Computer Science Principles

Web Programming

JavaScript Programming Essentials

CHAPTER 15: CONTROLLING ANIMATIONS WITH THE KEYBOARD

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Objectives

- Now that you know how to work with the canvas; draw and color objects; and make objects move, bounce, and grow in size, let’s liven things up by adding some interactivity!
- In this chapter, you’ll learn how to make your canvas animations respond when a user presses a key on the keyboard. This way, a player can control an animation by pressing an arrow key or one of a few assigned letters on their keyboard (like the classic W, A, S, D game controls). For example, instead of just having a ball bounce across a screen, we can have a player control the movement of the ball using the arrow keys.

jQuery

LECTURE 1

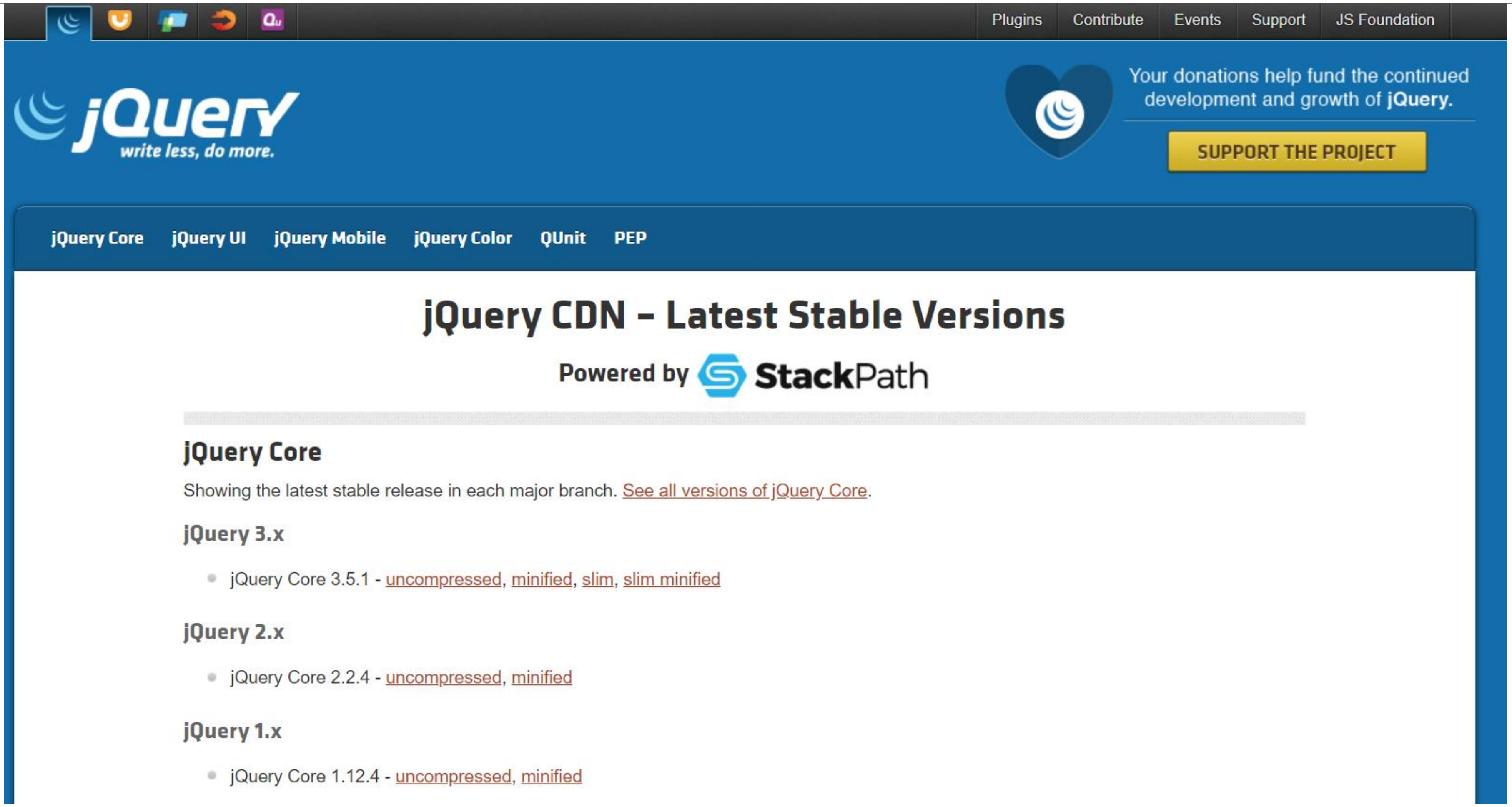
jQuery Links

Up until jQuery 1.11.1, you could use the following URLs to get the latest version of jQuery:

