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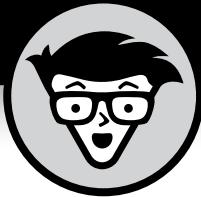
Paul McFedries

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Web Coding & Development All-in-One For Dummies®

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Introduction

When the web first came to the attention of the world's non-geeks back in the mid-1990s, the vastness and variety of its treasures were a wonder to behold. However, it didn't take long before a few courageous and intrepid souls dug a little deeper into this phenomenon and discovered something truly phenomenal: *They could make web pages, too!*

Why was that so amazing? Well, think back to those old days and think, in particular, of what it meant to create what we now call *content*. Think about television shows, radio programs, magazines, newspapers, books, and the other media of the time. The one thing they all had in common was that their creation was a decidedly *uncommon* thing. It required a *team* of professionals, a *massive distribution system*, and a *lot* of money. In short, it wasn't something that your average Okie from Muskogee would have any hope of duplicating.

The web appeared to change all of that because learning HTML was within the grasp of anybody who could feed himself, it had a built-in massive distribution system (the Internet, natch), and it required little or no money. For the first time in history, content was democratized and was no longer defined as the sole province of governments and mega-corporations.

Then reality set in.

People soon realized that merely building a website wasn't enough to attract "eyeballs," as the marketers say. A site had to have interesting, useful, or fun content, or people would stay away in droves. Not only that, but this good content had to be combined with a solid site design, which meant that web designers needed a thorough knowledge of HTML and CSS.

But, alas, eventually even all of that was not enough. To make their websites dynamic and interesting, to make their sites easy to navigate, and to give their sites those extra bells and whistles that surfers had come to expect, something more than content, HTML, and CSS was needed.

That missing link was *code*.

What we've all learned the hard way over the past few years is that you simply can't put together a world-class website unless you have some coding prowess in your site design toolkit. You need to know how to program your way out of

the basic problems that afflict most sites; how to use scripting to go beyond the inherent limitations of HTML and CSS; and how to use code to send and receive data from a web server. And it isn't enough just to copy the generic scripts that are available on the web and paste them into your pages. First of all, most of those scripts are very poorly written, and second of all, they invariably need some customization to work properly on your site.

About This Book

My goal in this book is to give you a complete education on web coding and development. You learn how to set up the tools you need, how to use HTML and CSS to design and build your site, how to use JavaScript and jQuery to program your pages, and how to use PHP and MySQL to program your web server. My aim is to show you that these technologies aren't hard to learn, and that even the greenest rookie programmers can learn how to put together web pages that will amaze their family and friends (and themselves).

If you're looking for lots of programming history, computer science theory, and long-winded explanations of concepts, I'm sorry but you won't find it here. My philosophy throughout this book comes from Linus Torvalds, the creator of the Linux operating system: "Talk is cheap. Show me the code." I explain what needs to be explained and then I move on without further ado (or, most of the time, without any ado at all) to examples and scripts that do more to illuminate a concept than any verbose explanations I could muster (and believe me, I can muster verbosity with the best of them).

How you approach this book depends on your current level of web coding expertise (or lack thereof):

- » If you're just starting out, begin at the beginning with Book 1 and work at your own pace sequentially through to Books 2 and 3. This will give you all the knowledge you need to pick and choose what you want to learn throughout the rest of the book.
- » If you know HTML and CSS, you can probably get away with taking a fast look at Book 2, then settle in with Book 3 and beyond.
- » If you've done some JavaScript coding already, I suggest working quickly through the material in Book 3, then dig into Book 4 a little slower if you don't already know jQuery. You'll then be ready to branch out and explore the rest of the book as you see fit.
- » If you're a relatively experienced JavaScript programmer, use Books 3 and 4 as a refresher, then tackle Book 5 to learn how to code the back end. I've got a few tricks in there that you might find interesting. After that, feel free to

consider the rest of the book a kind of coding smorgasbord that you can sample as your web development taste buds dictate.

Foolish Assumptions

This book is not a primer on the Internet or on using the World Wide Web. This is a coding and development book, pure and simple. This means I assume the following:

- » You know how to operate a basic text editor, and how to get around the operating system and file system on your computer.
- » You have an Internet connection.
- » You know how to use your web browser.

Yep, that's it.

“I’ve never coded before!”

If you’ve never done a stitch of computer programming before, even if you’re not quite sure what programming really is, don’t worry about it for a second because I had you in mind when I wrote this book. For too many years programming has been the property of “hackers” and other technowizards. That made some sense because the programming languages they were using — with bizarre names such as C++ and Perl — were exceedingly difficult to learn, and even harder to master.

This book’s main coding technologies — HTML, CSS, JavaScript, jQuery, PHP, and MySQL — are different. They’re nowhere near as hard to learn as those for-nerds-only languages. I honestly believe that *anyone* can become a savvy and successful web coder, and this book is, I hope, the proof of that assertion. Just follow along, examine my code carefully (particularly in the first few chapters), and practice what you learn, and you *will* master web coding and development.

“I have coded before!”

