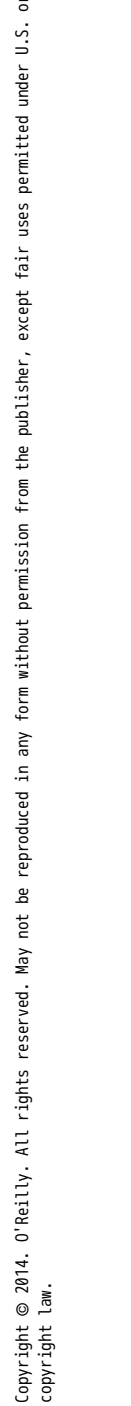
12 advanced object construction



Creating objects

So far we've been crafting objects by hand. For each object, we've used an **object literal** to specify each and every property. That's okay on a small scale, but for serious code we need something better. That's where **object constructors** come in. With constructors we can create objects much more easily, and we can create objects that all adhere to the same **design blueprint**—meaning we can use constructors to ensure each object has the same properties and includes the same methods. And with constructors we can write object code that is much more **concise** and a lot less error prone when we're creating lots of objects. So, let's get started and after this chapter you'll be talking constructors just like you grew up in Objectville.

Creating objects with object literals

So far in this book, you've been using *object literals* to create objects. With an object literal, you create an object by writing it out… well, literally. Like this:

```
var taxi = {
    make: "Webville Motors",
    model: "Taxi",
    year: 1955,
    color: "yellow",
    passengers: 4,
    convertible: false,
    mileage: 281341,
    started: false,

    start: function() { this.started = true;},
    stop: function() { this.started = false;},
    drive: function {
        // drive code here
    }
};
```

With an object literal you type out each part of the object within curly braces. When you're done, the result is an actual JavaScript object, which you typically assign to a variable for later use.

Object literals give you a convenient way to create objects anywhere in your code, but when you need to create lots of objects—say a whole fleet of taxis—you wouldn't want to type in a hundred different object literals now would you?

BRAIN POWER

Think about creating a fleet of taxi objects. What other issues might using object literals cause?

- ☐ Tired fingers from a lot of typing!
- ☐ Can you ensure that each taxi has the same properties? What if you make a mistake or typo, or leave out a property?
- ☐ A lot of object literals means a lot of code. Isn't that going to lead to slow download times for the browser?
- ☐ The code for the start, stop and drive methods would have to be duplicated over and over.
- ☐ What if you decide to add or delete a property (or to change the way start or stop work)? You'd have to make the change in all the taxis.
- ☐ Who needs taxis when we have Uber?

Using conventions for objects

The other thing we've been doing, so far, is creating objects *by convention*. For example, we've been putting properties and methods together and saying "it's a car!" or "it's a dog!", but the only thing that makes two such objects cars (or dogs) is that we've followed our own conventions.

Now, this technique might work on a small scale but it's problematic when we have lots of objects, or even lots of developers working in the same code who might not fully know or follow the conventions.

But don't take our word for it. Take a look at some of the objects we've seen earlier in the book, which we've been told are cars:

This definitely looks like the cars we've been dealing with. It has all the same properties and methods.

```
var taxi = {
    make: "Webville Motors",
    model: "Taxi",
    year: 1955,
    color: "yellow",
    passengers: 4,
    convertible: false,
    mileage: 281341,
    started: false,

    start: function() {
        this.started = true;
    },

    stop: function() {
        this.started
```

Okay, this looks a lot like our other car objects...but wait. This has a rocket thruster. Hmm, not sure this is really a car.

```
var rocketCar = {
    make: "Galaxy",
    model: "4000",
    year: 2001,
    color: "white",
    passengers: 6,
    convertible: false,
    mileage: 60191919,
    started: false,

    start: function() {
        this.started = true;
    },

    stop: function() {
        this.started = false;
    },

    drive: function() {
        // drive code here
    },

    thrust: function(amount) {
        // code for thrust
    }
};
```

The tbird looks like a great car, but we're not seeing some of the basic properties it needs, like mileage or color. It also seems to have a few extra properties. That could be a problem...

```
var tbird = {
    make: "Ford",
    model: "Thunderbird",
    year: 1957,
    passengers: 4,
    convertible: true,
    started: false,
    oilLevel: 1.0,

    start: function() {
        if (oilLevel > .75) {
            this.started = true;
        }
    },

    stop: function() {
        this.started = false;
    },

    drive: function() {
        // drive code here
    }

};
```

```
var toyCar = {
    make: "Mattel",
    model: "PeeWee",
    color: "blue",
    type: "wind up",
    price: "2.99"
};
```

Wait, this might be a car but it looks nothing like our other cars. It does have a make, model and color, but this looks like a toy, not a car. What's this doing here?

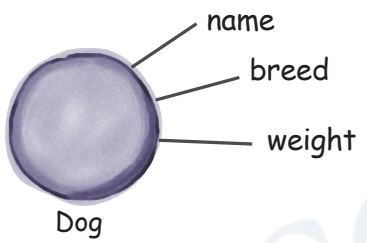
Introducing Object Constructors

Object constructors, or "constructors" for short, are your path to better object creation. Think of a constructor like a little factory that can create an endless number of similar objects.

In terms of code, a constructor is quite similar to a function that returns an object: you define it once and invoke it every time you want to create a new object. But as you'll see there's a little extra that goes into a constructor.

The best way to see how constructors work is to create one. Let's revisit our old friend, the dog object, from earlier in the book and write a constructor to create as many dogs as we need. Here's a version of the dog object we've used before, with a name, a breed and a weight.

Object constructors and functions are closely related. Keep that in mind as you're learning how to write and use constructors.



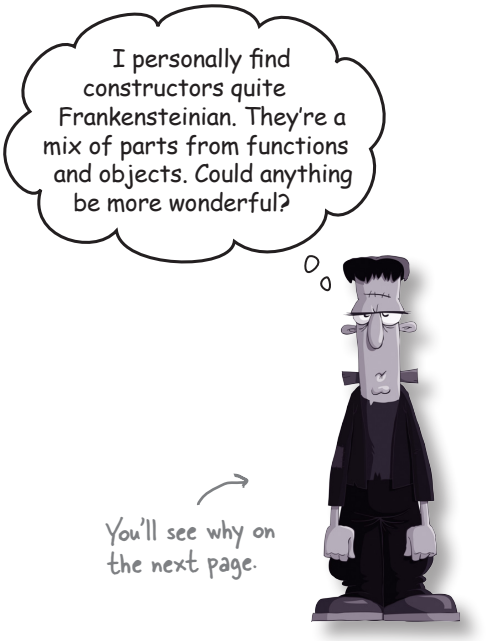
Now, if we were going to define such a dog with an object literal, it would look like this:

```
var dog = {
    name: "Fido",
    breed: "Mixed",
    weight: 38
};
```

Just a simple dog object created by an object literal. Now we need to figure out how to create a lot of these puppies.

But we don't want *just a Fido* dog, we want a way to create *any dog* that has a name, a breed and a weight. And, again, to do that we're going to write some code that looks like a function, with a dash of object syntax thrown in.

With that introduction, you must be a bit curious—go ahead and turn the page and let's get these constructors figured out and working for us.



How to create a Constructor

Using constructors is a two-step process: first we define a constructor, and then we use it to create objects. Let's first focus on creating a constructor.

What we want is a constructor that we can use to create dogs, and, more specifically, dogs with names, breeds and weights. So, we're going to define a function, called the constructor, that knows how to create dogs. Like this:

A constructor function looks just like a regular function.

But notice that we give the name of the constructor function a capital letter. This isn't required; but everyone does it as a convention.

The parameters of the function match the properties we want to supply for each individual dog.

```
function Dog(name, breed, weight) {
    this.name = name;
    this.breed = breed;
    this.weight = weight;
}
```

This part feels more like an object because we're assigning each parameter to what looks like a property.

The property names and parameter names don't have to be the same, but they often are—again, by convention.

Notice that this constructor function doesn't return anything.

Hmm, we're not using local variables like in most functions. Instead we're using the this keyword, and we've only used that inside objects so far.

Hang on; we'll look at how we use the constructor next and then all this is going to fall into place and make more sense.

Sharpen your pencil

We need your help. We've been using object literals to create ducks. Given what you learned above, can you write a constructor to create ducks for us? You'll find one of our object literals below to base your constructor on:

```
var duck = {
    type: "redheaded",
    canFly: true
}
```

Here's an example duck object literal.

