Computer Science Principles
Web Programming

JavaScript Programming Essentials

CHAPTER 12: OBJECT-ORIENTED PROGRAMMING

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Overview

LECTURE 1

Object-Oriented Programming

- Chapter 4 discussed JavaScript objects — collections of keys paired with values. In this chapter, we'll look at ways to create and use objects as we explore **object-oriented programming**.
- Object-oriented programming is a way to design and write programs so that all of the program's important parts are represented by objects. For example, when building a racing game, you could use object-oriented programming techniques to represent each car as an object and then create multiple car objects that share the same properties and functionality.

A Simple Object

LECTURE 1

A Simple Object

In Chapter 4, you learned that objects are made up of properties, which are simply pairs of keys and values. For example, in the following code the object dog represents a dog with the properties name, legs, and isAwesome:

```
var dog = {
    name: "Pancake",
    legs: 4,
    isAwesome: true
};
```

A Simple Object

Once we create an object, we can access its properties using dot notation (discussed in Accessing Values in Objects). For example, here's how we could access the name property of our dog object:

```
dog.name;
"Pancake"
```

We can also use dot notation to add properties to a JavaScript object, like this:

```
dog.age = 6;
```

This adds a new key-value pair (age: 6) to the object, as you can see below:

```
dog;
Object{name:"Pancake",legs:4,isAwesome:true,age:6}
```

Adding Methods to Objects

LECTURE 1

Adding Methods to Objects

- In the preceding example, we created several properties with different kinds of values saved to them: a string ("Pancake"), numbers (4 and 6), and a Boolean (true).
- In addition to strings, numbers, and Booleans, you can save a *function* as a property inside an object. When you save a function as a property in an object, that property is called a *method*.
- In fact, we've already used several built-in JavaScript methods, like the join method on arrays and the **toUpperCase** method on strings.

Adding Methods to Objects

- Now let’s see how to create our own methods. One way to add a method to an object is with dot notation. For example, we could add a method called bark to the dog object like this:

```
❶ dog.bark = function () {
❷   console.log("Woof woof! My name is " + this.name + "!");
  };
❸ dog.bark();
```

- Woof woof! My name is Pancake!

Adding Methods to Objects

- At ❶ we add a property to the dog object called bark and assign a function to it. At ❷, inside this new function, we use console.log to log Woof woof! My name is Pancake!.
- Notice that the function uses this.name, which retrieves the value saved in the object’s name property. Let’s take a closer look at how the this keyword works.

Using the this Keyword

- You can use the this keyword inside a method to refer to the object on which the method is currently being called. For example, when you call the bark method on the dog object, this refers to the dog object, so this.name refers to dog.name.
- The this keyword makes methods more versatile, allowing you to add the same method to multiple objects and have it access the properties of whatever object it's currently being called on.

Sharing a Method Between Multiple Objects

Let’s create a new function called **speak** that we can use as a method in multiple objects that represent different animals. When speak is called on an object, it will use the object’s name (this.name) and the sound the animal makes (**this.sound**) to log a message.

```
var speak = function () {
    console.log(this.sound + "! My name is " + this.name + "!");
};
```

Sharing a Method Between Multiple Objects

Now let’s create another object so we can add speak to it as a method:

```
var cat = {
    sound: "Miaow",
    name: "Mittens",
❶   speak: speak
};
```

Sharing a Method Between Multiple Objects

- Here we create a new object called cat, with sound, name, and speak properties. We set the speak property at ❶ and assign it the **speak** function we created earlier. Now **cat.speak** is a method that we can call by entering **cat.speak()**. Since we used the this keyword in the method, when we call it on cat, it will access the **cat** object's properties. Let's see that now:

```
    cat.speak();
```

- Miaow! My name is Mittens!

Sharing a Method Between Multiple Objects

- When we call the cat.speak method, it retrieves two properties from the cat object: this.sound (which is "Miaow") and **this.name** (which is "Mittens").
- We can use the same speak function as a method in other objects too:

Sharing a Method Between Multiple Objects

```
var pig = {
  sound: "Oink",
  name: "Charlie",
  speak: speak
};
var horse = {
  sound: "Neigh",
  name: "Marie",
  speak: speak
};
```

pig.speak();
Oink! My name is Charlie!
horse.speak();
Neigh! My name is Marie!