- https://code.jquery.com/jquery-latest.min.js - jQuery hosted (minified)
- https://code.jquery.com/jquery-latest.js - jQuery hosted (uncompressed)
- https://ajax.googleapis.com/ajax/libs/jquery/1/jquery.min.js - Google hosted (minified)
- https://ajax.googleapis.com/ajax/libs/jquery/1/jquery.js - Google hosted (uncompressed)

jQuery CDN – Latest Stable Versions

code.jQuery.com



jQuery CDN – Latest Stable Versions

Powered by StackPath

jQuery Core

Showing the latest stable release in each major branch. See all versions of jQuery Core.

jQuery 3.x

- jQuery Core 3.5.1 - uncompressed, minified, slim, slim minified

jQuery 2.x

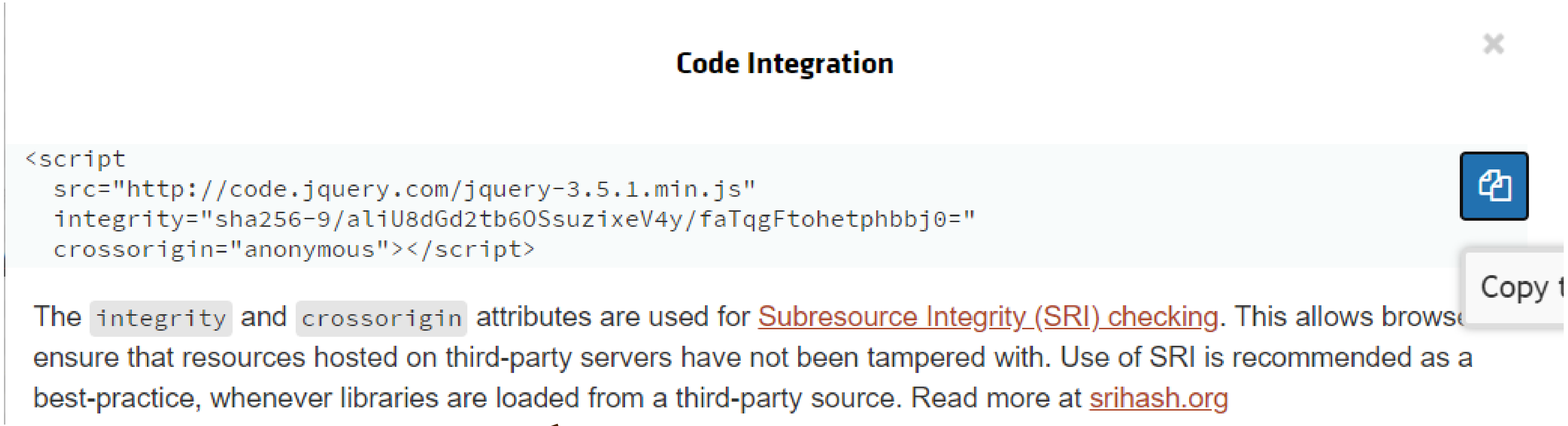
- jQuery Core 2.2.4 - uncompressed, minified

jQuery 1.x

- jQuery Core 1.12.4 - uncompressed, minified

jQuery CDN – Latest Stable Versions

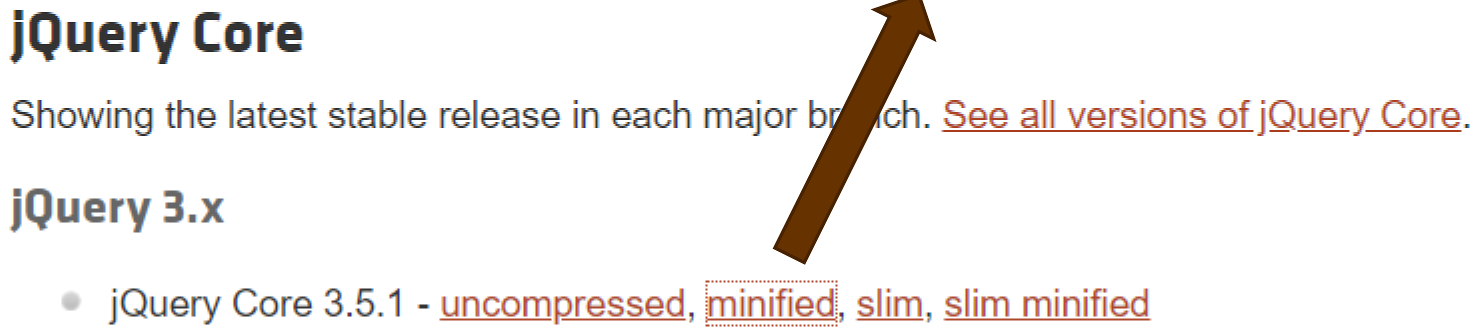
code.jQuery.com



Code Integration

```
<script
  src="http://code.jquery.com/jquery-3.5.1.min.js"
  integrity="sha256-9/aliU8dGd2tb6OSsuzixeV4y/faTqgFtohetphbbj0="
  crossorigin="anonymous"></script>
```