Write a constructor for creating ducks.

P.S. We know you haven't fully figured out how this all works yet, so for now concentrate on the syntax.

How to use a Constructor

We said using a constructor is a two-step process: first we create a constructor, then we use it. Well, we've created a Dog constructor, so let's use it. Here's how we do that:

To create a dog, we use the new operator with the constructor.

Followed by a call to the constructor.

And the arguments.

Try saying it out loud: "to create fido, I create a new dog object with the name Fido that is a mixed breed and weighs 38 pounds."

```
var fido = new Dog("Fido", "Mixed", 38);
```

So, to create a new dog object with a name of "Fido", a breed of "Mixed" and a weight of 38, we start with the `new` keyword and follow it by a call to the constructor function with the appropriate arguments. After this statement is evaluated, the variable `fido` will hold a reference to our new dog object.

Now that we have a constructor for dogs, we can keep making them:

```
var fluffy = new Dog("Fluffy", "Poodle", 30);

var spot = new Dog("Spot", "Chihuahua", 10);
```

That's a bit easier than using object literals isn't it? And by creating dog objects this way, we know each dog has the same set of properties: name, breed, and weight.


```
function Dog(name, breed, weight) {
    this.name = name;
    this.breed = breed;
    this.weight = weight;
}
var fido = new Dog("Fido", "Mixed", 38);
var fluffy = new Dog("Fluffy", "Poodle", 30);
var spot = new Dog("Spot", "Chihuahua", 10);
var dogs = [fido, fluffy, spot];

for (var i = 0; i < dogs.length; i++) {
    var size = "small";
    if (dogs[i].weight > 10) {
        size = "large";
    }
    console.log("Dog: " + dogs[i].name
                + " is a " + size
                + " " + dogs[i].breed);
}
```

Let's get some quick hands-on experience to help this all sink in. Go ahead and put this code in a page and give it a test drive. Write your output here.

How constructors work

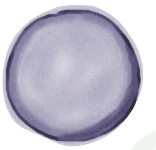
We've seen how to declare a constructor and also how to use it to create objects, but we should also take a look behind the scenes to see how a constructor actually works. Here's the key: to understand constructors we need to know what the `new` operator is doing.

We'll start with the statement we used to create `fido`:

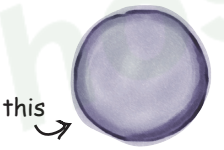
```
var fido = new Dog("Fido", "Mixed", 38);
```

Take a look at the right-hand side of the assignment, where all the action is. Let's follow its execution:

1. The first thing `new` does is create a new, empty object:



2. Next, `new` sets `this` to point to the new object.

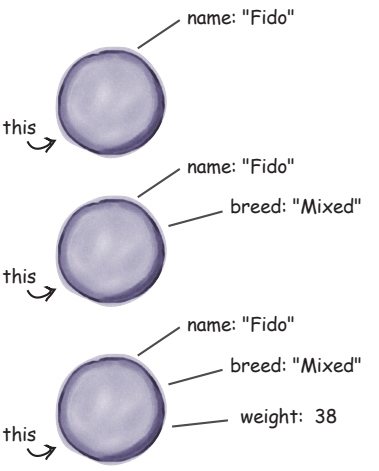


Remember from Chapter 5 that this holds a reference to the current object our code is dealing with.

3. With `this` set up, we now call the function Dog, passing "Fido", "Mixed" and 38 as arguments.

```
          "Fido"     "Mixed"     38
            ↓          ↓         ↓
function Dog(name, breed, weight) {
    this.name = name;
    this.breed = breed;
    this.weight = weight;
}
```

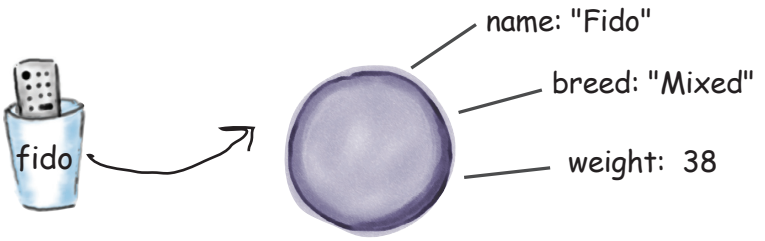
4. Next the body of the function is invoked. Like most constructors, Dog assigns values to properties in the newly created `this` object.



Executing the body of the Dog function customizes the new object with three properties, assigning them the values of the respective parameters.

5 Finally, once the Dog function has completed its execution the `new` operator returns `this`, which is a reference to the newly created object. Notice `this` is returned for you; you don't have to explicitly return it in your code. And after the new object has been returned, we assign that reference to the variable `fido`.

Behind the Scenes



BE the Browser

Below, you'll find JavaScript code with some mistakes in it. Your job is to play like you're the browser and find the errors in the code. After you've done the exercise look at the end of the chapter to see if you found them all. And, hey by the way, this is Chapter 12. Feel free to make style comments too. You've earned the right.

```
function widget(partNo, size) {
    var this.no = partNo;
    var this.breed = size;
}
function FormFactor(material, widget) {
    this.material = material,
    this.widget = widget,
    return this;
}

var widgetA = widget(100, "large");
var widgetB = new widget(101, "small");
var formFactorA = newFormFactor("plastic", widgetA);
var formFactorB = new ForumFactor("metal", widgetB);
```

You can put methods into constructors as well

The dog objects that the Dog constructor creates are just like the dogs from earlier in the book… except that our newly constructed dogs can't bark (because they don't have a `bark` method). This is easily fixed because in addition to assigning values to properties in the constructor, we can set up methods too. Let's extend the code to include a `bark` method:

By the way, as you know, methods in objects are properties too. They just happen to have a function assigned to them.

To add a bark method we simply assign a function, in this case an anonymous function, to the property this.bark.

```
function Dog(name, breed, weight) {
    this.name = name;
    this.breed = breed;
    this.weight = weight;
    this.bark = function() {
        if (this.weight > 25) {
            alert(this.name + " says Woof!");
        } else {
            alert(this.name + " says Yip!");
        }
    };
}
```

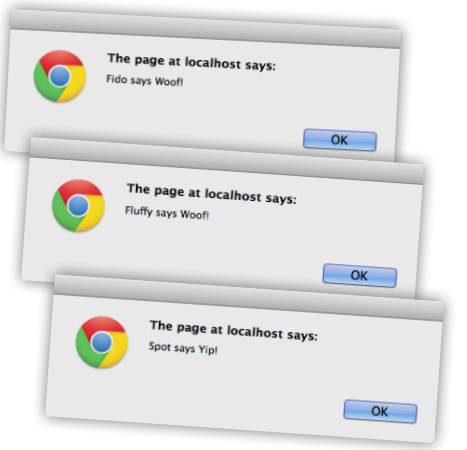
Now every dog object will also have a bark method that you can invoke.

Notice that, just like all the other objects we've created in the past, we use this to refer to the object we're calling the method on.

Take the bark method for a quick test drive

Enough talking about constructors, let's add the code above to an HTML page, and then add the code below to test it:

```
var fido = new Dog("Fido", "Mixed", 38);
var fluffy = new Dog("Fluffy", "Poodle", 30);
var spot = new Dog("Spot", "Chihuahua", 10);
var dogs = [fido, fluffy, spot];

for (var i = 0; i < dogs.length; i++) {
    dogs[i].bark();
}
```



Make sure your dog objects bark like they're supposed to.

We've got a constructor to create coffee drinks, but it's missing its methods.

We need a method, getSize, that returns a string depending on the number of ounces of coffee:

- 8oz is a small
- 12oz is a medium
- 16oz is a large

We also need a method, toString, that returns a string that represents your order, like "You've ordered a small House Blend coffee."

Write your code below, and then test it in the browser. Try creating a few different sizes of coffee. Check your answer before you go on.

```
function Coffee(roast, ounces) {
    this.roast = roast;
    this.ounces = ounces;



}

var houseBlend = new Coffee("House Blend", 12);
console.log(houseBlend.toString());

var darkRoast = new Coffee("Dark Roast", 16);
console.log(darkRoast.toString());
```

Write the two methods for this constructor here.

Here's our output; yours should look similar.