Sharing a Method Between Multiple Objects

- Again, each time this appears inside a method, it refers to the object on which the method is called. In other words, when you call horse.speak(), this will refer to horse, and when you call pig.speak(), this refers to pig.
- To share methods between multiple objects, you can simply add them to each object, as we just did with speak. But if you have lots of methods or objects, adding the same methods to each object individually can become annoying, and it can make your code messier, too. Just imagine if you needed a whole zoo full of 100 animal objects and you wanted each to share a set of 10 methods and properties.
- JavaScript object constructors offer a better way to share methods and properties between objects, as we'll see next.

Constructors

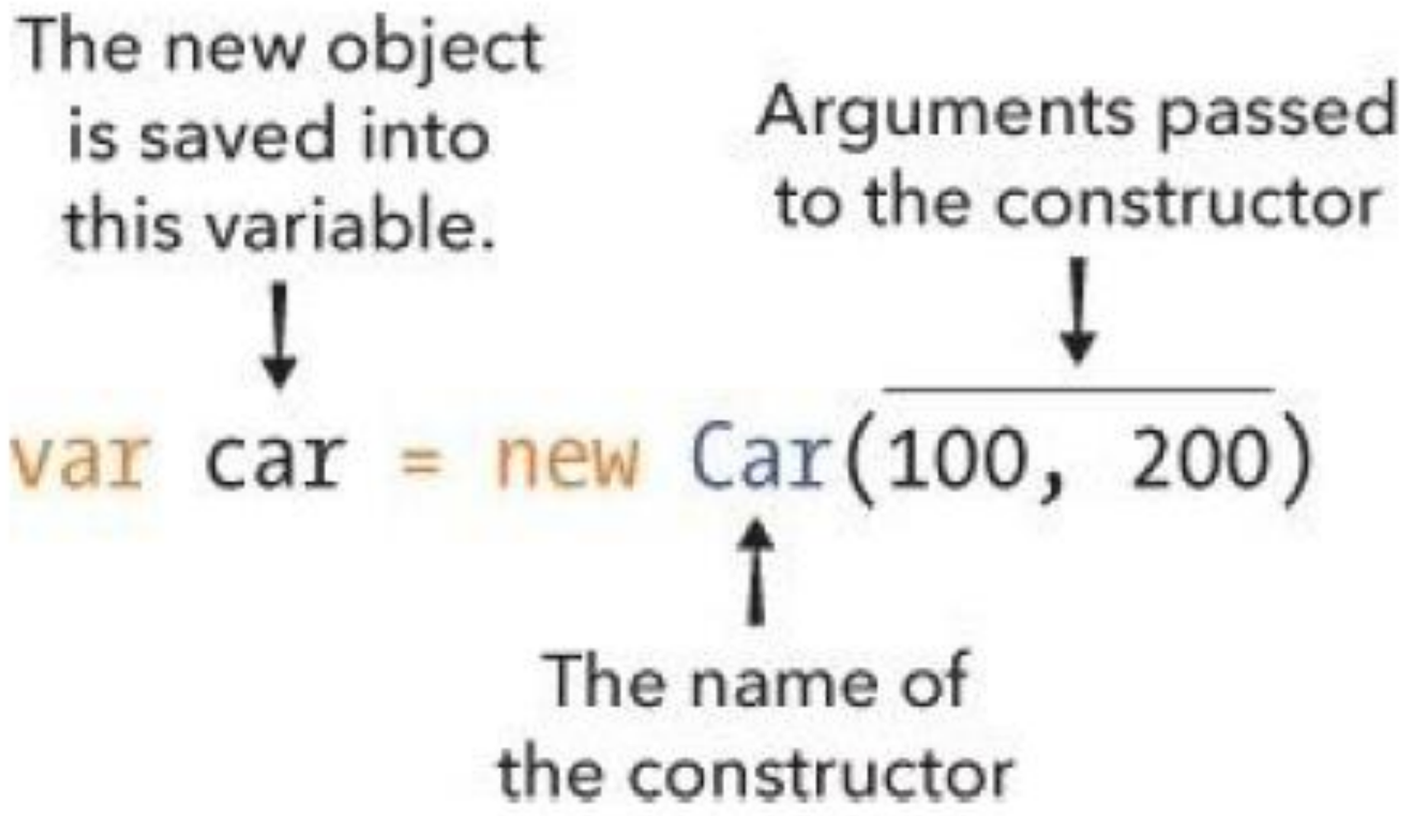
LECTURE 1

Creating Objects Using Constructors

- A JavaScript *constructor* is a function that creates objects and gives them a set of built-in properties and methods. Think of it as a specialized machine for creating objects, kind of like a factory that can churn out tons of copies of the same item.
- Once you’ve set up a constructor, you can use it to make as many of the same object as you want. To try it out, we’ll build the beginnings of a racing game, using a Car constructor to create a fleet of cars with similar basic properties and methods for steering and acceleration.

