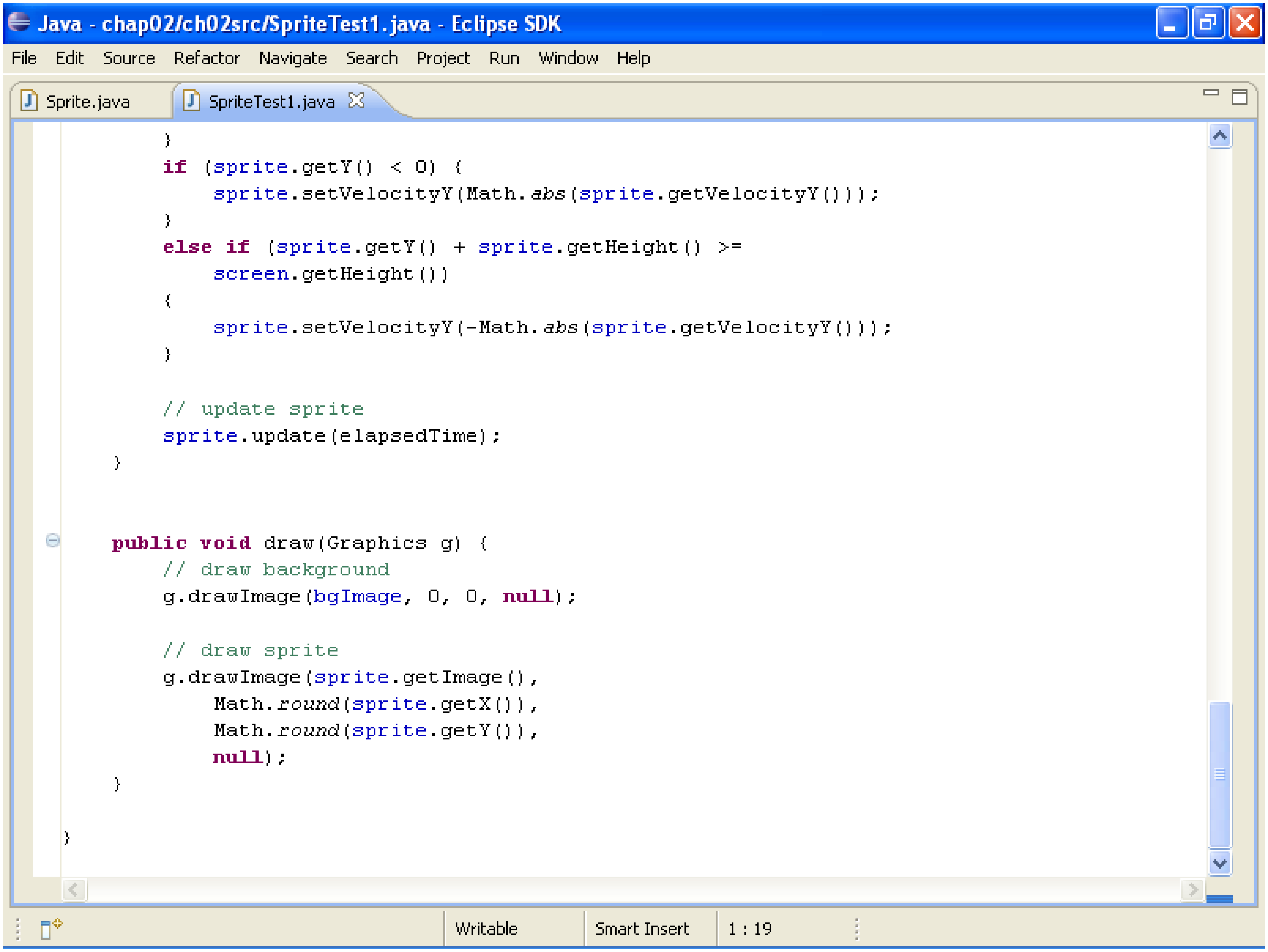


Java - chap02/ch02src/SpriteTest1.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
Sprite.java
SpriteTest1.java
Writable
Smart Insert
1 : 19

```java
            screen.setFullScreen(displayMode);
            loadImages();
            animationLoop();
        }
        finally {
            screen.restoreScreen();
        }
    }


    public void animationLoop() {
        long startTime = System.currentTimeMillis();
        long currTime = startTime;

        while (currTime - startTime < DEMO_TIME) {
            long elapsedTime =
                System.currentTimeMillis() - currTime;
            currTime += elapsedTime;

            // update the sprites
            update(elapsedTime);

            // draw and update the screen
            Graphics2D g = screen.getGraphics();
            draw(g);
            g.dispose();
            screen.update();
```



```
            // take a nap
            try {
                Thread.sleep(20);
            }
            catch (InterruptedException ex) { }
        }
    }


    public void update(long elapsedTime) {
        // check sprite bounds
        if (sprite.getX() < 0) {
            sprite.setVelocityX(Math.abs(sprite.getVelocityX()));
        }
        else if (sprite.getX() + sprite.getWidth() >=
            screen.getWidth())
        {
            sprite.setVelocityX(-Math.abs(sprite.getVelocityX()));
        }
        if (sprite.getY() < 0) {
            sprite.setVelocityY(Math.abs(sprite.getVelocityY()));
        }
        else if (sprite.getY() + sprite.getHeight() >=
            screen.getHeight())
        {
            sprite.setVelocityY(-Math.abs(sprite.getVelocityY()));
        }
```



Java - chap02/ch02src/SpriteTest1.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
Sprite.java
SpriteTest1.java

```java
            }
            if (sprite.getY() < 0) {
                sprite.setVelocityY(Math.abs(sprite.getVelocityY()));
            }
            else if (sprite.getY() + sprite.getHeight() >=
                screen.getHeight())
            {
                sprite.setVelocityY(-Math.abs(sprite.getVelocityY()));
            }

            // update sprite
            sprite.update(elapsedTime);
        }


    public void draw(Graphics g) {
        // draw background
        g.drawImage(bgImage, 0, 0, null);

        // draw sprite
        g.drawImage(sprite.getImage(),
            Math.round(sprite.getX()),
            Math.round(sprite.getY()),
            null);
    }

}
```

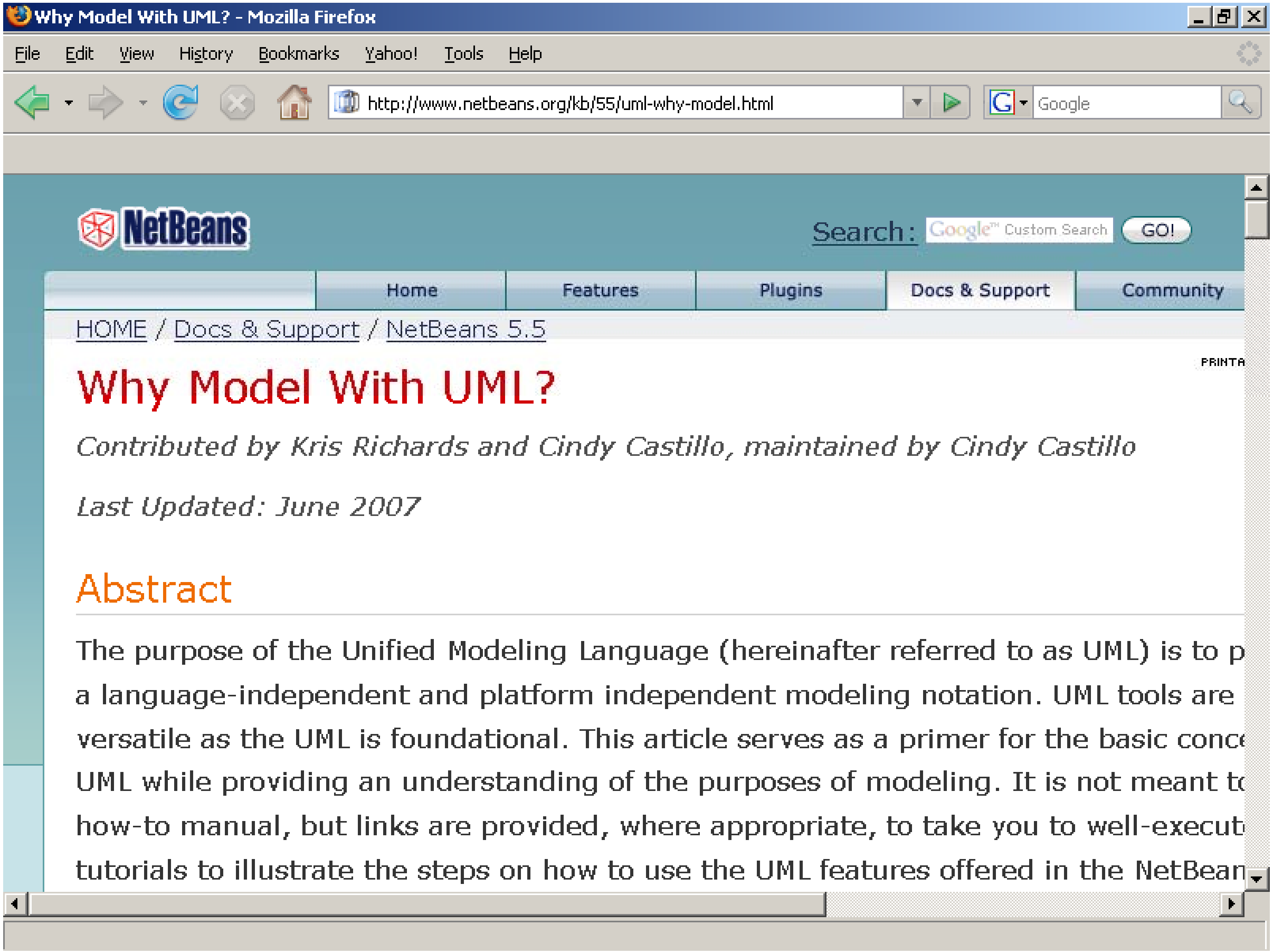
ECE 462
Object-Oriented Programming using C++ and Java

Unified Modeling Language

Yung-Hsiang Lu
yunglu@purdue.edu

Unified Modeling Language UML

- why to model?
  - abstraction, ignore details, or multiple levels of details
  - identify participating objects
  - communicate with people
  - use tools to generate code, check correctness ...
- why UML?
  - language independent
  - platform independent
  - international standard
  - expressive (state, sequence, time, interface ...)
  - tool rich (UML → code, code → UML ...)



