Chapter 5 – Abstraction

Acknowledgement: Michael Kolling, Bruce Chittenden

Why do we need Classes?

- Encapsulation – Information Hiding
- Abstraction - A technique to solve a whole class of problem rather than a specific one.
  - *A more formal Definition - a concept or idea not associated with any specific instance.*

Logical Operators

- Help us create more complex boolean expressions
  - And (&&)
    - Conjunction –true only when both conjuncts are true.
  - Or (||)
    - Disjunction –false only when both disjuncts are false.
  - Not (!)
    - Negation –changes the truth value between false and true.

Complex Boolean Expressions

- Combination of two or more boolean expressions
- If (!isDown && Greenfoot.isKeyDown(“w”))

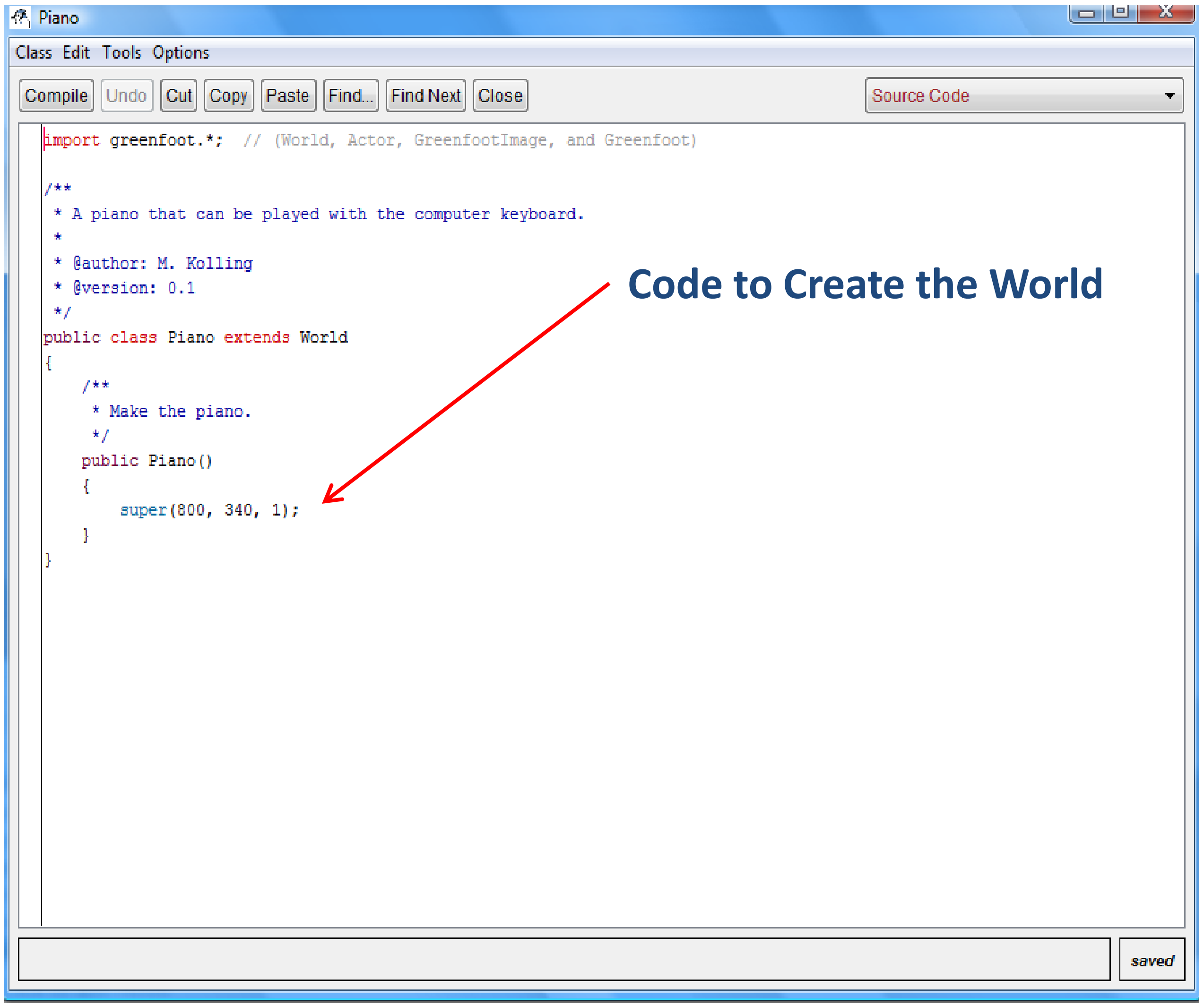
```
        {
                // Set of instructions to execute if the complex expression above
        evaluates to true.
        }
```

An informal representation of above expression can be

If ((not isDown) and (the keyboard key “w” is down or pressed))

        execute the set of instructions

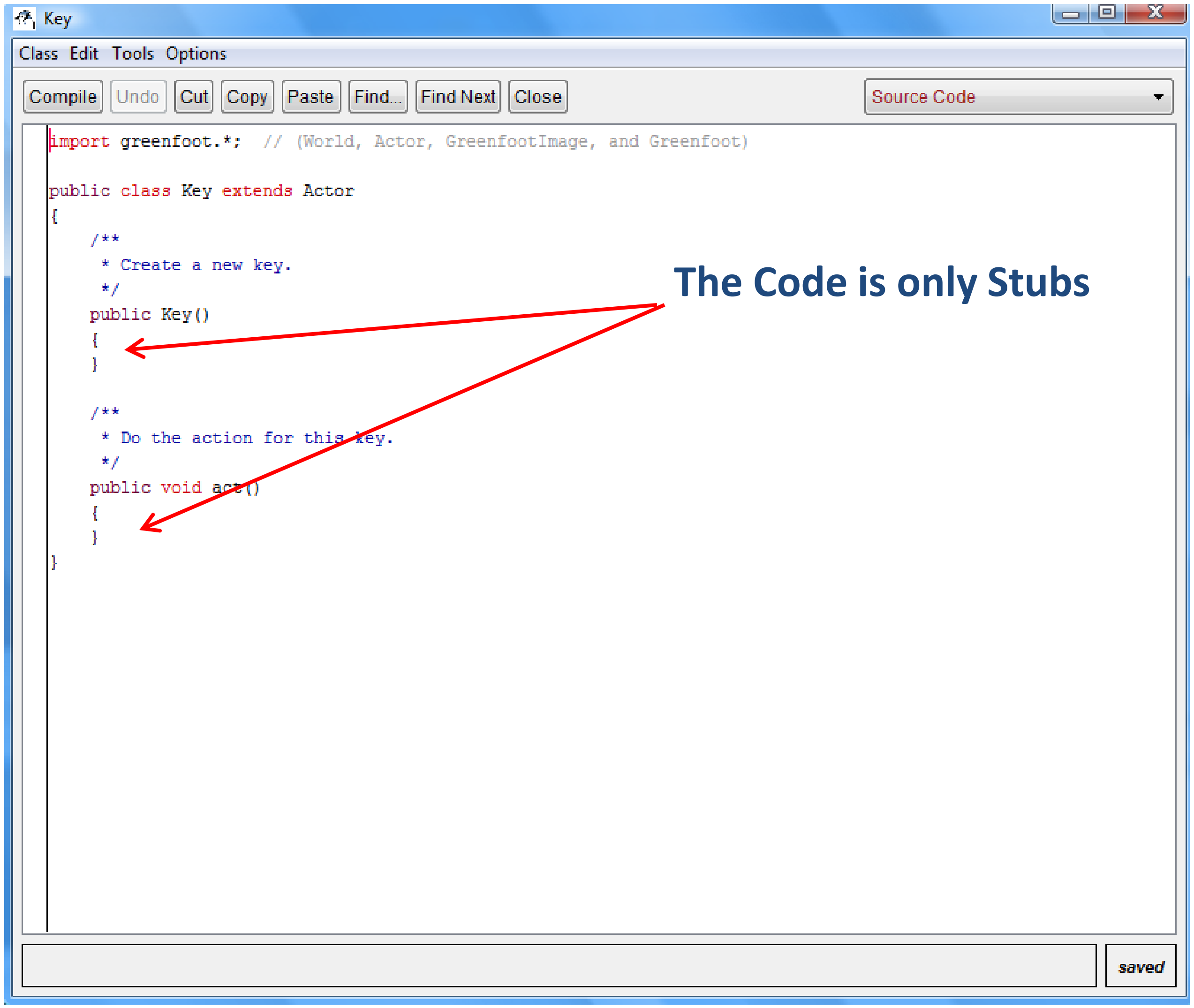
Exercise 5.1



```
import greenfoot.*;  // (World, Actor, GreenfootImage, and Greenfoot)

/**
 * A piano that can be played with the computer keyboard.
 *
 * @author: M. Kolling
 * @version: 0.1
 */
public class Piano extends World
{
    /**
     * Make the piano.
     */
    public Piano()
    {
        super(800, 340, 1);
    }
}
```

Code to Create the World

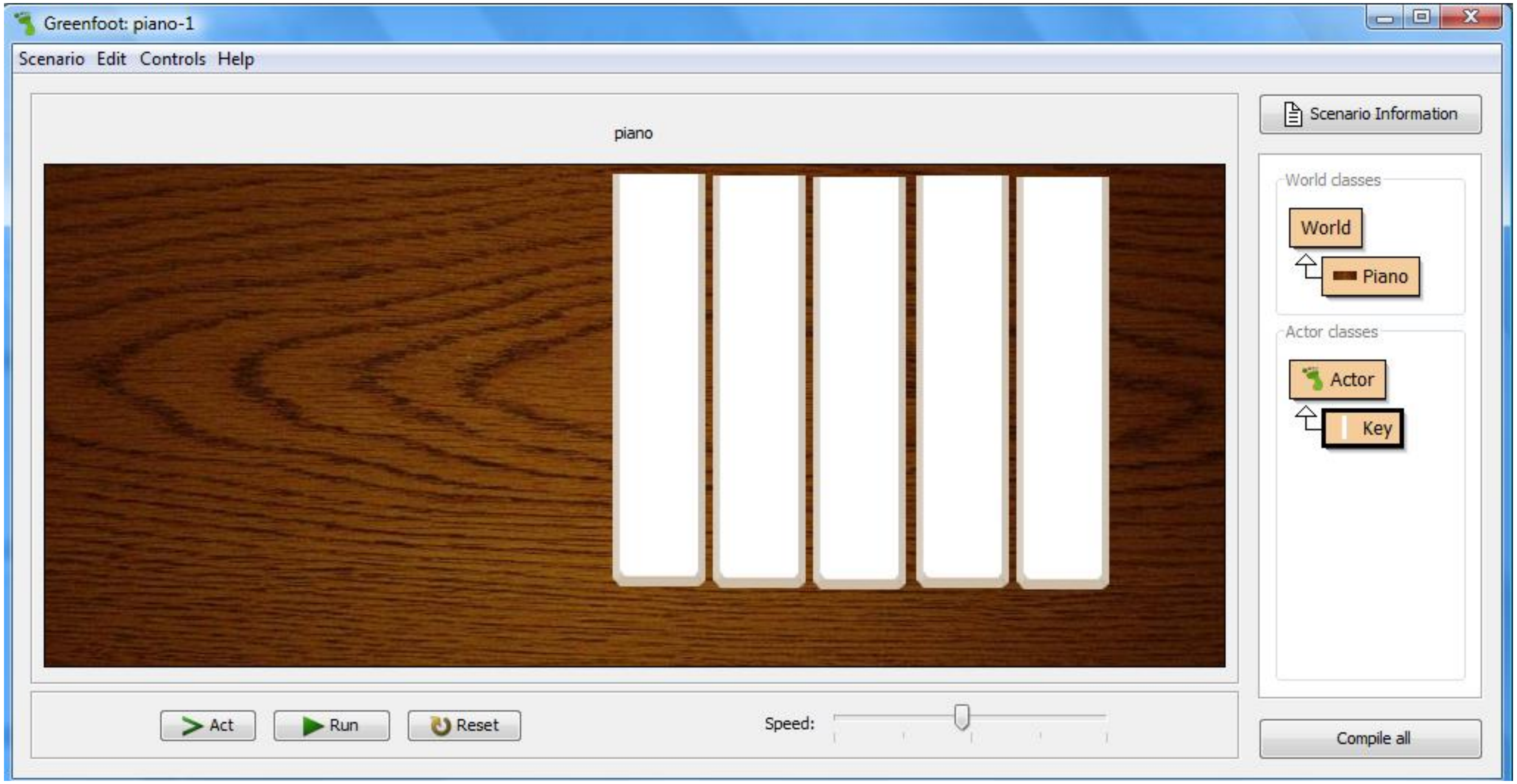
Exercise 5.1



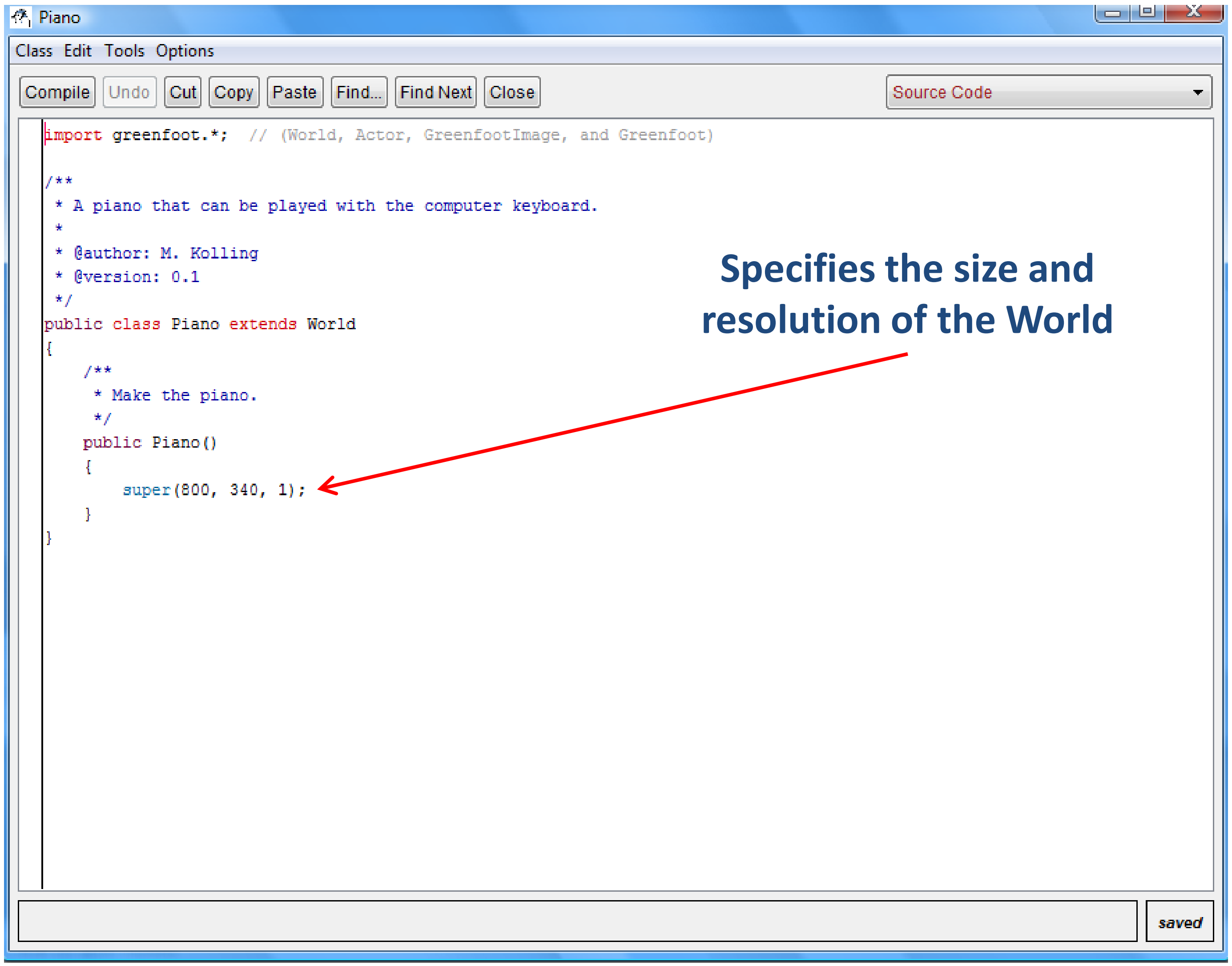
```
import greenfoot.*;  // (World, Actor, GreenfootImage, and Greenfoot)

public class Key extends Actor
{
    /**
     * Create a new key.
     */
    public Key()
    {
    }

    /**
     * Do the action for this key.
     */
    public void act()
    {
    }
}
```

The Code is only Stubs

Exercise 5.2


Greenfoot: piano-1
Scenario Edit Controls Help
piano
Scenario Information
World classes
World
Piano
Actor classes
Actor
Key
Act
Run
Reset
Speed:
Compile all

5.1 Animating the Key



```
import greenfoot.*;  // (World, Actor, GreenfootImage, and Greenfoot)

/**
 * A piano that can be played with the computer keyboard.
 *
 * @author: M. Kolling
 * @version: 0.1
 */
public class Piano extends World
{
    /**
     * Make the piano.
     */
    public Piano()
    {
        super(800, 340, 1);
    }
}
```

Specifies the size and resolution of the World

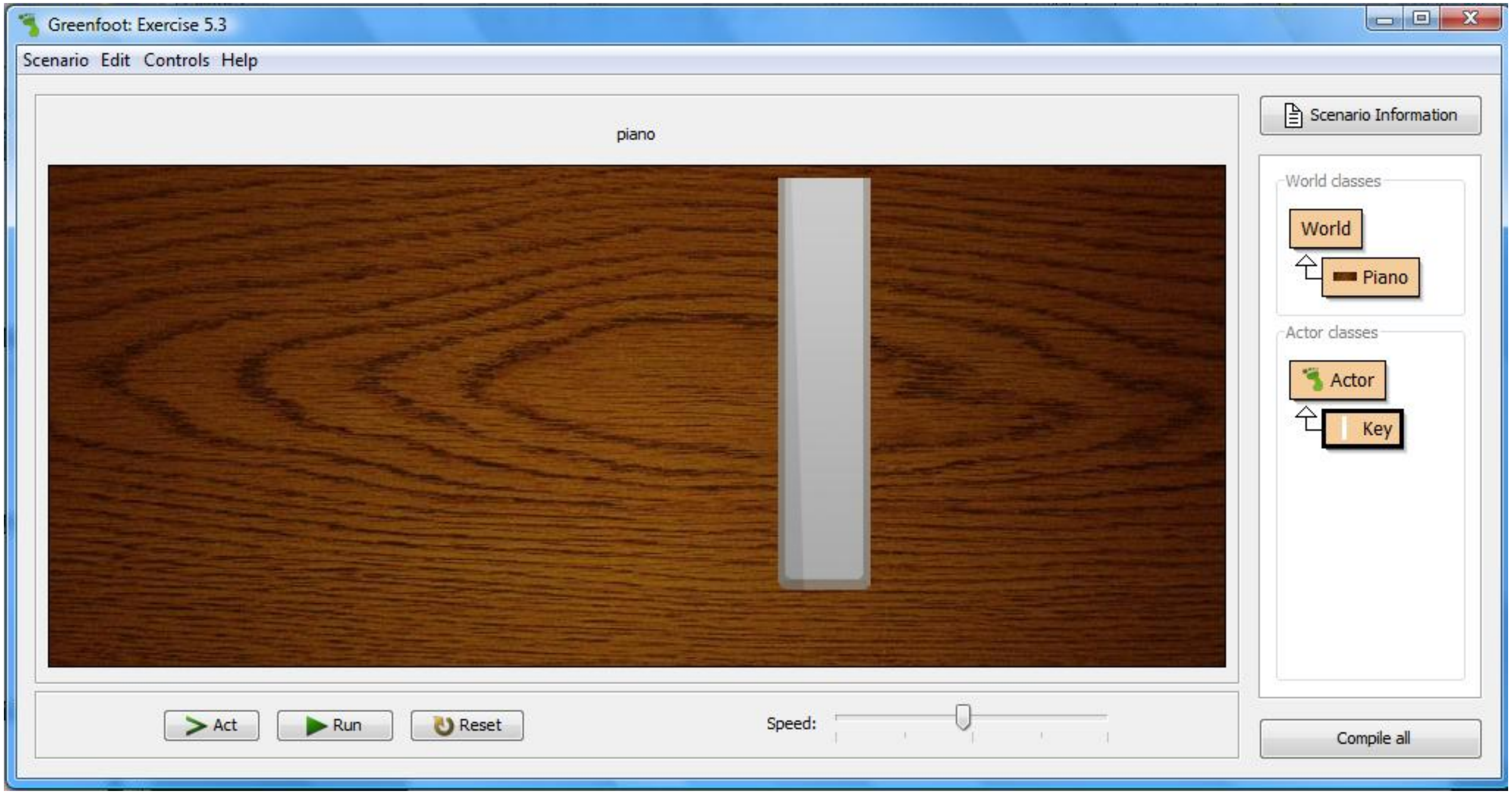
Code 5.1

```
import greenfoot.*;  // (World, Actor, GreenfootImage, and Greenfoot)

public class Key extends Actor
{
    /*
     * Create a new key.
     */
    public Key()
    {
    }

    /*
     * Do the action for this key.
     */
    public void act()
    {
    }
}
```

Code 5.2

```
public void act()
{
        if (Greenfoot.isKeyDown ("g"))
        {
                setImage ("white-key-down.png");
        }
        else
        {
                setImage ("white-key.png");
        }
}
```

Exercise 5.3


Greenfoot: Exercise 5.3
Scenario
Edit
Controls
Help
piano
Scenario Information
World classes
World
Piano
Actor classes
Actor
Key
Act
Run
Reset
Speed:
Compile all

Code 5.3

```
public void act ()
{
    if ( !isDown && Greenfoot.isKeyDown ("g"))
    {
        setImage ("white-key-down.png");
        isDown = true;
    }


    if ( isDown && !Greenfoot.isKeyDown ("g"))
    {
        setImage ("white-key.png");
        isDown = false;
    }
}
```