What if you’ve done some programming in the past? For example, you might have dipped a toe or two in the JavaScript waters already, or you might have dabbled with HTML and CSS. Will this book be too basic for you? No, not at all. My other main goal in this book is to provide you with a ton of truly *useful* examples that you can customize and incorporate into your own site. The book’s first few chapters start slowly to avoid scaring off those new to this programming business. But

once you get past the basics, I introduce you to lots of great techniques and tricks that will take your web coding skills to a higher level.

Icons Used in This Book



This icon points out juicy tidbits that are likely to be repeatedly useful to you — so please don't forget them.

REMEMBER



Think of these icons as the fodder of advice columns. They offer (hopefully) wise advice or a bit more information about a topic under discussion.

TIP



Look out! In this book, you see this icon when I'm trying to help you avoid mistakes that can cost you time, money, or embarrassment.

WARNING



When you see this icon, you've come across material that isn't critical to understand but will satisfy the curious. Think "inquiring minds want to know" when you see this icon.

TECHNICAL STUFF

Beyond the Book

Some extra content for this book is available on the web. Go online to find the following:

» **The examples used in the book:** You can find these here:

mcfedries.com/webcodingfordummies

The examples are organized by book and then by chapter within each book. For each example, you can view the code, copy it to your computer's clipboard, and run the code in the browser.

» **The WebDev Workshop:** To edit the book's examples and try your own code and see instant results, fire up the following site:

webdev.mcfedries.com

You won't break anything, so feel free to use the site run some experiments and play around with HTML, CSS, JavaScript, and jQuery.

1 **Getting Ready to Code for the Web**

Contents at a Glance

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| CHAPTER 2: | Setting Up Your Web Development Home | 21 |
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IN THIS CHAPTER

- » Learning how the web works
- » Understanding the front-end technologies of HTML and CSS
- » Understanding the back-end technologies of MySQL and PHP
- » Figuring out how JavaScript fits into all of this
- » Learning about dynamic web pages, web apps, and mobile web apps

Chapter **1**

How Web Coding and Development Work

More than mere consumers of technology, we are makers, adapting technology to our needs and integrating it into our lives.

— DALE DOUGHERTY

The 1950s were a hobbyist's paradise with magazines such as *Mechanix Illustrated* and *Popular Science* showing the do-it-yourselfer how to build a go-kart for the kids and how to soup up a lawnmower with an actual motor! Sixty years later, we're now firmly entrenched in the age of do-it-yourself tech, where folks indulge their inner geek to engage in various forms of digital tinkering and hacking. The personification of this high-tech hobbyist renaissance is the *maker*, a modern artisan who lives to create things, rather than merely consume them. Today's makers exhibit a wide range of talents, but the skill most sought-after not only by would-be makers themselves, but by the people who hire them, is web coding and development.

Have you ever visited a website and thought, “Hey, I can do better than that!”? Have you found yourself growing tired of merely reading text and viewing images

that someone else has put on the web? Is there something creative in you — stories, images, expertise, opinions — that you want to share with the world? If you answered a resounding “Yes!” to any of these questions, then congratulations: You have everything you need to get started with web coding and development. You have, in short, the makings of a maker.

The Nuts and Bolts of Web Coding and Development

If, as the King said very gravely in Lewis Carroll’s *Alice in Wonderland*, it’s best to “begin at the beginning,” then you’ve come to the right place. My goal here is to get you off on the right foot by showing you what web coding and web development are.

How the web works

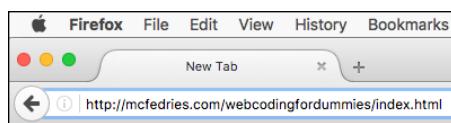
Before you can understand web coding and development, you need to take a step back and understand a bit about how the web itself works. In particular, you need to know what happens behind the scenes when you click a link or type a web page address into your browser. Fortunately, you don’t need to be a network engineer to understand this stuff, because I can explain the basics without much in the way of jargon. Here’s a high-level blow-by-blow of what happens:

1. You tell the web browser the web page you want to visit.

You do that either by clicking a link to the page or by typing the location — known as the *uniform resource locator* or *URL* (usually pronounced “you-are-ell,” but also sometimes “earl”) — into the browser’s address bar (see Figure 1-1).

FIGURE 1-1:

One way to get to a web page is to type the URL in the browser’s address bar.



2. The browser decodes the URL.

Decoding the URL means two things: First, it checks the prefix of the URL to see what type of resource you’re requesting; this is usually `http://` or `https://`, both of which indicate that the resource is a web page. Second, it gets the

URL's domain name — the something.com or whatever.org part — and asks the *domain name system* (DNS) to translate this into a unique location — called the IP (Internet Protocol) address — for the web server that hosts the page (see Figure 1-2).

FIGURE 1-2:
The browser extracts the prefix, domain, and the server address from the URL.

Decoding http://mcfedries.com/webcodingfordummies/index.html...
Results:
Prefix: http://
Domain name: mcfedries.com
Web server IP address: 162.144.120.37

3. The browser contacts the web server and requests the web page.

With the web server's unique IP address in hand, the web browser sets up a communications channel with the server and then uses that channel to send along a request for the web page (see Figure 1-3).

FIGURE 1-3:
The browser asks the web server for the web page.

Dear 162.144.120.37:

At your earliest convenience, please send me the mcfedries.com web page located at webcodingfordummies/indexhtml.