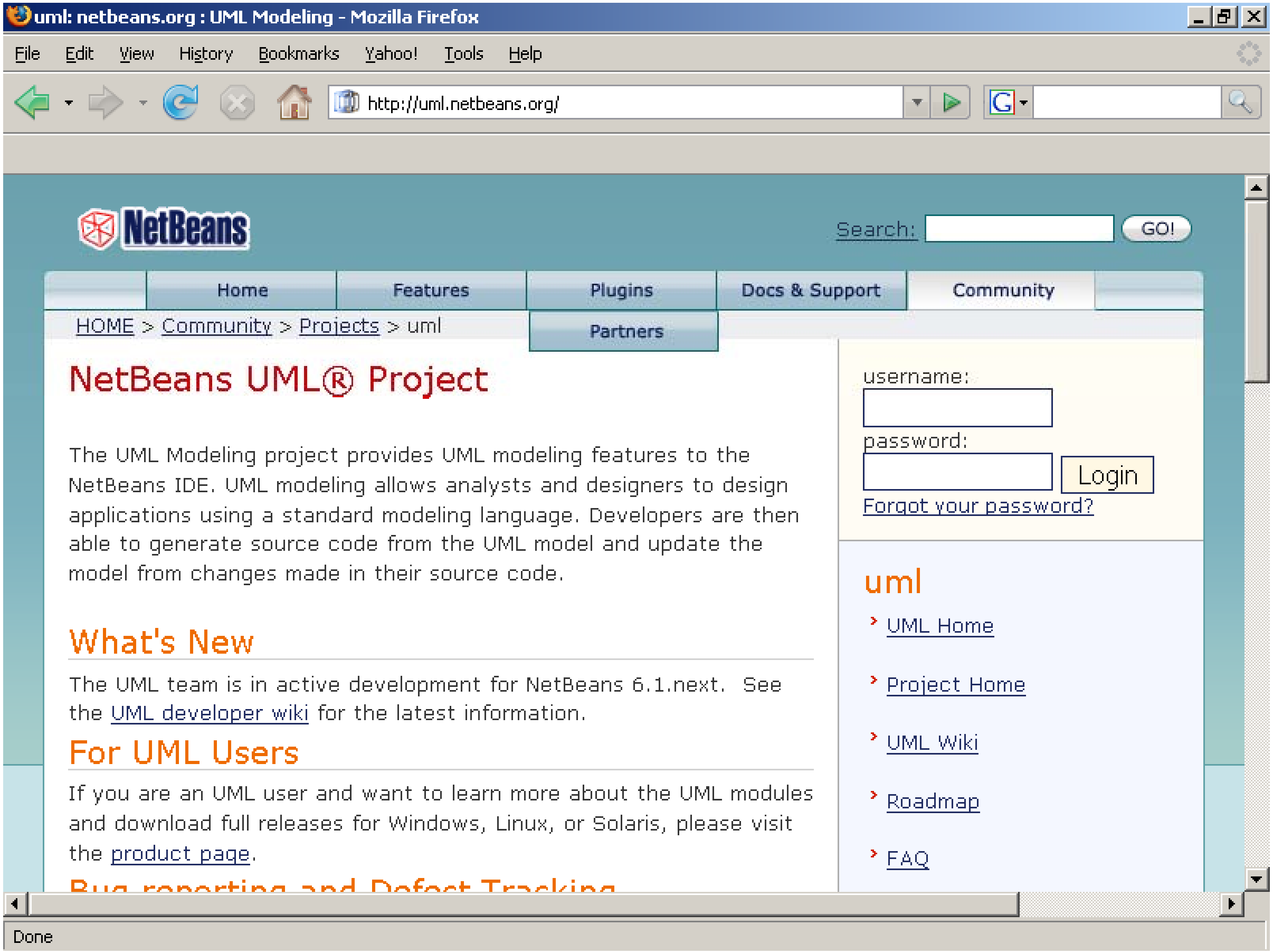
Why Model With UML?

Contributed by Kris Richards and Cindy Castillo, maintained by Cindy Castillo

Last Updated: June 2007

Abstract

The purpose of the Unified Modeling Language (hereinafter referred to as UML) is to p a language-independent and platform independent modeling notation. UML tools are versatile as the UML is foundational. This article serves as a primer for the basic conce UML while providing an understanding of the purposes of modeling. It is not meant to how-to manual, but links are provided, where appropriate, to take you to well-execut tutorials to illustrate the steps on how to use the UML features offered in the NetBean



uml: netbeans.org : UML Modeling - Mozilla Firefox
File Edit View History Bookmarks Yahoo! Tools Help
http://uml.netbeans.org/
NetBeans
Search: GO!
Home
Features
Plugins
Docs & Support
Community
Partners
HOME > Community > Projects > uml

NetBeans UML® Project

The UML Modeling project provides UML modeling features to the NetBeans IDE. UML modeling allows analysts and designers to design applications using a standard modeling language. Developers are then able to generate source code from the UML model and update the model from changes made in their source code.

What's New

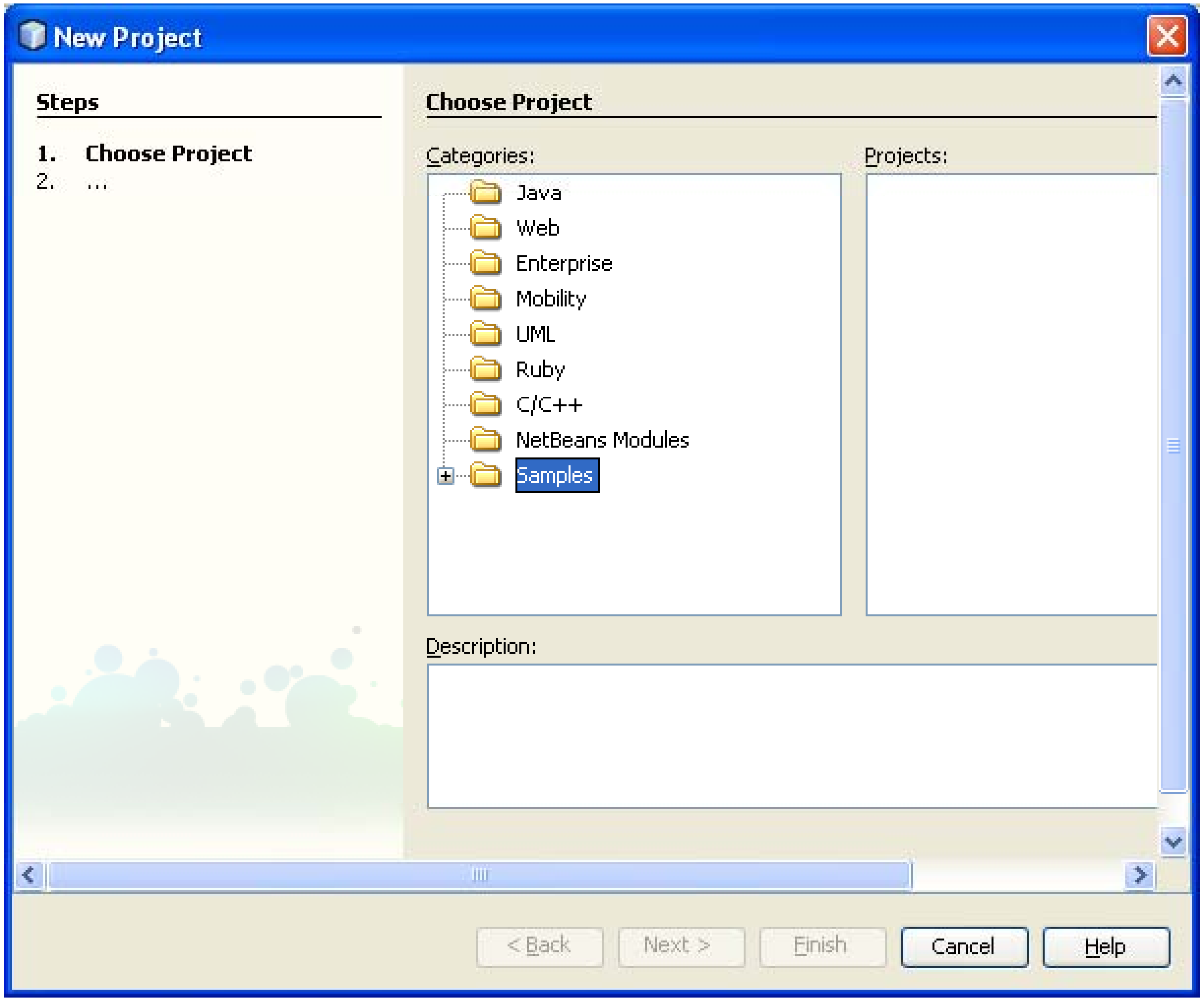
The UML team is in active development for NetBeans 6.1.next. See the UML developer wiki for the latest information.