Logical Operations AND and NOT

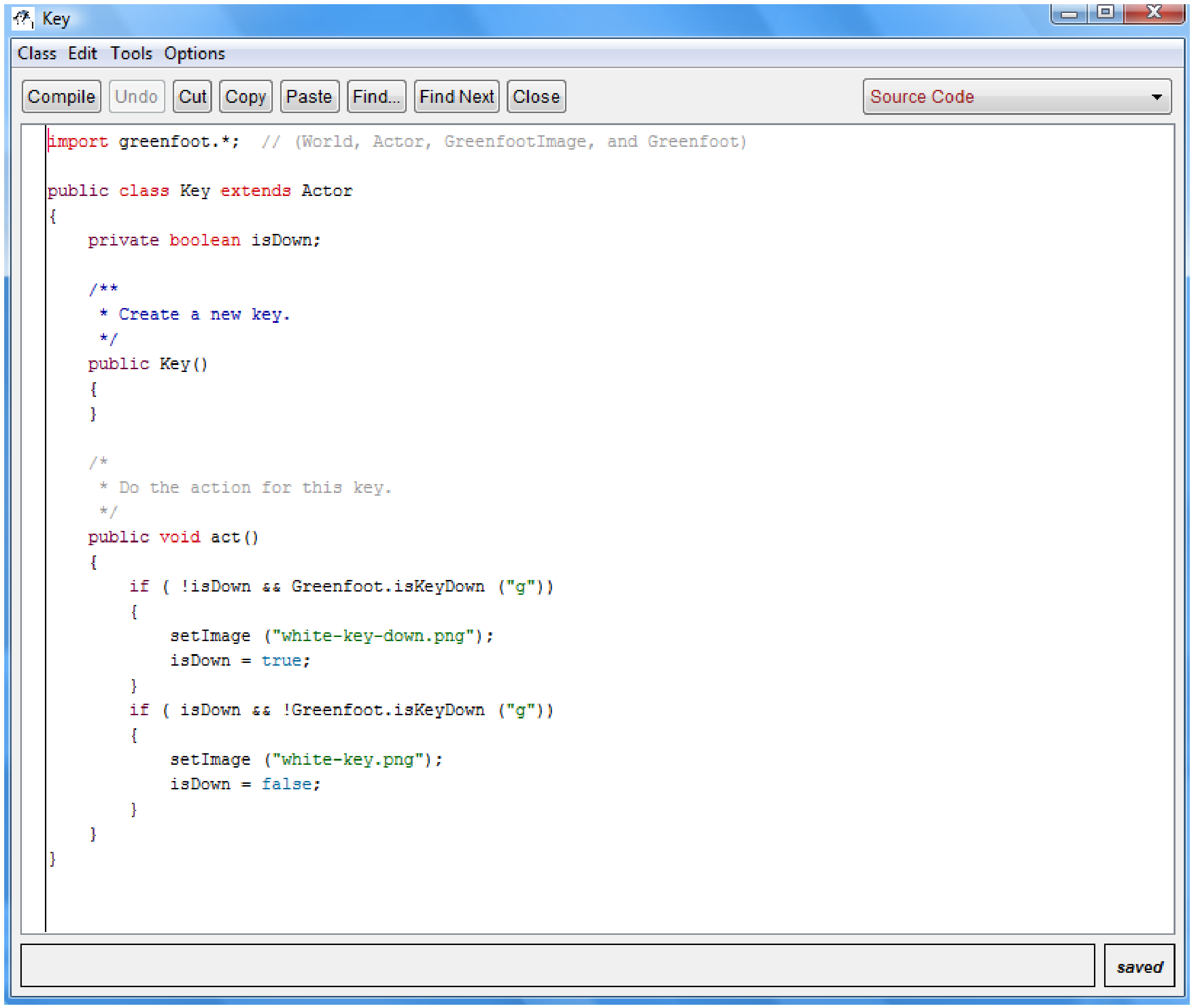
if (not isDown and “g” is down)

```
if ( !isDown && Greenfoot.isKeyDown ("g"))
{
        setImage ("white-key-down.png");
        isDown = true;
}
```

if (isDown and “g” is not down)

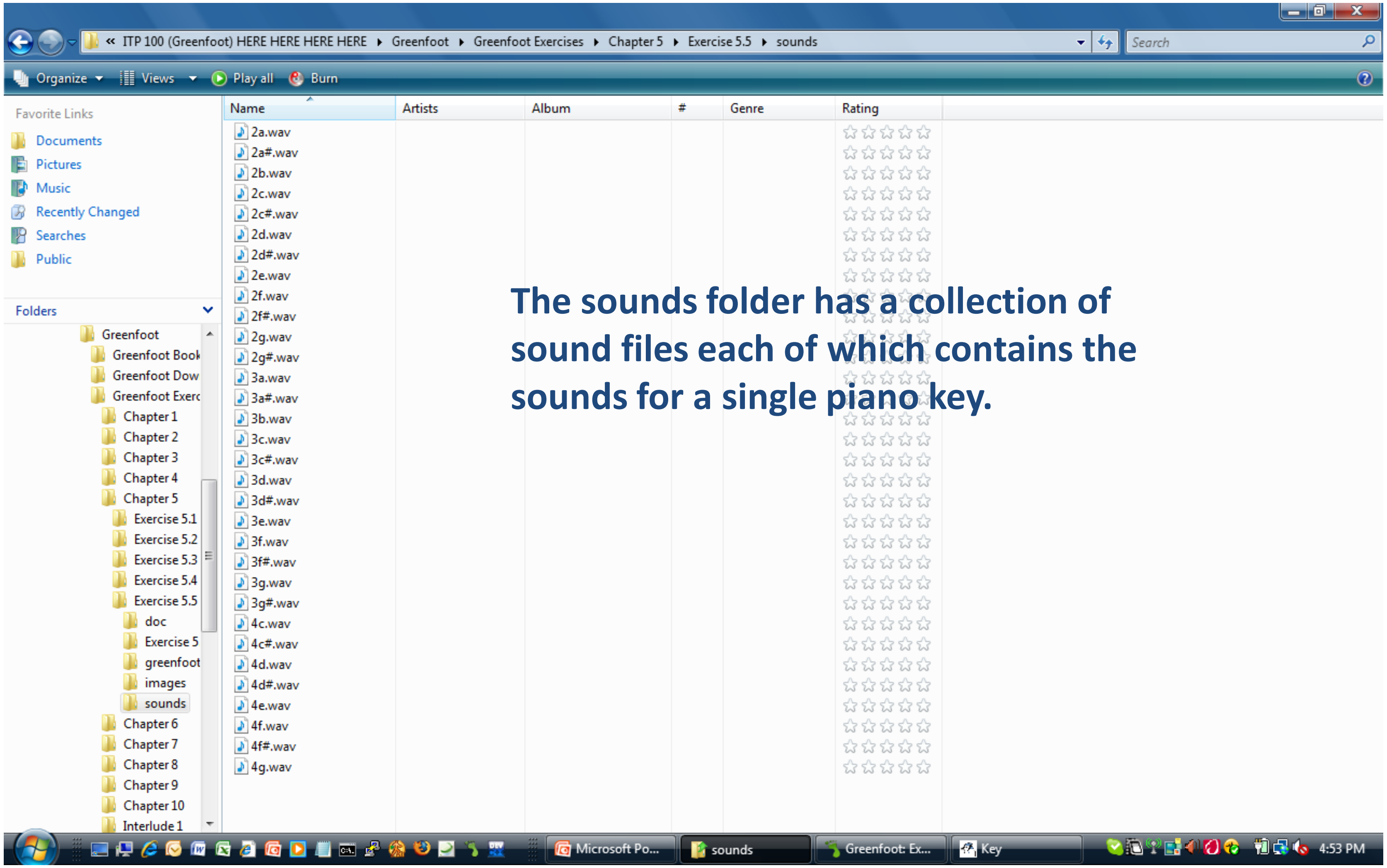
```
if ( isDown && !Greenfoot.isKeyDown ("g"))
{
        setImage ("white-key.png");
        isDown = false;
}
```

Exercise 5.4



```
import greenfoot.*;  // (World, Actor, GreenfootImage, and Greenfoot)

public class Key extends Actor
{
    private boolean isDown;

    /**
     * Create a new key.
     */
    public Key()
    {
    }

    /*
     * Do the action for this key.
     */
    public void act()
    {
        if ( !isDown && Greenfoot.isKeyDown ("g"))
        {
            setImage ("white-key-down.png");
            isDown = true;
        }
        if ( isDown && !Greenfoot.isKeyDown ("g"))
        {
            setImage ("white-key.png");
            isDown = false;
        }
    }
}
```

5.2 Producing the Sound



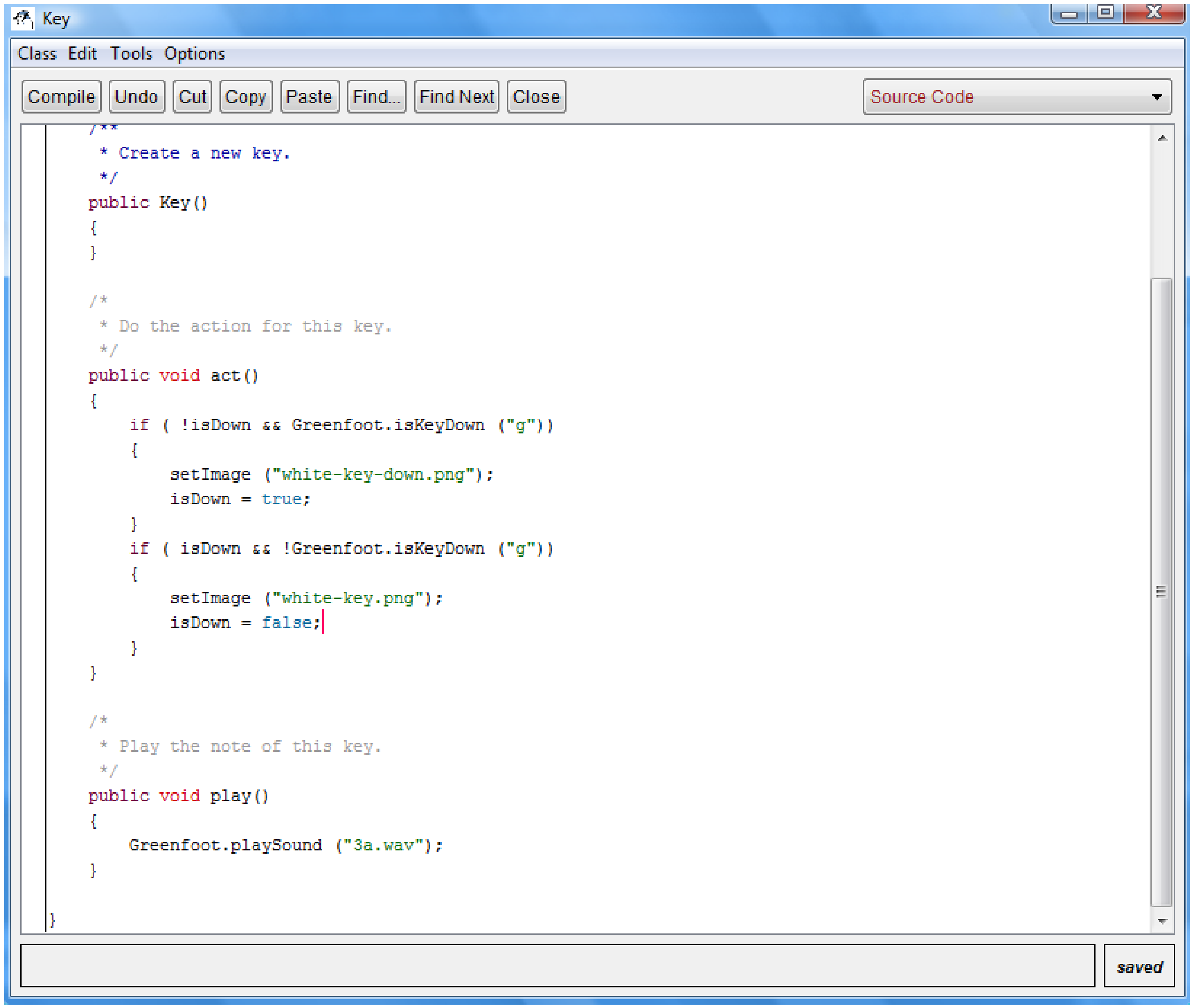
Name	Artists	Album	#	Genre	Rating
2a.wav					☆☆☆☆☆
2a#.wav					☆☆☆☆☆
2b.wav					☆☆☆☆☆
2c.wav					☆☆☆☆☆
2c#.wav					☆☆☆☆☆
2d.wav					☆☆☆☆☆
2d#.wav					☆☆☆☆☆
2e.wav					☆☆☆☆☆
2f.wav					☆☆☆☆☆
2f#.wav					☆☆☆☆☆
2g.wav					☆☆☆☆☆
2g#.wav					☆☆☆☆☆
3a.wav					☆☆☆☆☆
3a#.wav					☆☆☆☆☆
3b.wav					☆☆☆☆☆
3c.wav					☆☆☆☆☆
3c#.wav					☆☆☆☆☆
3d.wav					☆☆☆☆☆
3d#.wav					☆☆☆☆☆
3e.wav					☆☆☆☆☆
3f.wav					☆☆☆☆☆
3f#.wav					☆☆☆☆☆
3g.wav					☆☆☆☆☆
3g#.wav					☆☆☆☆☆
4c.wav					☆☆☆☆☆
4c#.wav					☆☆☆☆☆
4d.wav					☆☆☆☆☆
4d#.wav					☆☆☆☆☆
4e.wav					☆☆☆☆☆
4f.wav					☆☆☆☆☆
4f#.wav					☆☆☆☆☆
4g.wav					☆☆☆☆☆

The sounds folder has a collection of sound files each of which contains the sounds for a single piano key.

Code 5.4

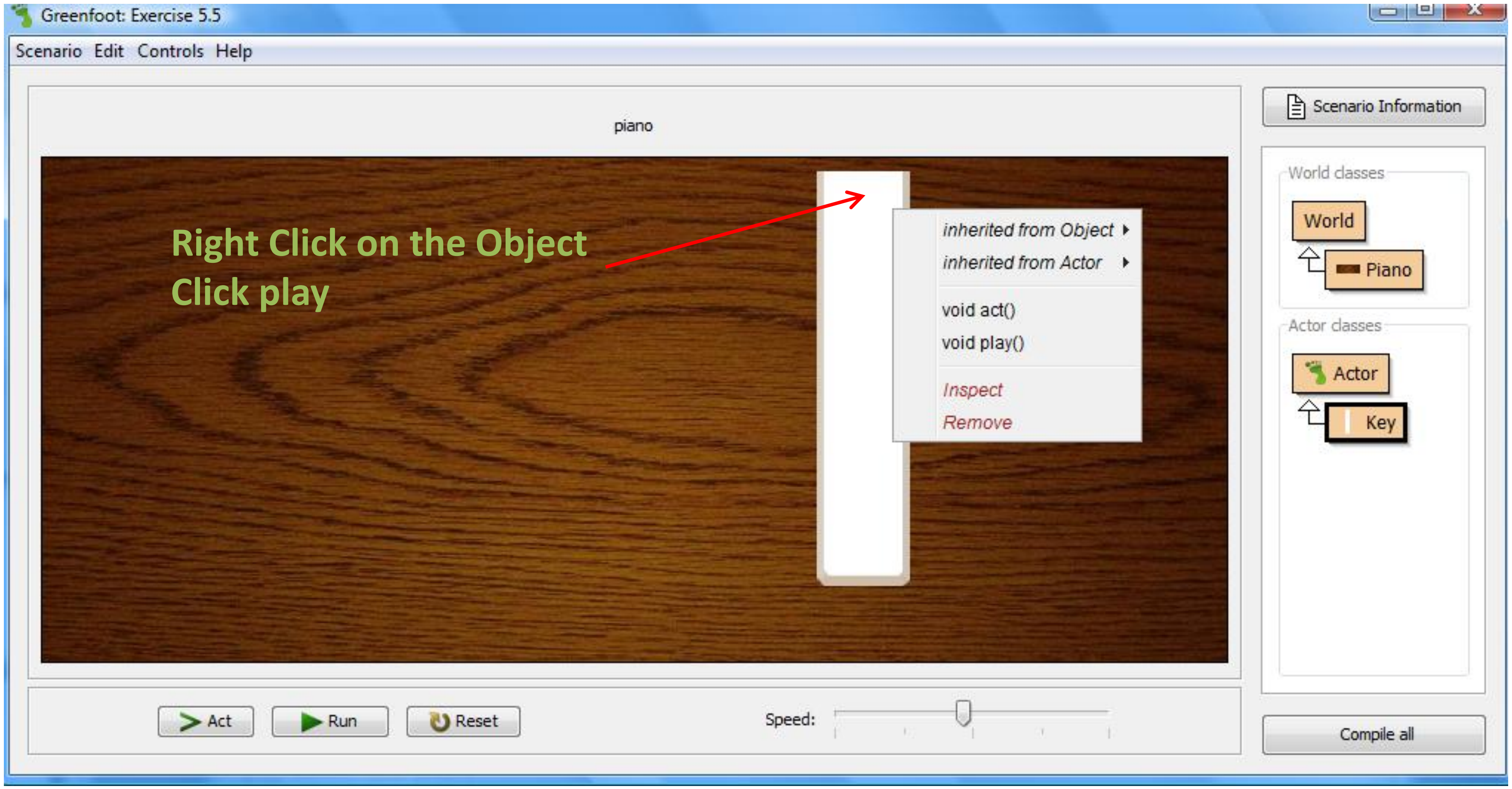
```
/*
 * Play the note of this key.
 */
public void play()
{
      Greenfoot.playSound ("3a.wav");
}
```

Exercise 5.5

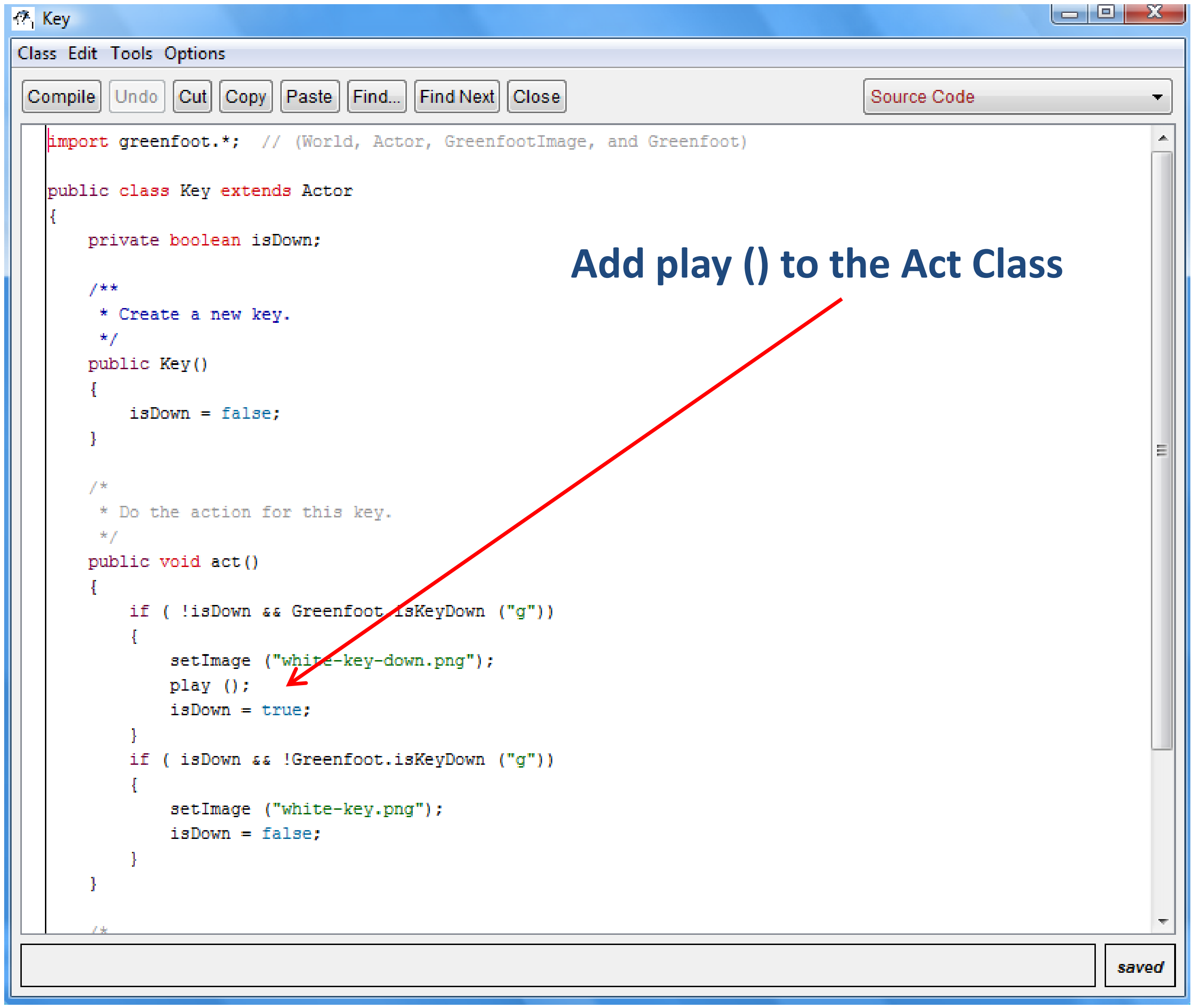


```
    /**
     * Create a new key.
     */
    public Key()
    {
    }

    /*
     * Do the action for this key.
     */
    public void act()
    {
        if ( !isDown && Greenfoot.isKeyDown ("g"))
        {
            setImage ("white-key-down.png");
            isDown = true;
        }
        if ( isDown && !Greenfoot.isKeyDown ("g"))
        {
            setImage ("white-key.png");
            isDown = false;
        }
    }

    /*
     * Play the note of this key.
     */
    public void play()
    {
        Greenfoot.playSound ("3a.wav");
    }

}
```

Exercise 5.6


Greenfoot: Exercise 5.5
Scenario Edit Controls Help
piano
Right Click on the Object
Click play
inherited from Object
inherited from Actor
void act()
void play()
Inspect
Remove
Scenario Information
World classes
World
Piano
Actor classes
Actor
Key
Act
Run
Reset
Speed:
Compile all