The `integrity` and `crossorigin` attributes are used for Subresource Integrity (SRI) checking. This allows browse ensure that resources hosted on third-party servers have not been tampered with. Use of SRI is recommended as a best-practice, whenever libraries are loaded from a third-party source. Read more at srihash.org



jQuery Core

Showing the latest stable release in each major branch. See all versions of jQuery Core.

jQuery 3.x

- jQuery Core 3.5.1 - uncompressed, minified, slim, slim minified

Keyboard Events

LECTURE 2

Keyboard Events

- JavaScript can monitor the keyboard through keyboard events. Each time a user presses a key on the keyboard, they generate a keyboard event, which is a lot like the mouse events we saw in Chapter 10.
- With mouse events, we used jQuery to determine where the cursor was when the event took place. With keyboard events, you can use jQuery to determine which key was pressed and then use that information in your code. For example, in this chapter we'll make a ball move left, right, up, or down when the user presses the left, right, up, or down arrow key.
- We'll use the keydown event, which is triggered whenever a user presses a key, and we'll use jQuery to add an event handler to the keydown event. That way, every time a keydown event occurs, our event handler function can find out which key was pressed and respond accordingly.

Setting Up the HTML File

To begin, create a clean HTML file containing the following code and save it as *keyboard.html*.

```
<!DOCTYPE html>
<html>
   <head>
    <title>Keyboard input</title>
   </head>
   <body>
    <canvas id="canvas" width="400" height="400"></canvas>
    <script src="https://code.jquery.com/jquery-2.1.0.js"></script>
    <script>
    // We'll fill this in next
    </script>
   </body>
</html>
```

Adding the keydown Event Handler

- Now let’s add some JavaScript to respond to keydown events. Enter this code inside the empty <script> tags in your *keyboard.html* file.

```
$("body").keydown(function (event) {
console.log(event.keyCode);
});
```

- In the first line, we use the jQuery $ function to select the body element in our HTML and then call the keydown method. The argument to the keydown method is a function that will be called whenever a key is pressed. Information about the keydown event is passed in to the function through the event object.
- For this program, we want to know which key was pressed, and that information is stored in the event object as event.keyCode.

Adding the keydown Event Handler

Inside the function, we use console.log to output the event object's keyCode property: a number representing the pressed key. Each key on your keyboard has a unique keycode. For example, the keycode for the spacebar is 32, and the left arrow is 37.

Once you've edited your *keyboard.html* file, save it and then open it in a browser. Now open the console so you can see the output, and click in the main browser window to have JavaScript register your keypresses. Now, if you start pressing keys, the corresponding keycodes should be printed to the console.

Adding the keydown Event Handler

- For example, if you type hi there, you should see the following output in the console:

```
72
73
32
84
72
69
82
69
```

- Every key you press has a different keycode. The H key is 72, the I key is 73, and so on.

Using an Object to Convert Keycodes into Names

- To make it easier to work with keys, we'll use an object to convert the keycodes into names so that the keypresses will be easier to recognize. In this next example, we create an object called keyNames, where the object keys are keycodes and the values are the names of those keys. Delete the JavaScript in *keyboard.html* and replace it with this:

Using an Object to Convert Keycodes into Names

```
  var keyNames = {
      32: "space",
      37: "left",
      38: "up",
      39: "right",
      40: "down"
  };
  $("body").keydown(function (event) {
❶     console.log(keyNames[event.keyCode]);
  });
```

Using an Object to Convert Keycodes into Names

- First, we create the keyNames object and fill it with the keycodes 32, 37, 38, 39, and 40. The keyNames object uses key-value pairs to match keycodes (such as 32, 37, and so on) with corresponding labels (such as "space" for the spacebar and "left" for the left arrow).
- We can then use this object to find out the name of a key based on its keycode. For example, to look up the keycode 32, enter keyNames[32]. That returns the string "space".

Using an Object to Convert Keycodes into Names

- At ❶, we use the keyNames object in the keydown event handler to get the name of the key that was just pressed. If the event keycode referenced by event.keyCode matches one of the keys in the keyNames object, this function will log the name of that key. If no key matches, this code will log undefined.
- Load *keyboard.html* in your browser. Open the console, click in the main browser window, and try pressing a few keys. If you press one of the five keys in the keyName object (the arrow keys or spacebar), the program should print the name of the key. Otherwise, it will print undefined.

Moving a Ball with the Keyboard

LECTURE 3

Moving a Ball with the Keyboard

- Now that we can determine which key is being pressed, we can write a program to use the keyboard to control the movement of a ball. Our program will draw a ball and move it to the right. Pressing the arrow keys will change the ball's direction, and pressing the spacebar will stop it. If the ball goes off the edge of the canvas, it will wrap around to the opposite side. For example, if the ball goes off the right edge of the canvas, it will show up again on the left edge while continuing to move in the same direction, as shown in Figure 15-1.