For UML Users

If you are an UML user and want to learn more about the UML modules and download full releases for Windows, Linux, or Solaris, please visit the product page.

Bug reporting and Defect Tracking

UML Example in Netbeans


New Project
Steps
1. Choose Project
2. ...
Choose Project
Categories:
Java
Web
Enterprise
Mobility
UML
Ruby
C/C++
NetBeans Modules
Samples
Projects:
Description:
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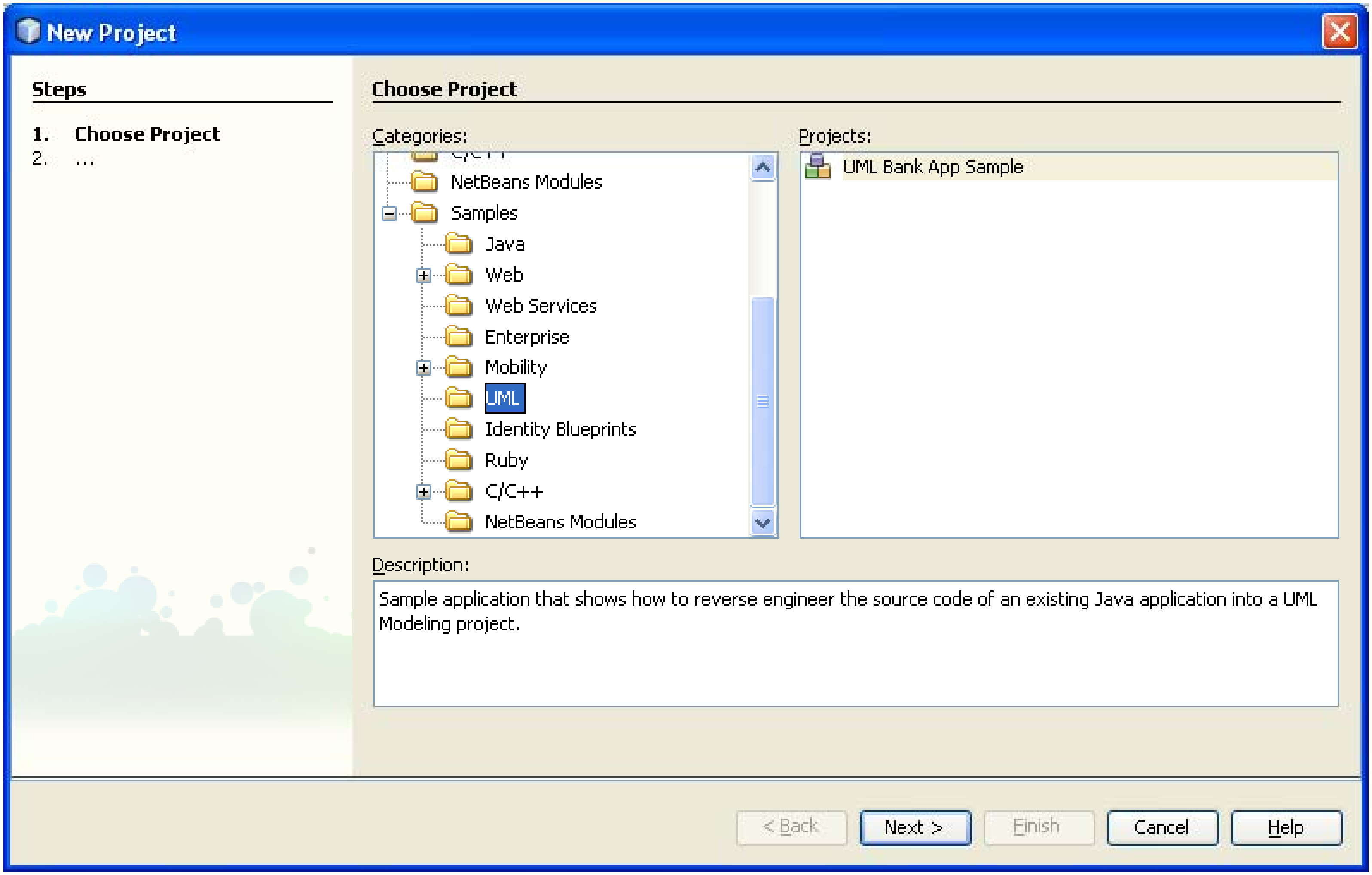
Cancel
Help

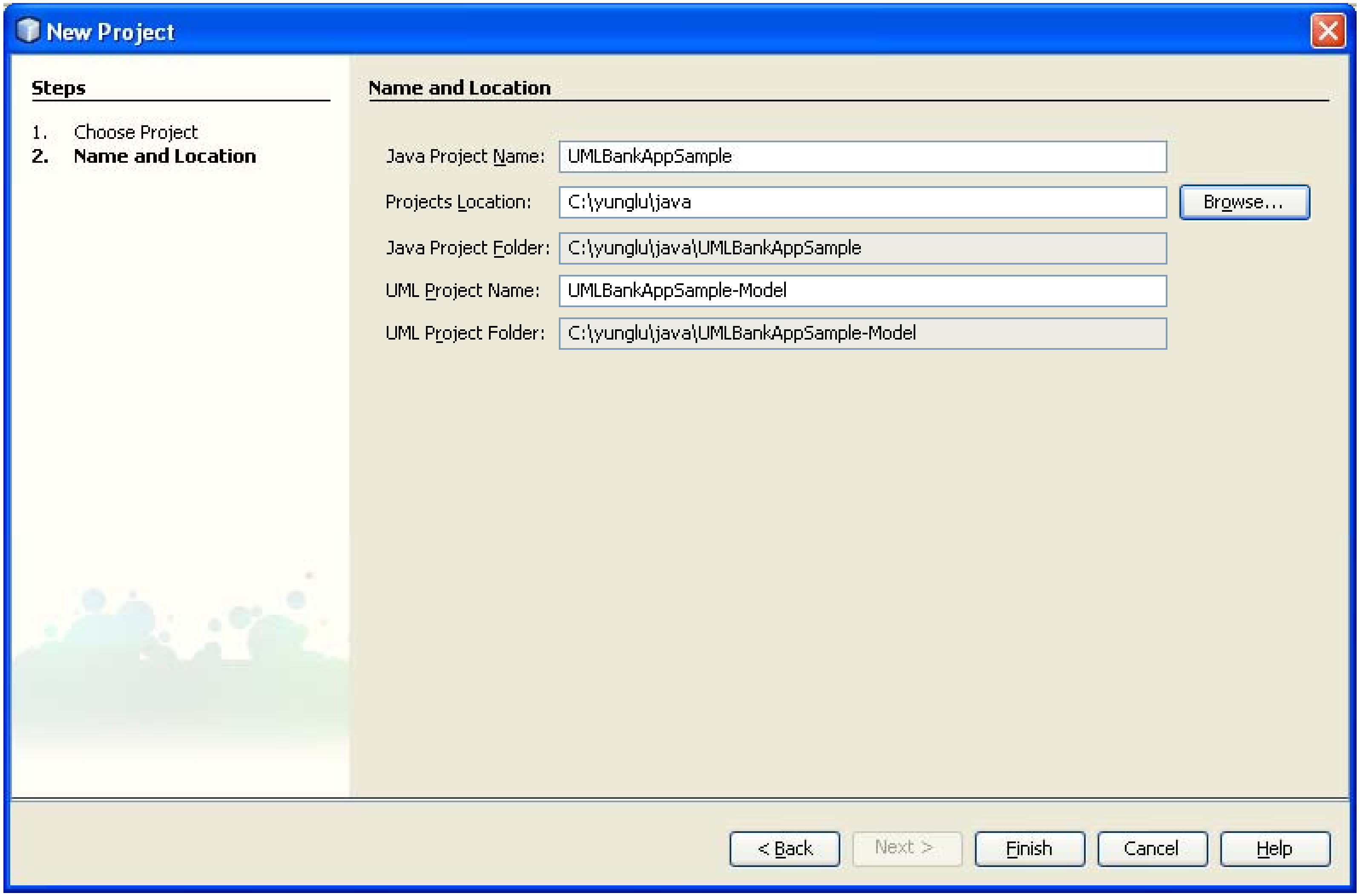


Categories: UML

Projects: UML Bank App Sample

Description:

Sample application that shows how to reverse engineer the source code of an existing Java application into a UML Modeling project.