Exercise 5.7

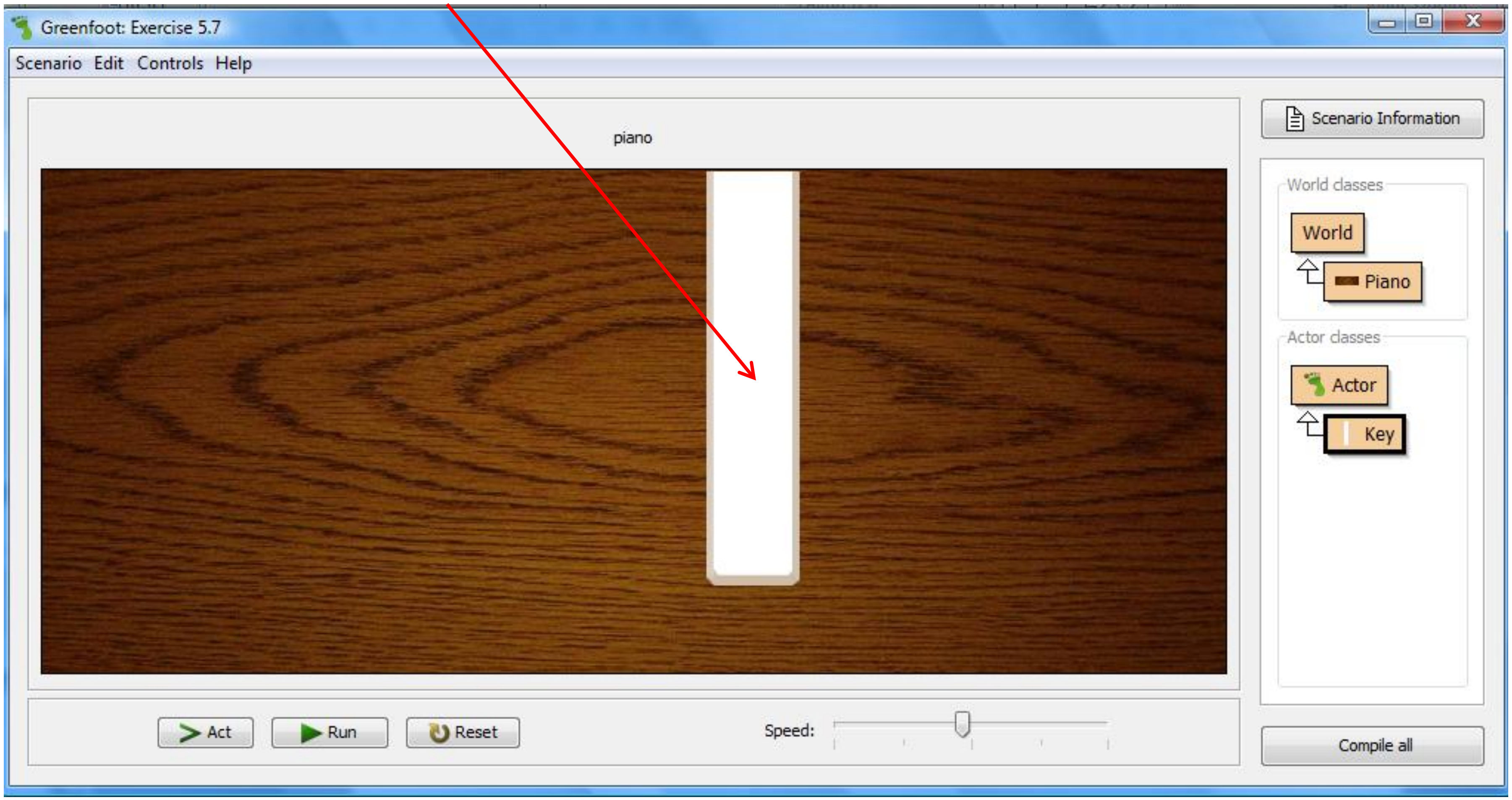


```
import greenfoot.*;  // (World, Actor, GreenfootImage, and Greenfoot)

public class Key extends Actor
{
    private boolean isDown;

    /**
     * Create a new key.
     */
    public Key()
    {
        isDown = false;
    }

    /*
     * Do the action for this key.
     */
    public void act()
    {
        if ( !isDown && Greenfoot.isKeyDown ("g"))
        {
            setImage ("white-key-down.png");
            play ();
            isDown = true;
        }
        if ( isDown && !Greenfoot.isKeyDown ("g"))
        {
            setImage ("white-key.png");
            isDown = false;
        }
    }

    /*
```

Add play () to the Act Class

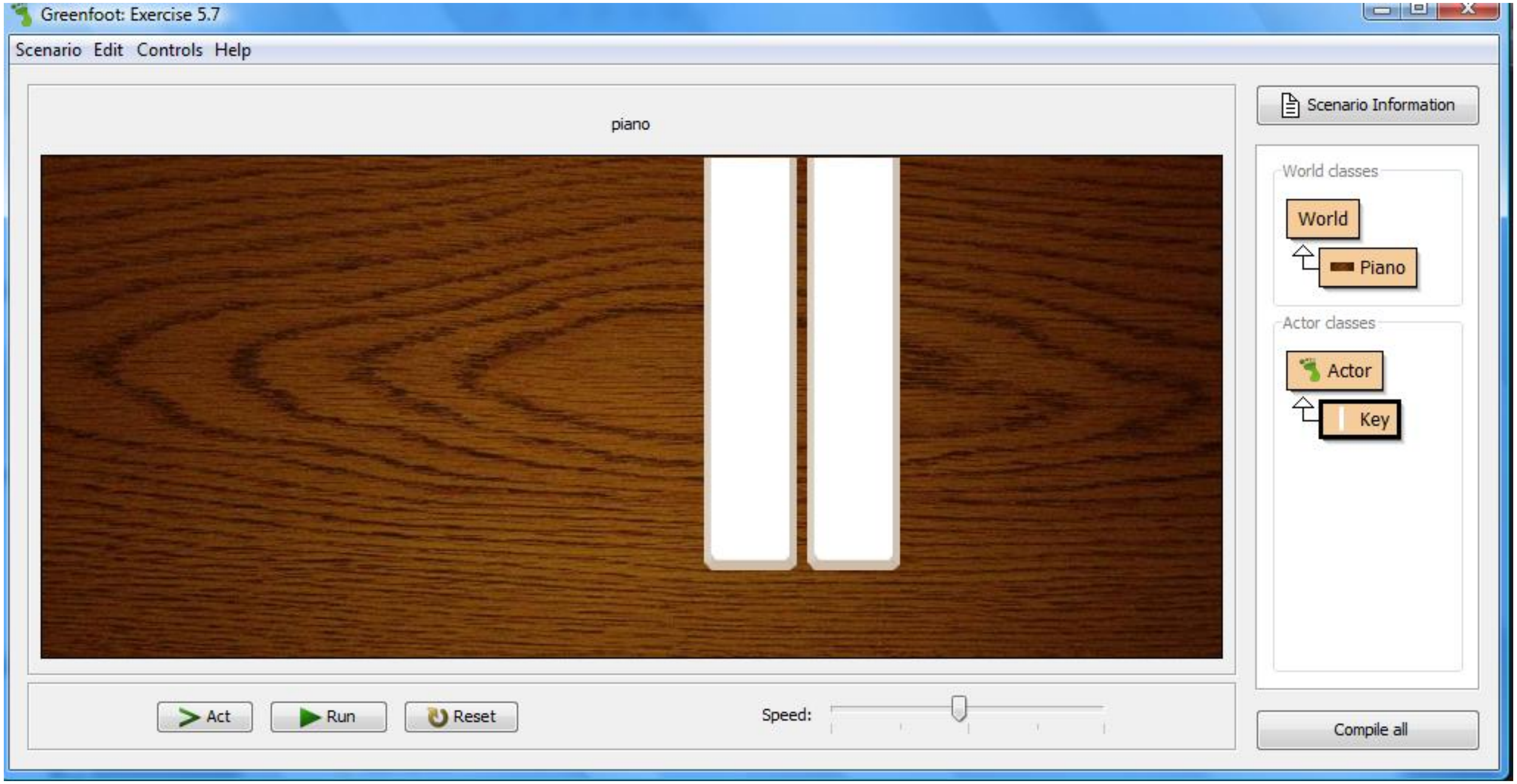
Exercise 5.7

Now the Key Plays a Note



Exercise 5.8

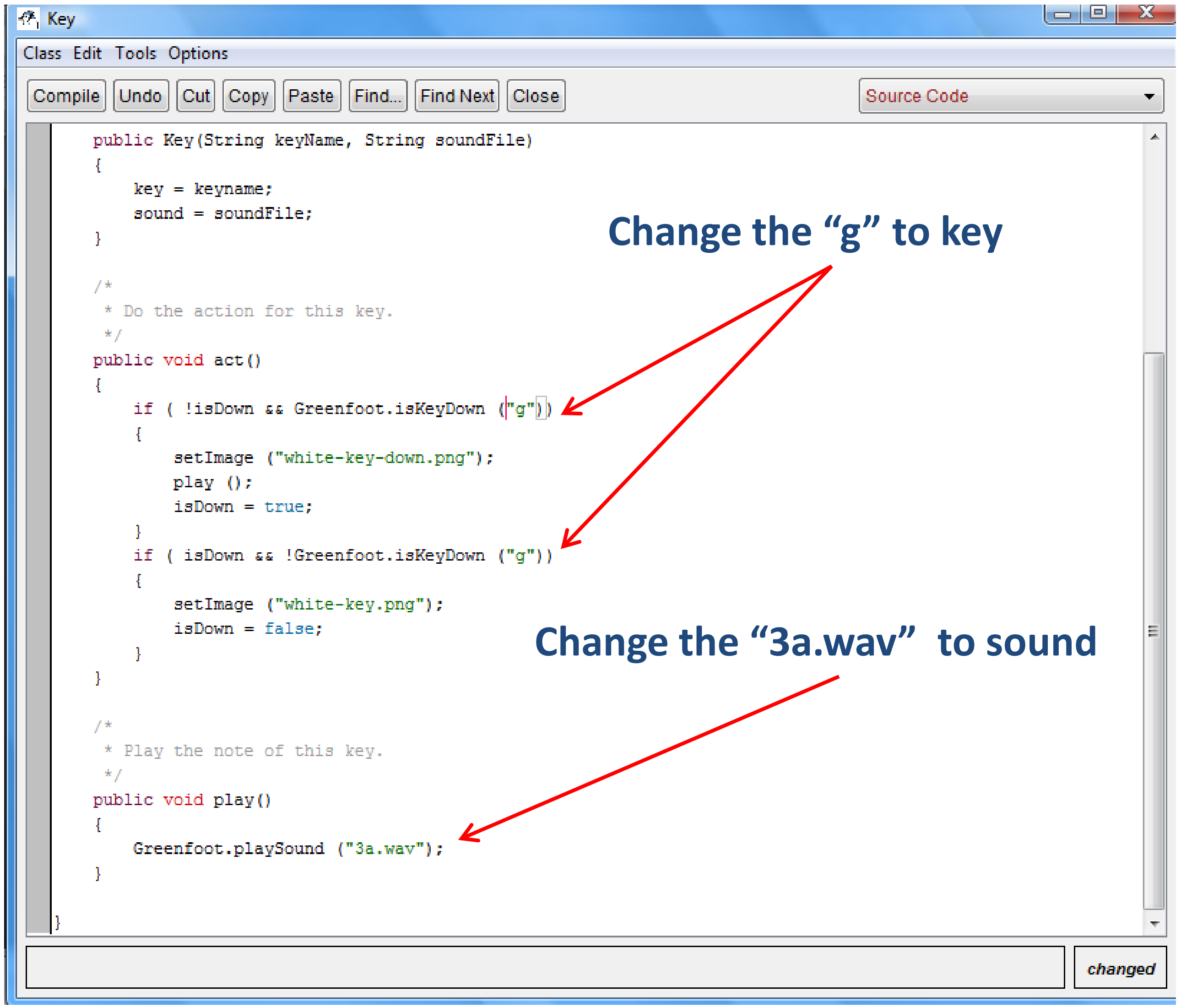
The Keys All React the Same Way



Code 5.5

```
public class Key extends Actor
{
    private boolean isDown;
    private String key;
    private String sound;

    /*
     * Create a new key linked to a given keyboard key, and
     * with a given sound.
     */
    public Key(String keyName, String soundFile)
    {
        key = keyName;
        sound = soundFile;
    }

    //  methods omitted.
}
```

Exercise 5.9



```
public Key(String keyName, String soundFile)
{
    key = keyname;
    sound = soundFile;
}

/*
 * Do the action for this key.
 */
public void act()
{
    if ( !isDown && Greenfoot.isKeyDown ("g"))
    {
        setImage ("white-key-down.png");
        play ();
        isDown = true;
    }
    if ( isDown && !Greenfoot.isKeyDown ("g"))
    {
        setImage ("white-key.png");
        isDown = false;
    }
}

/*
 * Play the note of this key.
 */
public void play()
{
    Greenfoot.playSound ("3a.wav");
}

}
```

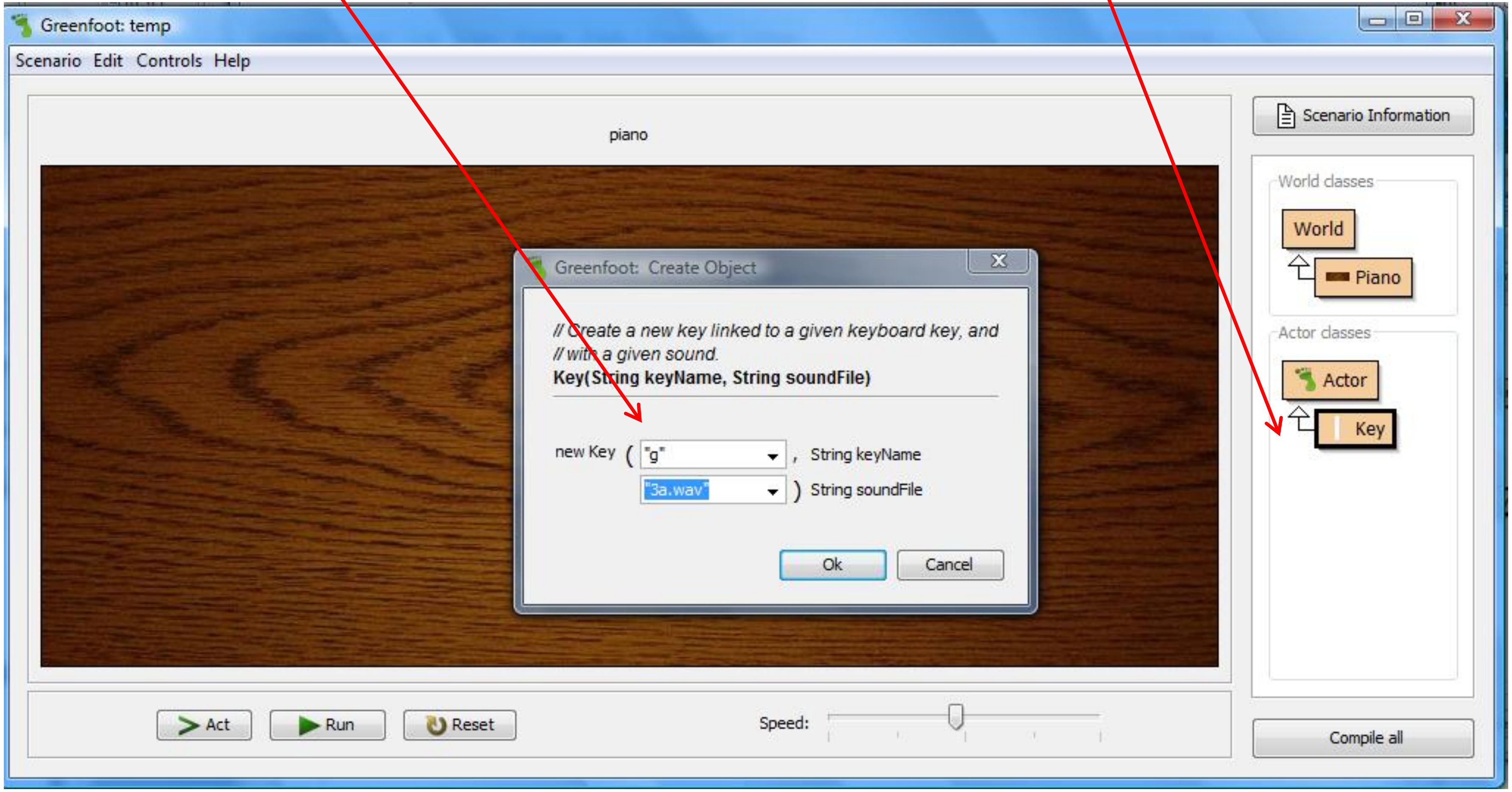
Change the “g” to key

Change the “3a.wav” to sound

Exercise 5.10

keyName is “g” and soundFile is “3a.wav”

Right Click Key
Select new Key

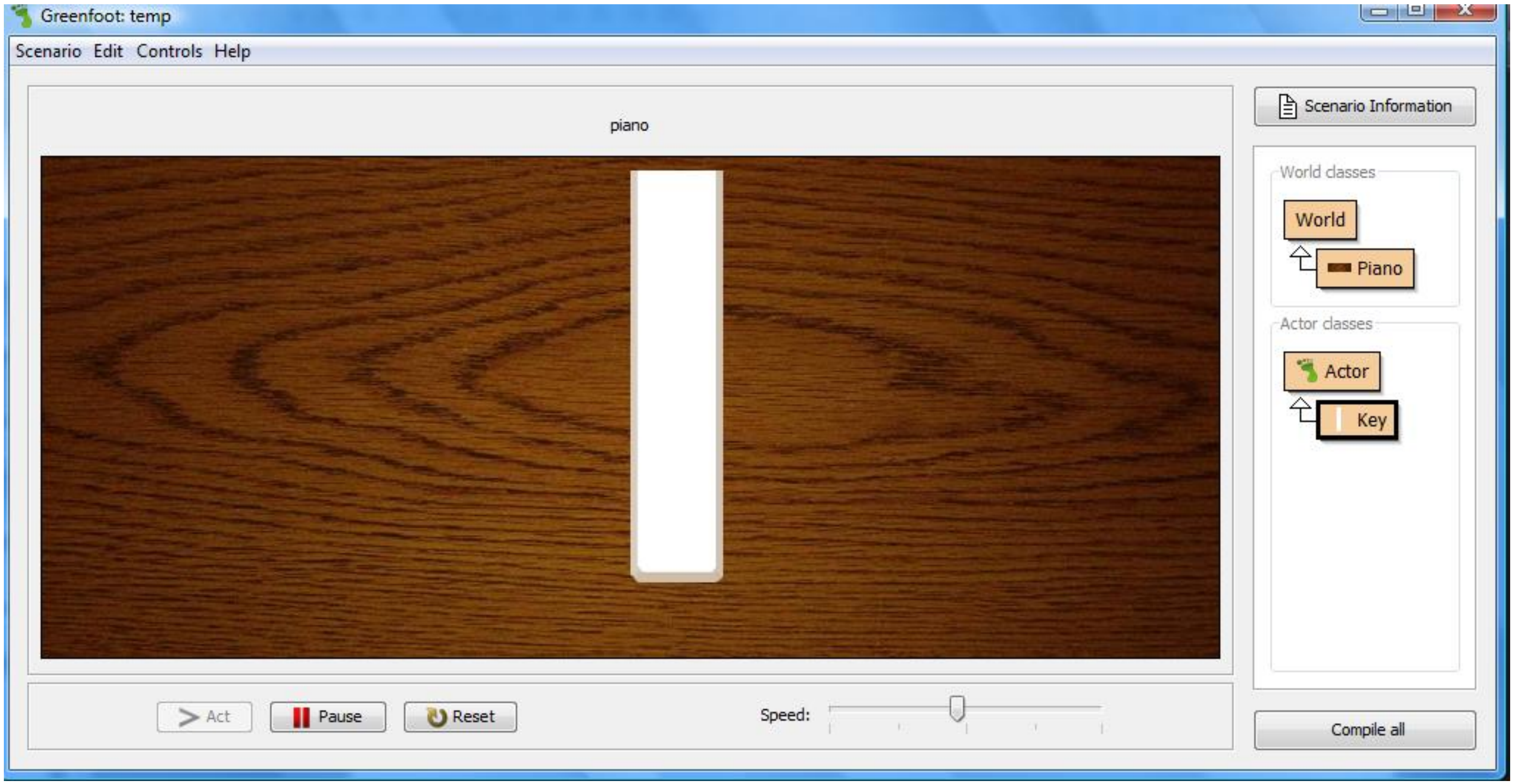


// Create a new key linked to a given keyboard key, and
// with a given sound.
Key(String keyName, String soundFile)