JavaScript console

```
You've ordered a medium House Blend coffee.
You've ordered a large Dark Roast coffee.
```

there are no Dumb Questions

Q: Why do constructor names start with a capital letter?

A: This is a convention that JavaScript developers use so they can easily identify which functions are constructors, and which functions are just regular old functions. Why? Because with constructor functions, you need to use the new operator. In general, using a capital letter for constructors makes them easier to pick out when you're reading code.

Q: So, other than setting up the properties of the `this` object, a constructor's just like a regular function?

A: If you mean computationally, yes. You can do anything in a constructor you can do in a regular function, like declare and use variables, use for loops, call other functions, and so on. The only thing you don't want to do is return a value (other than **this**) from a constructor because that will cause the constructor to not return the object it's supposed to be constructing.

Q: Do the parameter names of a constructor function have to match the property names?

A: No. You can use whatever names you want for the parameters. The parameters are just used to hold values that we want to assign to the object's properties to customize the object. What matters is the name of the properties you use for the object. That said, we often do use the same names for clarity, so we know which properties we're assigning by looking at the constructor function definition.

Q: Is an object created by a constructor just like an object created with a literal?

A: Yes, until you get into more advanced object design, which we'll do in the next chapter.

Q: Why do we need `new` to create objects? Couldn't we create an object in a regular function and return it (kind of like we did with makeCar in chapter 5)?

A: Yes, you could create objects that way, but like we said in the previous answer, there are some extra things that happen when you use `new`. We'll get more into these issues later in this chapter, and again in Chapter 13.

Q: I'm still a bit confused by `this` in the constructor. We're using `this` to assign properties to the object, and we're also using `this` in the methods of the object. Are these the same thing?

A: When you call a constructor (to create an object) the value of **this** is set to the new object that's being created so all the code that is evaluated in the constructor applies to that new object.

Later, when you call a method on an object, **this** is set to the object whose method you called. So the **this** in your methods will always refer to the object whose method was called.

Q: Is it better to create objects with a constructor than with object literals?

A: Both are useful. A constructor is useful when you want to create lots of objects with the same property names and methods. Using them is convenient, reuses code, and provides consistency across your objects.

But sometimes we just need a quick object, perhaps a one-time-use only object, and literals are concise and expressive to use for this.

So it really depends what your needs are. Both are great ways to create an object.

We'll see a good example of this a bit later.

DANGER ZONE

There's one aspect of constructors you need to be very careful about: don't forget to use the **new** keyword. It's easy to do because a constructor is, after all, a function, and you can call it without **new**. *But if you forget **new** on a constructor it can lead to buggy code that is hard to troubleshoot.* Let's take a look at what can happen when you forget the **new** keyword...

```
function Album(title, artist, year) {
    this.title = title;
    this.artist = artist;
    this.year = year;
    this.play = function() {
        // code here
    };
}
var darkside = Album("Dark Side of the Cheese","Pink Mouse", 1971);
darkside.play();
```

This looks like a well-constructed constructor.

But maybe that's okay because Album is a function.

Oops we forgot to use new!

Let's try to call the play method anyway. Oh, this isn't good...

```
Uncaught TypeError: Cannot call method 'play' of undefined
```

SAFETY CHECKLIST

Okay, let's read the checklist to see why this might have happened:

- ❏ Remember that **new** first creates a new object before assigning it to **this** (and then calling your constructor function). If you don't use **new**, a new object will never be created.
- ❏ That means any references to **this** in your constructor won't refer to a new album object, but rather, will refer to the global object of your application.
- ❏ If you don't use **new** there's no object to return from the constructor, which means there is no object assigned to the darkside variable, so darkside is undefined. That's why when we try to call the play method, we get an error saying the object we're trying to call it on is undefined.

The global object is the top-level object, which is where global variables get stored. In browsers, this object is the window object.

The Constructor Exposed

This week's interview: Getting to know new

Head First: `new`, where have you been hiding? How did we get to Chapter 12 before seeing you?

new: There are still a lot of scripts out there that don't use me, or use me without understanding me.

Head First: Why is that?

new: Because many scripters just use object literals or copy & paste code that uses me, without understanding how I work.

Head First: That's a good point… object literals are convenient, and I myself am not quite clear on when or how to use you just yet.

new: Well it's true, I am kind of an advanced feature. After all, to know how to use me, you first have to know how objects work, and how functions work, and how `this` works... it's a lot to wrap your head around before you even learn about me at all!

Head First: Can you give us the elevator pitch about yourself? Now that our readers know about objects, functions, and `this`, it would be great for them to get motivated for learning about you.

new: Let me think for a second… Okay here you go: I'm the operator that operates on constructor functions to create new objects.

Head First: Umm, I hate to break it to you but that isn't the best elevator pitch.

new: Gimme a break, I'm an operator, not a PR lackey.

Head First: Well, you do raise several questions with that pitch. First of all, you're an operator?

new: Yup! I'm an operator. Put me in front of a function call and I change everything. An operator operates on its operands. In my case, I have only one operand and that operand is a function call.

Head First: Right, so explain exactly how you operate.

new: Well, first, I make a new object. Everyone thinks that the constructor function is what does it, but it's actually me. It's a thankless job.

Head First: Go on…

new: Okay, so then I call the constructor function and make sure that the new object I've created is referenced by the `this` keyword in the body of the function.

Head First: Why do you do that?

new: So that the statements in the body of the function have a way to refer to the object. After all, the whole point of a constructor function is to extend that object using new properties and methods. If you're using the constructor to create objects like dogs and cars, you're going to want those objects to have some properties, right?

Head First: Right. And then?

new: Then I make sure that the new object that was created is returned from the constructor. It's a nice convenience so that developers don't have to remember to return it themselves.

Head First: It does sound very convenient. Now why would anyone use an object literal after learning you?

new: Oh, object literal and I go way back. He's a great guy, and I'd use him in a second if I had to create a quick object. But, you want me when you've got to create a lot of similar objects, when you want to make sure your objects are taking advantage of code reuse, when you want to ensure some consistency, and after you've learned a little more, to support some even more advanced uses.

Head First: More advanced? Oh do tell!

new: Now now, let's keep these readers focused. We'll talk more in the next chapter.

Head First: I think I need to re-read this interview first! Until then…

It's Production Time!

You've learned your object construction skills just in time because we've just received a big order for cars and we can't be creating them all by hand. We need to use a constructor so we can get the job done on time. We're going to do that by taking the car object literals we've used so far in the book, and using them as a guide for creating a constructor to make cars.

Check out the various kinds of cars we need to build below. Notice we've already taken the liberty of making their properties and methods uniform, so they all match across each car. For now, we won't worry about special options, or toy cars and rocket cars (we'll come back to that later). Go ahead and take a look, and then let's build a constructor that can create car objects for any kind of car that has these property names and methods:

```
var chevy = {
    make: "Chevy",
    model: "Bel Air",
    year: 1957,
    color: "red",
    passengers: 2,
    convertible: false,
    mileage: 1021,
    started: false,

    start: function() {
      this.started = true;
    },

    stop: function() {
      this.started = false;
    },

    drive: function() {
      if (this.started) {
        console.log(this.make + " " +
              this.model + " goes zoom zoom!");
      } else {
        console.log("Start the engine first.");
      }
    }
};
```

```
var cadi = {
    make: "GM",
    model: "Cadillac",
    year: 1955,
    color: "tan",
    passengers: 5,
    convertible: false,
    mileage: 12892,
    started: false,
    start: function() {...},
    stop: function() {...},
    drive: function() {...}
```

```
var fiat = {
    make: "Fiat",
    model: "500",
    year: 1957,
    color: "Medium Blue",
    passengers: 2,
    convertible: false,
    mileage: 88000,
    started: false,
    start: function() {...},
    stop: function() {
    drive: function()
};
```

```
var taxi = {
    make: "Webville Motors",
    model: "Taxi",
    year: 1955,
    color: "yellow",
    passengers: 4,
    convertible: false,
    mileage: 281341,
    started: false,
    start: function() {...},
    stop: function() {...},
    drive: function() {...}
};
```

Use everything you've learned to create a Car constructor. We suggest the following order:

1. Start by providing the function keyword (actually we did that for you) followed by the constructor name. Next supply the parameters; you'll need one for each property that you want to supply an initial value for.