Sincerely,
W. Browser

4. The web server decodes the page request.

Decoding the page request involves a number of steps. First, if the web server is shared between multiple user accounts, the server begins by locating the user account that owns the requested page. The server then uses the page address to find the directory that holds the page and the file in which the page code is stored (see Figure 1-4).

FIGURE 1-4:
The server uses the page request to get the account, directory, and filename.

Decoding mcfedries.com/webcodingfordummies/index.html...
Results:
User account: paulmcfedries
Directory: webcodingfordummies
Filename: index.html

5. The web server sends the web page file to the web browser (see Figure 1-5).

FIGURE 1-5:
The web server
sends the
requested web
page file to the
browser.

Dear W. Browser:

Thank you for contacting us. Here is the file you requested. Let us know if you need anything else.

Best,
mcfedries.com Web Server

6. The web browser decodes the web page file.

Decoding the page file means looking for text to display, instructions on how to display that text, and other resources required by the page, such as images and fonts (see Figure 1-6).

FIGURE 1-6:
The web browser
scours the page
file to see if it
needs anything
else from the
server.

Decoding index.html...

Results:

Text: Received
Formatting: Request styles.css
Images: Request logo.png, cover.jpg
Audio: None
Video: None
Data: Request book examples

7. If the web page requires more resources, the web browser asks the server to pass along those resources (see Figure 1-7).

FIGURE 1-7:
The web browser
goes back to the
server to ask for
the other data
needed to display
the web page.

Dear 162.144.120.37:

Thank you for the page file. If it's not too much trouble, could you please also send along the following:

*styles.css
logopng
cover.jpg
Book examples from the database*

8. For each of the requested resources, the web server locates the associated file and sends it to the browser (see Figure 1-8).

FIGURE 1-8:
The web server sends the browser the rest of the requested files.

Dear W. Browser:

You're very welcome. We're here to serve! We're gathering your order and will send along the extra data you requested shortly.

Best,
mcfedries.com Web Server

9. The web browser gathers up all the text, images, and other resources and displays the page in all its digital splendor in the browser's content window (see Figure 1-9).



FIGURE 1-9:
At long last, the web browser displays the web page.

How the web works, take two

Another way to look at this process is to think of the web as a giant mall or shopping center, where each website is a storefront in that mall. When you request a web page from a particular site, the browser takes you into that site's store and asks the clerk for the web page. The clerk goes into the back of the store, locates the page, and hands it to the browser. The browser checks the page and asks for any other needed files, which the clerk retrieves from the back. This process is repeated until the browser has everything it needs, and it then puts all the page pieces together for you, right there in the front of the store.

This metaphor might seem a bit silly, but it serves to introduce yet another metaphor, which itself illustrates one of the most important concepts in web development. In the same way that our website store has a front and a back, so, too, is web development separated into a front end and a back end:

- » **Front end:** That part of the web page that the web browser displays in the browser window. That is, it's the page stuff you see and interact with.
- » **Back end:** That part of the web page that resides on the web server. That is, it's the page stuff that the server gathers based on the requests it receives from the browser.

As a consumer of web pages, you only ever deal with the front end, and even then you only passively engage with the page by reading its content, looking at its images, or clicking its links or buttons.

However, as a maker of web pages — that is, as a web developer — your job entails dealing with both the front end and the back end. Moreover, that job includes coding what others see on the front end, coding how the server gathers its data on the back end, and coding the intermediate tasks that tie the two together.

Understanding the Front End: HTML and CSS

As I mention in the previous section, the *front end* of the web development process involves what users see and interact with in the web browser window. It's the job of the web developer to take a page design — which you might come up with yourself, but is more often something cooked up by a creative type who specializes in web design — and make it web-ready. Getting a design ready for the web means translating the design into the code required for the browser to display the page somewhat faithfully. (I added the hedge word “somewhat” there because it's not always easy to take a design that looks great in Photoshop or Illustrator and make it look just as good on the web. However, with the techniques you learn in this book, you'll almost always be able to come pretty close.)

You need code to create the front end of a web page because without it your page will be quite dull. For example, consider the following text:

COPENHAGEN—Researchers from Aalborg University announced today that they have finally discovered the long sought-after Soup-Nuts Continuum. Scientists around the world have been

searching for this elusive item ever since Albert Einstein's mother-in-law proposed its existence in 1922.

"Today is an incredible day for the physics community and for humanity as a whole," said senior researcher Lars Gruntwerk.
"Today, for the first time in history, we are on the verge of knowing everything from soup to, well, you know, nuts."

If you plop that text onto the web, you get the result shown in Figure 1-10. As you can see, the text is very plain, and the browser didn't even bother to include the paragraph break.

FIGURE 1-10:
Text-only
web pages are
dishwater-dull.

COPENHAGEN—Researchers from Aalborg University announced today that they have finally discovered the long sought-after Soup-Nuts Continuum. Scientists around the world have been searching for this elusive item ever since Albert Einstein's mother-in-law proposed its existence in 1922. "Today is an incredible day for the physics community and for humanity as a whole," said senior researcher Lars Gruntwerk. "Today, for the first time in history, we are on the verge of knowing everything from soup to, well, you know, nuts."