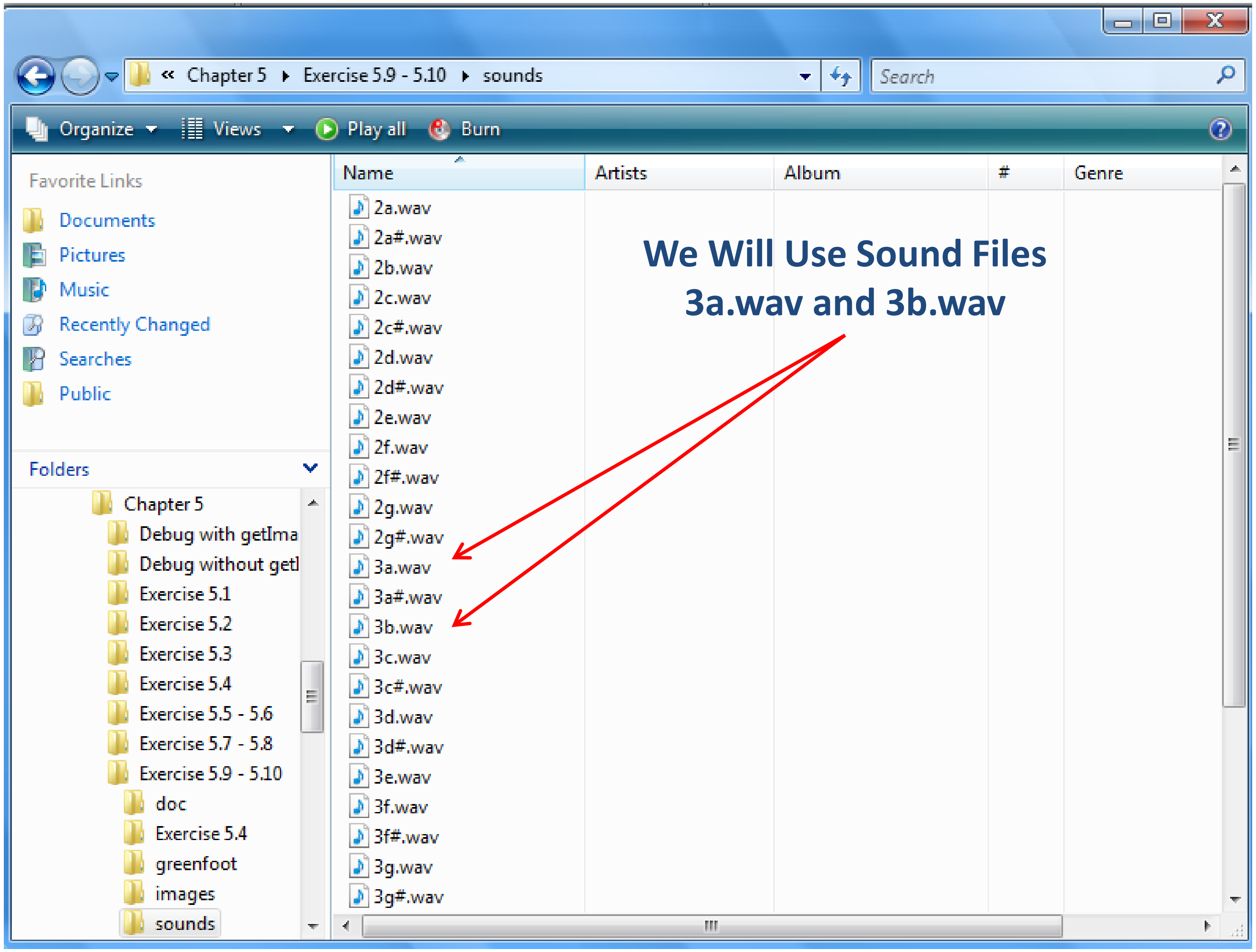
new Key ("g" , String keyName
"3a.wav") String soundFile

Exercise 5.10

Key Works as Before



sounds Folder



« Chapter 5 ▸ Exercise 5.9 - 5.10 ▸ sounds

Organize Views Play all Burn

Favorite Links
- Documents
- Pictures
- Music
- Recently Changed
- Searches
- Public

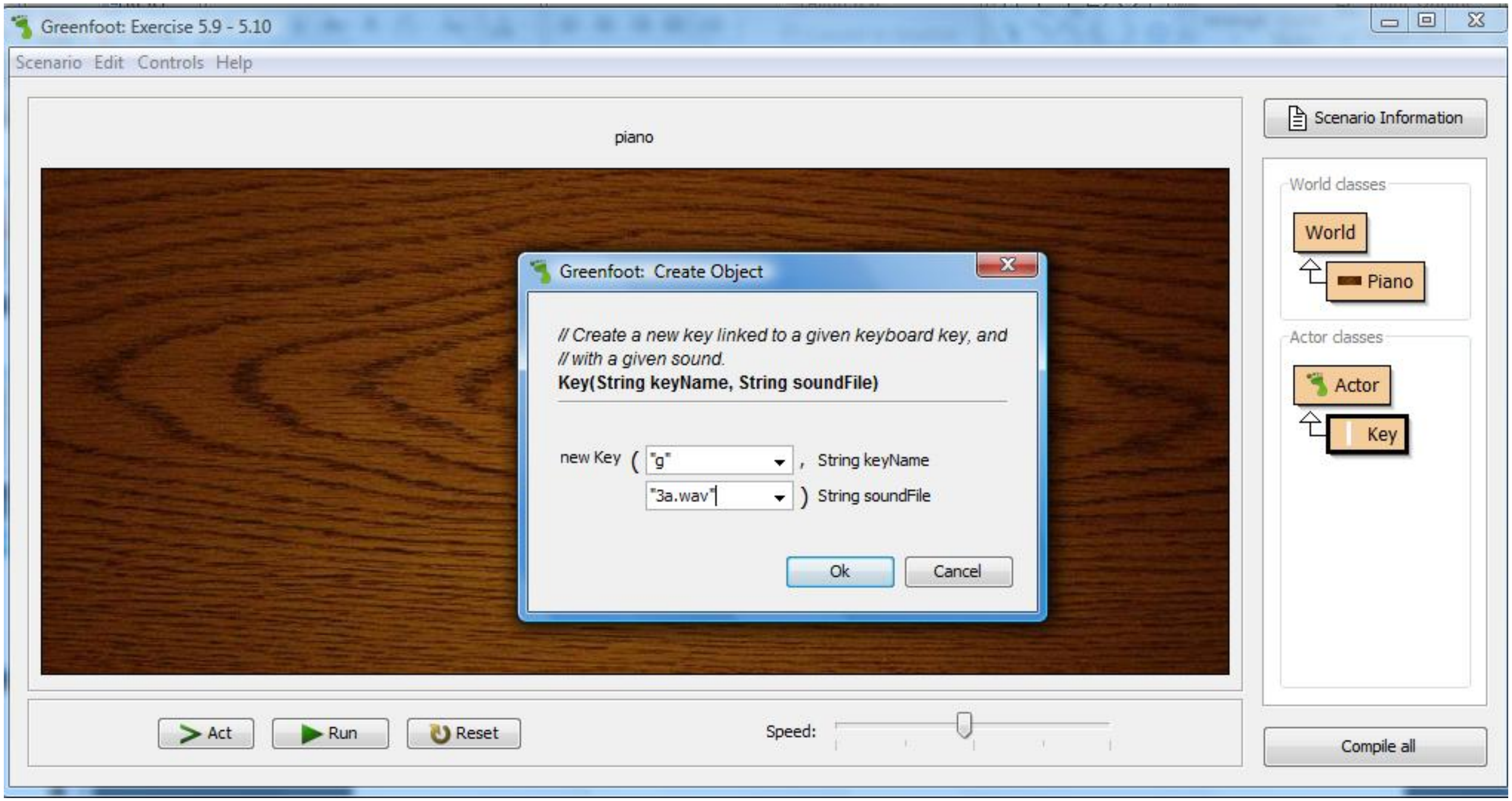
Folders
- Chapter 5
  - Debug with getIma
  - Debug without getI
  - Exercise 5.1
  - Exercise 5.2
  - Exercise 5.3
  - Exercise 5.4
  - Exercise 5.5 - 5.6
  - Exercise 5.7 - 5.8
  - Exercise 5.9 - 5.10
    - doc
    - Exercise 5.4
    - greenfoot
    - images
    - sounds

Name	Artists	Album	#	Genre
2a.wav				
2a#.wav				
2b.wav				
2c.wav				
2c#.wav				
2d.wav				
2d#.wav				
2e.wav				
2f.wav				
2f#.wav				
2g.wav				
2g#.wav				
3a.wav				
3a#.wav				
3b.wav				
3c.wav				
3c#.wav				
3d.wav				
3d#.wav				
3e.wav				
3f.wav				
3f#.wav				
3g.wav				
3g#.wav				

We Will Use Sound Files 3a.wav and 3b.wav

Exercise 5.10

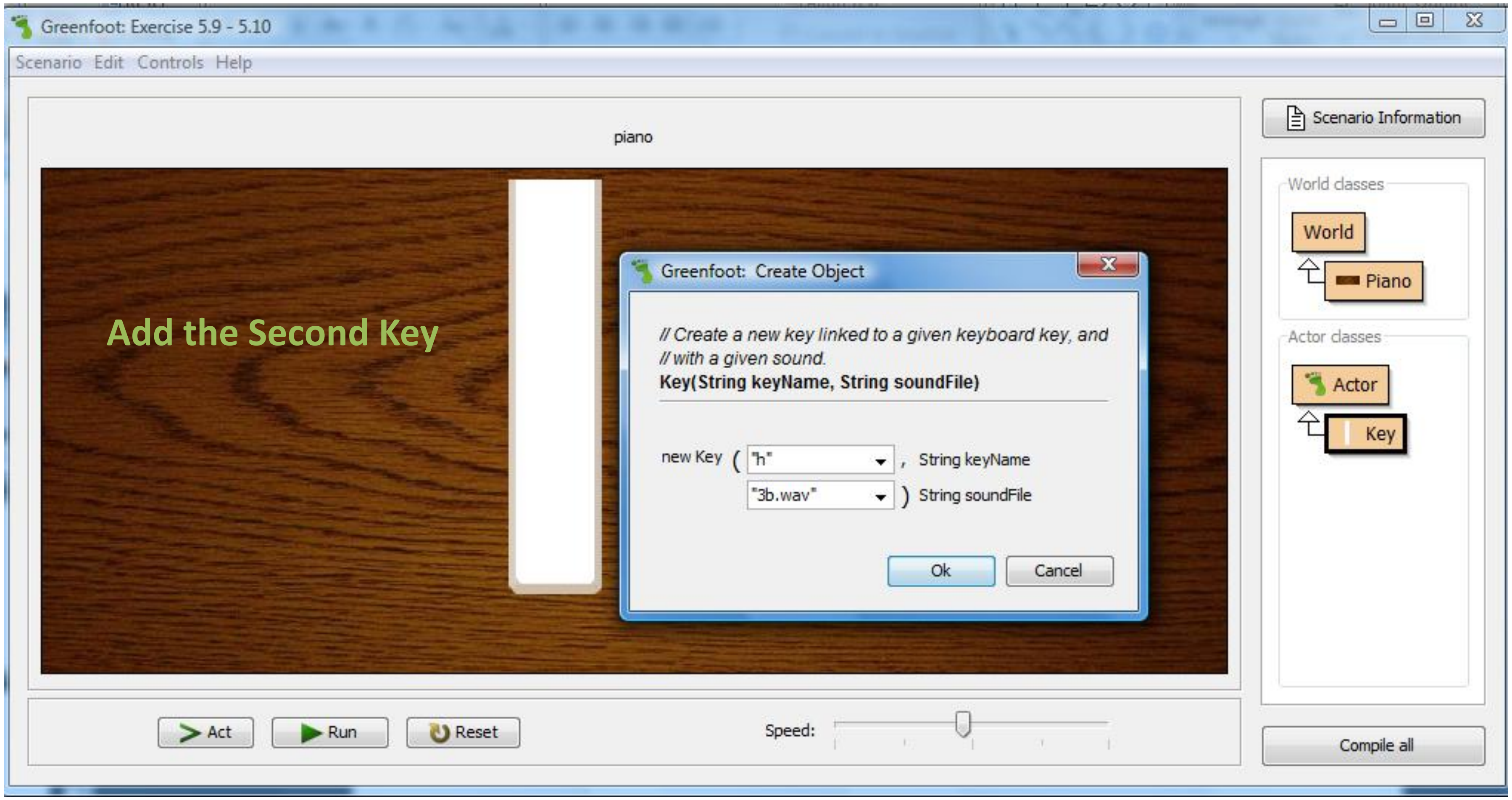
Add the First Key



// Create a new key linked to a given keyboard key, and
// with a given sound.
Key(String keyName, String soundFile)

new Key ("g" , String keyName
"3a.wav") String soundFile

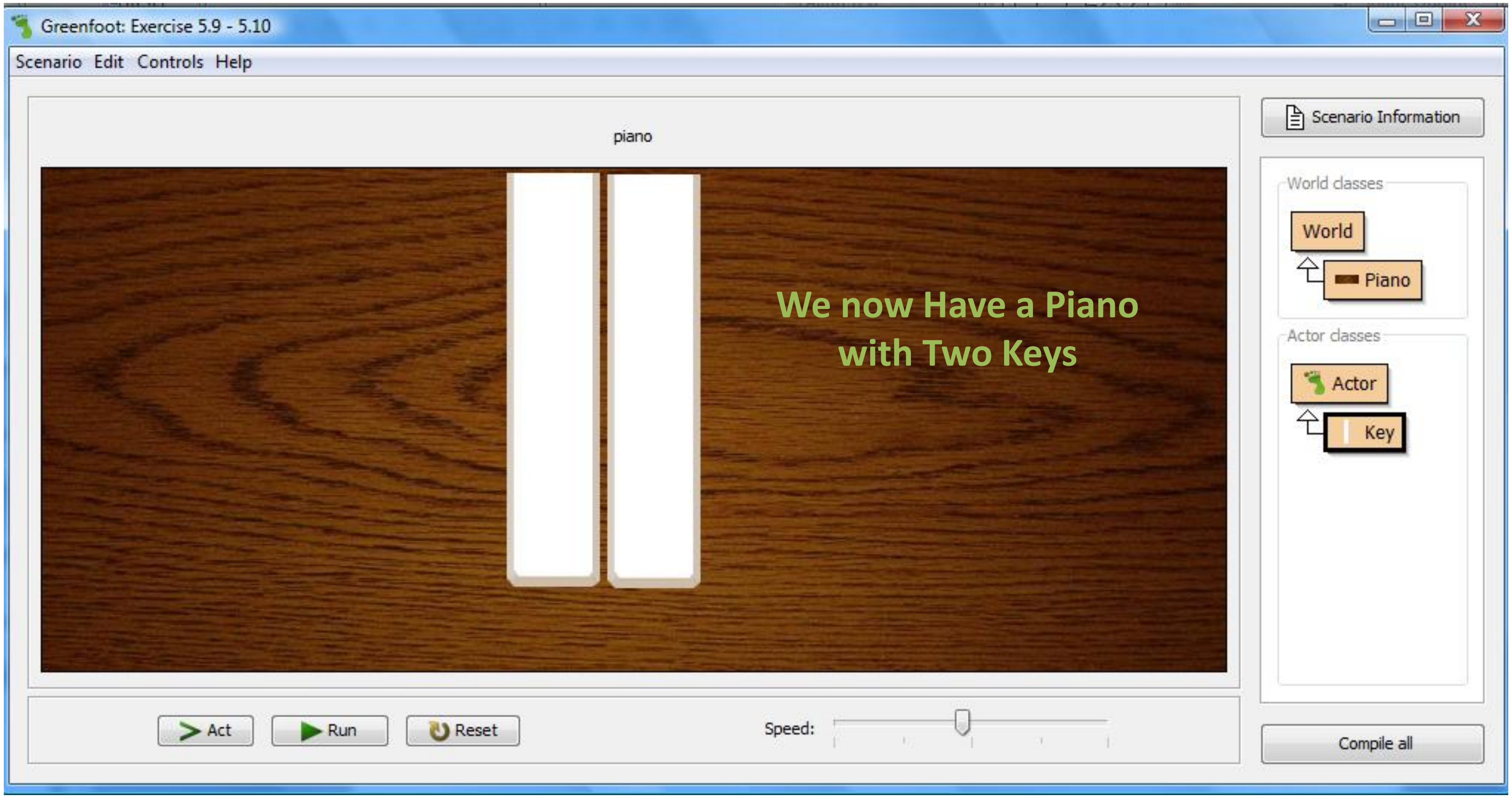
Exercise 5.10



// Create a new key linked to a given keyboard key, and
// with a given sound.
Key(String keyName, String soundFile)

new Key ("h" , String keyName
"3b.wav") String soundFile

Exercise 5.10



We now Have a Piano with Two Keys

5.4 Building the Piano

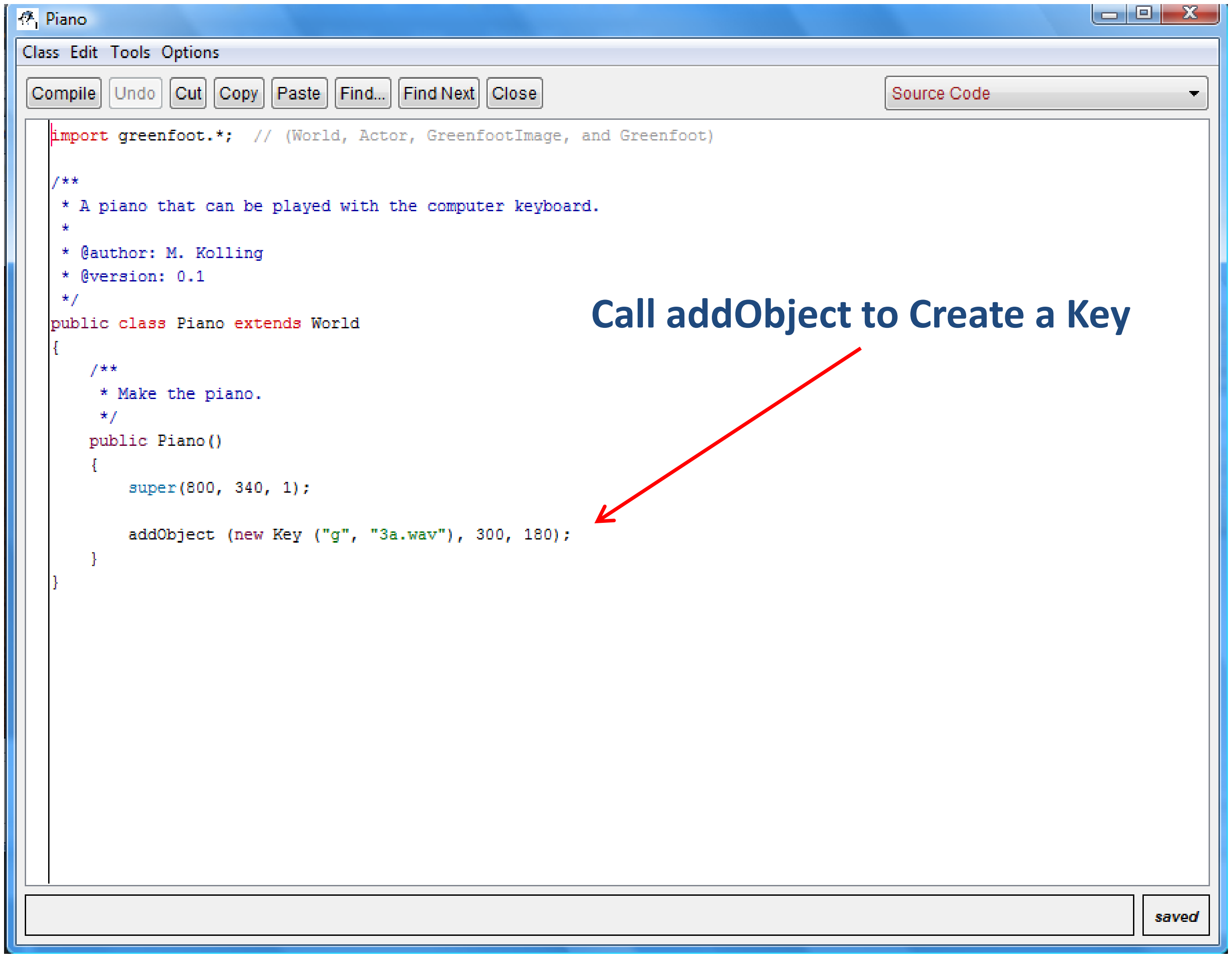
addObject (new Key (“g”, “3a.wav”, 300, 180);

Remember that the expression

new Key (“g”, “3a.wav”)

creates a new Key object with a specific key and a sound file.