2. Next, assign each property in the object its initial value (make sure you use `this` along with the property name).

3. Finally, add in the three car methods: start, drive and stop.

```
function ________(_____________________________________________) {

}
```

All your work goes here.

Make sure you check all your work with the answer at the end of the chapter before proceeding!

Let's test drive some new cars

Now that we have a way to mass-produce car objects, let's make some, and put them through their paces. Start by putting the Car constructor in an HTML page, then add some test code.

Note: you won't be able to do this unless you did the exercise on the previous page!

Here's the code we used; feel free to alter and extend it:

First we're using the constructor to create all the cars from Chapter 5.

```
var chevy = new Car("Chevy", "Bel Air", 1957, "red", 2, false, 1021);
var cadi = new Car("GM", "Cadillac", 1955, "tan", 5, false, 12892);
var taxi = new Car("Webville Motors", "Taxi", 1955, "yellow", 4, false, 281341);
var fiat = new Car("Fiat", "500", 1957, "Medium Blue", 2, false, 88000);
```

But why stop there?

```
var testCar = new Car("Webville Motors", "Test Car", 2014, "marine", 2, true, 21);
```

Let's create the book's test drive car!

Feel free to add your own favorite or fictional car too.

Are you starting to see how easy creating new objects can be with constructors? Now let's take these cars for a test drive:

```
var cars = [chevy, cadi, taxi, fiat, testCar];

for(var i = 0; i < cars.length; i++) {
    cars[i].start();
    cars[i].drive();
    cars[i].drive();
    cars[i].stop();
}
```

Here's the output we got. Did you add your own car to the mix? Try changing what the cars do (like driving before the car is started). Or, maybe you can make the number of times we call the drive method random?

JavaScript console

```
Chevy Bel Air goes zoom zoom!
Chevy Bel Air goes zoom zoom!
GM Cadillac goes zoom zoom!
GM Cadillac goes zoom zoom!
Webville Motors Taxi goes zoom zoom!
Webville Motors Taxi goes zoom zoom!
Fiat 500 goes zoom zoom!
Fiat 500 goes zoom zoom!
Webville Motors Test Car goes zoom zoom!
Webville Motors Test Car goes zoom zoom!
```

Don't count out object literals just yet

We've had some discussion of object constructors versus object literals, and mentioned that object literals are still quite useful, but you really haven't seen a good example of that. Well, let's do a little reworking of the Car constructor code, so you can see where using some object literals actually cleans up the code and makes it more readable and maintainable.

Let's look at the Car constructor again and see how we might be able to clean it up a bit.

Notice we're using a lot of parameters here. We count seven.

The more we add (and we always end up adding more as the requirements for objects grow), the harder this is to read.

```
function Car(make, model, year, color, passengers, convertible, mileage) {
    this.make = make;
    this.model = model;
    this.year = year;
    this.color = color;
    this.passengers = passengers;
    this.convertible = convertible;
    this.mileage = mileage;
    this.started = false;

    this.start = function() {
        this.started = true;
    };
    //rest of the methods here
}
```

And when we write code that calls this constructor we have to make sure we get the arguments all in exactly the right order.

So the problem we're highlighting here is that we have a heck of a lot of parameters in the Car constructor, making it difficult to read and maintain. It's also difficult to write code to call this constructor. While that might seem like a minor inconvenience, it actually causes more bugs than you might think, and not only that, they're often nasty bugs that are hard to diagnose at first.

They're hard to diagnose because if you switch two variables, the code is still syntactically correct, but it doesn't function correctly because you've switched two values.

Or if you leave out a value, all kinds of craziness can ensue!

However, there is a common technique that we can use when passing all these arguments that can be used for any function, whether or not it's a constructor. The technique works like this: take all your arguments, throw them in an object literal, and then pass that literal to your function—that way you're passing all your values in one container (the literal object) and you don't have worry about matching the order of your arguments and parameters.

Let's rewrite the code to call the Car constructor, and then do a slight rework of the constructor code to see how this works.

Rewiring the arguments as an object literal

Let's take the call to the Car constructor and rework its arguments into an object literal:

All you need to do is take each argument and place it in an object literal with an appropriate property name. We use the same property names used in the constructor.

```
var cadi = new Car("GM", "Cadillac", 1955, "tan", 5, false, 12892);
```

We've kept the same order, but there is no reason you'd have to.

```
var cadiParams = {make: "GM",
                  model: "Cadillac",
                  year: 1955,
                  color: "tan",
                  passengers: 5,
                  convertible: false,
                  mileage: 12892};
```

And then we can rewrite the call to the Car constructor like this:

```
var cadiParams = {make: "GM",
                  model: "Cadillac",
                  year: 1955,
                  color: "tan",
                  passengers: 5,
                  convertible: false,
                  mileage: 12892};

var cadi = new Car(cadiParams);
```

Wow, talk about a makeover. Not only is this much cleaner, it's a lot more readable, at least in our humble opinion.

Now we're passing a single argument to the Car constructor.

But we're not done yet because the constructor itself is still expecting seven arguments, not one object. Let's rework the constructor code, and then we'll give this a test.

Reworking the Car constructor

Now you need to remove all the individual parameters in the Car constructor and replace them with properties from the object that we're passing in. We'll call that parameter `params`. You also need to rework the code a bit to use this object. Here's how:

```
var cadiParams = {make: "GM",
                  model: "Cadillac",
                  year: 1955,
                  color: "tan",
                  passengers: 5,
                  convertible: false,
                  mileage: 12892};

var cadi = new Car(cadiParams);

function Car(params) {
    this.make = params.make;
    this.model = params.model;
    this.year = params.year;
    this.color = params.color;
    this.passengers = params.passengers;
    this.convertible = params.convertible;
    this.mileage = params.mileage;
    this.started = false;

    this.start = function() {
        this.started = true;
    };
    this.stop = function() {
        this.started = false;
    };
    this.drive = function() {
        if (this.started) {
            alert("Zoom zoom!");
        } else {
            alert("You need to start the engine first.");
        }
    };
}
```

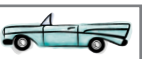
No changes here, we've just reproduced the object literal and the call to the Car constructor from the previous page.

First things first. We'll replace the seven parameters of the Car constructor with one parameter, for the object we're passing in.

Then for each reference to a parameter, we substitute the corresponding property from the object passed into the function.

In our methods we never use a parameter directly. It wouldn't make sense to because we always want to use the object's properties (which we do using the `this` variable). So, no changes are needed to this code at all.

Test drive



Update the `cadi` and all your other cars, and test your code.

```
cadi.start();
cadi.drive();
cadi.drive();
cadi.stop();
```

Exercise

Copy the Car and Dog constructors into one file, and then add the code below along with it. Give this a run and capture the output.

You'll find the Dog constructor on page 530.

```
var limoParams = {make: "Webville Motors",
                  model: "limo",
                  year: 1983,
                  color: "black",
                  passengers: 12,
                  convertible: true,
                  mileage: 21120};

var limo = new Car(limoParams);
var limoDog = new Dog("Rhapsody In Blue", "Poodle", 40);

console.log(limo.make + " " + limo.model + " is a " + typeof limo);
console.log(limoDog.name + " is a " + typeof limoDog);
```

Put the output here.

Say someone handed you an object and you wanted to know what type of object it was (is it a Car? a Dog? Superman?), or you wanted to see if it was the same type as another object. Would the typeof operator be helpful?

there are no Dumb Questions

Q: Remind me what typeof does again?

A: The typeof operator returns the type of its operand. If you pass it a string you'll get back "string", if you pass it an object you'll get back "object" and so on. You can pass it any type: a number, a string, a boolean, or a more complex type like an object or function. But typeof can't be more specific and tell you the object is a dog or a car.

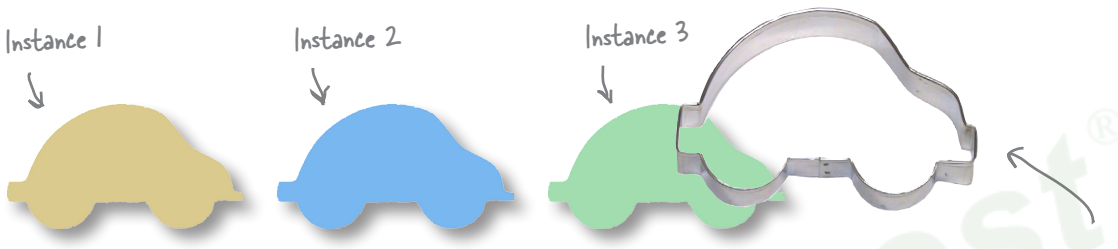
Q: So if typeof can't tell me that my object is a dog or car, how do I determine what is what?