Anatomy of the Constructor

- Each time you call a constructor, it creates an object and gives the new object built-in properties. To call a normal function, you enter the function name followed by a pair of parentheses.
- To call a constructor, you enter the keyword new (which tells JavaScript that you want to use your function as a constructor), followed by the constructor name and parentheses. Figure 12-1 shows the syntax for calling a constructor.


The new object is saved into this variable.
Arguments passed to the constructor
The name of the constructor

```
var car = new Car(100, 200)
```

Figure 12-1. The syntax for calling a constructor named `Car` *with two arguments*

Creating a Car Constructor

Now let’s create a Car constructor that will add an x and y property to each new object it creates.

These properties will be used to set each car’s onscreen position when we draw it.

Creating the HTML Document

- Before we can build our constructor, we need to create a new HTML document. Make a new file called *cars.html* and enter this HTML into it:

```
<!DOCTYPE html>
<html>
      <head>
      <title>Cars</title>
      </head>
      <body>
      <script src="https://code.jquery.com/jquery-3.4.1.js"></script>
      <script>
        // Code goes here
      </script>
      </body>
</html>
```

Demonstration Program

CARS0.HTML

The Car Constructor function

- Now add this code to the empty <script> tags in *cars.html* (replacing the comment // Code goes here) to create the Car constructor that gives each car a set of coordinates.

```
<script>
    var Car = function (x, y) {
        this.x = x;
        this.y = y;
    };
</script>
```

- Our new constructor Car takes the arguments x and y. We’ve added the properties this.x and this.y to store the x and y values passed to Car in our new object. This way, each time we call Car as a constructor, a new object is created with its x and y properties set to the arguments we specify.

Calling the Car Constructor

- As I mentioned earlier, the keyword new tells JavaScript that we're calling a constructor to create a new object. For example, to create a car object named tesla, open *cars.html* in a web browser and then enter this code in the Chrome JavaScript console:

```
var tesla = new Car(10, 20);
tesla;
Car {x: 10, y: 20}
```

Calling the Car Constructor

- The code new Car(10, 20) tells JavaScript to create an object using Car as a constructor, pass in the arguments 10 and 20 for its x and y properties, and return that object. We assign the returned object to the tesla variable with var tesla.
- Then when we enter tesla, the Chrome console returns the name of the constructor and its x and y values: Car {x: 10, y: 20}.

Drawing the Cars

LECTURE 1

Drawing the Cars

- To show the objects created by the Car constructor, we'll create a function called drawCar to place an image of a car at each car object's (*x*, *y*) position in a browser window. Once we've seen how this function works, we'll rewrite it in a more object-oriented way in Adding a draw Method to the Car Prototype.

Add this code between the <script> tags in *cars.html*:

```
<script>
     var Car = function (x, y) {
          this.x = x;
          this.y = y;
     };
     var drawCar = function (car) {
❶    var carHtml = '<img src="http://nostarch.com/images/car.png">';
❷    var carElement = $(carHtml);
❸    carElement.css({
               position: "absolute",
               left: car.x,
               top: car.y
          });
❹    $("body").append(carElement);
     };
</script>
```

Drawing the Cars

- At ❶ we create a string containing HTML that points to an image of a car. (Using single quotes to create this string lets us use double quotes in the HTML.)
- At ❷ we pass carHTML to the $ function, which converts it from a string to a jQuery element. That means the carElement variable now holds a jQuery element with the information for our <img> tag, and we can tweak this element before adding it to the page.

Drawing the Cars

- At ❸ we use the css method on carElement to set the position of the car image. This code sets the left position of the image to the car object's x value and its top position to the y value.
- In other words, the left edge of the image will be x pixels from the left edge of the browser window, and the top edge of the image will be y pixels down from the top edge of the window.