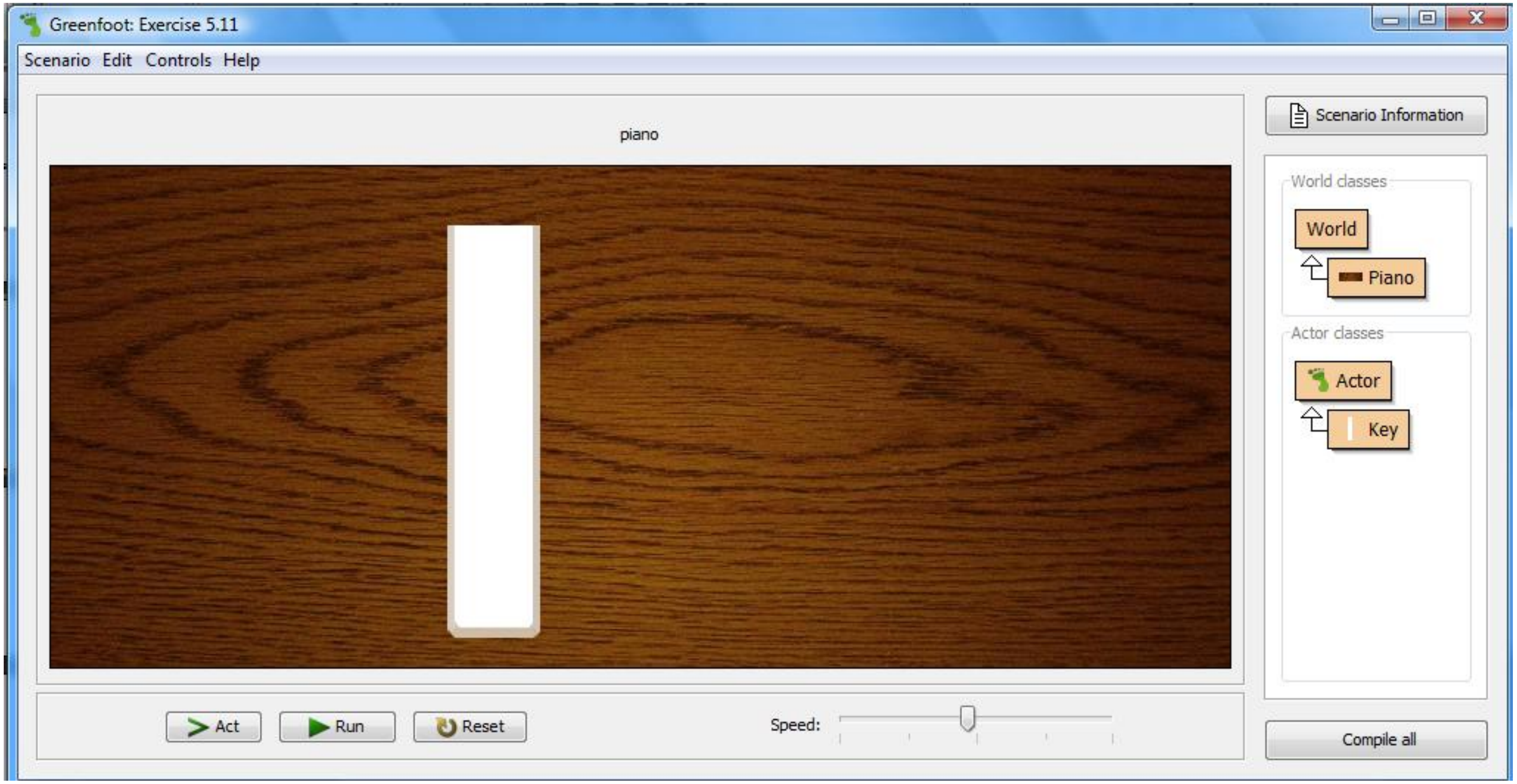
Exercise 5.11



```
import greenfoot.*;  // (World, Actor, GreenfootImage, and Greenfoot)

/**
 * A piano that can be played with the computer keyboard.
 *
 * @author: M. Kolling
 * @version: 0.1
 */
public class Piano extends World
{
    /**
     * Make the piano.
     */
    public Piano()
    {
        super(800, 340, 1);

        addObject (new Key ("g", "3a.wav"), 300, 180);
    }
}
```

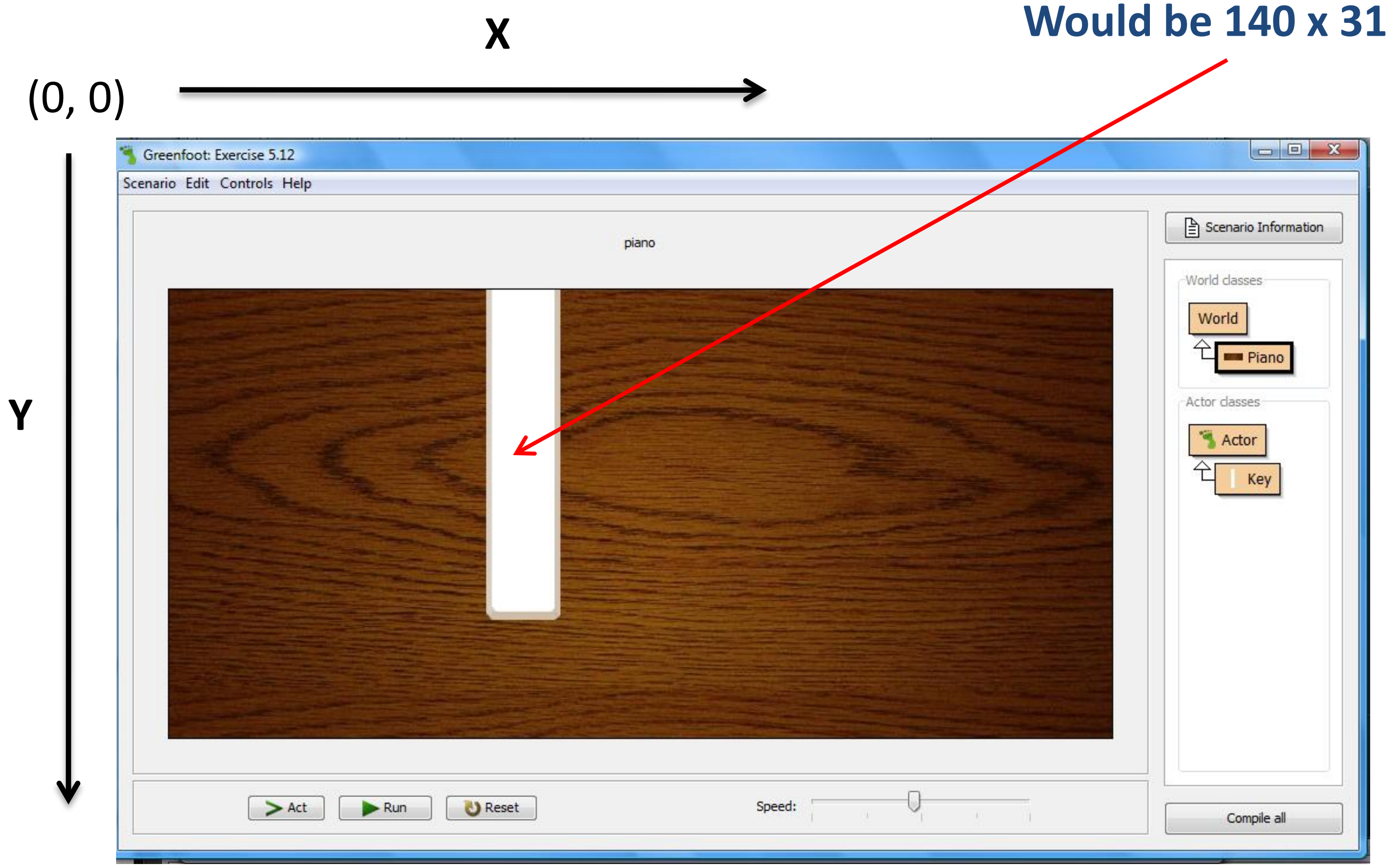
Call addObject to Create a Key

Exercise 5.11



Exercise 5.12

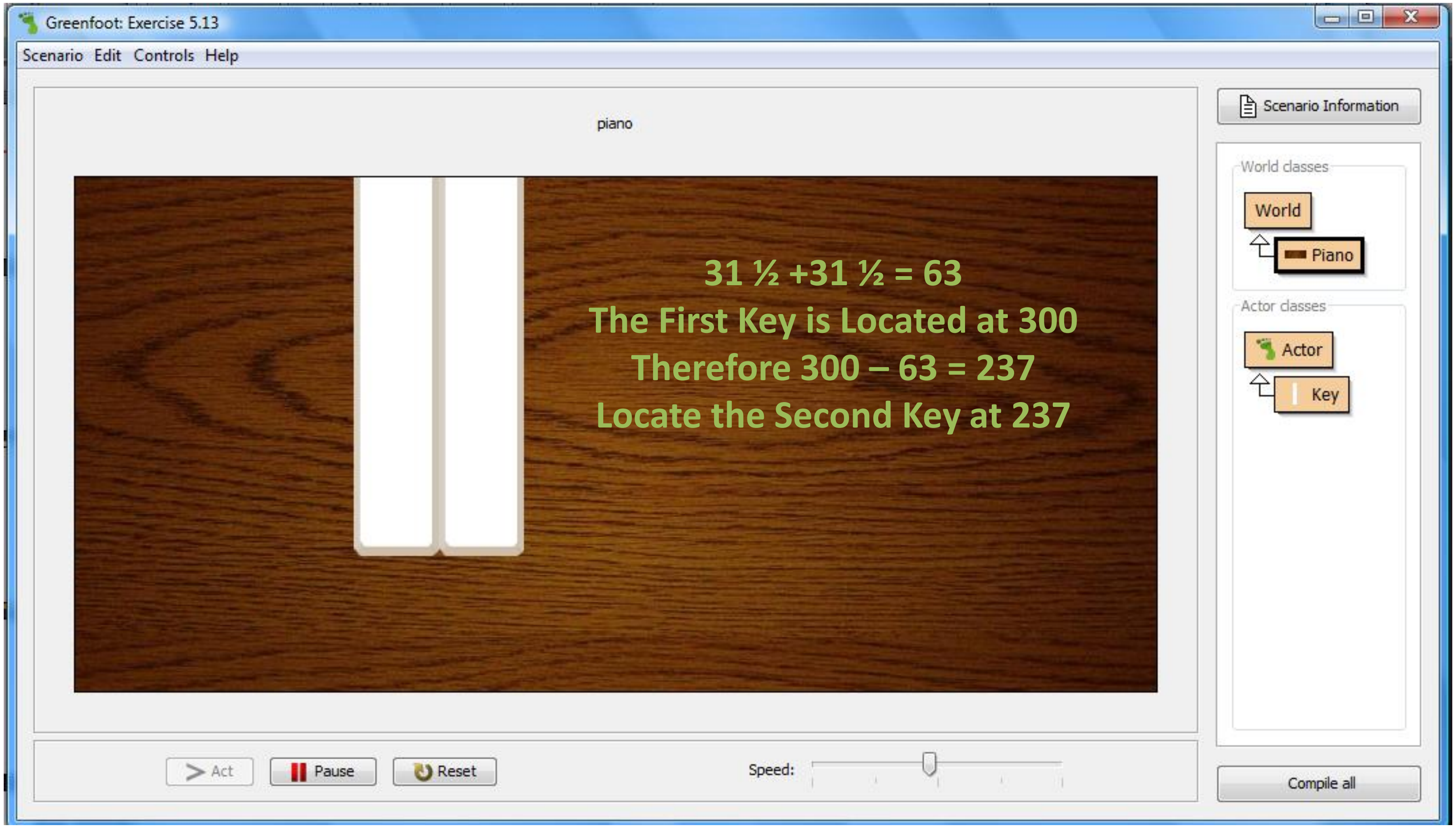
The Key is 280 x 63
Therefore the Center of the Key
Would be 140 x 31 ½



Exercise 5.12

```
import greenfoot.*;  // (World, Actor, GreenfootImage, and Greenfoot)

/*
  * A piano that can be played with the computer keyboard.
  *
  * @author: M. Kolling
  * @version: 0.1
  */
public class Piano extends World
{
        /*
          * Make the piano.
          */
        public Piano()
        {
                super(800, 380, 1);

                addObject (new Key ("g", "3a.wav"), 300, 140);
        }
}
```

Exercise 5.13



31 ½ +31 ½ = 63
The First Key is Located at 300
Therefore 300 – 63 = 237
Locate the Second Key at 237

Exercise 5.13

```
import greenfoot.*;  // (World, Actor, GreenfootImage, and Greenfoot)

/*
 * A piano that can be played with the computer keyboard.
 *
 * @author: M. Kolling
 * @version: 0.1
 */
public class Piano extends World
{
      /**
        * Make the piano.
        */
      public Piano()
      {
            super(800, 380, 1);

            addObject (new Key ("g", "3a.wav"), 300, 140);
            addObject (new Key ("f", "3g.wav"), 237, 140);
      }
}
```

Exercise 5.14

```
public class Piano extends World
{
    /*
     * Make the piano.
     */
    public Piano()
    {
        super(800, 380, 1);
        makeKeys ();
    }

    /*
     * Create the Piano Keys.
     */
    public void makeKeys()
    {
        addObject (new Key ("g", "3a.wav"), 300, 140);
        addObject (new Key ("f", "3g.wav"), 237, 140);
    }
}
```

Loops

- Repetition in programs allows us to repeat something over and over.
- We achieve repetition through loops.
- A loop is a statement in programming languages that can execute a section of code multiple times.
- We will look at a while loop to help us repeat.

While-loop

- This will keep looping until the condition indicated on the loop is false.

```
while (/*booleanExpression*/)
{
        //code that should be repeated
}
```

While-Loop

- In order to help us keep track of how many times we are looping, we need to create a variable to store a count.
- Inside the loop, we also must remember to increment the count so that the loop executes the correct number of times.

While loop

```
while (true)
{
        //code that should be repeated
}
```

- This loop will continue forever because true is always true.

5.5 Loops: The While Loop

```
while ( condition )
{
        statement;
        statement;
        .  .  .
}
```

While Loop

```
int count = 0;
while (count < 10)
{
        //code that should be repeated
        count = count + 1;
}
```

The code in this loop will execute 10 times

Local Variables

```
int  i = 0;

while ( i < 100 )
{
      statement;
      statement;
      .  .  .
      i = i + 1;
}
```

Local Variable

- A local variable is declared inside a method body, not at the beginning of the class
- It has no visibility modifier (private or public) in front of it
- It exists only until the current method finishes running, then it will be erased

for Loop Better Than while

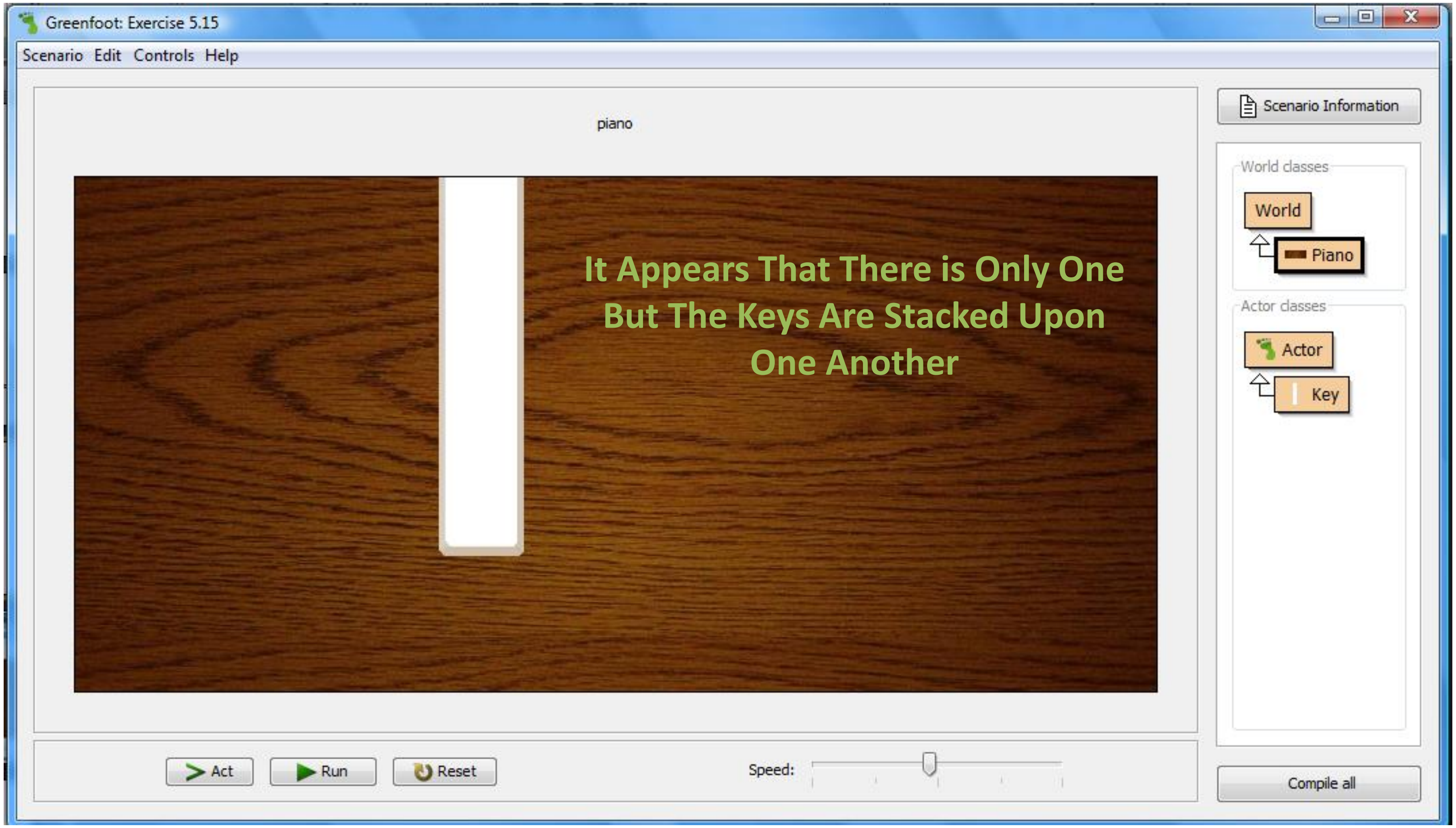
```
int  i = 0;
while ( i < 100 )
{
        statement;
        statement;
        .  .  .
        i = i + 1;
}
```

```
int  i;
for ( i=0; i < 100; i++)
{
        statement;
        statement;
        .  .  .
}
```

Exercise 5.15

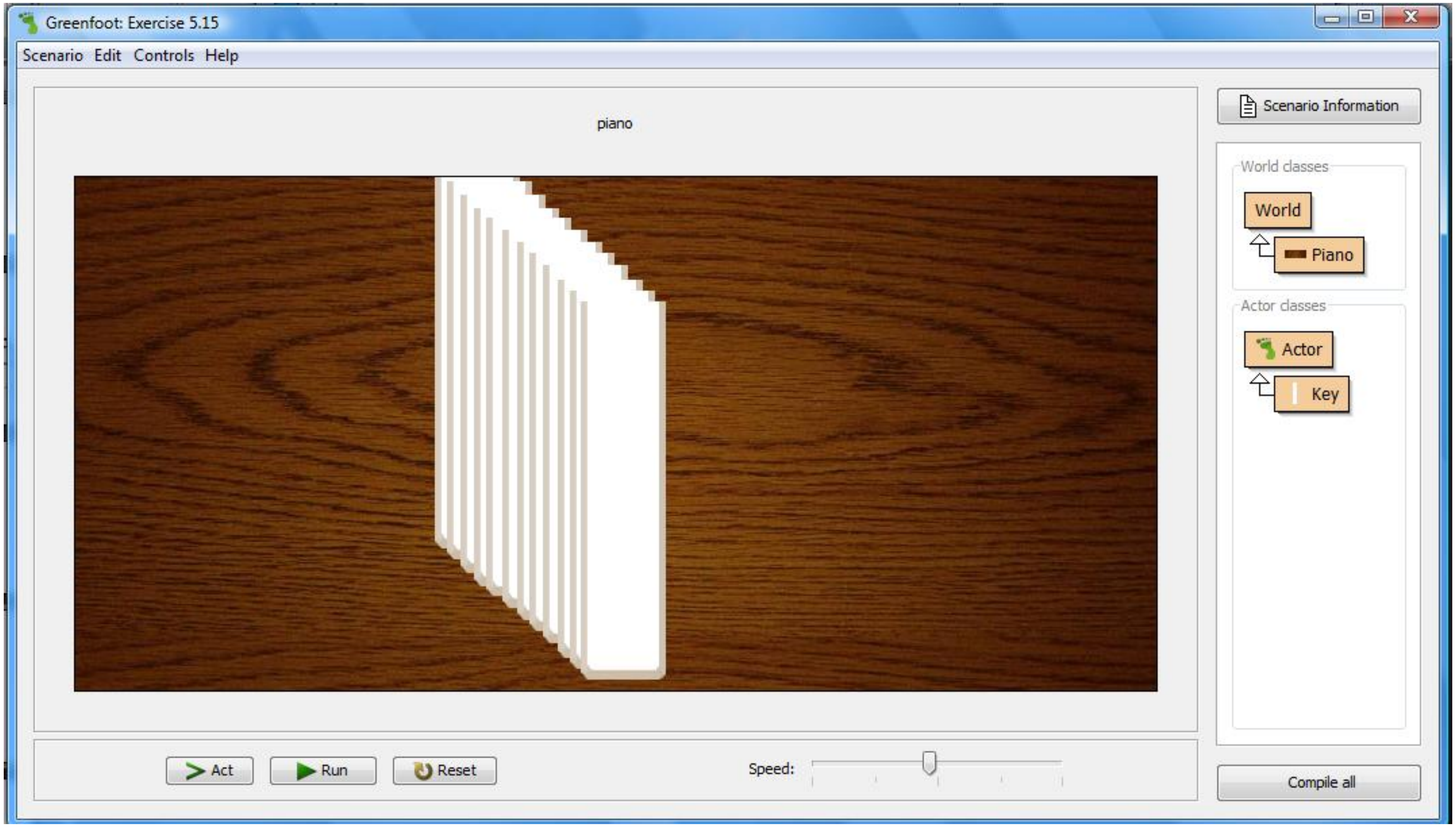
```
/*
 * Create the Piano Keys
 */
public void makeKeys()
{
    int i;

    for (i=0; i<12; i++)
        addObject (new Key ("g", "3a.wav"), 300, 140);
}
```

Exercise 5.15



It Appears That There is Only One But The Keys Are Stacked Upon One Another

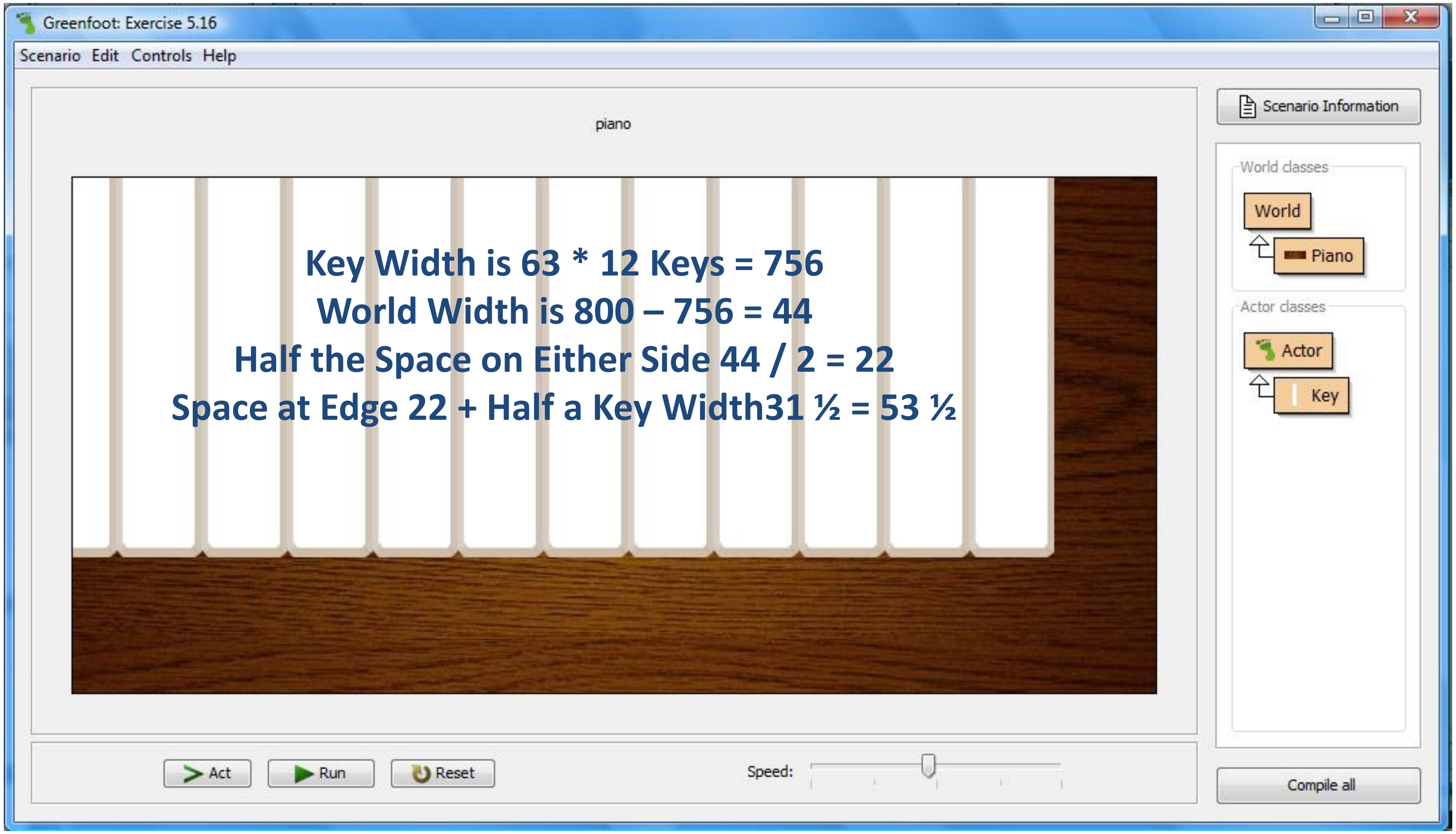
Exercise 5.15



Exercise 5.16

```
/*
 * Create the Piano Keys
 */
Public void makeKeys()
{
    int i;

    for (i=0; i<12; i++)
        addObject (new Key ("g", "3a.wav"), i*63, 140);
}
```