A: Many other object-oriented languages, like Java or C++, have a strong notion of object typing. In those languages you can examine an object and determine exactly what type of object it is. But, JavaScript treats objects and their types in a looser, more dynamic way. Because of this, many developers have jumped to the conclusion that JavaScript has a less powerful object system, but the truth is, its object system is actually more general and flexible. Because JavaScript's type system is more dynamic, it's a little more difficult to determine if an object is a dog or a car, and it depends on what you think a dog is or a car is. However, we have another operator that can give us a little more information... so continue reading.

Understanding Object Instances

You can't look at a JavaScript object and determine that it is an object of a specific type, like a dog or a car. In JavaScript, objects are dynamic structures, and the type of all objects is just "object," no matter what properties and methods it has. But we can get some information about an object if we know the *constructor* that created the object.

Remember that each time you call a constructor using the `new` operator, you are creating a new instance of an object. And, if you used, say, the Car constructor to do that, then we say, informally, that the object is a car. More formally, we say that object is an *instance of* a Car.



As you know, each instance can have its own unique set of property values, but we think of all the objects created from the Car constructor as instances of Car.

You can think of these cars as being the same kind of object because they all were created by the same constructor.

Now saying an object is an instance of some constructor is more than just talk. We can actually write code to inspect the constructor that made an object with the `instanceof` operator. Let's look at some code:

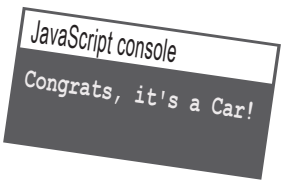
```
var cadiParams = {make: "GM", model: "Cadillac", year: 1955, color: "tan",
                  passengers: 5, convertible: false, mileage: 12892};

var cadi = new Car(cadiParams);

if (cadi instanceof Car) {
    console.log("Congrats, it's a Car!");
};
```

The instanceof operator returns true if the object was created by the specified constructor.

In this case we're saying "Is the cadi object an instance that was created by the Car constructor?"

As it turns out, one of the things the `new` operator does behind the scenes when the object is created is to store information that allows it to determine, at any time, the constructor that created the object. And `instanceof` uses that to determine if an object is an instance of a certain constructor.

It's a bit more complicated than we're describing here, but we'll talk about that in the next chapter.



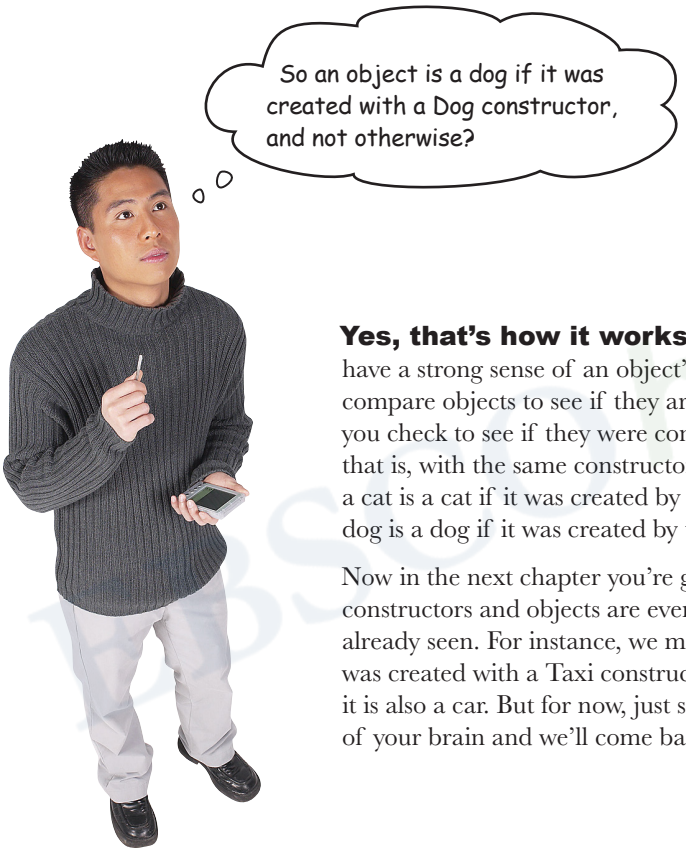
We need a function named dogCatcher that returns true if the object passed to it is a dog, and false otherwise. Write that function and test it with the rest of the code below. Don't forget to check your answer at the end of the chapter before you go on!

```
function dogCatcher(obj) {



}
```

Add your code here to implement the dogCatcher function.

And here's your test code.

```
function Cat(name, breed, weight) {
    this.name = name;
    this.breed = breed;
    this.weight = weight;
}
var meow = new Cat("Meow", "Siamese", 10);
var whiskers = new Cat("Whiskers", "Mixed", 12);

var fido = {name: "Fido", breed: "Mixed", weight: 38};

function Dog(name, breed, weight) {
    this.name = name;
    this.breed = breed;
    this.weight = weight;
    this.bark = function() {
        if (this.weight > 25) {
            alert(this.name + " says Woof!");
        } else {
            alert(this.name + " says Yip!");
        }
    };
}
var fluffy = new Dog("Fluffy", "Poodle", 30);
var spot = new Dog("Spot", "Chihuahua", 10);
var dogs = [meow, whiskers, fido, fluffy, spot];

for (var i = 0; i < dogs.length; i++) {
    if (dogCatcher(dogs[i])) {
        console.log(dogs[i].name + " is a dog!");
    }
}
```



Yes, that's how it works. JavaScript doesn't have a strong sense of an object's type, so if you need to compare objects to see if they are both cats or both dogs, you check to see if they were constructed the same way—that is, with the same constructor function. As we've said, a cat is a cat if it was created by the Cat constructor, and a dog is a dog if it was created by the Dog constructor.

Now in the next chapter you're going to see JavaScript constructors and objects are even more flexible than we've already seen. For instance, we might have an object that was created with a Taxi constructor, and yet we know that it is also a car. But for now, just stash that idea in the back of your brain and we'll come back to it later.

Even constructed objects can have their own independent properties

We've talked a lot about how to use constructors to create consistent objects—objects that have the same set of properties and the same methods. But what we haven't mentioned is that using constructors still doesn't prevent us from changing an object into something else later, because after an object has been created by a constructor, it can be altered.

What exactly are we talking about? Remember when we introduced object literals? We looked at how we could add and delete properties after the object was created. You can do the same with objects created from constructors:

Here's our dog Fido, created with the Dog constructor.

```
var fido = new Dog("Fido", "Mixed", 38);
fido.owner = "Bob";
delete fido.weight;
```

We can add a new property just by assigning it a value in our object.

Or we can get rid of a property by using the delete operator.

You can even add new methods if you like:

To add a method just assign the method to a new property name in the object.

```
fido.trust = function(person) {
                return (person === "Bob");
             };
```

Anonymous function alert! See, they're everywhere!

Notice that here we're changing only the fido object. If we add a method to fido, only fido has that method. No other dogs have it:

```
var notBite = fido.trust("Bob");
```

This code works because trust is defined in the fido object. So notBite is true.

```
var spot = new Dog("Spot", "Chihuahua", 10);
notBite = spot.trust("Bob");
```

This code doesn't work because spot doesn't have a method trust, resulting in: "TypeError: Object #<Dog> has no method 'trust'"

Yes, a car is still a car, even if you change it later.
And what we mean by that is if you check to see if your object is still an instance of Car, it will be. For instance, if we create a car object:

```
var cadiParams = {make: "GM", model: "Cadillac",
                  year: 1955, color: "tan",
                  passengers: 5, convertible: false,
                  mileage: 12892};
var cadi = new Car(cadiParams);
```

We can add a new property `chrome` and delete the property `convertible`:

```
cadi.chrome = true;
delete cadi.convertible;
```

and yet, the `cadi` is still a car:

```
cadi instanceof Car
```

Evaluates to true.

This is what we meant earlier when we said that JavaScript has a dynamic type system.

Now is it really a car in practical terms? What if we deleted every property in the object? Would it still be a car? The `instanceof` operator would tell us yes. But judging by our own terms, probably not.