So, if you can't just throw naked text onto the web, what's a would-be web developer to do? Ah, that's where you start earning your web scout merit badges by adding code that tells the browser how you want the text displayed. That code comes in two flavors: structure and formatting.

Adding structure: HTML

The first thing you usually do to code a web page is give it some structure. This means breaking up the text into paragraphs, adding special sections such as a header and footer, organizing text into bulleted or numbered lists, dividing the page into columns, and much more. The web coding technology that governs these and other web page structures is called (deep breath) *Hypertext Markup Language*, or *HTML*, for short.

HTML consists of a few dozen special symbols called *tags* that you sprinkle strategically throughout the page. For example, if you want to tell the web browser that a particular chunk of text is a separate paragraph, you place the `<p>` tag (the `p` here is short for paragraph) before the text and the `</p>` tag after the text.

In the code that follows, I've added these paragraph tags to the plain text that I show earlier. As you can see in Figure 1-11, the web browser displays the text as two separate paragraphs, no questions asked.

```
<p>  
COPENHAGEN—Researchers from Aalborg University announced today  
that they have finally discovered the long sought-after
```

```
Soup-Nuts Continuum. Scientists around the world have been  
searching for this elusive item ever since Albert Einstein's  
mother-in-law proposed its existence in 1922.  
</p>  
<p>  
"Today is an incredible day for the physics community and for  
humanity as a whole," said senior researcher Lars Grntwerk.  
"Today, for the first time in history, we are on the verge of  
knowing everything from soup to, well, you know, nuts."  
</p>
```

FIGURE 1-11:
Adding paragraph tags to the text separates the text into two paragraphs.

COPENHAGEN—Researchers from Aalborg University announced today that they have finally discovered the long sought-after Soup-Nuts Continuum. Scientists around the world have been searching for this elusive item ever since Albert Einstein's mother-in-law proposed its existence in 1922.

"Today is an incredible day for the physics community and for humanity as a whole," said senior researcher Lars Grntwerk. "Today, for the first time in history, we are on the verge of knowing everything from soup to, well, you know, nuts."



REMEMBER

HTML is one of the fundamental topics of web development, and you learn all about it in Book 2, Chapter 1.

Adding style: CSS

HTML takes care of the structure of the page, but if you want to change the formatting of the page, then you need to turn to a second front-end technology: *cascading style sheets*, known almost universally as just CSS. With CSS in hand, you can play around with the page colors and fonts, you can add margins and borders around things, and you can mess with the position and dimensions of page elements.

CSS consists of a large number of *properties* that enable you to customize many aspects of the page to make it look the way you want. For example, the `width` property lets you specify how wide a page element should be; the `font-family` property enables you to specify a typeface for an element; and the `font-size` property lets you dictate the type size of an element. Here's some CSS code that applies all three of these properties to every `p` element (that is, every `<p>` tag) that appears in a page (note that `px` is short for pixels):

```
p {  
    width: 700px;  
    font-family: sans-serif;  
    font-size: 24px;  
}
```

When used with the sample text from the previous two sections, you get the much nicer-looking text shown in Figure 1-12.

FIGURE 1-12:
With the judicious use of a few CSS properties, you can greatly improve the look of a page.

COPENHAGEN—Researchers from Aalborg University announced today that they have finally discovered the long sought-after Soup-Nuts Continuum. Scientists around the world have been searching for this elusive item ever since Albert Einstein's mother-in-law proposed its existence in 1922.

"Today is an incredible day for the physics community and for humanity as a whole," said senior researcher Lars Gruntwerk. "Today, for the first time in history, we are on the verge of knowing everything from soup to, well, you know, nuts."



REMEMBER

CSS is a cornerstone of web development. You learn much more about it in Book 2, Chapters 2, 3, and 4.

Understanding the Back End: PHP and MySQL

Many web pages are all about the front end. That is, they consist of nothing but text that has been structured by HTML tags and styled by CSS properties, plus a few extra files such as images and fonts. Sure, all these files are transferred from the web server to the browser, but that's the extent of the back end's involvement.

These simple pages are ideal when you have content that doesn't change very often, if ever. With these so-called *static* pages, you plop in your text, add some HTML and CSS, perhaps point to an image or two, and you're done.

But there's another class of page that has content that changes frequently. It could be posts added once or twice a day, or sports or weather updates added once or twice an hour. With these so-called *dynamic* pages, you might have some text, HTML, CSS, and other content that's static, but you almost certainly don't want to be updating the changing content by hand.

Rather than making constant manual changes to such pages, you can convince the back end to do it for you. You do that by taking advantage of two popular back-end technologies: MySQL and PHP.

Storing data on the server: MySQL

MySQL is a relational database management system that runs on the server. You use it to store the data you want to use as the source for some (or perhaps even all) of the data you want to display on your web page. Using a tool called Structured Query Language (SQL, pronounced “ess-kew-ell,” or sometimes “sequel”), you can specify which subset of your data you want to use.



REMEMBER

If phrases such as “relational database management system” and “Structured Query Language” have you furrowing your brow, don’t sweat it: I explain all in Book 5, Chapter 2.