Exercise 5.16



Key Width is 63 * 12 Keys = 756
World Width is 800 – 756 = 44
Half the Space on Either Side 44 / 2 = 22
Space at Edge 22 + Half a Key Width31 ½ = 53 ½

Exercise 5.17

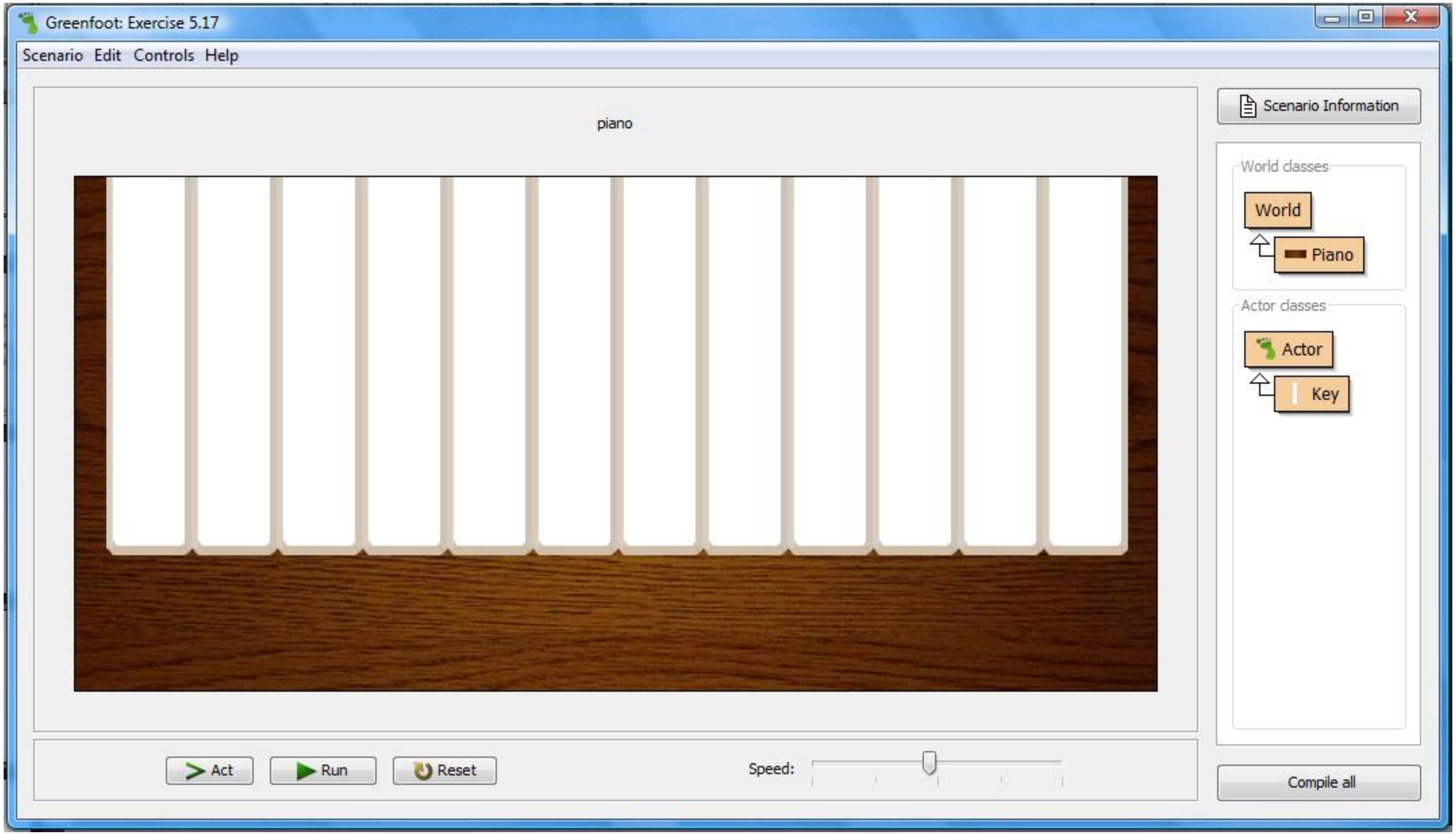
```
for (i=0; i<12; i++)
        addObject (new Key ("g", "3a.wav"), i*63 + 54, 140);
```

The for Loop Will Execute 12 Times
The Values for i Will Be 0, 1, . . ., 11

Exercise 5.17

```
/*
 * Create the Piano Keys
 */
public void makeKeys()
{
	int i;

	for (i=0; i<12; i++)
		addObject (new Key ("g", "3a.wav"),  i*63 + 54, 140);
}
```

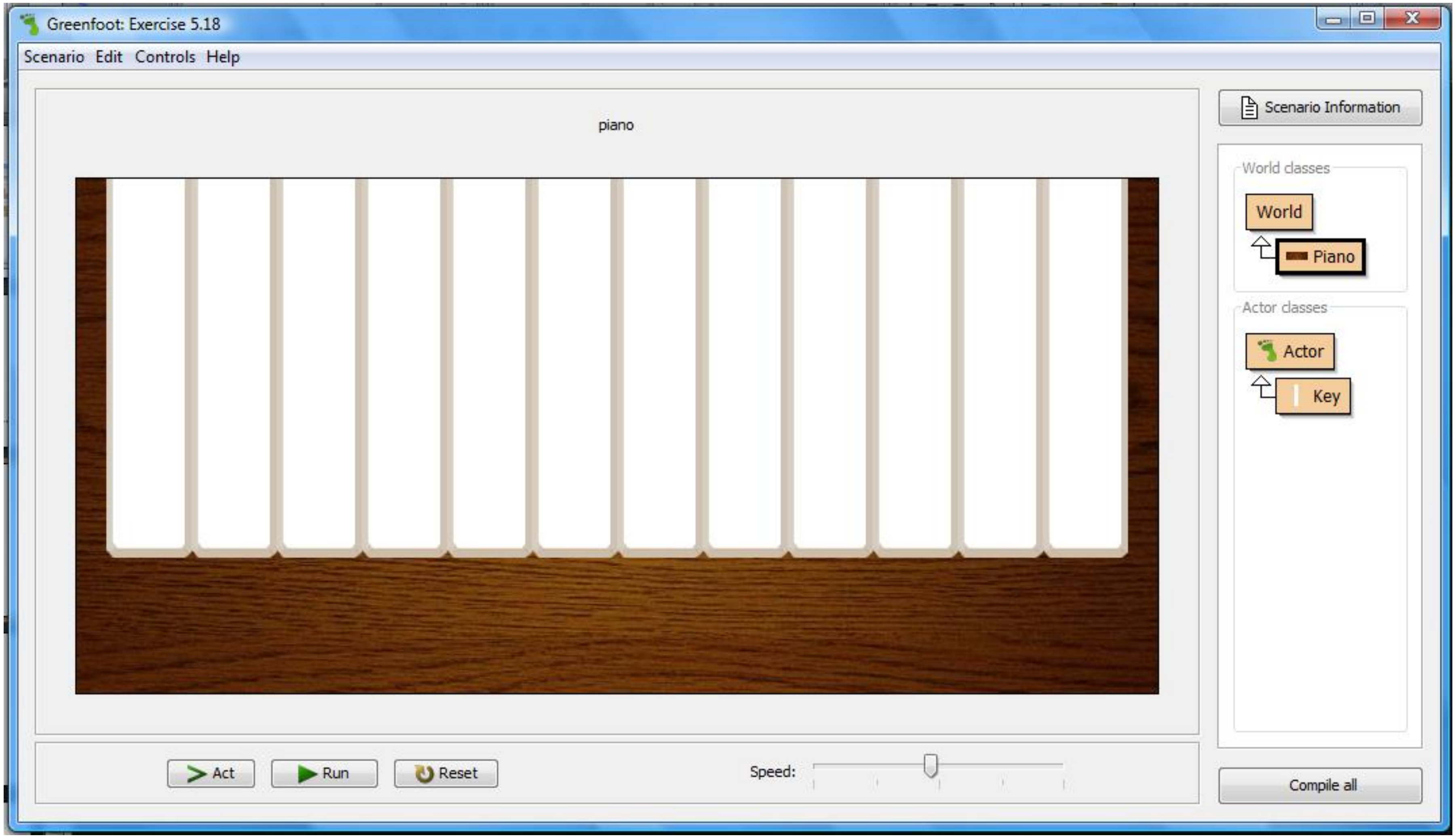
Exercise 5.17



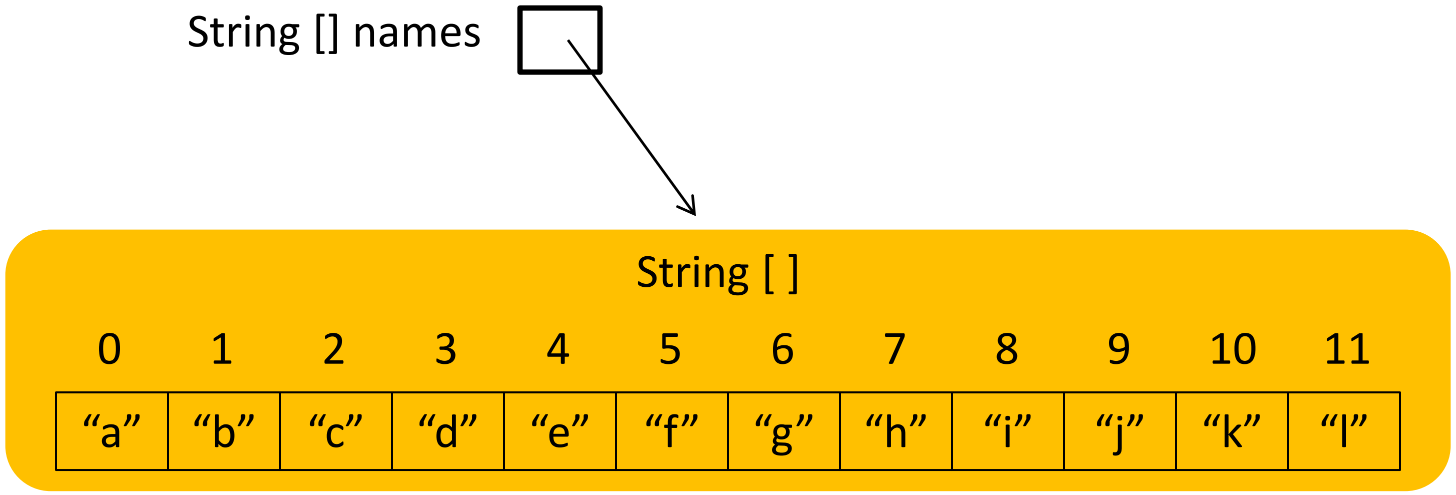
Exercise 5.18

```
/*
 * Create the Piano Keys
 */
public void makeKeys()
{
    int i;
    int keyWidth;
    int keyHeight;
    int spaceAtEdge;

    Key key = new Key(" ", " ");
    keyWidth = key.getImage().getWidth();
    keyHeight = key.getImage().getHeight();
    spaceAtEdge = (800 - keyWidth*12) / 2;

    for (i=0; i<12; i++)
        addObject (new Key ("g", "3a.wav"), keyWidth*i + spaceAtEdge + keyWidth/2, keyHeight / 2);
}
```

Exercise 5.18



5.6 Using Arrays



```
String [ ] names;
names = {“a”, “b”, “c”, “d”, “e”, “f”, “g”, “h”, “i”, “j”, “k”, “l” };
```

names [3] contains the string “d”

Code 5.6

```
public class Piano extends World
{
        private String[] whiteKeys =
                { "a", "s", "d", "f", "g", "h", "j", "k", "l", ";", "'", "\\" };
        private  String[] whiteNotes =
                { "3c", "3d", "3e", "3f", "3g", "3a", "3b", "4c", "4d", "4e", "4f", "4g“ };

        // constructor and methods omitted
}
```

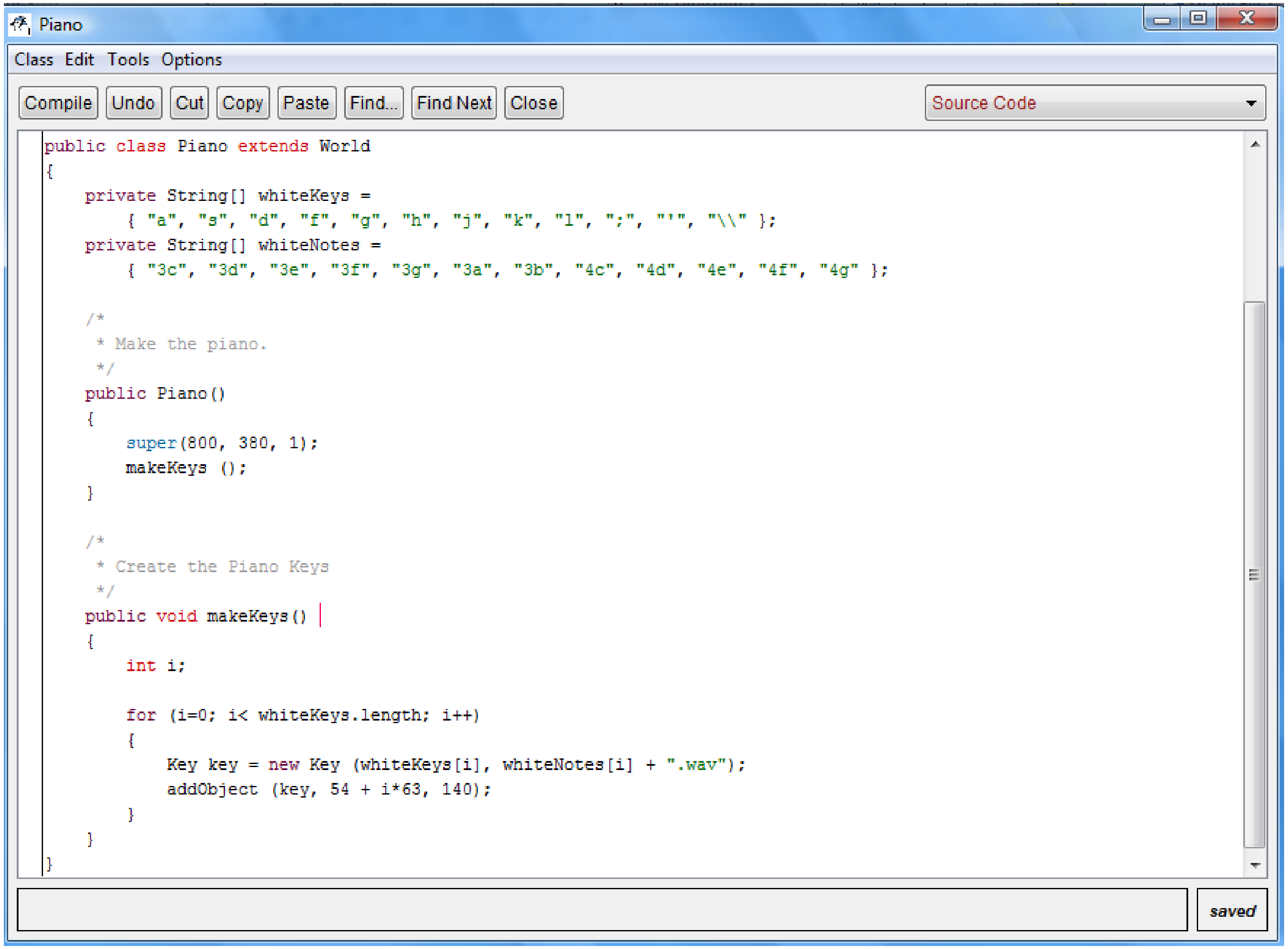
Code 5.7

We moved the creation of a new key out of the addObject method

Use a plus symbol (+) to concatenate whiteNotes[i] with “.wav”

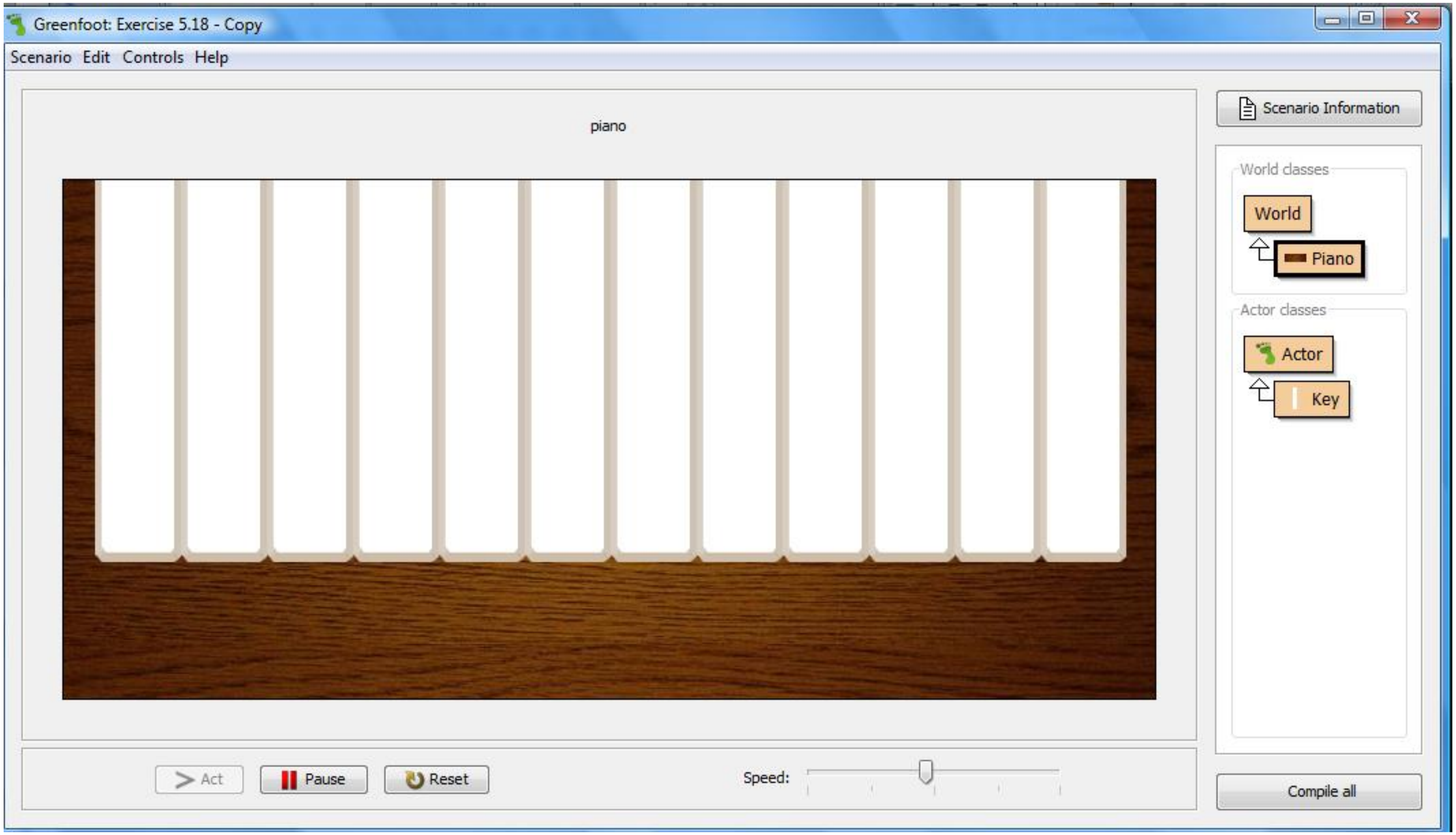
```
/*
 * Create the Piano Keys
 */
public void makeKeys()
{
    int i;

    for (i=0; i < whiteKeys.length;  i++)
    {
        Key key = new Key (whiteKeys[i],  whiteNotes[i] + ".wav");
        addObject (key,  54  +  i*63,  140);
    }
}
```