Chances are, you won't often want to use a constructor to create an object and then later change it into something that's unrecognizable as an object created by that constructor. In general, you'll use constructors to create objects that are fairly consistent. But if you need objects that are more flexible, well, JavaScript can handle that. It's your job as a code designer to decide how to use constructors and objects in a way that makes sense for you (and don't forget your coworkers).

Real World Constructors

JavaScript comes with a set of constructors for instantiating some handy objects—like objects that know how to deal with dates and times, objects that are great at finding patterns in text, and even objects that will give you a new perspective on arrays. Now that you know how constructors work, and also how to use the `new` keyword, you're in a great position to make use of these constructors, or more importantly the objects they create. Let's just take a quick dip into a couple, and then you'll be all ready to go out and explore them on your own.

Let's start with JavaScript's built-in date object. To get one we just use its constructor:

```
var now = new Date();
```

Creates a new date representing the current date and time.

Calling the Date constructor gives you back an instance of Date that represents the current local date and time. With a date object in hand, you can then use its methods to manipulate dates (and times) and also retrieve various properties of a date and time. Here are a few examples:

```
var dateString = now.toString();
```

Returns a string that represents the date, like "Thu Feb 06 2014 17:29:29 GMT-0800 (PST)".

```
var theYear = now.getFullYear();
```

Returns the year in the date.

```
var theDayOfWeek = now.getDay();
```

Returns a number for the day of the week represented by the date object, like 1 (for Monday).

You can easily create date objects representing any date and time by passing additional arguments to the Date constructor. For instance, say you need a date object representing "May 1, 1983", you can do that with:

```
var birthday = new Date("May 1, 1983");
```

You can pass a simple date string to the constructor like this.

And you can get even more specific by including a time:

```
var birthday = new Date("May 1, 1983 08:03 pm");
```

Now, we're including a time in the string too.

We are, of course, just giving you a flyby of the date object; you'll want to check out its full set of properties and methods in *JavaScript: The Definitive Guide*.

The Array object

Next up, another interesting built-in object: the array object. While we've been creating arrays using the square bracket notation [1, 2, 3], you can create arrays using a constructor too:

```
var emptyArray = new Array();
```

Creates an empty array with length zero.

Here, we're creating a new, empty array object. And at any time we can add items to it, like this:

```
emptyArray[0] = 99;
```

This should look familiar. This is the same way we've always added items to an array.

We can also create array objects that have a specific size. Say we want an array with three items:

```
var oddNumbers = new Array(3);
oddNumbers[0] = 1;
oddNumbers[1] = 3;
oddNumbers[2] = 5;
```

We create an array of length three, and fill it in with values after we create it.

Here we've created an array of length three. Initially the three items in `oddNumbers` are undefined, but we then set each item in the array to a value. You could easily add more items to the array if you wanted.

None of this should be shockingly different than what you're used to. Where the array object gets interesting is in its set of methods. You already know about array's `sort` method, and here are a few other interesting ones:

```
oddNumbers.reverse();
```

This reverses all the values in the array (so we have 5, 3, 1 in oddNumbers now). Notice, the method changes the original array.

```
var aString = oddNumbers.join(" - ");
```

The join method creates a string from the values in oddNumbers placing a " - " between the values, and returns that string. So this returns the string "5 - 3 - 1".

```
var areAllOdd = oddNumbers.every(function(x) {
    return ((x % 2) !== 0);
});
```

The every method takes a function and tests each value of the array to see if the function returns true or false when called on that value. If the function returns true for all the array items, then the result of the every method is true.

Again, that's just the tip of the iceberg, so take a look at *JavaScript: The Definitive Guide* to fully explore the array object. You've got all the knowledge you need to take it on.

Good catch. The bracket notation, [ ], that you've been using to create arrays is actually just a shorthand for using the Array constructor directly. Check out these two equivalent ways of creating empty arrays:

```
var items = new Array();
var items = [];
```

These do the same thing. The bracket notation is supported in the JavaScript language to make your life easier when creating arrays.

Likewise, if you write code like this:

```
var items = ["a", "b", "c"];
```

We call this array literal syntax.

That's just a shorthand for using the constructor in another way:

```
var items = new Array("a", "b", "c");
```

If you pass more than one argument, this creates an array holding the values you pass it.

And, the objects created from the literal notation or by using the constructor directly are the same, so you can use methods on either one.

You might be asking why you'd ever use the constructor rather than the literal notation. The constructor comes in handy when you need to create an array of a specific size you determine at runtime, and then add items to it later, like this:

```
var n = getNumberOfWidgetsFromDatabase();
var widgets = new Array(n);
for(var i=0; i < n; i++) {
    widgets[i] = getDatabaseRecord(i);
}
```

This code presumably uses big arrays that we won't know the size of until runtime.

So, for creating a quick array, using the array literal syntax to create your array objects works wonderfully, but using the Array constructor might make sense when you're creating the array programmatically. You can use either or both as much as you want.

Even more fun with built-in objects

Date and array aren't the only built-in objects in JavaScript. There are lots of other objects that come with the language you might find handy at times. Here's a short list (there are more, so search online for "JavaScript's standard built-in objects" if you're curious!).

Object By using the Object constructor you can create objects. Like arrays, the object literal notation { } is equivalent to using new Object(). More on this later.

Math This object has properties and methods for doing math stuff. Like Math.PI and Math.random().

RegExp Use this constructor to create regular expression objects, which allow you to search for patterns, even complex ones, in text.

Error This constructor creates standard error objects that are handy when catching errors in your code.

there are no Dumb Questions

Q: I'm confused by how the Date and Array constructors work: they seem to support zero or more arguments. Like with Date, if I don't provide an argument, then I get today's date, but I can also pass arguments to get other dates. How does that work?

A: Right, good catch. It's possible to write functions that do different things based on the number of arguments. So if the Array constructor has zero arguments, the constructor knows it is creating an empty array; if it has one argument it knows that's the size of the array, and if it has more, then those arguments are all initial values.

Q: Can we do that with our constructors?

A: Of course. This is something we haven't covered, but every function gets passed an arguments object that contains all the arguments passed to the function. You can use this to determine what was passed and act appropriately (check the appendix for more on the arguments object). There are other techniques based on checking to see which of your parameters is set to undefined.

Q: We used Math earlier in the book. Why don't I have to say "new Math" to instantiate a math object before I use it?

A: Great question. Actually, Math is not a constructor, or even a function. It's an object. As you know, Math is a built-in object that you can use to do things like get the value of pi (with `Math.PI`) or generate a random number (with `Math.random`). Think of Math as just like an object literal that has a bunch of useful properties and methods in it, built-in for you to use whenever you write JavaScript code. It just happens to have a capital first letter to let you know that it's built-in to JavaScript.

Q: I know how to check if an object is an instance of a constructor name, but how do I write the code to ask if two objects have the same constructor?

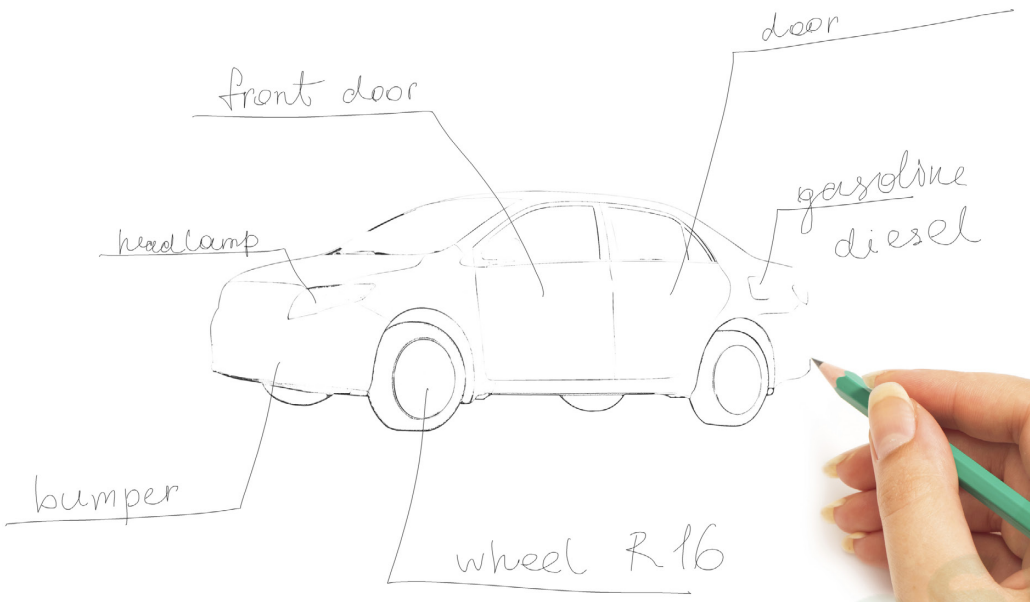
A: You can check to see if two objects have the same constructor like this:

```
((fido instanceof Dog) &&
        (spot instanceof Dog))
```

If this expression results in true, then fido and spot were indeed created by the same constructor.