Accessing data on the server: PHP

PHP is a programming language used on the server. It’s a very powerful and full-featured language, but for the purposes of this book, you use PHP mostly to interact with MySQL databases. You can use PHP to extract from MySQL the subset of data you want to display, manipulate that data into a form that’s readable by the front end, and then send the data to the browser.



REMEMBER

You learn about the PHP language in Book 5, Chapter 1, and you learn how to use PHP to access MySQL data in Book 5, Chapter 3.

How It All Fits Together: JavaScript and jQuery

Okay, so now you have a front end consisting of HTML structure and CSS styling, and a back end consisting of MySQL data and PHP code. How do these two seemingly disparate worlds meet to create a full web page experience?

In the website-as-store metaphor that I introduce earlier in this chapter, I use the image of a store clerk taking an order from the web browser and then going into the back of the store to fulfill that order. That clerk is the obvious link between the front end and the back end, so what technology does that clerk represent? She actually represents two technologies that I use in this book: JavaScript and jQuery.

Front end, meet back end: JavaScript

The secret sauce that brings the front end and the back end together to create the vast majority of the web pages you see today, is JavaScript. JavaScript is a

programming language and is the default language used for coding websites today. JavaScript is, first and foremost, a front-end web development language. That is, JavaScript runs inside the web browser and it has access to everything on the page: the text, the images, the HTML tags, the CSS properties, and more. Having access to all the page stuff means that you can use code to manipulate, modify, even add and delete web page elements.

But although JavaScript runs in the browser, it's also capable of reaching out to the server to access back-end stuff. For example, with JavaScript you can send data to the server to store that data in a MySQL database. Similarly, with JavaScript you can request data from the server and then use code to display that data on the web page.



REMEMBER

JavaScript is very powerful, very useful, and very cool, so Book 3 takes nine full chapters to help you learn it well. Also, you learn how JavaScript acts as a bridge between the front end and the back end in Book 6, Chapter 1.

Making your web coding life easier: jQuery

JavaScript is extremely powerful, but sometimes using certain JavaScript statements and structures can be a bit unwieldy. For example, here's a bit of JavaScript code:

```
var subheads = document.getElementsByClassName('subheadings');
```

This will no doubt look like gibberish to you now, but my purpose here is only to have you remark the length of that statement. Now compare the following:

```
var subheads = $('.subheadings');
```

Believe it or not, these statements do exactly the same thing, except the second one is written using a JavaScript package called *jQuery*. *jQuery* is a collection — called a *library* — of JavaScript code that makes it easier and faster to code for the web. Not only does *jQuery* give you shorter ways to reference web page elements, but it also incorporates routines that make it easier for you to manipulate HTML tags and CSS properties, navigate and manipulate web page elements, add animation effects, and much more.



REMEMBER

jQuery is extremely powerful and useful stuff, and you'll be thankful you've got it in your web development toolkit. You learn just enough *jQuery* to be dangerous in Book 4.

How Dynamic Web Pages Work

It's one thing to know about HTML and CSS and PHP and all the rest, but it's quite another to actually do something useful with these technologies. That, really, is the goal of this book, and to that end the book spends several chapters later covering how to create wonderful things called *dynamic web pages*. A dynamic web page is one that includes content that, rather than being hard-wired into the page, is generated on-the-fly from the web server. This means the page content can change based on a request by the user, by data being added to or modified on the server, or in response to some event, such as the clicking of a button or link.

It likely sounds a bit like voodoo to you now, so perhaps a bit more detail is in order. For example, suppose you want to use a web page to display some data that resides on the server. Here's a general look at the steps involved in that process:

- 1. JavaScript determines the data that it needs from the server.**

JavaScript has various ways it can do this, such as extracting the information from the URL, reading an item the user has selected from a list, or responding to a click from the user.

- 2. JavaScript sends a request for that data to the server.**

In most cases, and certainly in every case you see in this book, JavaScript sends this request by calling a PHP script on the server.

- 3. The PHP script receives the request and passes it along to MySQL.**

The PHP script uses the information obtained from JavaScript to create an SQL command that MySQL can understand.

- 4. MySQL uses the SQL command to extract the required information from the database and then return that data to the PHP script.**

- 5. The PHP script manipulates the returned MySQL data into a form that JavaScript can use.**

JavaScript can't read raw MySQL data, so one of PHP's most important tasks is to convert that data into a format called JavaScript Object Notation (JSON, for short, and pronounced like the name Jason) that JavaScript is on friendly terms with (see Book 6, Chapter 1 for more about this process).

- 6. PHP sends the JSON data back to JavaScript.**

- 7. JavaScript displays the data on the web page.**

One of the joys of JavaScript is that you get tremendous control over how you display the data to the user. Through existing HTML and CSS, and by manipulating these and other web page elements using JavaScript, you can show your data in the best possible light.



REMEMBER

To expand on these steps and learn how to create your own dynamic web pages, check out the three chapters in Book 6.

What Is a Web App?

You no doubt have a bunch of apps residing on your smartphone. If you use Windows 10 on your PC, then you have not only the pre-installed apps such as Mail and Calendar, but you might also have one or more apps downloaded from the Windows Store. If the Mac is more your style, then you're probably quite familiar with apps such as Music and Messages, and you might have installed a few others from the App Store. We live, in other words, in a world full of apps which, in the context of your phone or computer, are software programs dedicated to a single topic or task.