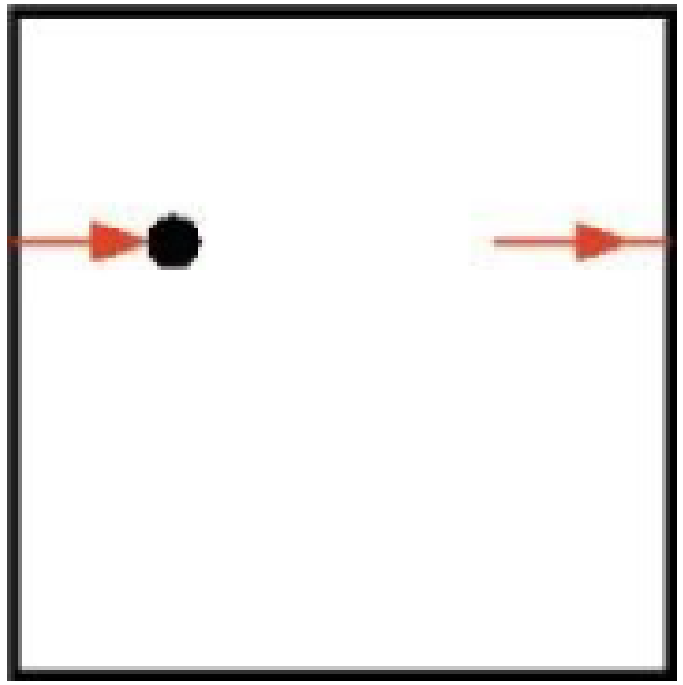


Figure 15-1. If the ball moves off the right side of the canvas, it will reappear on the left.

Moving a Ball with the Keyboard

- We’ll use an object called keyActions to find out which key was pressed and then use that information to set the direction of the ball’s movement. We’ll use setInterval to continually update the ball’s position and redraw it at its new position.

Setting Up the Canvas

- First we need to set up the canvas and the context object. Open *keyboard.html* and replace the JavaScript between the second set of <script> tags with this code:

```
var canvas = document.getElementById("canvas");
var ctx    = canvas.getContext("2d");
var width  = canvas.width;
var height = canvas.height;
```

Setting Up the Canvas

- On the first line, we use document.getElementById to select the canvas element. On the second line, we call getContext on the canvas to get the context object. Then, in the var width and var height lines, we store the width and height of the canvas element in the variables width and height. This way, when we need the canvas dimensions, we can use these variables instead of having to enter the numbers manually. Now, if we choose to change the size of the canvas, we can simply edit the HTML, and the JavaScript code should still work.

Defining the circle Function

- Next, we define the same circle function for the ball that we used in Chapter 14. Add this function after the code from the previous section:

```
var circle = function (x, y, radius, fillCircle) {
  ctx.beginPath();
  ctx.arc(x, y, radius, 0, Math.PI * 2, false);
  if (fillCircle) {
    ctx.fill();
  } else {
    ctx.stroke();
  }
};
```

Creating the Ball Constructor

Now we’ll create a Ball constructor. We’ll use this constructor to create the moving ball object. We’ll be using the same technique for moving this ball as we did in Chapter 14 — using the xSpeed and ySpeed properties to control the horizontal and vertical speed of the ball. Add this code after the circle function:

```
var Ball = function () {
   this.x = width / 2;
   this.y = height / 2;
   this.xSpeed = 5;
   this.ySpeed = 0;
};
```

Creating the Ball Constructor

- We set the **x** and **y** values (the ball’s position) to **width** / 2 and **height** / 2 so that the ball will start at the center of the canvas. We also set **this.xSpeed** to 5 and **this.ySpeed** to 0. This means that the ball will start the animation by moving to the right (that is, with each animation step, its x position will increase by 5 pixels and its y position will stay the same).

Defining the move Method

- In this section, we'll define the move method. We'll add this method to **Ball.prototype** to move the ball to a new location based on its current location, **xSpeed** and **ySpeed**. Add this method after the Ball constructor:

Defining the move Method

```
    Ball.prototype.move = function () {
        this.x += this.xSpeed;
        this.y += this.ySpeed;
❶ if (this.x < 0) {
        this.x = width;
    } else if (this.x > width) {
        this.x = 0;
    } else if (this.y < 0) {
        this.y = height;
    } else if (this.y > height) {
        this.y = 0;
    }
```

Defining the move Method

- First we update this.x and this.y using this.xSpeed and this.ySpeed, just as we did in Chapter 14 (see Moving the Ball). After that is the code for when the ball reaches the edge of the canvas.
- The if...else statement at ❶ checks the ball's position to see if it has moved off the edge of the canvas. If it has, this code makes the ball wrap around to the other side of the canvas. For example, if the ball goes off the left edge of the canvas, it should reappear from the right side of the canvas. In other words, if this.x is less than 0, we set this.x to width, which places it at the very right edge of the canvas. The rest of the if...else statement deals with the other three edges of the canvas in a similar way.