Q: If I create an object with an object literal, what is it an instance of? Or is it not an instance of anything?

A: An object literal is an instance of Object. Think of Object as the constructor for the most generic kind of object in JavaScript. You'll learn much more about how Object figures into JavaScript's object system in the next chapter.



Webville Motors is revolutionizing car production by creating all their cars from a prototype car. The prototype gives you all the basics you need: a way to start, drive and stop it along with a couple properties like the make and year it was manufactured—but the rest is up to you. Want it to be red or blue? No problem, just customize it. Need for it to have a fancy stereo? No problem, go crazy, add it.

So this is your opportunity to design your perfect car. Create a CarPrototype object below, and make the car of your dreams. Check out our design at the end of the chapter before moving on.

Draw your car here.

```
function CarPrototype() {
    this.make = "Webville Motors";
    this.year = 2013;
    this.start = function() {...};
    this.stop = function() {...};
    this.drive = function() {...};
}
```

And customize the prototype here.

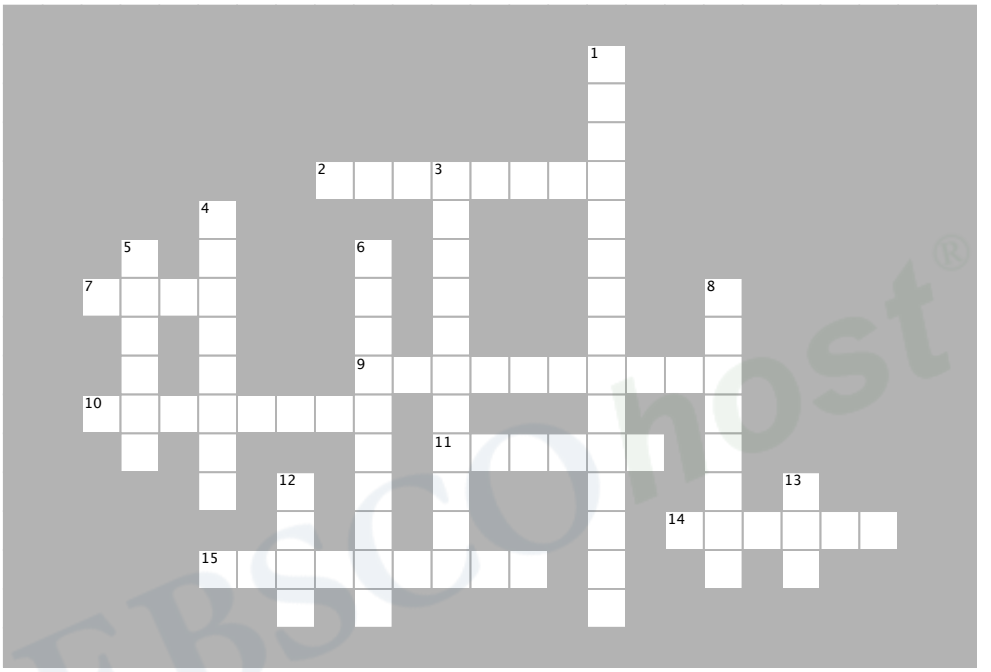
Oh, and where are we going with this? You'll find out in the next chapter! By the way, you're done with this chapter... Oh, but there's still the bullet points and the crossword puzzle to do!

BULLET POINTS

- An **object literal** works well when you need to create a small number of objects.
- A **constructor** works well when you need to create many similar objects.
- Constructors are functions that are meant to be used with the **new** operator. We capitalize the names of constructors by convention.
- Using a constructor we can create objects that are consistent, having the same property names and methods.
- Use the **new** operator with a constructor function call to create an object.
- When you use **new** with a constructor function call, it creates a new, empty object, which is assigned to **this** within the body of the constructor.
- Use **this** in a constructor function to access the object being constructed and add properties to the object.
- A new object is returned automatically by the constructor function.
- If you forget to use **new** with a constructor, no object is created. This will cause errors in your code that can be difficult to debug.
- To customize objects, we pass arguments to a constructor, and use those values to initialize the properties of the object being created.
- If a constructor has a lot of parameters, consider consolidating them into one object parameter.
- To know if an object was created by a specific constructor, use the **instanceof** operator.
- You can modify an object that was created by a constructor just like you can modify an object literal.
- JavaScript comes with a number of constructors you can use to create useful objects like date objects, regular expressions and arrays.

JavaScript cross

Construct some new connections in your brain with this crossword puzzle.



ACROSS

2. A constructor is a _____.

7. If you want to save my birthday in a variable, you'll need a _____ constructor.

9. You can use an object literal to pass arguments to a constructor when the constructor has lots of these.

10. When you create an object from a constructor, we say it is an _____ of the constructor.

11. A constructor is a bit like a _____ cutter.

14. The constructor function returns the newly constructed _____.

15. If you forget to use new with a constructor, you might see a _____.

DOWN

1. Constructor syntax is a bit _____.

3. You can add a property to an object created by a _____ whenever you want.

4. new is an _____, not a PR lackey.

5. The Webville Motors test car comes in this color.

6. Using a constructor, we can make our cars so they have all the same _____.

8. Never hold a _____ over your laptop.

12. The limo and the limoDog are the same _____.

13. To create an object with a constructor, you use the ____ operator.

Sharpen your pencil Solution

We need your help. We've been using object literals to create ducks. Given what you learned above, can you write a constructor to create ducks for us? You'll find one of our object literals below to base your constructor on. Here's our solution.

```
var duck = {
    type: "redheaded",
    canFly: true
}
```

Here's an example duck object literal.

Write a constructor for creating ducks.

```
function Duck(type, canFly) {
    this.type = type;
    this.canFly = canFly;
}
```

P.S. We know you haven't fully figured out how this all works yet, so for now concentrate on the syntax.

Exercise Solution

```
function Dog(name, breed, weight) {
    this.name = name;
    this.breed = breed;
    this.weight = weight;
}
var fido = new Dog("Fido", "Mixed", 38);
var fluffy = new Dog("Fluffy", "Poodle", 30);
var spot = new Dog("Spot", "Chihuahua", 10);
var dogs = [fido, fluffy, spot];

for (var i = 0; i < dogs.length; i++) {
    var size = "small";
    if (dogs[i].weight > 10) {
        size = "large";
    }
    console.log("Dog: " + dogs[i].name
                + " is a " + size
                + " " + dogs[i].breed);
}
```

Get some quick hands on experience to help this all sink in. Go ahead and put this code in a page and give it a test drive. Write your output here.

JavaScript console

```
Dog: Fido is a large Mixed
Dog: Fluffy is a large Poodle
Dog: Spot is a small Chihuahua
```

BE the Browser Solution

Below, you'll find JavaScript code with some mistakes in it. Your job is to play like you're the browser and find the errors in the code. Here's our solution.

If widget is to be a constructor, it needs a capital letter for W. That won't cause an error, but it's a good convention to follow.

We don't need "var" in front of this. We're not declaring new variables, we're adding properties to an object.

Also, by convention we usually name the parameters the same as the property names. So probably this.partNo and this.size would be better.

```
function widget(partNo, size) {
    var this.no = partNo;
    var this.breed = size;
}
```

We're using commas instead of semicolons. Remember, in the constructor we use normal statements rather than comma separated property name/value pairs.

We're returning this and we don't need to. The constructor will do it for us. This statement won't cause an error, but it's not necessary.

```
function FormFactor(material, widget) {
    this.material = material,
    this.widget = widget,
    return this;
}
```

Forgot new!

Needs a space between new and the constructor name.