Drawing the Cars

- Finally, at ❹ we use jQuery to append the carElement to the body element of the web page. This final step makes the carElement appear on the page. (For a reminder on how append works, see Creating New Elements with jQuery.)

Demonstration Program

CARS1.HTML

Testing Function

LECTURE 1

Testing the drawCar Function

- Let’s test the drawCar function to make sure it works. Add this code to your *cars.html* file (after the other JavaScript code) to create two cars.

```
$("body").append(carElement);
};
var tesla = new Car(20, 20);
var nissan = new Car(100, 200);
drawCar(tesla);
drawCar(nissan);
</script>
```

- Here, we use the Car constructor to create two car objects, one at the coordinates (20, 20) and the other at (100, 200), and then we use drawCar to draw each of them in the browser. Now when you open *cars.html*, you should see two car images in your browser window, as shown in Figure 12-2.

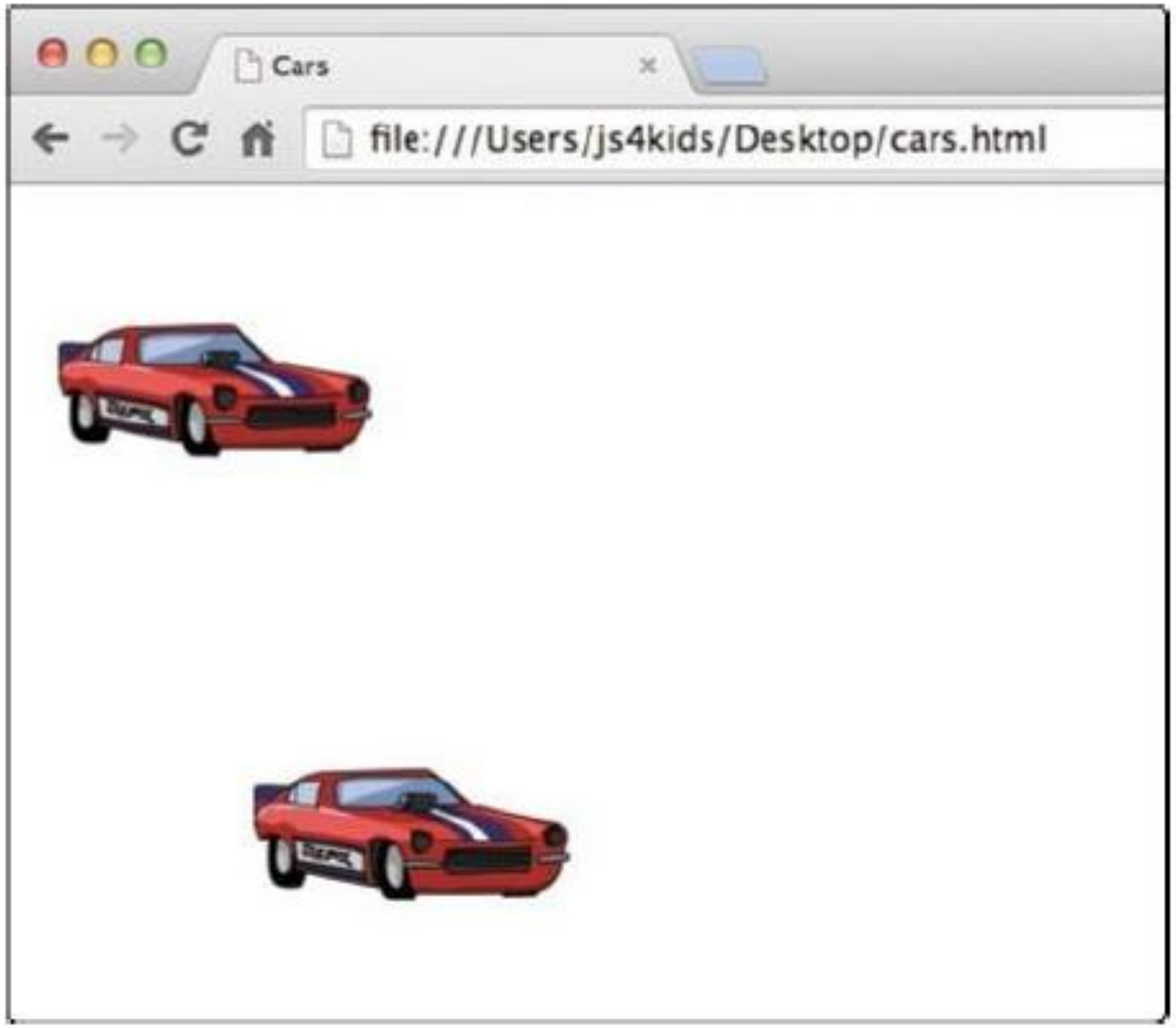


Figure 12-2. Drawing cars using drawCar

Demonstration Program