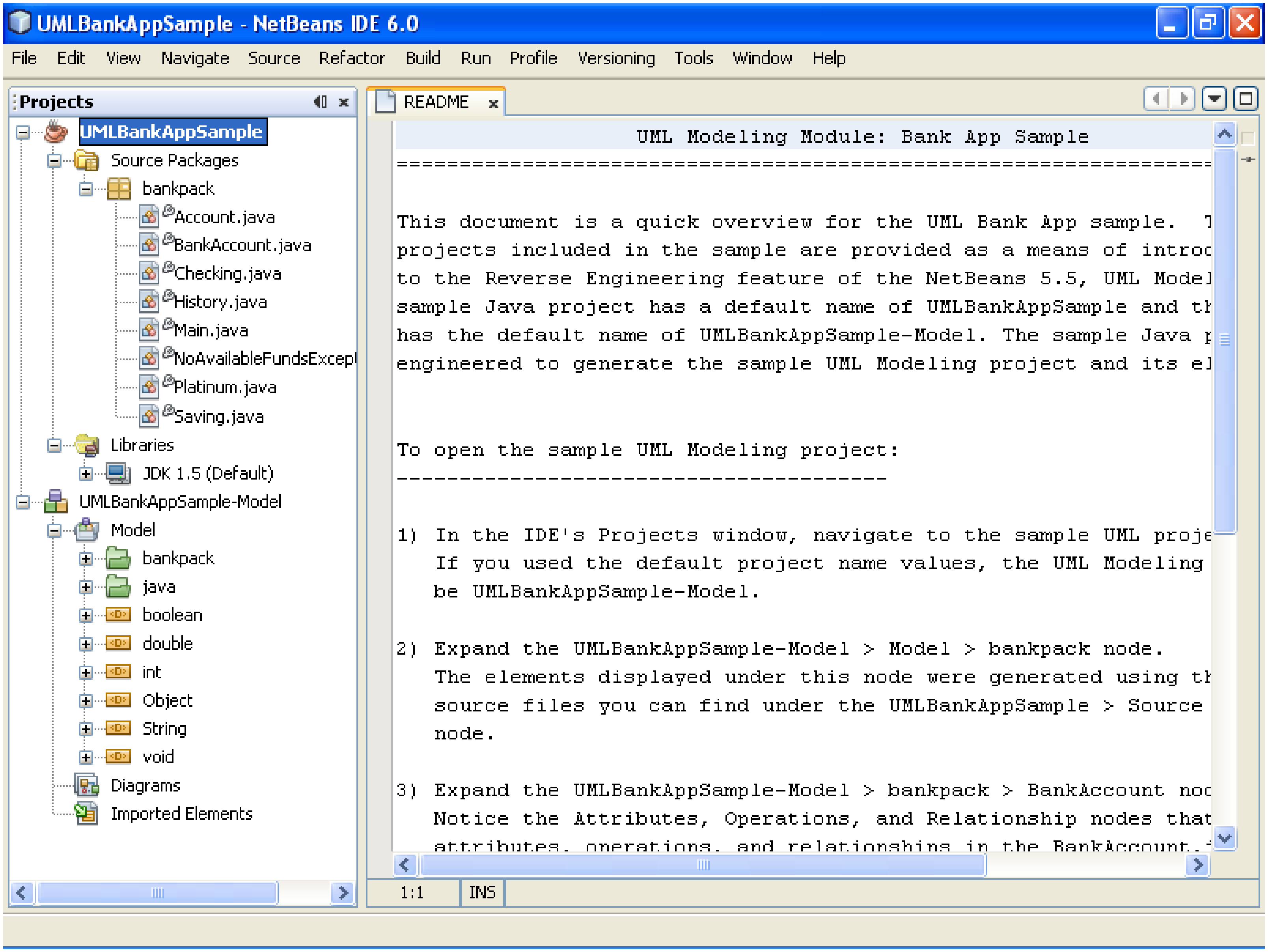
Java Project Name: UMLBankAppSample

Projects Location: C:\yunglu\java

Java Project Folder: C:\yunglu\java\UMLBankAppSample

UML Project Name: UMLBankAppSample-Model

UML Project Folder: C:\yunglu\java\UMLBankAppSample-Model



```
                    UML Modeling Module: Bank App Sample
=================================================================

This document is a quick overview for the UML Bank App sample.  T
projects included in the sample are provided as a means of introc
to the Reverse Engineering feature of the NetBeans 5.5, UML Model
sample Java project has a default name of UMLBankAppSample and tl
has the default name of UMLBankAppSample-Model. The sample Java p
engineered to generate the sample UML Modeling project and its el


To open the sample UML Modeling project:
---------------------------------------

1)  In the IDE's Projects window, navigate to the sample UML proje
    If you used the default project name values, the UML Modeling
    be UMLBankAppSample-Model.

2)  Expand the UMLBankAppSample-Model > Model > bankpack node.
    The elements displayed under this node were generated using tl
    source files you can find under the UMLBankAppSample > Source
    node.

3)  Expand the UMLBankAppSample-Model > bankpack > BankAccount noc
    Notice the Attributes, Operations, and Relationship nodes that
    attributes, operations, and relationships in the BankAccount.
```

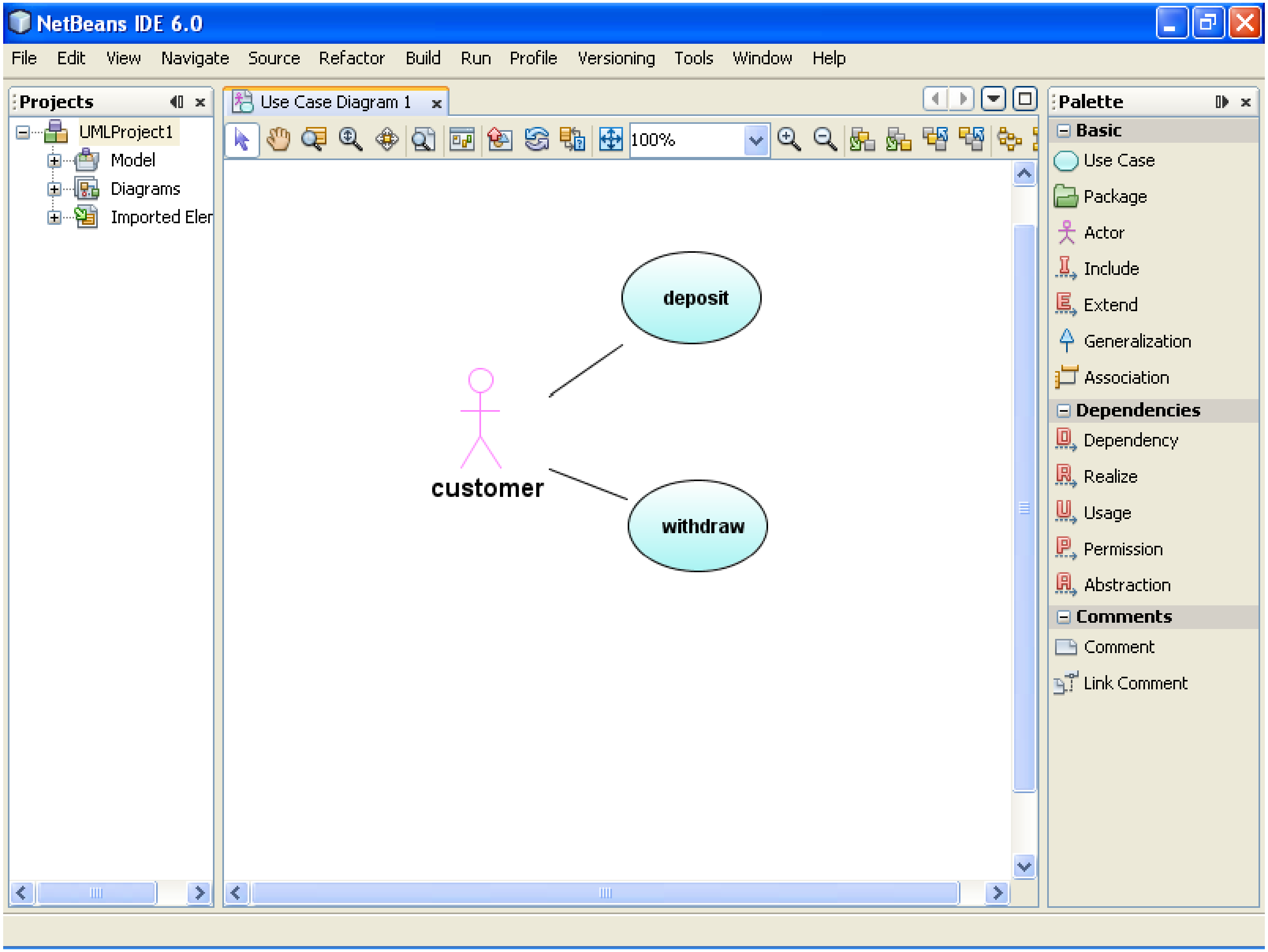
What Does a Model Say?

- relationships among objects
  - which objects participate in an activity
  - actions and interfaces
  - transitions of attributes
- sequence of actions
- specialization, composition, ownership
- quantities

- In addition, one critical value of a model is to help a developer **think before doing**.

Modeling a Bank

- objects:
  - people: customers, tellers, bank managers, loan evaluators, ATM maintainers ...
  - data: accounts
  - properties: branch offices, ATM machines, furniture ...
- actions: deposit, withdraw, apply for loans, approve or reject applications, collect money from ATM ...
- relationships among objects
  - customer can deposit, withdraw cash, or talk to teller
  - customer cannot talk to ATM maintainer
  - ATM maintainer cannot approve or reject loan applications
  - ATM can accept deposit; desk cannot ...