Exercise 5.19

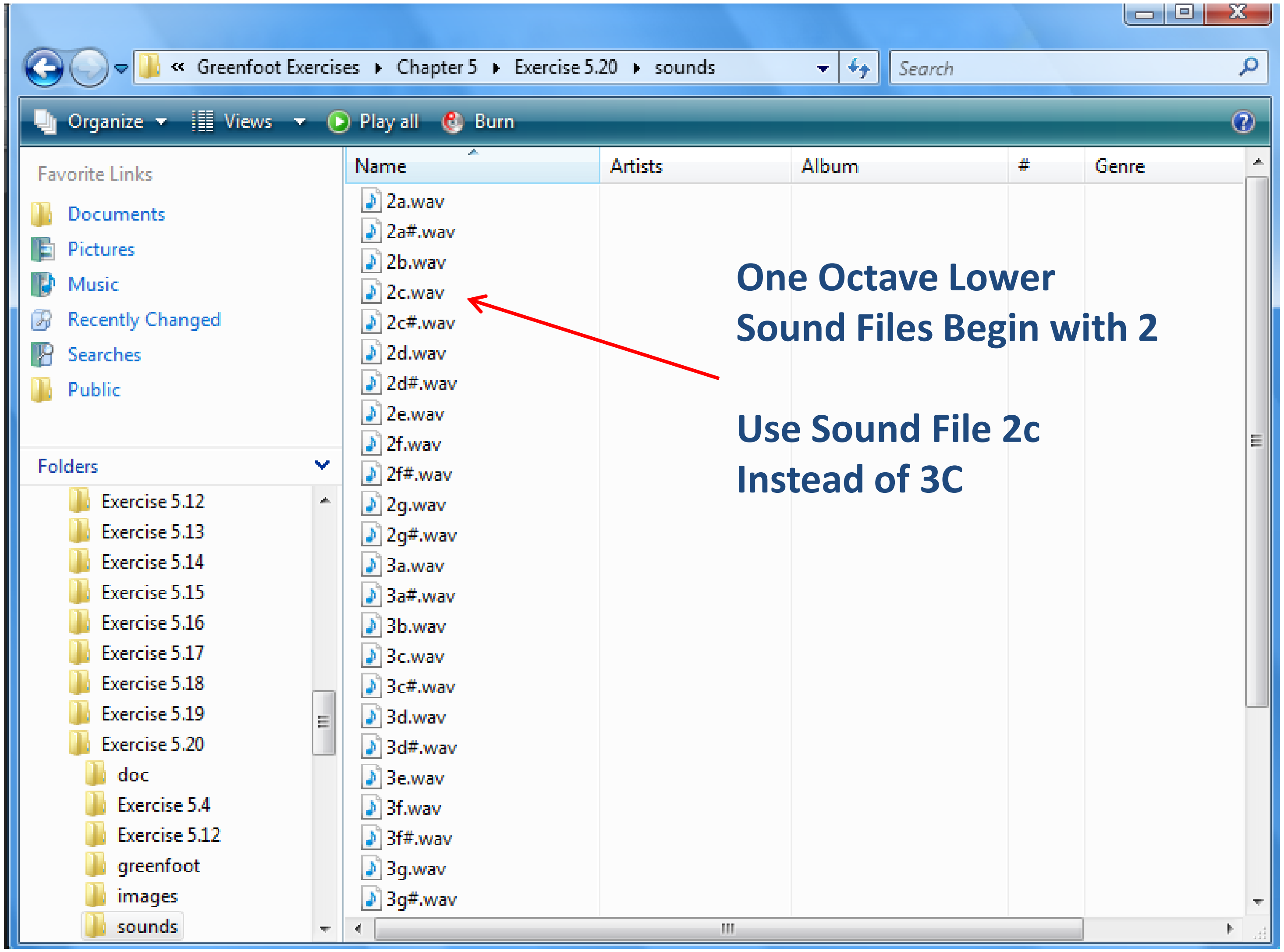


```
public class Piano extends World
{
    private String[] whiteKeys =
        { "a", "s", "d", "f", "g", "h", "j", "k", "l", ";", "'", "\\" };
    private String[] whiteNotes =
        { "3c", "3d", "3e", "3f", "3g", "3a", "3b", "4c", "4d", "4e", "4f", "4g" };

    /*
     * Make the piano.
     */
    public Piano()
    {
        super(800, 380, 1);
        makeKeys ();
    }

    /*
     * Create the Piano Keys
     */
    public void makeKeys()
    {
        int i;

        for (i=0; i< whiteKeys.length; i++)
        {
            Key key = new Key (whiteKeys[i], whiteNotes[i] + ".wav");
            addObject (key, 54 + i*63, 140);
        }
    }
}
```

Exercise 5.19



Exercise 5.20



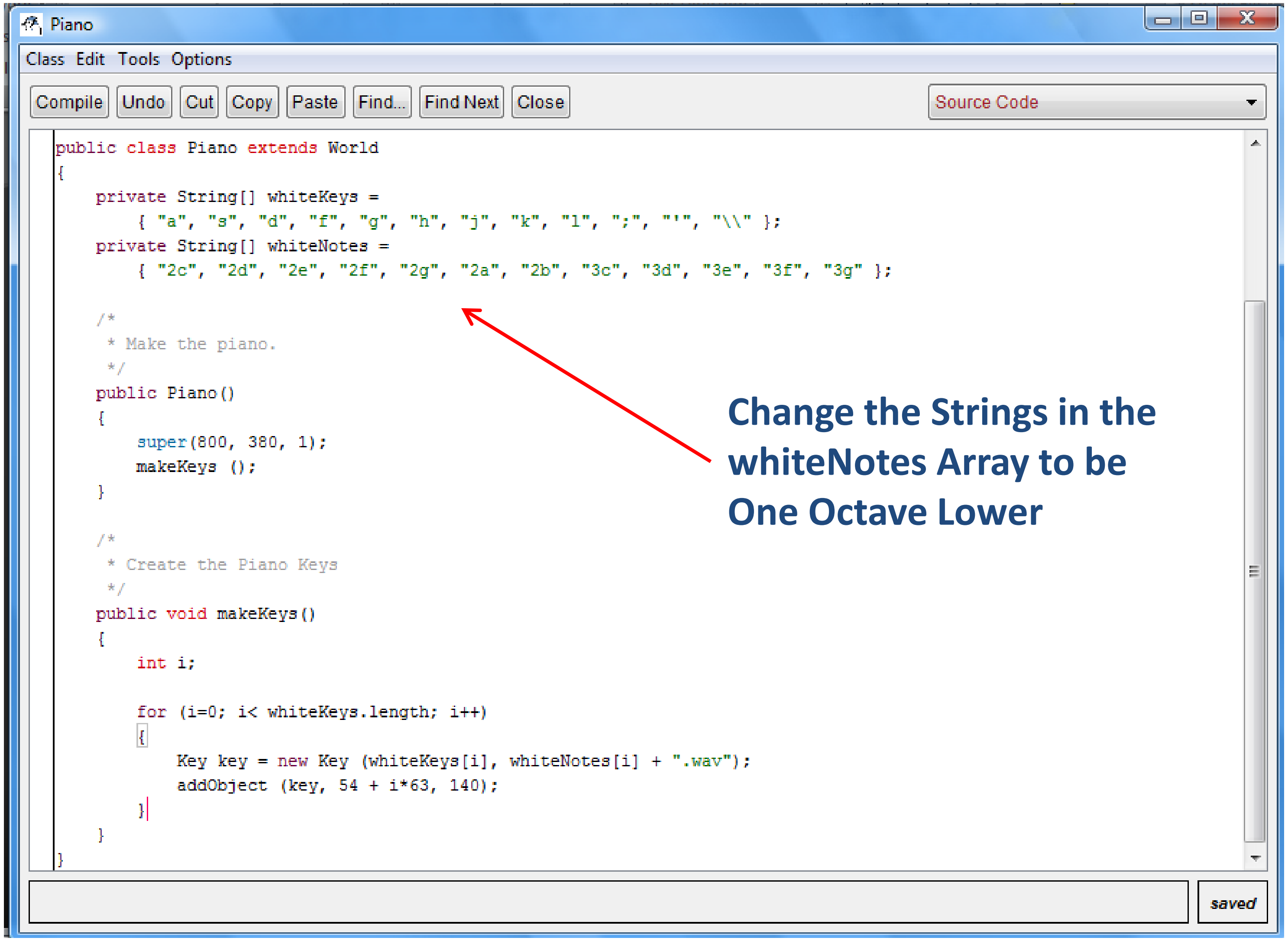
Exercise 5.12
Exercise 5.13
Exercise 5.14
Exercise 5.15
Exercise 5.16
Exercise 5.17
Exercise 5.18
Exercise 5.19
Exercise 5.20
doc
Exercise 5.4
Exercise 5.12
greenfoot
images
sounds

2a.wav
2a#.wav
2b.wav
2c.wav
2c#.wav
2d.wav
2d#.wav
2e.wav
2f.wav
2f#.wav
2g.wav
2g#.wav
3a.wav
3a#.wav
3b.wav
3c.wav
3c#.wav
3d.wav
3d#.wav
3e.wav
3f.wav
3f#.wav
3g.wav
3g#.wav

One Octave Lower Sound Files Begin with 2

Use Sound File 2c Instead of 3C

Exercise 5.20



```
public class Piano extends World
{
    private String[] whiteKeys =
        { "a", "s", "d", "f", "g", "h", "j", "k", "l", ";", "'", "\\" };
    private String[] whiteNotes =
        { "2c", "2d", "2e", "2f", "2g", "2a", "2b", "3c", "3d", "3e", "3f", "3g" };

    /*
     * Make the piano.
     */
    public Piano()
    {
        super(800, 380, 1);
        makeKeys ();
    }

    /*
     * Create the Piano Keys
     */
    public void makeKeys()
    {
        int i;

        for (i=0; i< whiteKeys.length; i++)
        {
            Key key = new Key (whiteKeys[i], whiteNotes[i] + ".wav");
            addObject (key, 54 + i*63, 140);
        }
    }
}
```

Change the Strings in the whiteNotes Array to be One Octave Lower

Exercise 5.22

```
public Key  (String keyName, String soundFile)
{
        key = keyName;
        sound = soundFile;
}
```

Exercise 5.22

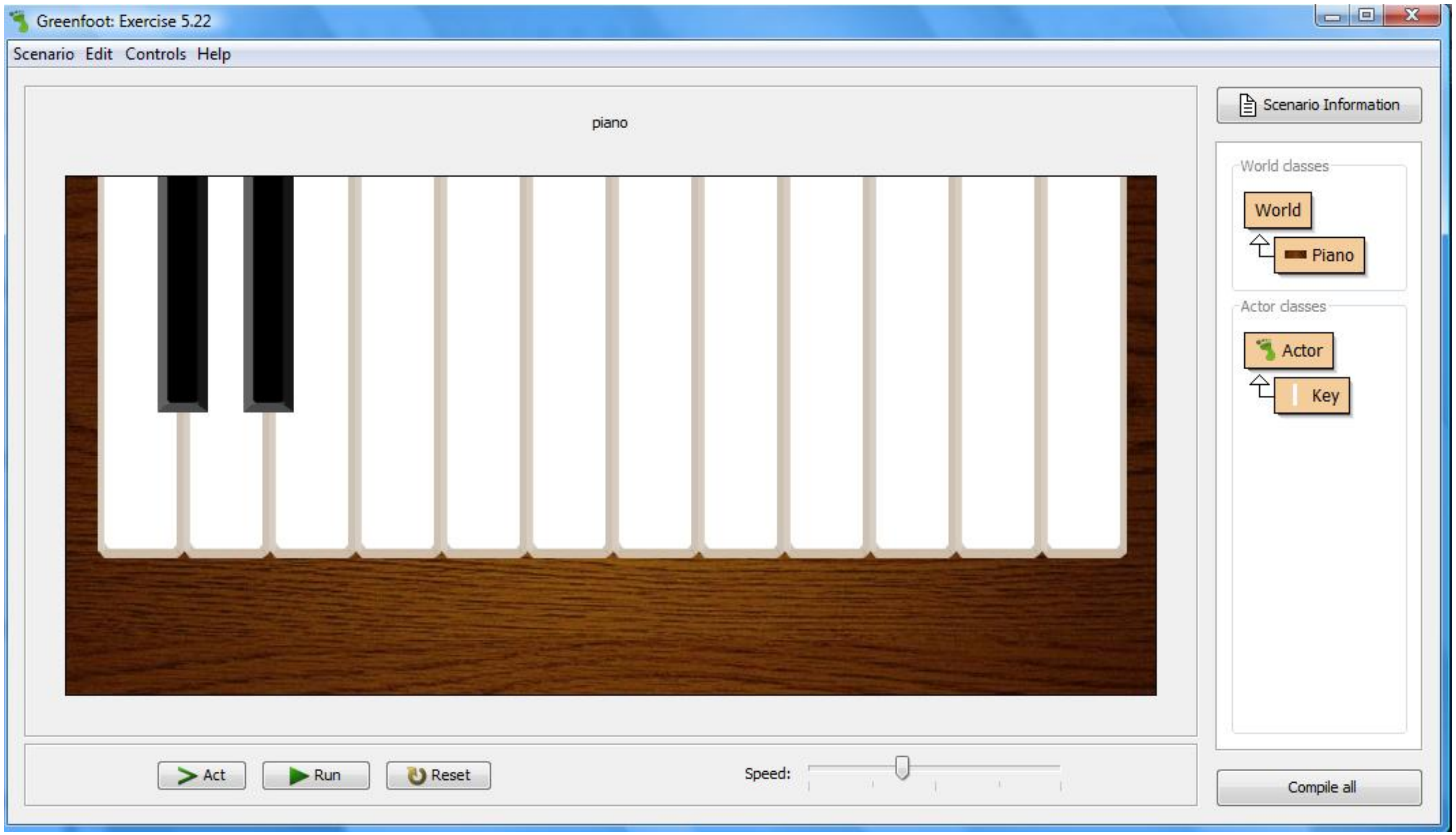
```
public Key  (String keyName, String soundFile, String img1, String img2)
{
	key = keyName;
	sound = soundFile;
	upImage = img1;
	downImage = img2;
	setImage (upImage);
	isDown = false;
}
```

Change the Key Class so That It Can Make Either White or Black Keys

Exercise 5.22

```
public void makeKeys()
{
      int i;
      Key key;

      /*
        * Make the White Keys
        */
      for (i=0; i< whiteKeys.length; i++)
      {
            key = new Key (whiteKeys[i], whiteNotes[i] + ".wav", "white-key.png", "white-key-down.png");
            addObject (key, 54 + i*63, 140);
      }

      /*
        * Make the Black Keys
        */
      key = new Key(blackKeys[0], blackNotes[0]+".wav", "black-key.png", "black-key-down.png");
      addObject(key, 85 + (0*63), 86);
      key = new Key(blackKeys[1], blackNotes[1]+".wav", "black-key.png", "black-key-down.png");
      addObject(key, 85 + (1*63), 86);
}
```

Exercise 5.22

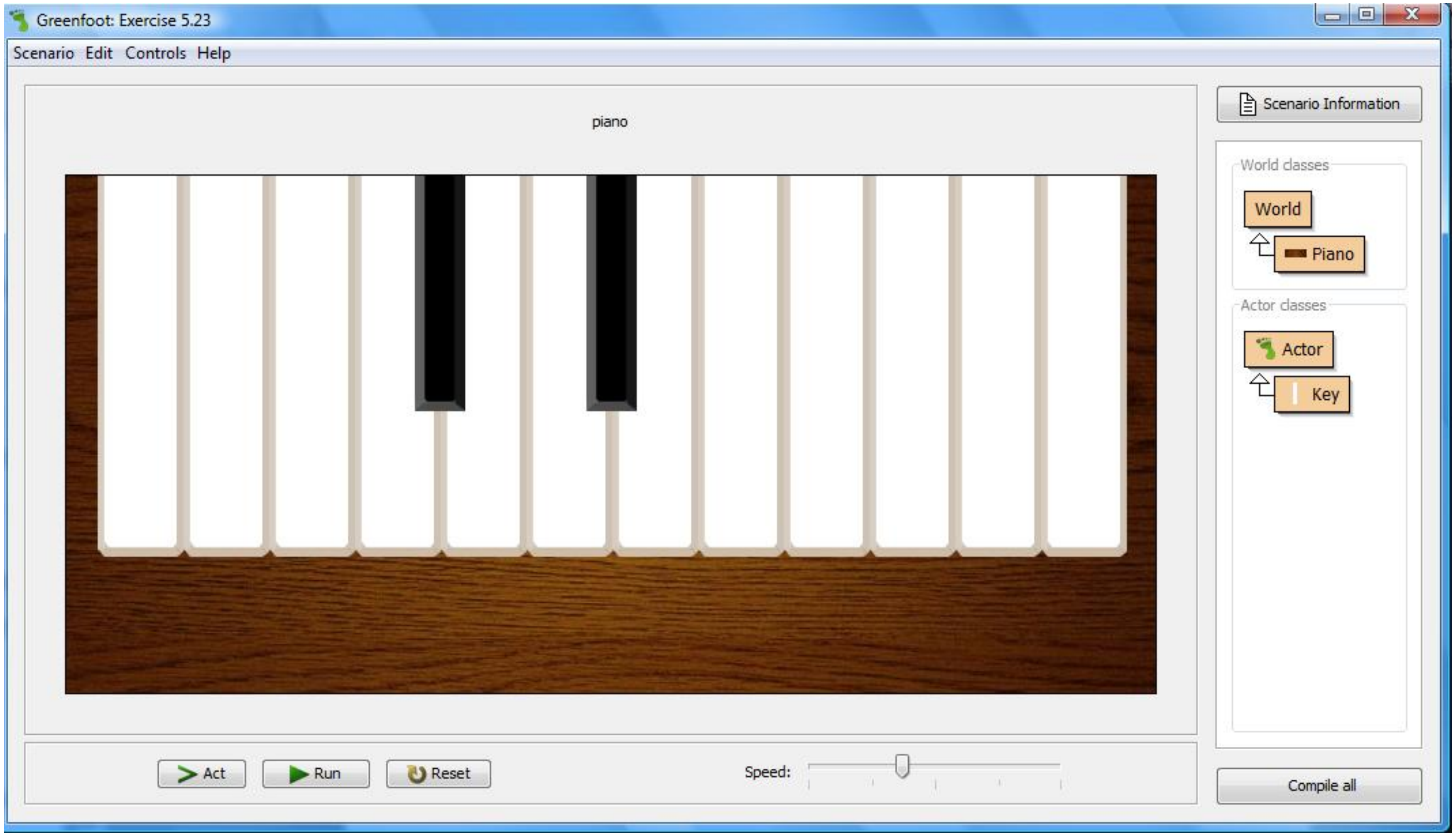


Exercise 5.23

```
        /*
         * Make the Black Keys
         */
        i = getValidIndex ();
        key = new Key(blackKeys[i], blackNotes[i]+".wav", "black-key.png", "black-key-down.png");
        addObject(key, 85 + (i*63), 86);
        i = getValidIndex ();
        key = new Key(blackKeys[i], blackNotes[i]+".wav", "black-key.png", "black-key-down.png");
        addObject(key, 85 + (i*63), 86);
}

public int getValidIndex ()
{
        int i;

        i = Greenfoot.getRandomNumber (12);
        while ( blackKeys[i].equals("") )
                i = Greenfoot.getRandomNumber (12);
        return (i);
}
```

Add Two Black Keys

Exercise 5.23



Exercise 5.24

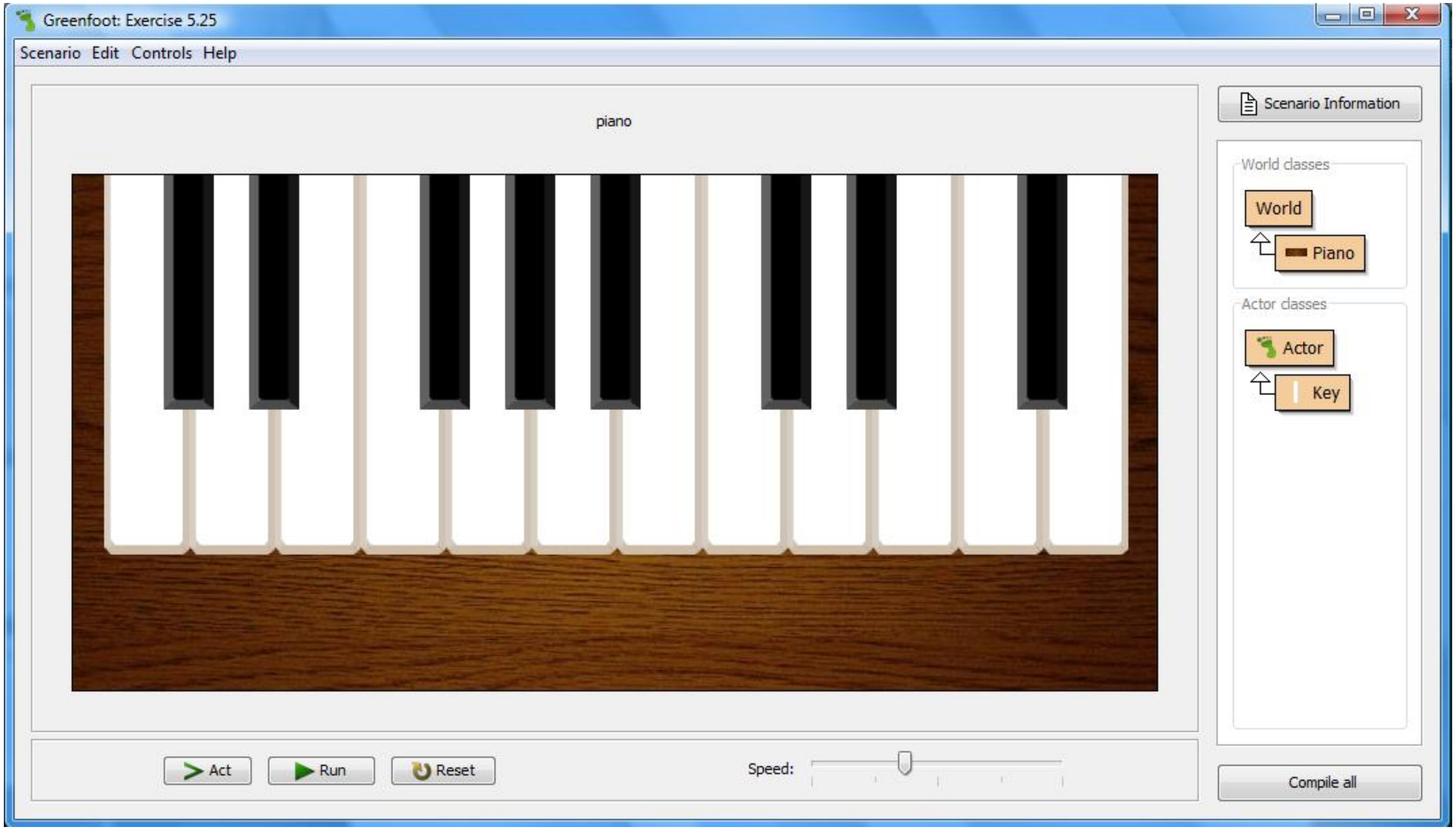
```
private String[] whiteKeys =
      { "A", "S", "D", "F", "G", "H", "J", "K", "L", ";", "'", "\\" };
private  String[] whiteNotes =
      { "3c", "3d", "3e", "3f", "3g", "3a", "3b", "4c", "4d", "4e", "4f", "4g" };

private String[] blackKeys =
      { "W", "E", "", "T", "Y", "U", "", "O", "P", "", "]" };
private String[] blackNotes =
      { "3c#", "3d#", "", "3f#", "3g#", "3a#", "", "4c#", "4d#", "", "4f#" };
```