Defining the draw Method

- We'll use the draw method to draw the ball. Add this after the definition of the move method:

```
Ball.prototype.draw = function () {
circle(this.x, this.y, 10, true);
};
```

- This method calls the circle function.
- It uses the ball's x and y values to set the center of the ball, sets the radius to 10, and sets fillCircle to true. Figure 15-2 shows the resulting ball.

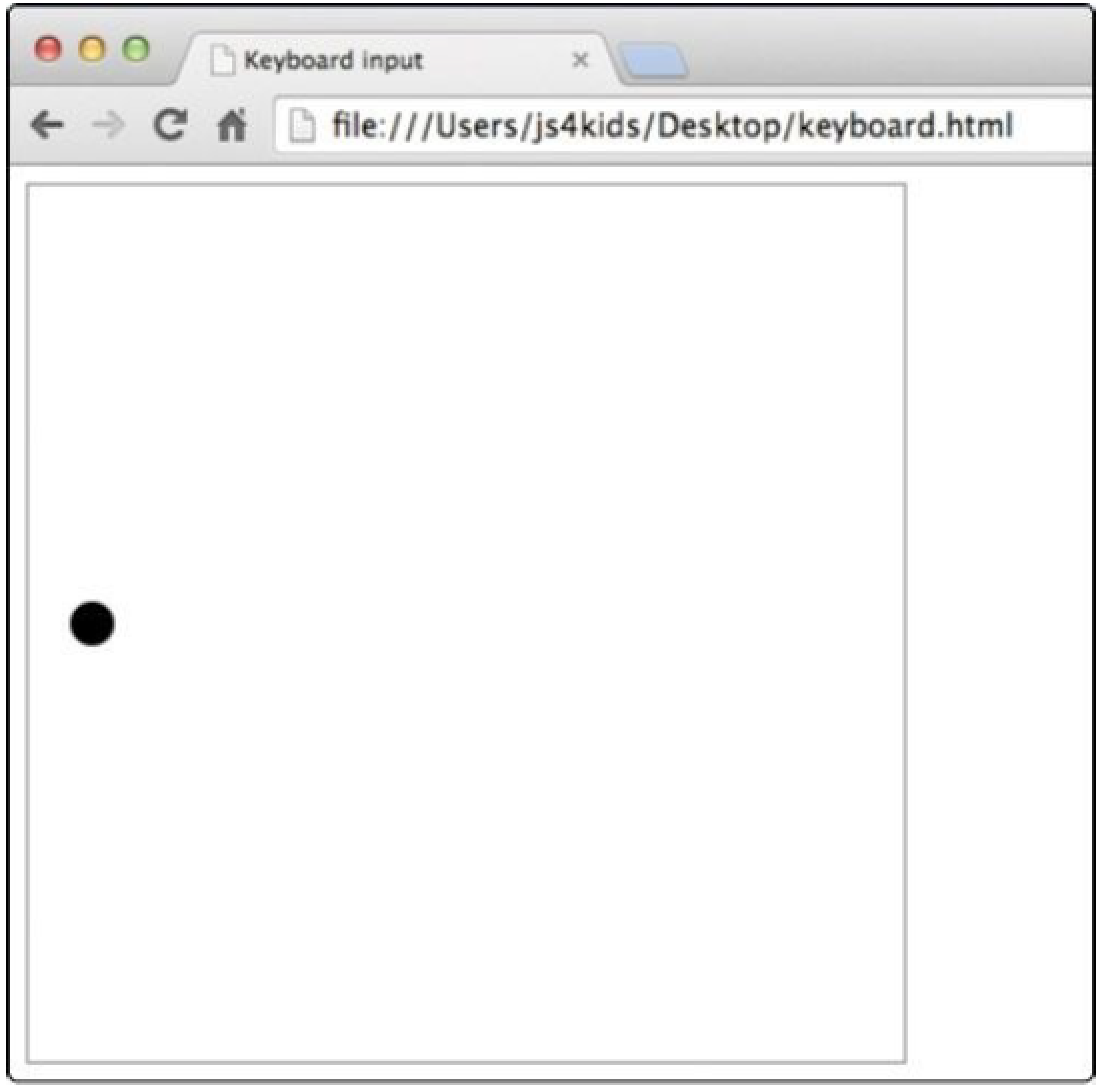


Figure 15-2. The ball is a filled circle with a radius of 10.