So what then is a *web app*? It's actually something very similar to an app on a device or PC. That is, it's a website, built using web technologies such as HTML, CSS, and JavaScript, that has two main characteristics:

- » The web app is focused on a single topic or task.
- » The web app offers some sort of interface that enables the user to operate the app in one or more ways.

In short, a web app is a website that looks and acts like an app on a device or computer. This is opposed to a regular website, which usually tackles several topics or tasks and has an interface that for the most part only enables users to navigate the site.



REMEMBER

To get the scoop on building your very own web apps, head on over to the four chapters in Book 7.

What Is a Mobile Web App?

In late 2016, the world reached a milestone of sorts when the percentage of people accessing the web via mobile devices such as smartphones and tablets surpassed the percentage of people doing the web thing using desktops and notebooks. The gap between mobile web users and everyone else has only widened since then, so it's safe to say that we live in a mobile web world now.

What does that mean for you as a web developer? It means you can't afford to ignore mobile users when you build your web pages. It means you can't code your web pages using a gigantic desktop monitor and assume that everything will look great on a relatively tiny smartphone screen. It means that you'd do well to embrace the mobile web in a big old bear hug by creating not just web apps, but *mobile web apps*. What's the difference? A mobile web app is the same as a web app — that is, it has content and an interface dedicated to a single topic or task — but with a design built from the ground up to look good and work well in a mobile device. This is known as the *mobile-first* approach to web development, and it's one of the hottest topics in the web coding world.



REMEMBER

To learn how to create your own mobile web apps, look no farther than the two chapters in Book 8.

What's the Difference between Web Coding and Web Development?

After all this talk of HTML, CSS, MySQL, JavaScript, and jQuery, after the bird's-eye view of dynamic sites, web apps, and mobile web apps, you might be wondering when the heck I'm going to answer the most pressing question of the all: What in the name of Sir Tim Berners-Lee (inventor of the web) is the difference between web coding and web development?

I'm glad you asked! Some people would probably answer that question by saying that there's no real difference at all, because "web coding" and "web development" are two ways of referring to the same thing: Creating web pages using programming tools.

Hey, it's a free country, but to my mind I think there's a useful distinction to be made between web coding and web development:

- » *Web coding* is the pure programming part of creating a web page, particularly using JavaScript/jQuery on the front end and PHP on the back end.
- » *Web development* is the complete web page creation package, from building a page with HTML tags, to formatting the page with CSS, to storing data on the back end with MySQL, to accessing that data with PHP, to bridging the front and back ends using JavaScript and jQuery.

However you look at it, this book teaches you everything you need to know to become both a web coder and a web developer.

IN THIS CHAPTER

- » Understanding the need for a web development environment
- » Gathering the tools you need for a local development setup
- » Installing a local web development environment on a Windows PC
- » Installing a local web development environment on a Mac
- » Learning what to look for in a good text editor

Chapter 2

Setting Up Your Web Development Home

He is happiest, be he king or peasant, who finds peace in his home.

— JOHANN WOLFGANG VON GOETHE

One of the truly amazing things about web development is that, with the exception of the databases on the server, all you ever work with are basic text files. But surely all the structure you add with HTML tags requires some obscure and complex file type? No way, José: It's text all the way down. What about all that formatting stuff associated with CSS? Nope: nothing but text. PHP? Text. JavaScript and jQuery? Text and, again, text.

What this text-only landscape means is that you don't need any highfalutin, high-priced software to develop for the web. A humble text editor is all you require to dip a toe or two in the web coding waters.

But what if you want to get more than your feet wet in web coding? What if you want to dive in, swim around, perhaps do a little snorkeling? Ah, then you need to take things up a notch or three and set up a proper web development environment

on your computer. This will give you everything you need to build, test, and refine your web development projects. In this chapter, you get your web coding adventure off to a rousing start by exploring how to set up a complete web development environment on your Windows PC or Mac.

What Is a Local Web Development Environment?

In programming circles, an *integrated development environment* (IDE) is a collection of software programs that make it easy and efficient to write code. Most development environments are tailored to a particular programming language and come with tools for editing, testing, and compiling code (that is, converting the code to its final form as an application).

In the web coding game, we don't have IDEs, per se, but we do have a similar beast called a *local web development environment*, which is also a collection of software. It usually includes the following:

- » A web server
- » A relational database management system (RDBMS) to run on the web server
- » A server-side programming language
- » An interface for controlling (starting, stopping, and so on) the web server
- » An interface for accessing and manipulating the RDBMS

The key point to grok here is that this is a “local” web development environment, which means that it gets installed on your PC or Mac. This enables you to build and test your web development projects right on your computer. You don't need a web hosting service or even an Internet connection, for that matter. Everything runs conveniently on your computer, so you can concentrate on coding and leave the deployment of the site until you're ready.

Do You Need a Local Web Development Environment?

Okay, if it's possible to use a simple text editor to develop web pages, why not do just that? After all, every Windows PC and Mac in existence comes with a

pre-installed text editor, and there are lots of free third-party text editors ripe for downloading, so why bother installing the software for a local web development environment?