Exercise 5.25

```
public void makeKeys()
{
    int i;
    Key key;

    /*
     * Make the White Keys
     */
    for (i=0; i< whiteKeys.length; i++)
    {
        key = new Key (whiteKeys[i], whiteNotes[i] + ".wav", "white-key.png", "white-key-down.png");
        addObject (key, 54 + i*63, 140);
    }

    /*
     * Make the Black Keys
     */
    for(i = 0; i < whiteKeys.length-1; i++)
    {
        if( ! blackKeys[i].equals("") )
        {
            key = new Key(blackKeys[i], blackNotes[i]+".wav", "black-key.png", "black-key-down.png");
            addObject(key, 85 + (i*63), 86);
        }
    }
}
```

Add Another Loop to Create the Black Keys This Code Must Handle the Gaps That Exist with the Black Keys

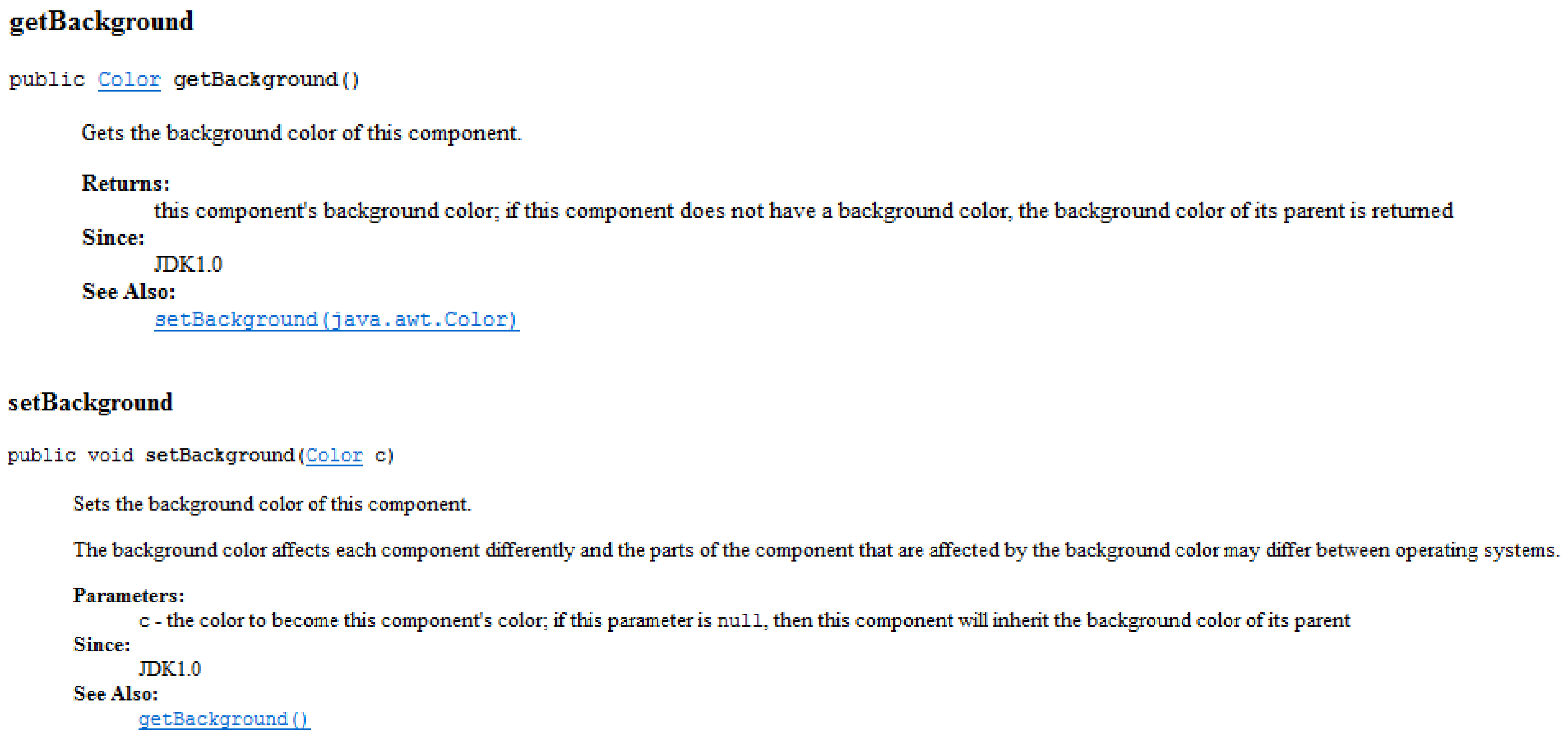
Exercise 5.25



Exercise 5.26

```
/*
 * Display a message
 */
public void showMessage()
{
      GreenfootImage bg = getBackground();
      bg.setColor (Color.WHITE);
      bg.drawString ("Click Run and then use your keyboard to play", 25, 320);
}
```

get and set Background



getBackground

```
public Color getBackground()
```

Gets the background color of this component.

Returns:
this component's background color; if this component does not have a background color, the background color of its parent is returned
Since:
JDK1.0
See Also:
`setBackground(java.awt.Color)`

setBackground

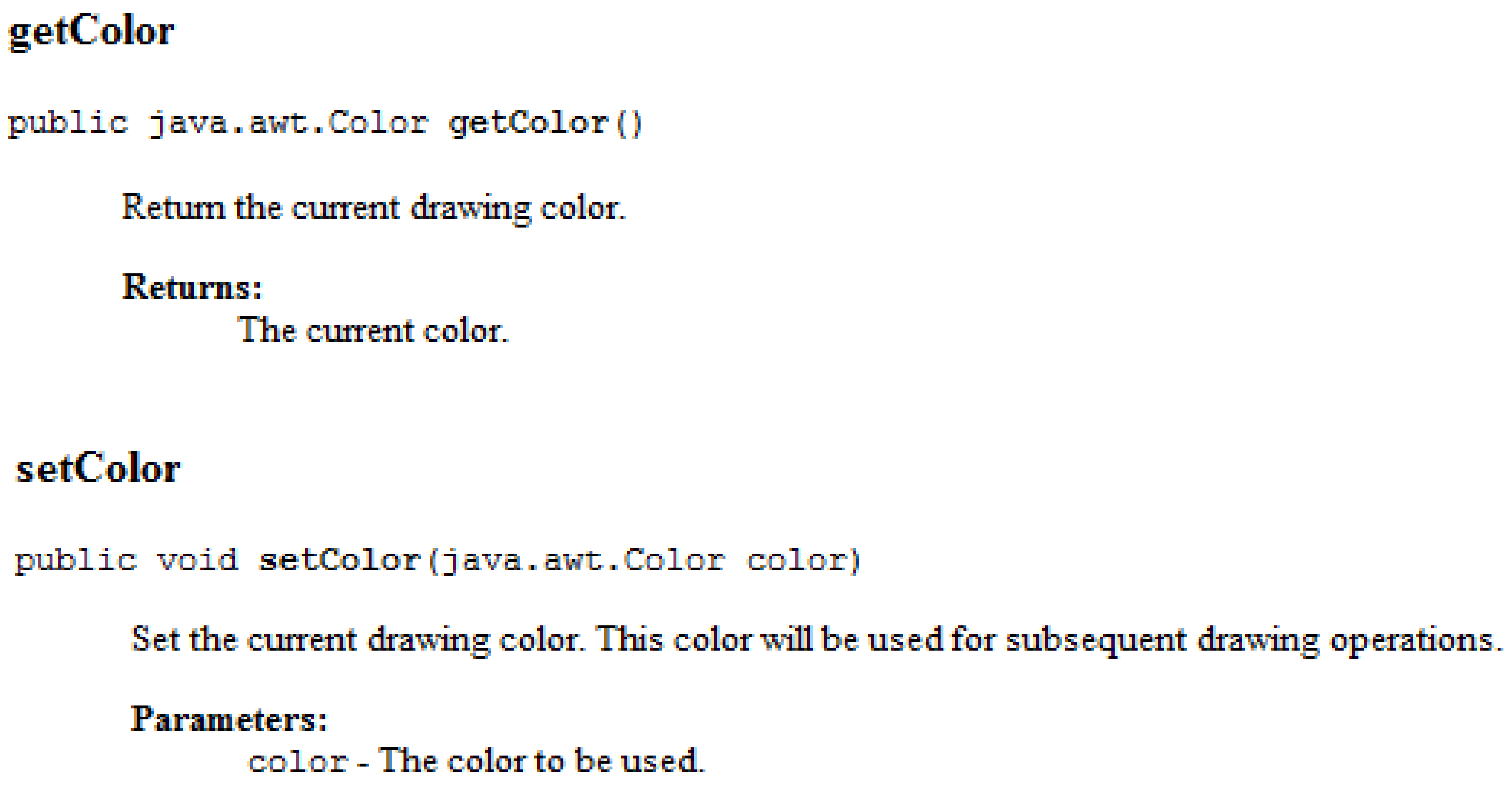
```
public void setBackground(Color c)
```

Sets the background color of this component.

The background color affects each component differently and the parts of the component that are affected by the background color may differ between operating systems.

Parameters:
`c` - the color to become this component's color; if this parameter is `null`, then this component will inherit the background color of its parent
Since:
JDK1.0
See Also:
`getBackground()`

get and set Color



getColor

```
public java.awt.Color getColor()
```

Return the current drawing color.

Returns:
The current color.

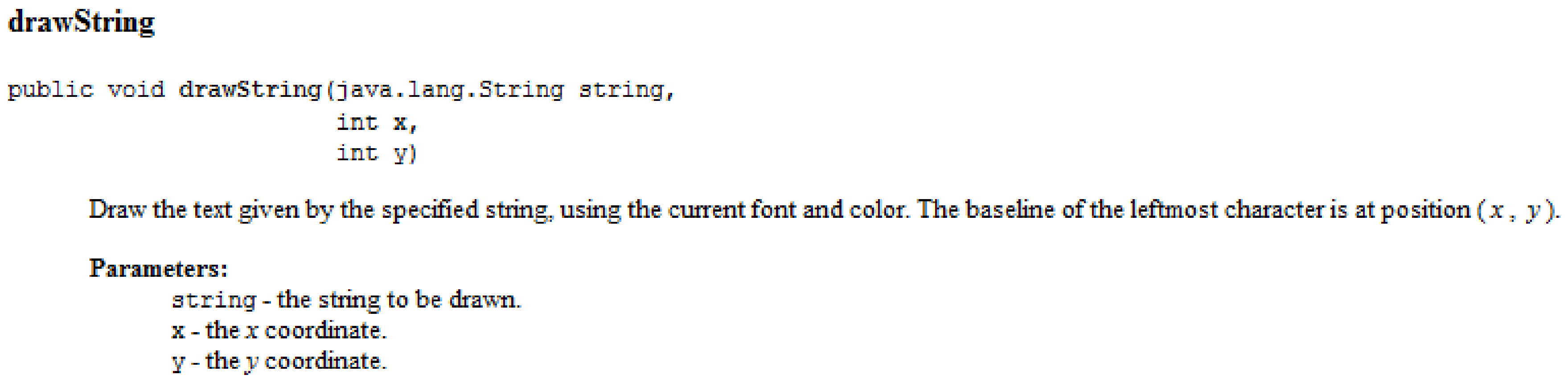
setColor

```
public void setColor(java.awt.Color color)
```

Set the current drawing color. This color will be used for subsequent drawing operations.

Parameters:
`color` - The color to be used.

drawString



drawString

```
public void drawString(java.lang.String string,
                       int x,
                       int y)
```

Draw the text given by the specified string, using the current font and color. The baseline of the leftmost character is at position (*x* , *y*).

Parameters:

`string` - the string to be drawn.
`x` - the *x* coordinate.
`y` - the *y* coordinate.

java.awt.Color

A Color object represents a color. Color class provides static fields that return a specific Color object: BLACK, BLUE, GREEN, RED, CYAN, ORANGE, YELLOW.

For example, to obtain a Color object that represents green, use this code:

```
Color color = Color.GREEN;
```

Create a custom color by passing red-green-blue (RGB) values to the Color class's constructor:

```
Color myColor = new Color (246, 27, 27);
```

To change a component's color, call the setForeGround and setBackGround methods of the component.

```
component.setForeGround (Color.YELLOW);
component.setBackGround (Color.RED);
```

Abstract Window Toolkit (AWT)

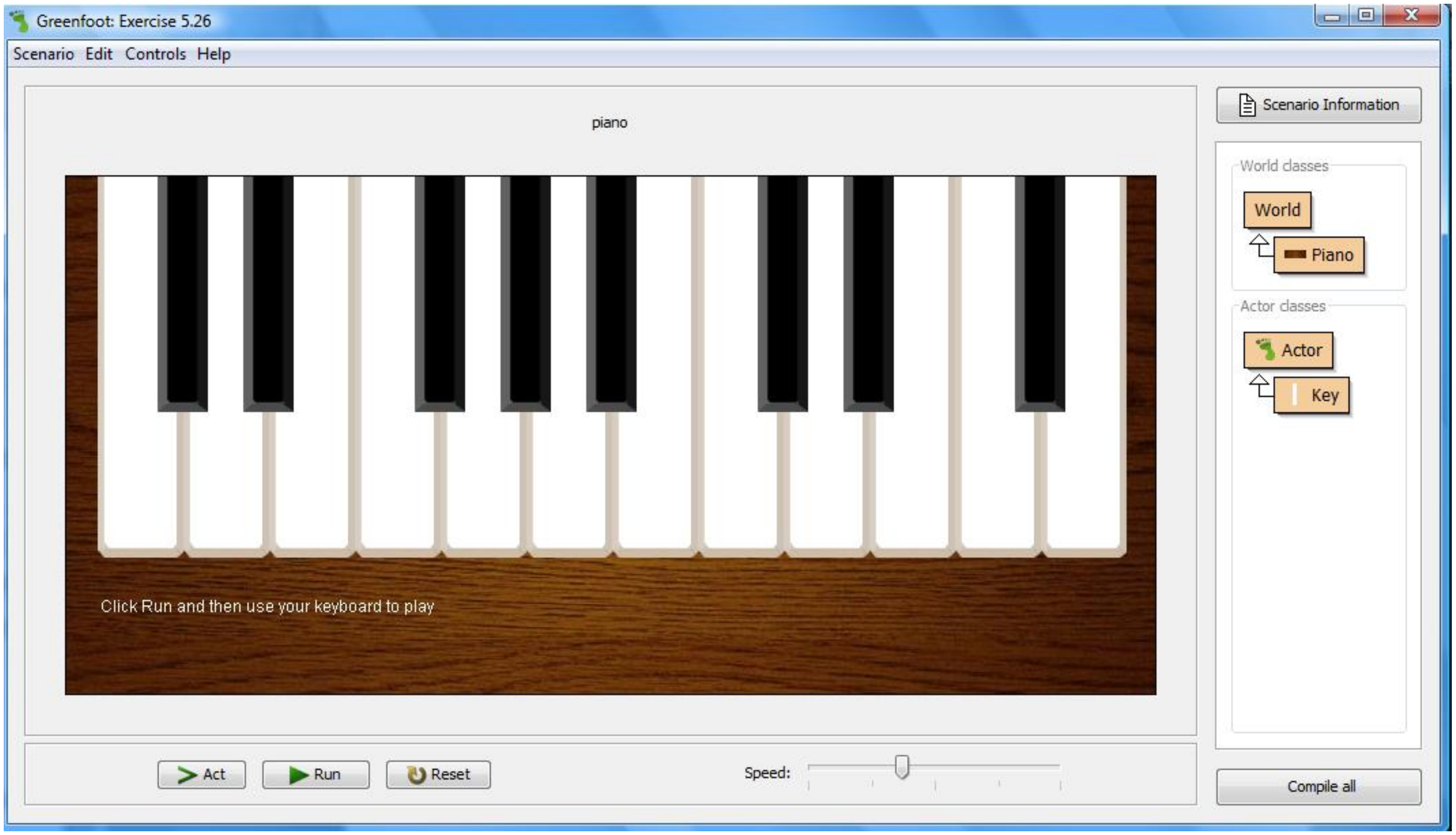
The **Abstract Window Toolkit** (AWT) is Java's original platform-dependent windowing, graphics, and user-interface widget toolkit. The AWT is now part of the Java Foundation Classes (JFC) — the standard API for providing a graphical user interface (GUI) for a Java program.

AWT Architecture

The **AWT** provides two levels of APIs:

- A general interface between Java and the native system, used for windowing, events, layout managers. This API is at the core of Java GUI programming and is also used by Swing and Java 2D. It contains:
  - The interface between the native windowing system and the Java application;
  - The core of the GUI event subsystem;
  - Several layout managers;
  - The interface to input devices such as mouse and keyboard; and
  - A java.awt.datatransfer package for use with the Clipboard and Drag and Drop.
- A basic set of GUI widgets such as buttons, text boxes, and menus. It also provides the AWT Native Interface, which enables rendering libraries compiled to native code to draw directly to an AWT Canvas object drawing surface.

Exercise 5.26



Click Run and then use your keyboard to play

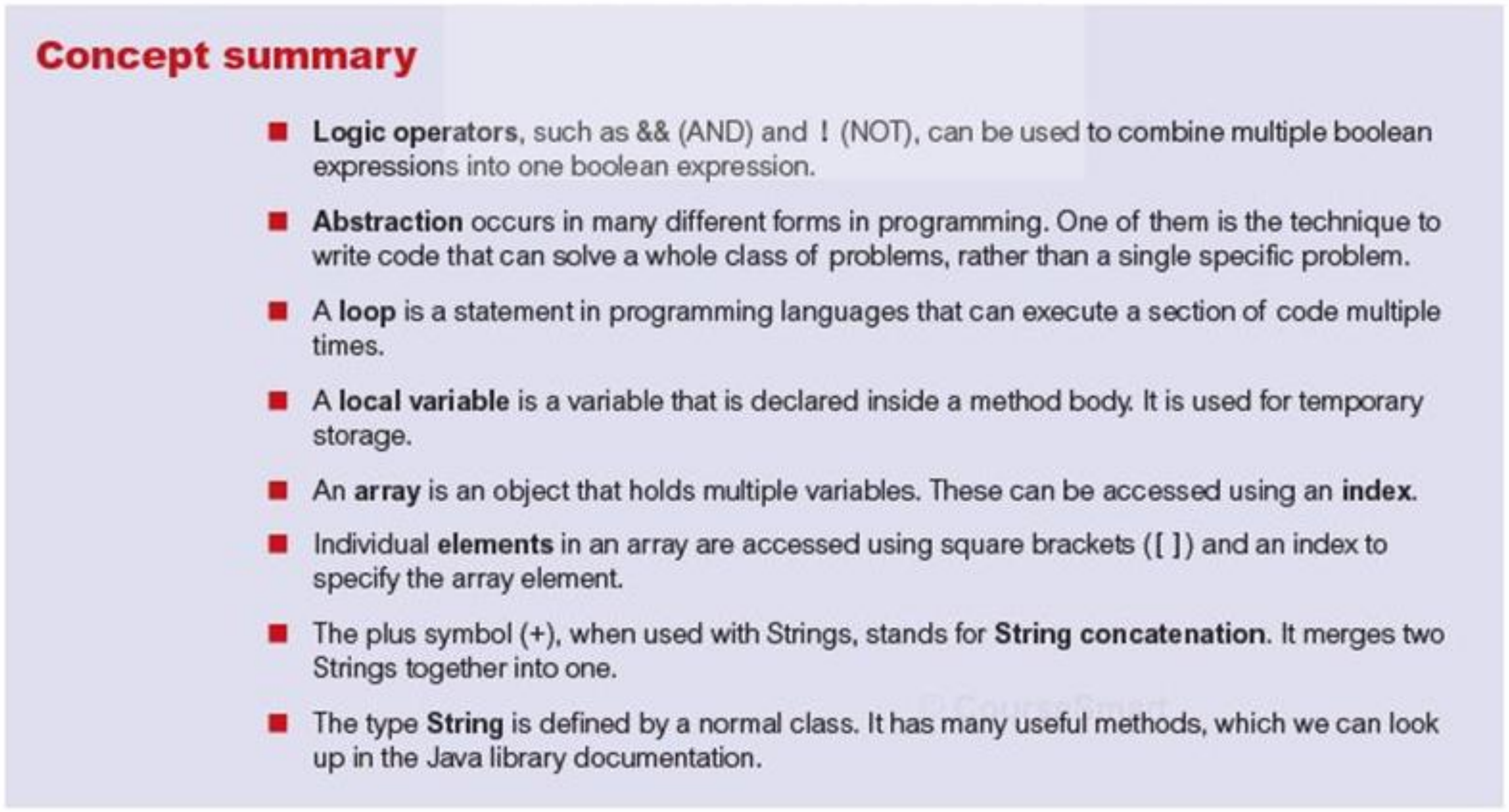
5.26 Summary of Programming Techniques

In this chapter, we have seen two very fundamental and important concepts for more sophisticated programming: loops and arrays.

Loops allow us to write code that executes a sequence of statements many times over.

The other major new concept we used was an array. An array can provide many variables (all of the same type) in one single object.

Concept Summary



Concept summary

- **Logic operators**, such as && (AND) and ! (NOT), can be used to combine multiple boolean expressions into one boolean expression.
- **Abstraction** occurs in many different forms in programming. One of them is the technique to write code that can solve a whole class of problems, rather than a single specific problem.
- A **loop** is a statement in programming languages that can execute a section of code multiple times.
- A **local variable** is a variable that is declared inside a method body. It is used for temporary storage.
- An **array** is an object that holds multiple variables. These can be accessed using an **index**.
- Individual **elements** in an array are accessed using square brackets ([ ]) and an index to specify the array element.
- The plus symbol (+), when used with Strings, stands for **String concatenation**. It merges two Strings together into one.
- The type **String** is defined by a normal class. It has many useful methods, which we can look up in the Java library documentation.