NetBeans IDE 6.0
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UMLProject1
Model
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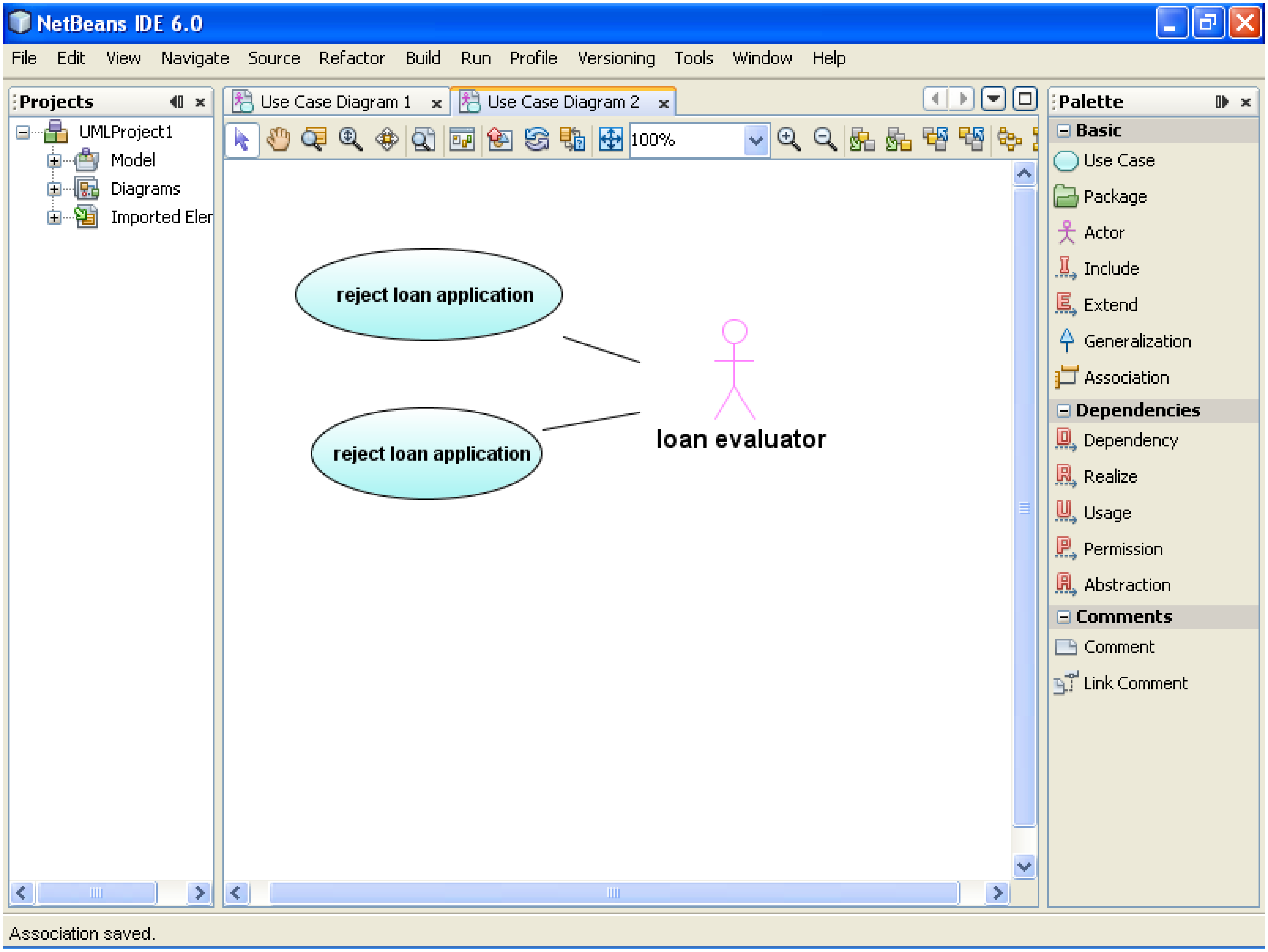
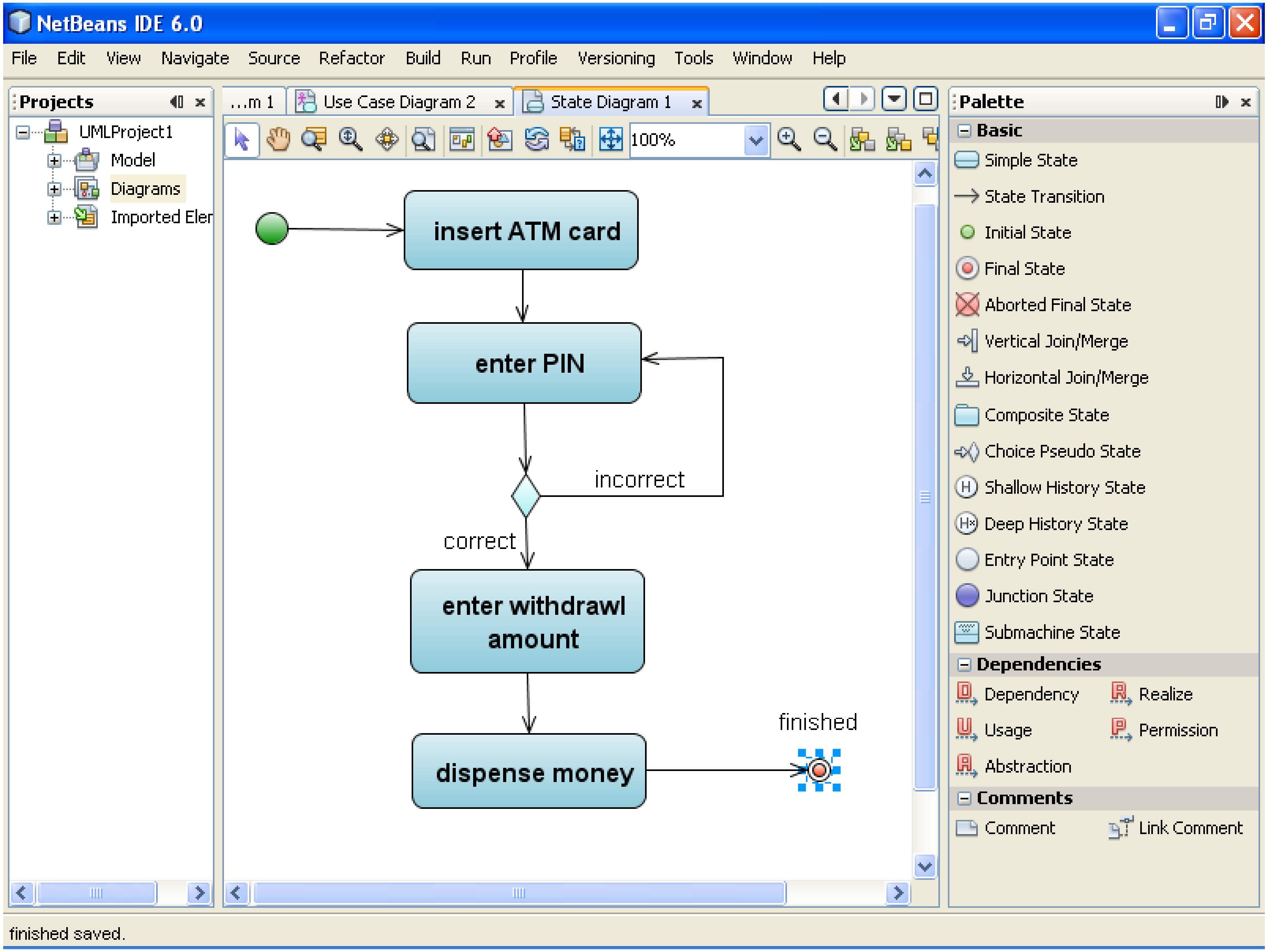
Use Case Diagram 1
100%
deposit
customer
withdraw
Palette
Basic
Use Case
Package
Actor
Include
Extend
Generalization
Association
Dependencies
Dependency
Realize
Usage
Permission
Abstraction
Comments
Comment
Link Comment



Association saved.

Model States and Transitions

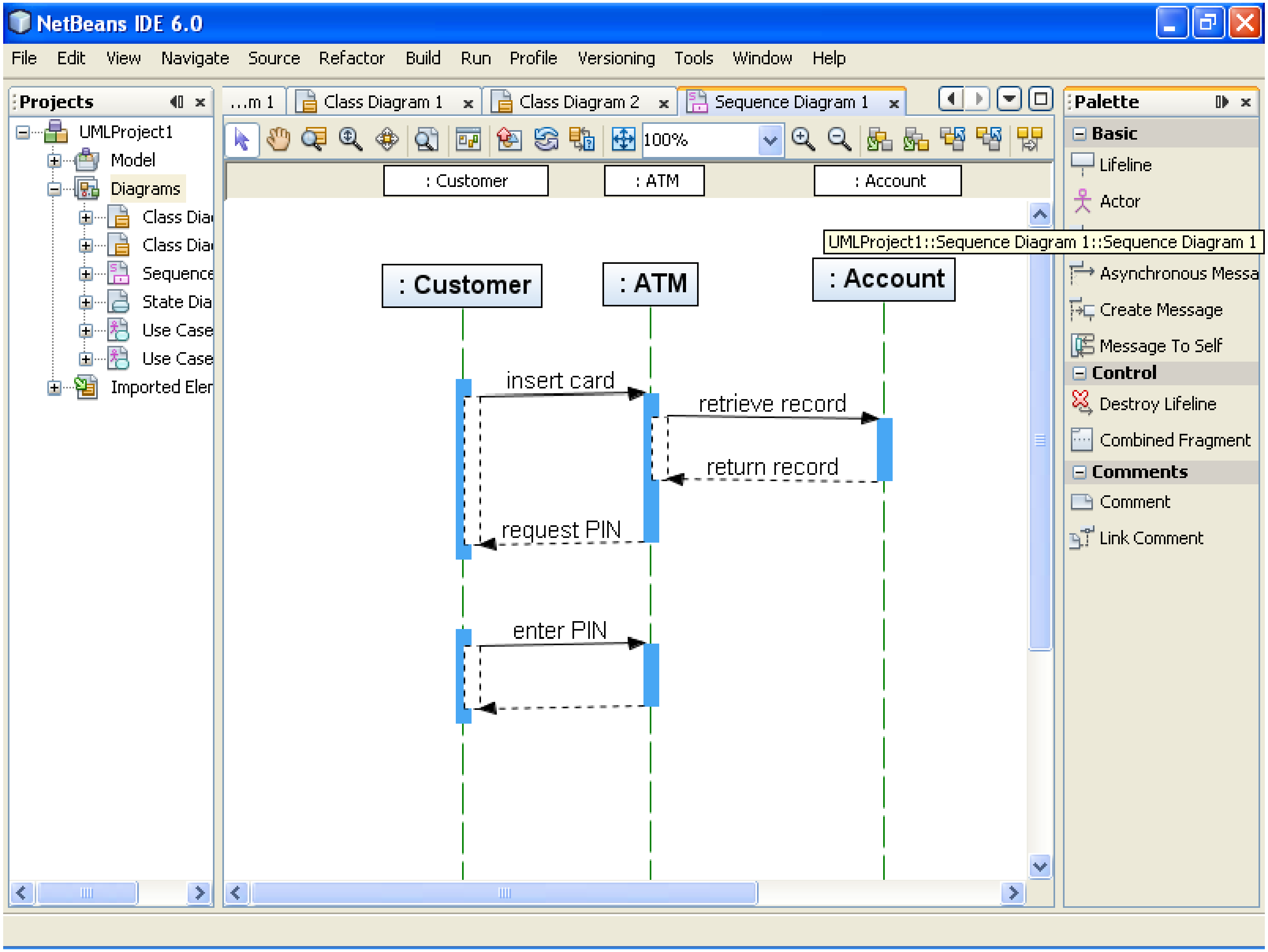
- Many objects' behaviors depend on the values (i.e. state) of the objects' attributes.
  - age ⇒ vote
  - account balance ⇒ withdraw
  - available credit ⇒ purchase
- Objects' behaviors often follow strict orders based on the transitions of the attributes.
  - vending machine must accept payment before returning changes
  - customer must open an account before withdrawing money
  - a user must enter the password before checking email
  - a bank customer must insert the ATM card and enter PIN before deposit