To be perfectly honest, I'm not going to stand here and tell you that a local web development setup is a must. Certainly if all you're doing for now is getting started with a few static web pages built using HTML, CSS, and JavaScript, then you don't yet need access to the back end. Similarly, if you're building websites and web apps for your own use and you already have a web host that gives you access to MySQL and PHP, then you can definitely get away with using just your trusty text editor.

However, there are two major exceptions that pretty much require you to build your web stuff locally:

- » If you're building a website or app for someone else and you don't have access to their web server.
- » If you're building a new version of an existing website or app, which means that you don't want to mess with the production code while tinkering (and therefore making mistakes) with the new code.

That said, there's also something undeniably cool about having a big-time web server purring away in the background of your computer. So, even if you don't think you'll need a full-blown web development environment in the short term, think about installing one anyway, if only so you can say you're "running Apache 2.4 locally" at your next cocktail party.

Setting Up the XAMPP for Windows Development Environment

If you're running Windows, then I highly recommend the web development environment XAMPP for Windows, which in its most recent version (at least as I write this in early 2018) requires Windows Vista or later. XAMPP for Windows is loaded with dozens of features, but for our needs the following are the most important:

- » **Apache:** This is an open-source web server that runs about half of all the websites on Earth.
- » **MariaDB:** This is an open-source server database that is fully compatible with MySQL (discussed in Book 1, Chapter 1).

- » **PHP:** This is the server-side programming language that I talk about briefly in Book 1, Chapter 1.
- » **phpMyAdmin:** This is an interface that enables you to access and manipulate MariaDB databases.

So all of this requires big bucks, right? Nope. XAMPP for Windows is completely free.

To get started, head for the Apache Friends website at www.apachefriends.org, and then download XAMPP for Windows. Be sure to get the most recent version.

Installing XAMPP for Windows

Once the download is complete, follow these steps to install XAMPP for Windows:

1. Open the installation file that you downloaded.

The download is an executable file, so you can double-click it to get the installation off the ground.

2. Enter your User Account Control (UAC) credentials to allow the install.

If you're the administrator of your PC, click Yes. Otherwise, you need to enter the username and password of the PC's administrator account.

3. When XAMPP displays a warning about installing with UAC activated, click OK.

This oddly worded warning means that if you install XAMPP in the default folder (usually C:\Program Files), then it might have problems running normally because UAC imposes restrictions on that folder. You can ignore this because later (see Step 6) I show you how to install XAMPP in a different folder that doesn't suffer from this problem.

4. When the XAMPP Setup Wizard appears, click Next.

5. In the Select Components dialog box (see Figure 2-1), deselect the check box beside any component you don't want installed, and then click Next.

For a basic install, you only need Apache, MySQL, PHP, and phpMyAdmin. If your PC is running low on disk space, consider not installing the other components. If you're rich in disk space, go ahead and install everything because, hey, after all of this you might be inspired to learn Perl (which is another server-side programming language).

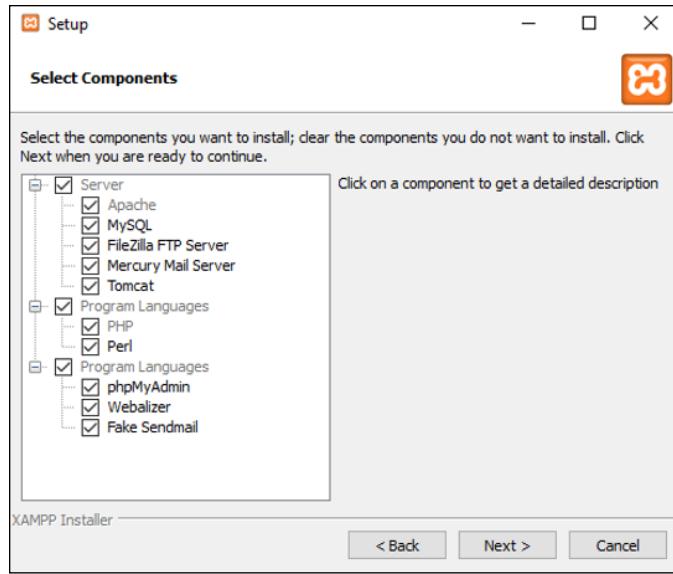


FIGURE 2-1:
Use this Setup Wizard dialog box to deselect the check box beside any component you don't want installed.

6. In the Installation Folder dialog box, type the location where you want XAMPP installed, then click Next.

Be sure to avoid the folders C:\Program Files and C:\Program Files (x86), for the reason I described back in Step 3. Most folks create a xampp folder in C:\ and install everything there (see Figure 2-2).

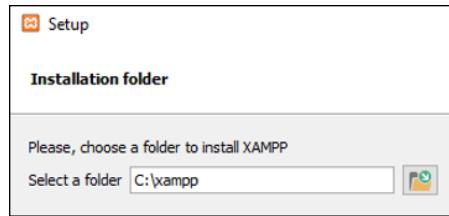


FIGURE 2-2:
To install XAMPP, use a subfolder in the main C:\ folder (such as C:\xampp).

7. The Setup Wizard lets you know that Bitnami for XAMPP can install content management systems such as WordPress and Drupal. Click OK.