Creating a setDirection Method

- Now we have to create a way to set the direction of the ball. We’ll do that with a method called **setDirection**. This method will be called by our **keydown** event handler, which you’ll see in the next section. The **keydown** handler will tell **setDirection** which key was pressed by passing it a string ("left", "up", "right", "down", or "stop"). Based on that string, **setDirection** will change the **xSpeed** and **ySpeed** properties of the ball to make it move in the direction that matches the keypress.
- For example, if the string "down" is passed, we set **this.xSpeed** to **0** and **this.ySpeed** to **5**. Add this code after the draw method:

Creating a setDirection Method

```
Ball.prototype.setDirection = function (direction) {
    if (direction === "up") {
        this.xSpeed = 0;
        this.ySpeed = -5;
    } else if (direction === "down") {
        this.xSpeed = 0;
        this.ySpeed = 5;
    } else if (direction === "left") {
        this.xSpeed = -5;
        this.ySpeed = 0;
    } else if (direction === "right") {
        this.xSpeed = 5;
        this.ySpeed = 0;
    } else if (direction === "stop") {
        this.xSpeed = 0;
        this.ySpeed = 0;
    }
};
```

Creating a setDirection Method

- The entire body of this method is one long if...else statement. The new direction is passed into the method as the direction argument. If direction is equal to "up", we set the ball's xSpeed property to 0 and its ySpeed property to -5. The other directions are handled in the same way. Finally, if the direction is set to the string "stop", we set both this.xSpeed and this.ySpeed to 0, which means that the ball will stop moving.

Reacting to the Keyboard

This next snippet of code creates a ball object using the Ball constructor, and it listens for keydown events in order to set the ball's direction. Add this code after the setDirection method:

```
❶ var ball = new Ball();
❷ var keyActions = {
     32: "stop",
     37: "left",
     38: "up",
     39: "right",
     40: "down"
  };
❸ $("body").keydown(function (event) {
❹ var direction = keyActions[event.keyCode];
❺     ball.setDirection(direction);
  });
```

Reacting to the Keyboard

- At ❶, we create a ball object by calling new Ball(). At ❷ we create a keyActions object, which we'll use to convert keycodes to their corresponding direction. This object is the same as the keyNames object we created in Using an Object to Convert Keycodes into Names, except that for 32 (the keycode for the spacebar) we replace the label "space" with "stop" since we want the spacebar to stop the ball from moving.
- At ❸ we use the jQuery $ function to select the body element and then call the keydown method to listen for keydown events. The function passed to the keydown method is called every time a key is pressed.

Reacting to the Keyboard

- Inside this function, we use keyActions[event.keyCode] at ❹ to look up the label for the key that was pressed and assign that label to the direction variable. This sets the direction variable to a direction: "left" if the left arrow is pressed, "right" if the right arrow is pressed, "up" for the up arrow, "down" for the down arrow, and "stop" for the spacebar. If any other key is pressed, direction is set to undefined, and the animation won’t be affected.
- Finally, at ❺ we call the setDirection method on the ball object, passing the direction string. As you saw before, setDirection updates the ball’s xSpeed and ySpeed properties based on the new direction.

Animating the Ball

- All we have left to do now is animate the ball. The following code should look familiar, since it’s quite similar to what we used in Chapter 14. It uses the setInterval function that we’ve seen in the animation code in previous chapters to update the ball’s position at regular intervals. Add this code after the code from the previous section:

Animating the Ball

```
setInterval(function () {
 ctx.clearRect(0, 0, width, height);
 ball.draw();
 ball.move();
 ctx.strokeRect(0, 0, width, height);
}, 30);
```