finished saved.

Sequence of Actions

- State diagrams do not express the objects involved.
- For example, the previous diagram does not specify the necessity of a customer and an ATM machine.
- In fact, three objects are involved
  - customer
  - ATM
  - account (and the balance)


NetBeans IDE 6.0
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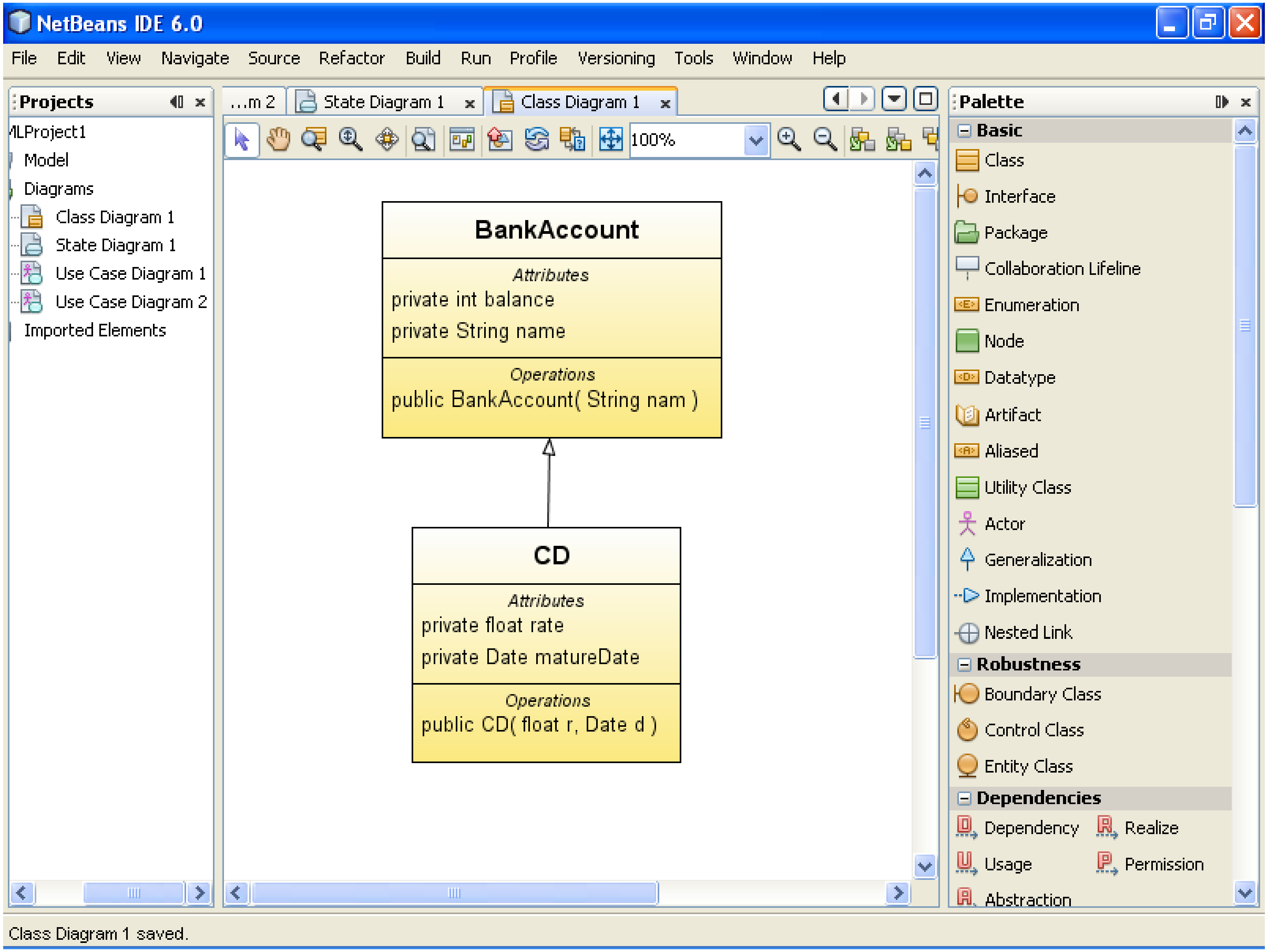
Projects
...m 1
Class Diagram 1
Class Diagram 2
Sequence Diagram 1
100%
UMLProject1
Model
Diagrams
Class Dia
Class Dia
Sequence
State Dia
Use Case
Use Case
Imported Eler
: Customer
: ATM
: Account
UMLProject1::Sequence Diagram 1::Sequence Diagram 1
insert card
retrieve record
return record
request PIN
enter PIN
Palette
Basic
Lifeline
Actor
Asynchronous Messa
Create Message
Message To Self
Control
Destroy Lifeline
Combined Fragment
Comments
Comment
Link Comment

Class Diagram



BankAccount

Attributes
private int balance
private String name

Operations
public BankAccount(String nam)

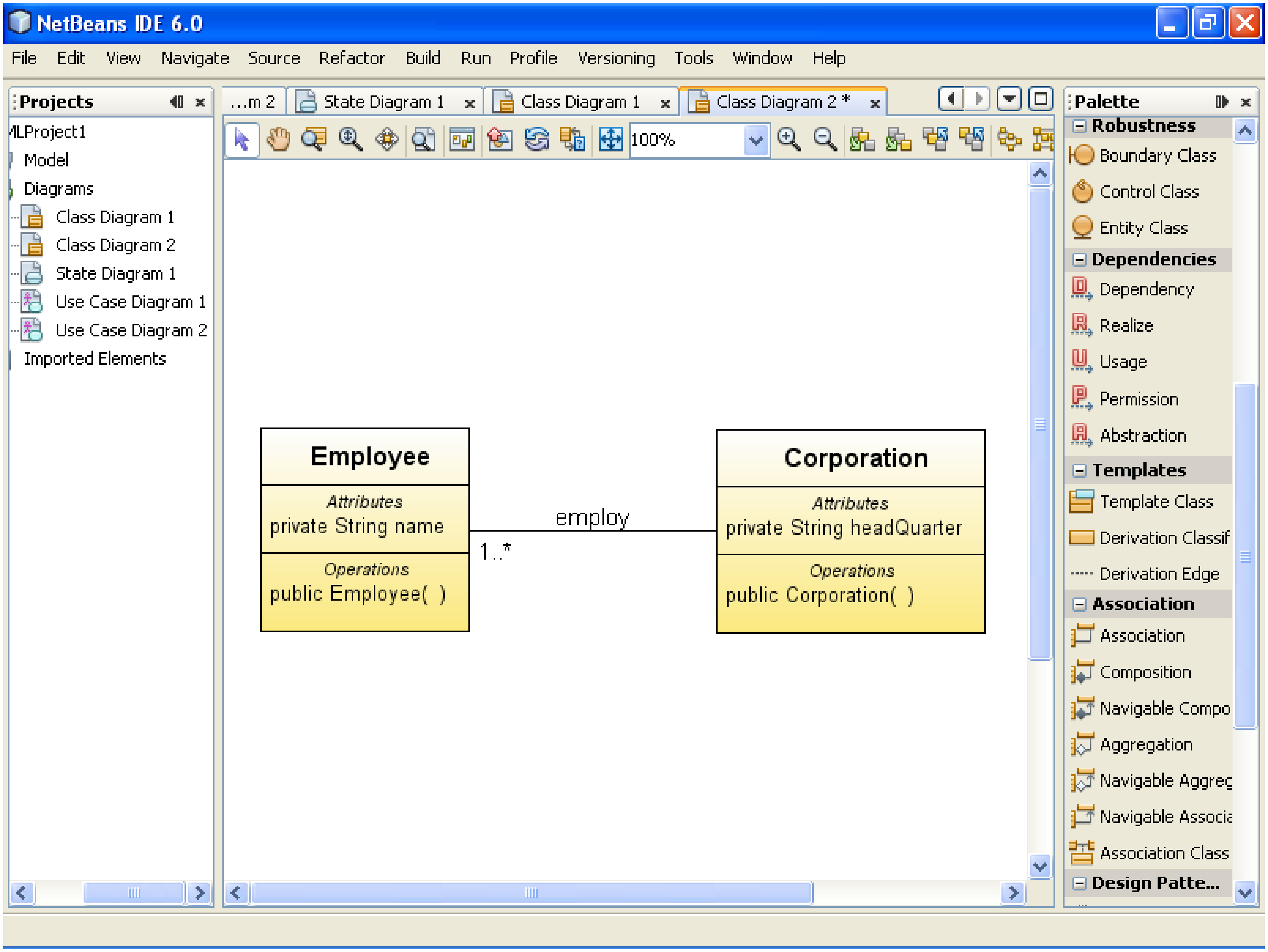
CD

Attributes
private float rate
private Date matureDate

Operations
public CD(float r, Date d)

Class Diagram 1 saved.