Misspelled the name of the constructor.

```
var widgetA = widget(100, "large");
var widgetB = new widget(101, "small");
var formFactorA = newFormFactor("plastic", widgetA);
var formFactorB = new ForumFactor("metal", widgetB);
```

Exercise Solution

We've got a constructor to create coffee drinks, but it's missing its methods.

We need a method, getSize, that returns a string depending on the number of ounces of coffee:

- 8oz is a small
- 12oz is a medium
- 16oz is a large

We also need a method, toString, that returns a string specifying your order.

Write your code below, and then test it in the browser. Try creating a few different sizes of coffee. Here's our solution.

```
function Coffee(roast, ounces) {
    this.roast = roast;
    this.ounces = ounces;
    this.getSize = function() {
        if (this.ounces === 8) {
            return "small";
        } else if (this.ounces === 12) {
            return "medium";
        } else if (this.ounces === 16) {
            return "large";
        }
    };
    this.toString = function() {
        return "You've ordered a " + this.getSize() + " "
               + this.roast + " coffee.";
    };
}

var houseBlend = new Coffee("House Blend", 12);
console.log(houseBlend.toString());

var darkRoast = new Coffee("Dark Roast", 16);
console.log(darkRoast.toString());
```

The getSize method looks at the ounces property of the object, and returns the corresponding size string.

Remember, this will be the object whose method we call. So if we call houseBlend.size, then this will be the houseBlend object.

The toString method just returns a string description of the object. It uses the getSize method to get the size of the coffee.

We create two coffee objects and call the toString method and display the resulting string.

JavaScript console

```
You've ordered a medium House Blend coffee.
You've ordered a large Dark Roast coffee.
```

Here's our output; yours should look similar.

Use everything you've learned to create a Car constructor. We suggest the following order:

1. Start by providing the function keyword (actually we did that for you) followed by the constructor name. Next supply the parameters; you'll need one for each property that you want to supply an initial value for.
2. Next, assign each property in the object its initial value (make sure you use `this` along with the property name).
3. Finally, add in the three car methods: start, drive and stop.

Here's our solution.

The constructor name is Car.

And seven parameters, one for each property we want to customize.

```
1 function Car(make, model, year, color, passengers, convertible, mileage) {

  2   this.make = make;
      this.model = model;
      this.year = year;
      this.color = color;
      this.passengers = passengers;
      this.convertible = convertible;
      this.mileage = mileage;
      this.started = false;

  3   this.start = function() {
          this.started = true;
      };
      this.stop = function() {
          this.started = false;
      };
      this.drive = function() {
          if (this.started) {
              alert("Zoom zoom!");
          } else {
              alert("You need to start the engine first.");
          }
      };
  }
```

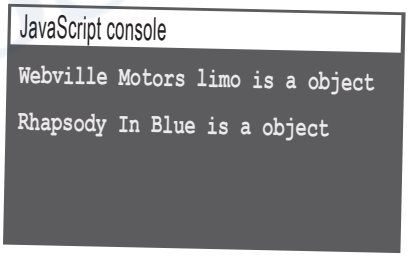
Each property of the new car object that's customized with a parameter is set to the parameter name. Notice we're using the same name for the property and the parameter by convention.

The started property is just initialized to false.

The methods are exactly the same as before, but now they're assigned to properties in the object with slightly different syntax because we're in a constructor not an object literal.

Copy the Car and Dog constructors into one file, and then add the code below along with it. Give this a run and capture the output. Here's our result:

```
var limoParams = {make: "Webville Motors",
                  model: "limo",
                  year: 1983,
                  color: "black",
                  passengers: 12,
                  convertible: true,
                  mileage: 21120};

var limo = new Car(limoParams);
var limoDog = new Dog("Rhapsody In Blue", "Poodle", 40);

console.log(limo.make + " " + limo.model + " is a " + typeof limo);
console.log(limoDog.name + " is a " + typeof limoDog);
```



What we got.

Exercise Solution

We need a function, dogCatcher, that returns true if the object passed to it is a Dog, and false otherwise. Write that function and test it with the rest of the code below. Here's our solution:

```
function dogCatcher(obj) {
    if (obj instanceof Dog) {
        return true;
    } else {
        return false;
    }
}
```

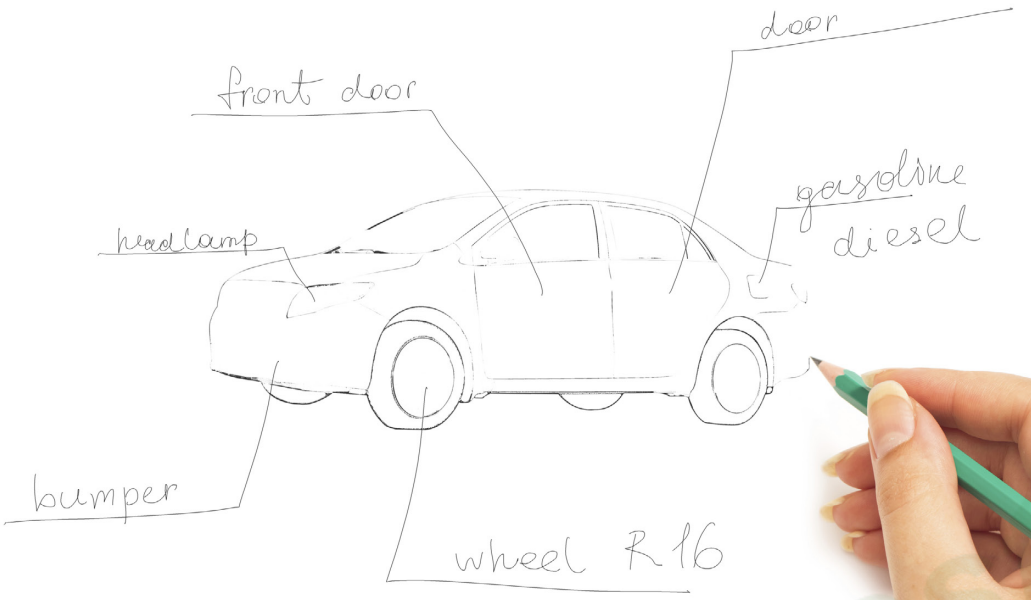
Or more succinctly:

```
function dogCatcher(obj) {
    return (obj instanceof Dog);
}
```

```
function Cat(name, breed, weight) {
    this.name = name;
    this.breed = breed;
    this.weight = weight;
}
var meow = new Cat("Meow", "Siamese", 10);
var whiskers = new Cat("Whiskers", "Mixed", 12);

var fido = {name: "Fido", breed: "Mixed", weight: 38};

function Dog(name, breed, weight) {
    this.name = name;
    this.breed = breed;
    this.weight = weight;
    this.bark = function() {
        if (this.weight > 25) {
            alert(this.name + " says Woof!");
        } else {
            alert(this.name + " says Yip!");
        }
    };
}
var fluffy = new Dog("Fluffy", "Poodle", 30);
var spot = new Dog("Spot", "Chihuahua", 10);
var dogs = [meow, whiskers, fido, fluffy, spot];

for (var i = 0; i < dogs.length; i++) {
    if (dogCatcher(dogs[i]) {
        console.log(dogs[i].name + " is a dog!");
    }
}
```

JavaScript console

```
Fluffy is a dog!
Spot is a dog!
```



Webville Motors is revolutionizing car production by creating all their cars from a prototype car. The prototype gives you all the basics you need: a way to start, drive and stop it along with a couple properties like the make and year it was manufactured—but the rest is up to you. Want it to be red or blue? No problem, just customize it. Need for it to have a fancy stereo? No problem, go crazy, add it.

So this is your opportunity to design your perfect car. Check out our design below.

```
function CarPrototype() {
    this.make = "Webville Motors";
    this.year = 2013;
    this.start = function() {...};
    this.stop = function() {...};
    this.drive = function() {...};
}
```

Draw your car here.

```
var taxi = new CarPrototype();
taxi.model = "Delorean Remake";
taxi.color = "silver";
taxi.currentTime = new Date();
taxi.fluxCapacitor = {type: "Mr. Fusion"};
taxi.timeTravel = function(date) {...};
```

And customize the prototype here.

Oh, and where are we going with this? You'll find out in the next chapter! By the way, you're done with this chapter now.

JavaScript cross Solution