Animating the Ball

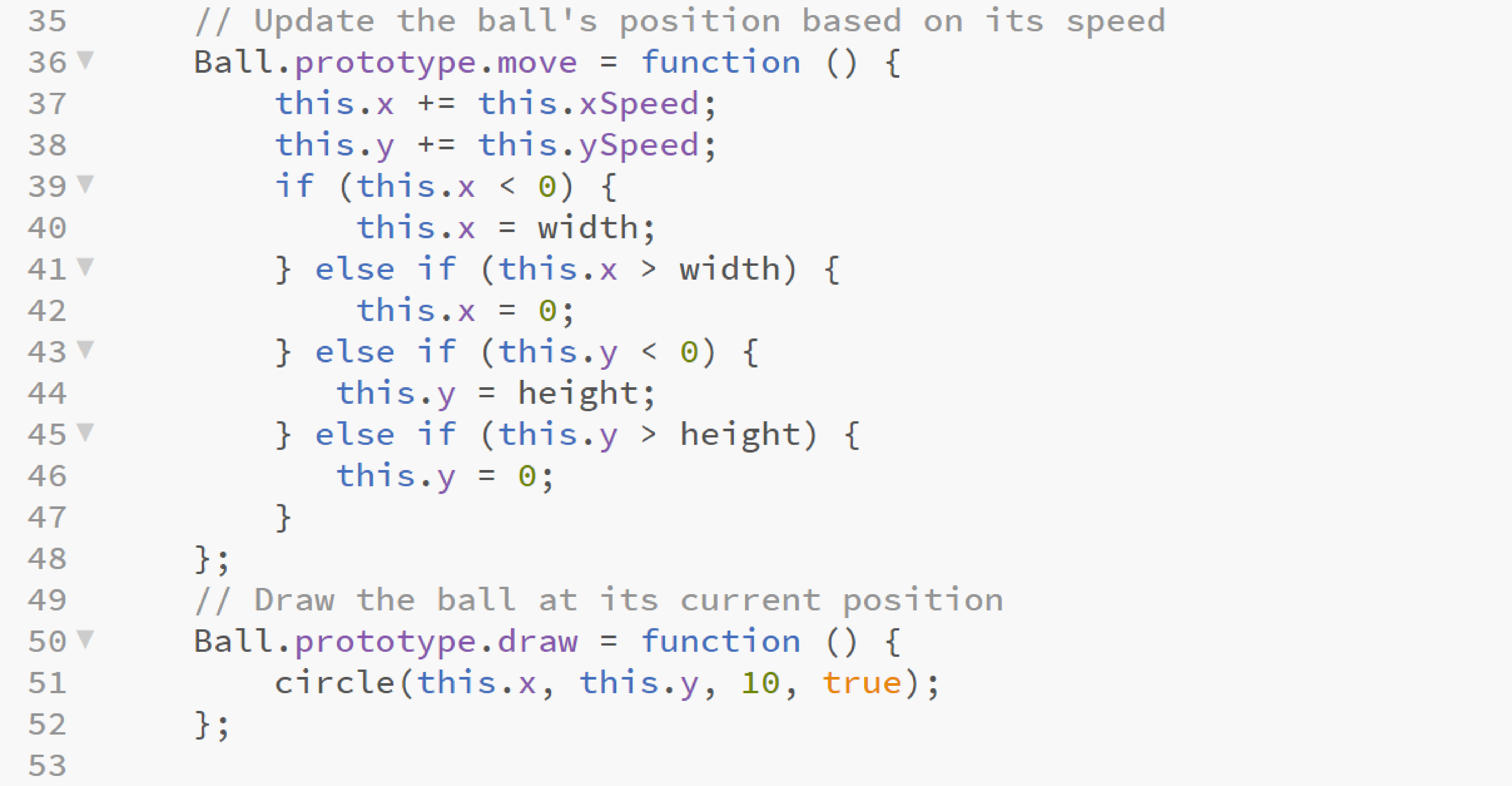
- We use **setInterval** to call our animation function every 30 milliseconds. The function first clears the entire canvas with **clearRect** and then calls the draw and move methods on the ball. As we've seen, the draw method simply draws a circle at the ball's current location, and the move method updates the ball's position based on its **xSpeed** and **ySpeed** properties. Finally, it draws a border with **strokeRect** so we can see the edge of the canvas.

Putting It All Together

LECTURE 3

```html
<!DOCTYPE html>
<html>
<head>
<title>Canvas</title>
    <style>
        canvas{
            border: 3px solid lightblue;
        }
    </style>
    <script src="http://code.jquery.com/jquery-3.5.1.min.js"></script>
</head>
<body>
<canvas id="canvas" width="200" height="200"></canvas>
<script>
```

```
    var canvas = document.getElementById("canvas");
    var ctx = canvas.getContext("2d");
    var width = canvas.width;
    var height = canvas.height;
    var circle = function (x, y, radius, fillCircle) {
        ctx.beginPath();
        ctx.arc(x, y, radius, 0, Math.PI * 2, false);
        if (fillCircle) {
            ctx.fill();
        } else {
            ctx.stroke();
        }
    };
    // The Ball constructor
    var Ball = function () {
        this.x = width / 2;
        this.y = height / 2;
        this.xSpeed = 5;
        this.ySpeed = 0;
    };
```



```
// Update the ball's position based on its speed
Ball.prototype.move = function () {
    this.x += this.xSpeed;
    this.y += this.ySpeed;
    if (this.x < 0) {
        this.x = width;
    } else if (this.x > width) {
        this.x = 0;
    } else if (this.y < 0) {
       this.y = height;
    } else if (this.y > height) {
       this.y = 0;
    }
};
// Draw the ball at its current position
Ball.prototype.draw = function () {
    circle(this.x, this.y, 10, true);
};
```

```
// Set the ball's direction based on a string
Ball.prototype.setDirection = function (direction) {
    if (direction === "up") {
        this.xSpeed = 0;
        this.ySpeed = -5;
    } else if (direction === "down") {
        this.xSpeed = 0;
        this.ySpeed = 5;
    } else if (direction === "left") {
        this.xSpeed = -5;
        this.ySpeed = 0;
    } else if (direction === "right") {
        this.xSpeed = 5;
        this.ySpeed = 0;
    } else if (direction === "stop") {
        this.xSpeed = 0;
        this.ySpeed = 0;
    }
};
```

```
    // Create the ball object
    var ball = new Ball();
    // An object to convert keycodes into action names
    var keyActions = {
        32: "stop",
        37: "left",
        38: "up",
        39: "right",
        40: "down"
    };
    // The keydown handler that will be called for every keypress
    $("body").keydown(function (event) {
        var direction = keyActions[event.keyCode];
        ball.setDirection(direction);
    });
    // The animation function, called every 30 ms
    setInterval(function () {
        ctx.clearRect(0, 0, width, height);
        ball.draw();
        ball.move();
        ctx.strokeRect(0, 0, width, height);
    }, 30);
</script>
</body>
</html>
```

Running the Code

LECTURE 4

Running the Code

- Now our program is complete. When you run the program, you should see a black ball moving across the canvas to the right, as shown in Figure 15-3. When it reaches the right side of the canvas, it should wrap around to the left side and keep moving to the right.
- When you press the arrow keys, the ball should change direction, and pressing the spacebar should make the ball stop.