Quantity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State Diagram 1
Class Diagram 1
Class Diagram 2 *
100%
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Model
Diagrams
Class Diagram 1
Class Diagram 2
State Diagram 1
Use Case Diagram 1
Use Case Diagram 2
Imported Elements
Employee
Attributes
private String name
Operations
public Employee( )
employ
1..*
Corporation
Attributes
private String headQuarter
Operations
public Corporation( )
Palette
Robustness
Boundary Class
Control Class
Entity Class
Dependencies
Dependency
Realize
Usage
Permission
Abstraction
Templates
Template Class
Derivation Classif
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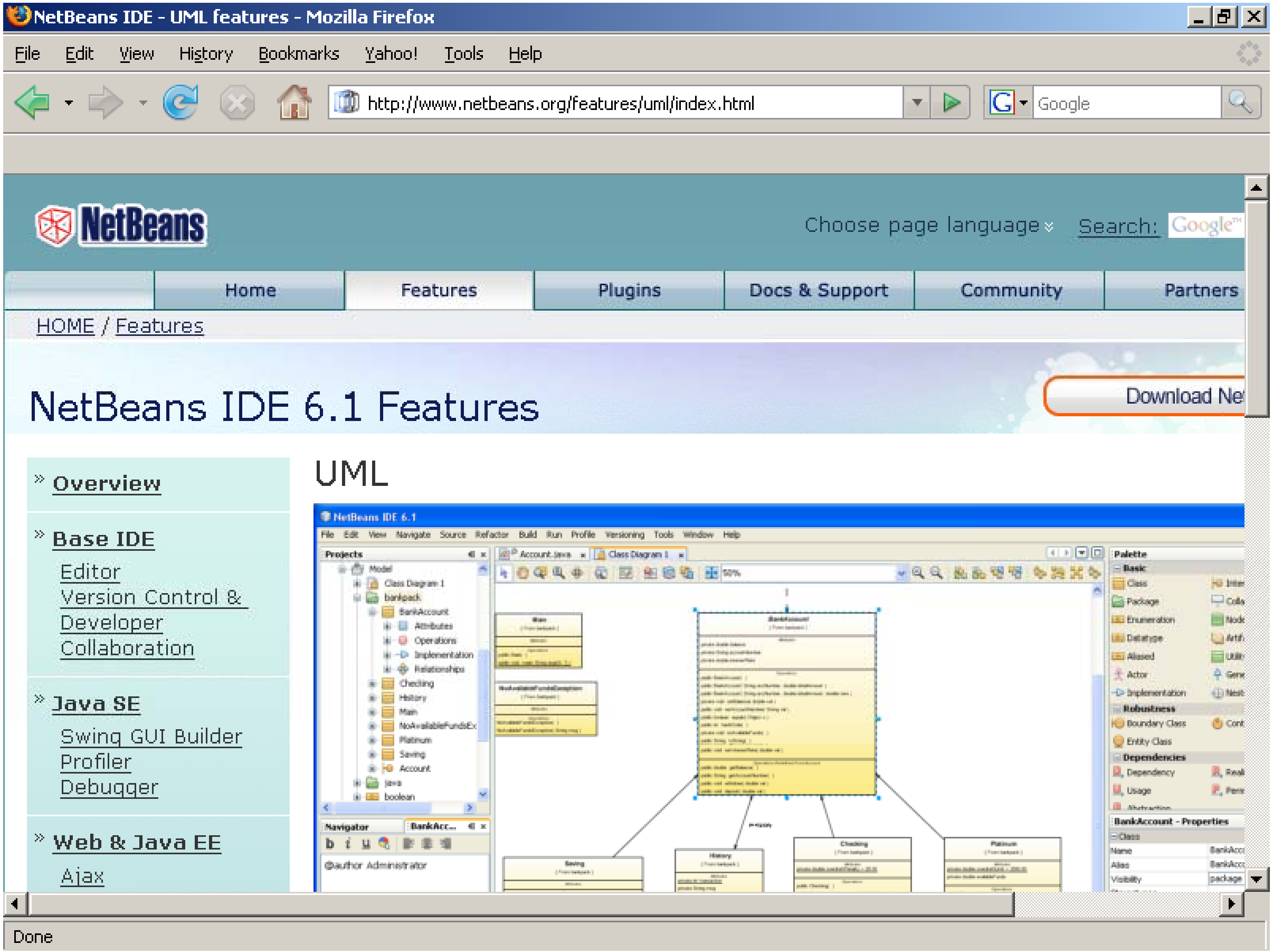
Start a UML Project in Netbeans


NetBeans IDE - UML features - Mozilla Firefox
File Edit View History Bookmarks Yahoo! Tools Help
http://www.netbeans.org/features/uml/index.html
Google
NetBeans
Choose page language
Search:
Home
Features
Plugins
Docs & Support
Community
Partners
HOME / Features
Download Ne
Done

NetBeans IDE 6.1 Features

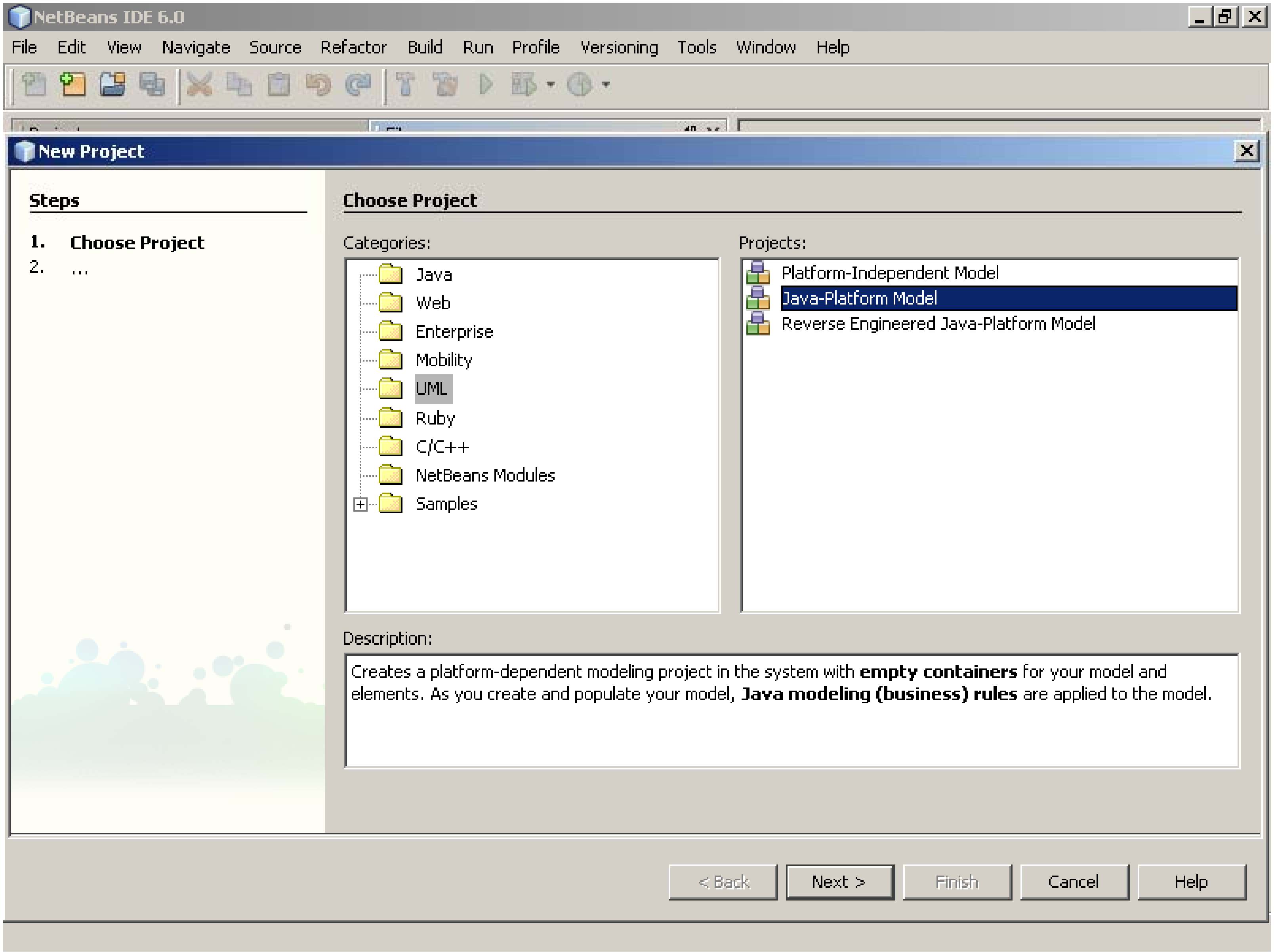
» Overview

» Base IDE
- Editor
- Version Control &
- Developer
- Collaboration

» Java SE
- Swing GUI Builder
- Profiler
- Debugger

» Web & Java EE
- Ajax

UML


NetBeans IDE 6.0
File Edit View Navigate Source Refactor Build Run Profile Versioning Tools Window Help
< Back
Next >
Finish
Cancel
Help