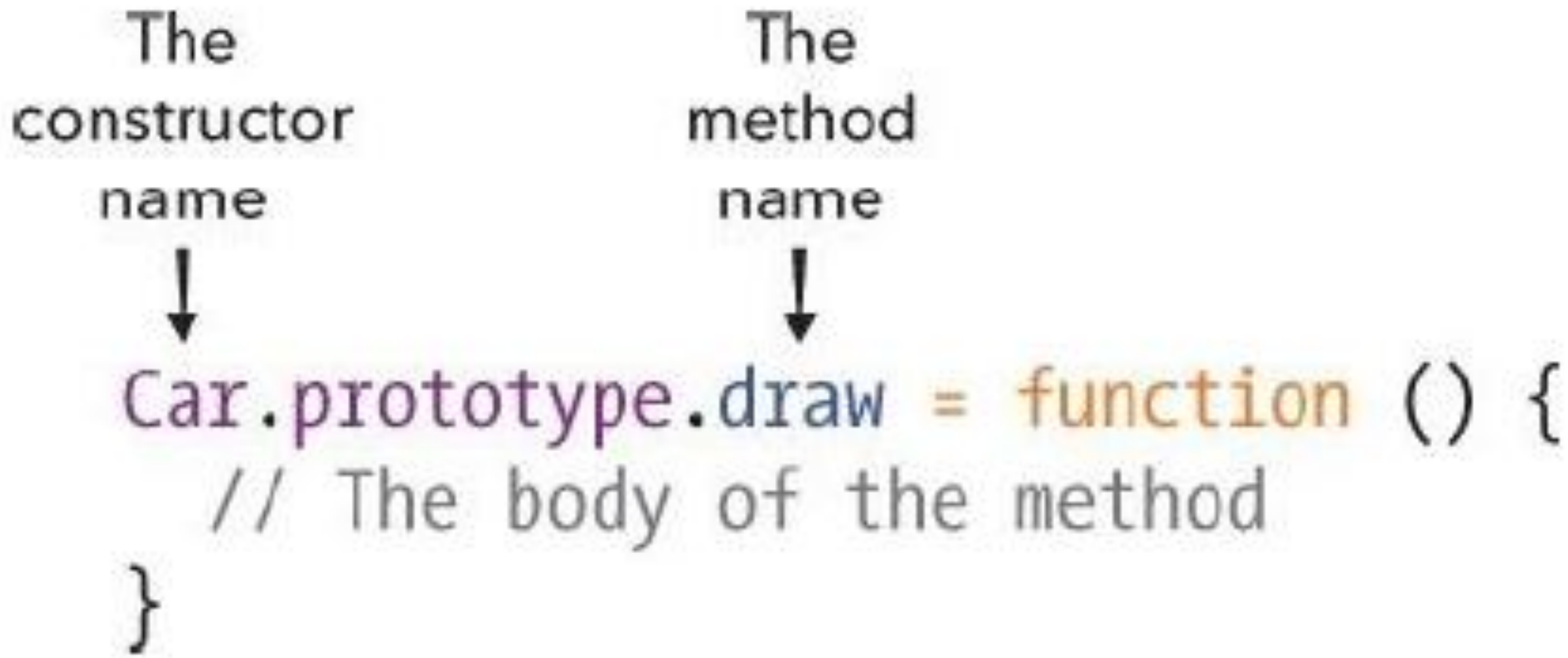
CARS.HTML

Prototypes

LECTURE 1

Customizing Objects with Prototypes

- A more object-oriented way to draw our cars would be to give each car object a draw method. Then, instead of writing drawCar(tesla), you'd write tesla.draw(). In object-oriented programming, we want objects to have their own functionality built in as methods. In this case, the drawCar function is always meant to be used on car objects, so instead of saving drawCar as a separate function, we should include it as part of each car object.
- JavaScript *prototypes* make it easy to share functionality (as methods) between different objects. All constructors have a prototype property, and we can add methods to it. Any method that we add to a constructor's prototype property will be available as a method to all objects created by that constructor.
- Figure 12-3 shows the syntax for adding a method to a prototype property.



```
Car.prototype.draw = function () {
  // The body of the method
}
```