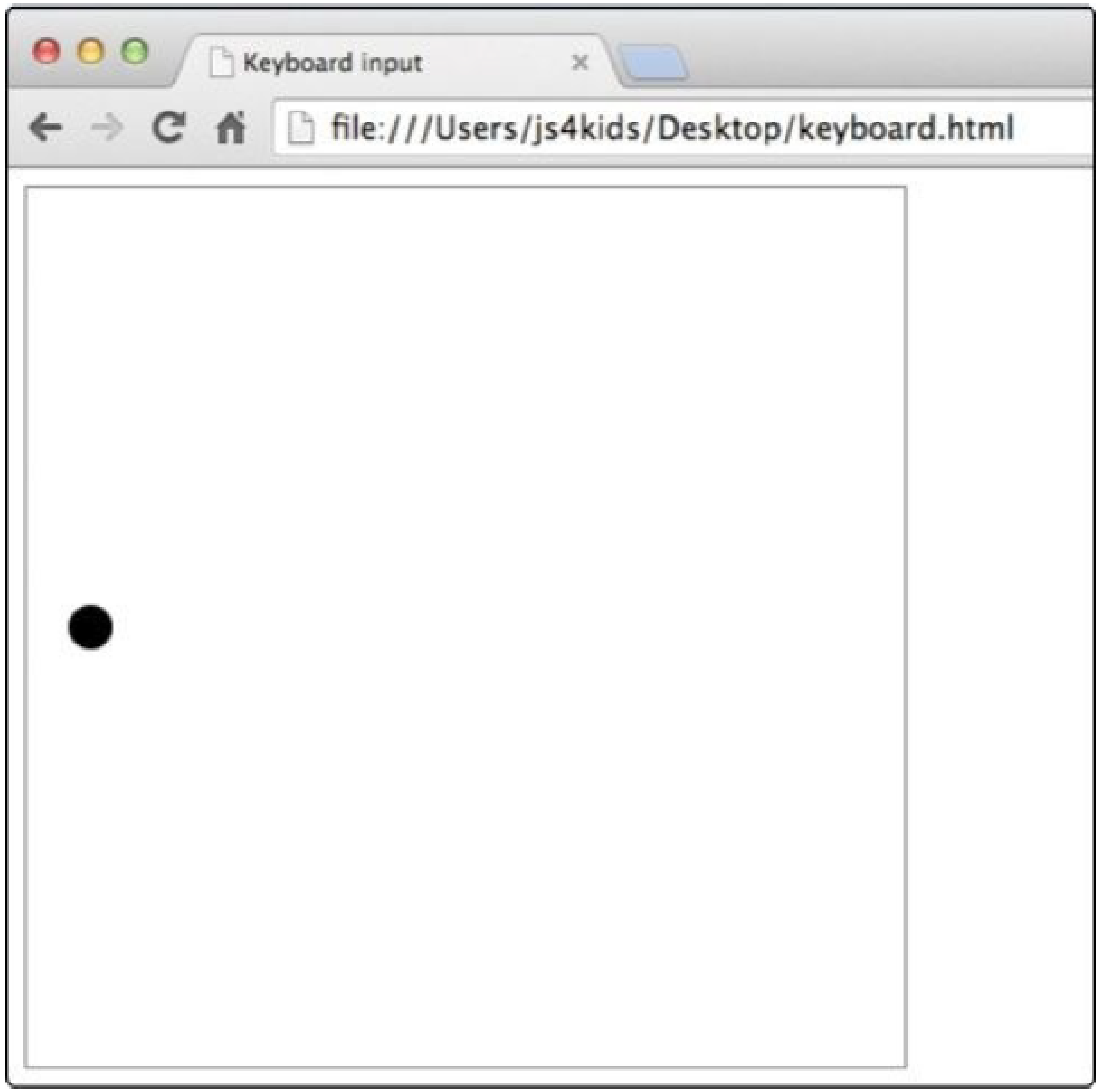


Figure 15-3. A screenshot from the moving ball animation

Summary

LECTURE 5

Summary

- In this chapter, you learned how to make programs that react to keyboard events. We used this knowledge to create a moving ball, where the ball's direction is set by the keyboard.
- Now that we can draw to the canvas, create animations, and update those animations based on user input, we can create a simple canvas-based game! In the next chapter, we'll re-create the classic Snake game, combining everything we've learned up until now.