New Project

Steps

1. Choose Project
2. ...

Choose Project

Categories:

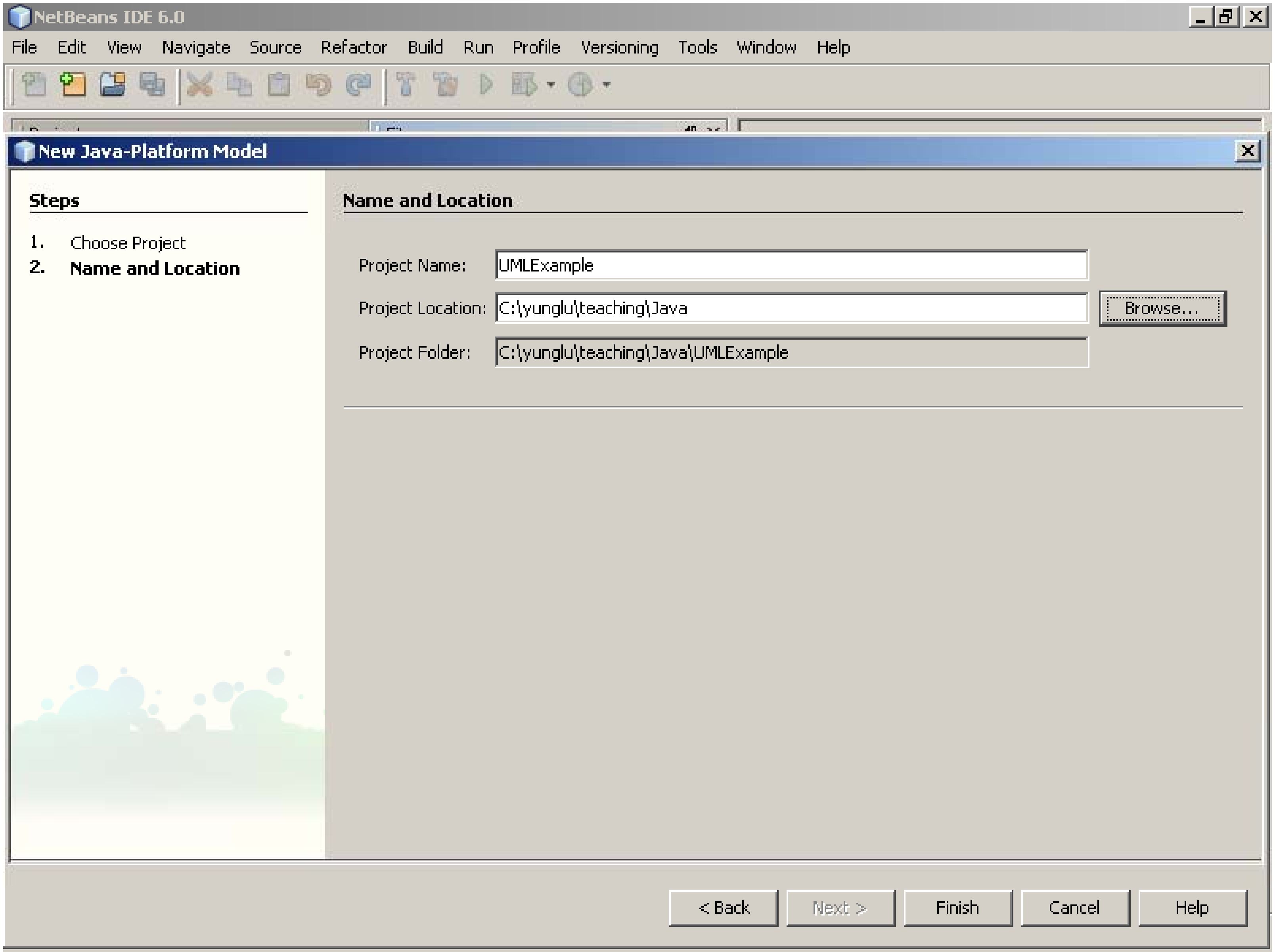
- Java
- Web
- Enterprise
- Mobility
- UML
- Ruby
- C/C++
- NetBeans Modules
- Samples

Projects:

- Platform-Independent Model
- Java-Platform Model
- Reverse Engineered Java-Platform Model

Description:

Creates a platform-dependent modeling project in the system with **empty containers** for your model and elements. As you create and populate your model, **Java modeling (business) rules** are applied to the model.



Project Name: UMLExample

Project Location: C:\yunglu\teaching\Java

Project Folder: C:\yunglu\teaching\Java\UMLExample

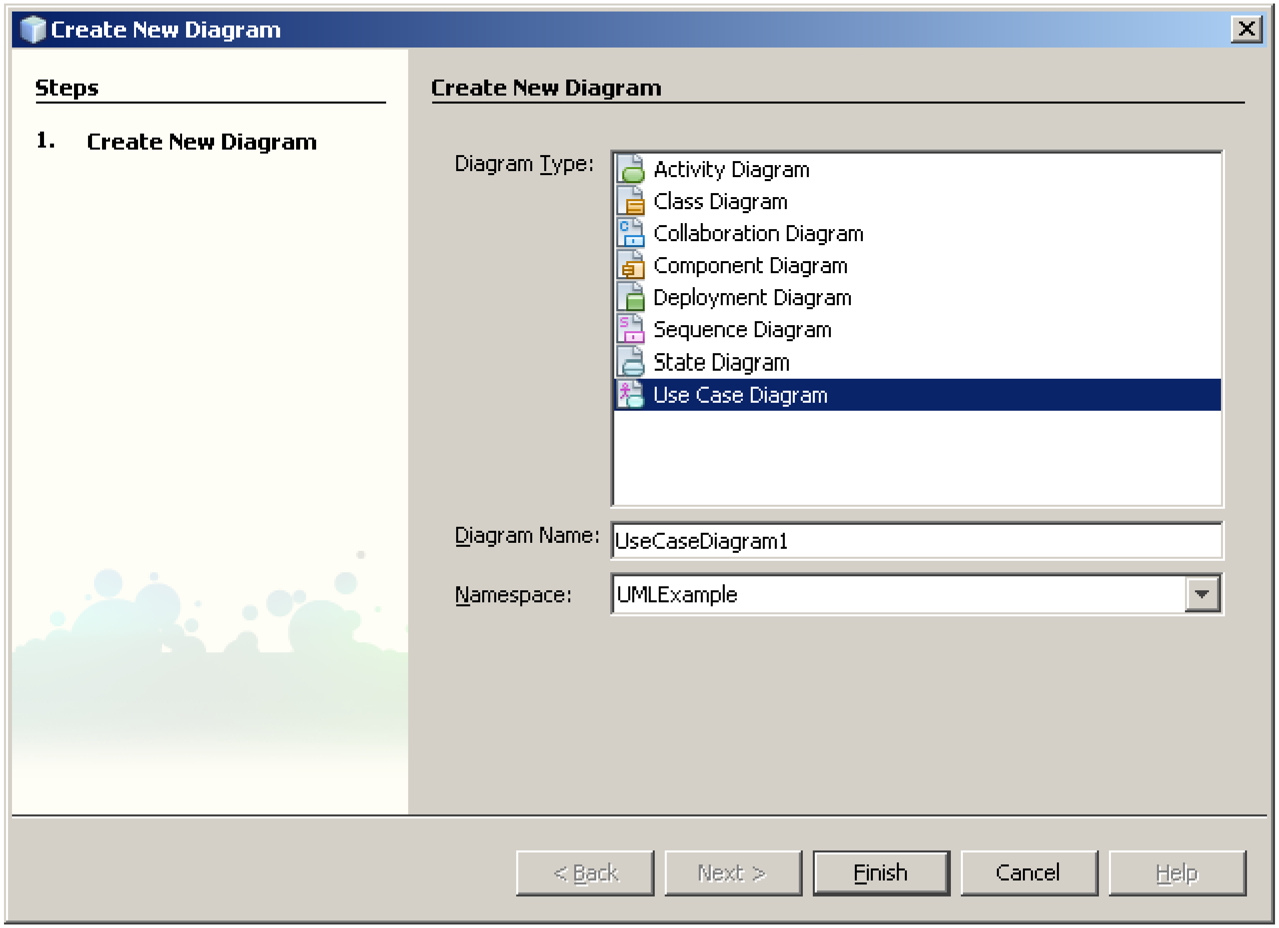


Diagram Type:

- Activity Diagram
- Class Diagram
- Collaboration Diagram
- Component Diagram
- Deployment Diagram
- Sequence Diagram
- State Diagram
- Use Case Diagram

Diagram Name: UseCaseDiagram1

Namespace: UMLExample