Figure 12-3. The syntax for adding a method to a prototype property

Adding a draw Method to the Car Prototype

- Let’s add a draw method to Car.prototype so that all objects we create using Car will have the draw method. Using File ▸ Save As, save your cars.html file as cars2.html.
- Then replace all of the JavaScript in your second set of <script> tags in cars2.html with this code:

```
❶ var Car = function (x, y) {
            this.x = x;
            this.y = y;
      };
❷ Car.prototype.draw = function () {
      var carHtml = '<img src="http://nostarch.com/images/car.png">';
❸     this.carElement = $(carHtml);
      this.carElement.css({
                  position: "absolute",
❹                 left: this.x,
                  top: this.y
            });
      $("body").append(this.carElement);
      };
var tesla = new Car(20, 20);
var nissan = new Car(100, 200);
tesla.draw();
nissan.draw();
```

Adding a draw Method to the Car Prototype

- After creating our Car constructor at ❶, we add a new method called draw to Car.prototype at ❷.
- This makes the draw method part of all of the objects created by the Car constructor.
- The contents of the draw method are a modified version of our drawCar function. First, we create an HTML string and save it as carHTML. At ❸ we create a jQuery element representing this HTML, but this time we save it as a property of the object by assigning it to this.carElement. Then at ❹, we use this.x and this.y to set the coordinates of the top-left corner of the current car image. (Inside a constructor, this refers to the new object currently being created.)

Adding a draw Method to the Car Prototype

- When you run this code, the result should look like Figure 12-2. We haven’t changed the code’s functionality, only its organization. The advantage to this approach is that the code for drawing the car is part of the car, instead of a separate function.

Demonstration Program

CARS2.HTML

Adding a moveRight Method

- Now let's add some methods to move the cars around, beginning with a moveRight method to move the car 5 pixels to the right of its current position. Add the following code after your definition of Car.prototype.draw:

```
        this.carElement.css({
                position: "absolute",
                left: this.x,
                top: this.y
        });
$("body").append(this.carElement);
};
Car.prototype.moveRight = function () {
        this.x += 5;
        this.carElement.css({
                left: this.x,
                top: this.y
        });
};
```

Adding a moveRight Method

- We save the moveRight method in Car.prototype to share it with all objects created by the Car constructor. With this.x += 5 we add 5 to the car's x value, which moves the car 5 pixels to the right.
- Then we use the css method on this.carElement to update the car's position in the browser.
- Try the moveRight method in the browser console. First, refresh *cars2.html*, and then open the console and enter these lines:

```
tesla.moveRight();
tesla.moveRight();
tesla.moveRight();
```

- Each time you enter tesla.moveRight, the top car should move 5 pixels to the right. You could use this method in a racing game to show the car moving down the racetrack.

Adding the Left, Up, and Down move Methods

- Now we’ll add the remaining directions to our code so that we can move our cars around the screen in any direction. These methods are basically the same as moveRight, so we’ll write them all at once.

Add the following methods to *cars2.html* just after the code for moveRight:

```
Car.prototype.moveRight = function () {
                this.x += 5;
                this.carElement.css({
                        left: this.x,
                        top: this.y
                });
        };
Car.prototype.moveLeft = function () {
                this.x -= 5;
                this.carElement.css({
                        left: this.x,
                        top: this.y
                });
        };
Car.prototype.moveUp = function () {
                this.y -= 5;
                this.carElement.css({
                        left: this.x,
                        top: this.y
                });
        };
Car.prototype.moveDown = function () {
                this.y += 5;
                this.carElement.css({
                        left: this.x,
                        top: this.y
                });
        }
```

- Each of these methods moves the car by 5 pixels in the specified direction by adding or subtracting 5 from each car’s x or y value.

Demonstration Program

CARS3.HTML