If you don't care about any of this, be sure to deselect the Learn More About Bitnami for XAMPP check box before you click OK.

8. Click Next to begin the installation.

9. If you see a Windows Security Alert similar to the one shown in Figure 2-3, select the Private Networks check box, deselect the Public Networks check box, and then click Allow Access.



REMEMBER

However, just because you select the Private Networks check box, it doesn't mean that people on your network can access (much less mess with) your local web server. XAMPP for Windows is configured out of the box to be accessible only from the computer on which it's installed.

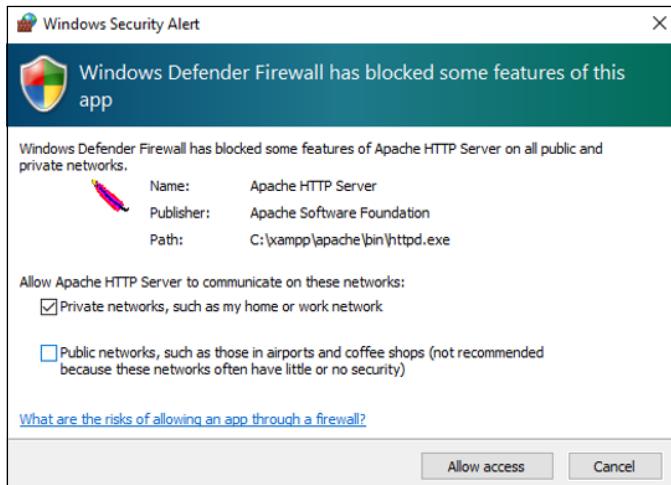


FIGURE 2-3:
If the Windows Security Alert dialog box shows up, be sure to allow Apache to communicate on your private network, but not on any public networks.

10. When the install is complete, click Finish.

Be sure to deselect the Do You Want to Start the Control Panel Now check box. I talk about the correct way to start the Control Panel in the next section.

Running the XAMPP for Windows Control Panel

The XAMPP Control Panel enables you to start, stop, and configure the XAMPP apps, particularly the Apache web server and the MySQL database system. For best results, you should start the program with administrator privileges, which you can do by following these steps:

1. Click Start.
2. Find and open the XAMPP folder in the All Apps list.

Depending on your version of Windows, you might have to click All Apps to get to the All Apps list.
3. Right-click XAMPP Control Panel, click More, and then click Run as Administrator.

Depending on your version of Windows, you might not have to click More to get to the Run as Administrator command.

- 4. If you're the administrator of your PC, click Yes. Otherwise, you need to enter the username and password of the PC's administrator account.**
- 5. The first time you run the Control Panel, you're asked to choose a language. Select the radio button for the language you prefer, then click Save.**

The XAMPP Control Panel appears, as shown in Figure 2-4.

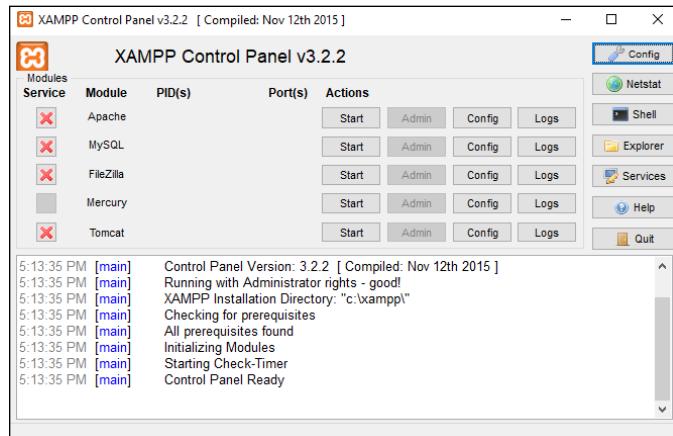


FIGURE 2-4:
You use the XAMPP Control Panel to control and configure apps such as Apache and MySQL.

To start an app, click the corresponding Start button. That button name changes to Stop, meaning you can later stop the service by clicking its Stop button.



TIP

You'll always want the Apache and MySQL apps running, so you can save a bit of time by having the XAMPP Control Panel launch these two apps automatically when you open the program. Click Config, select the Apache and MySQL check boxes, and then click Save.



REMEMBER

If when you start an app you see a Windows Security Alert dialog box similar to the one shown earlier in Figure 2-3. Select the Private Networks check box, deselect the Public Networks check box, and then click Allow Access.

Accessing your local web server

With XAMPP for Windows installed and Apache up and running, congratulations are in order: You've got a web server running on your PC! That's great, but how do

you access your shiny, new web server? There are two ways, depending on what you're doing:

- » **Adding files and folders to the web server:** Place the files and folders in the `htdocs` subfolder of your main XAMPP install folder. For example, if you installed XAMPP to `C:\xampp`, then your web server's root folder will be `C:\xampp\htdocs`.
- » **Viewing the files and folders on the server:** Open your favorite web browser and navigate to the `localhost` address (or to `127.0.0.1`, which gets you to the same place). If you have the XAMPP Control Panel open, you can also click the Apache app's Admin button.

By default, your local website is configured to automatically redirect `localhost` to `localhost/dashboard/`, shown in Figure 2-5, which gives you access to several XAMPP tools.

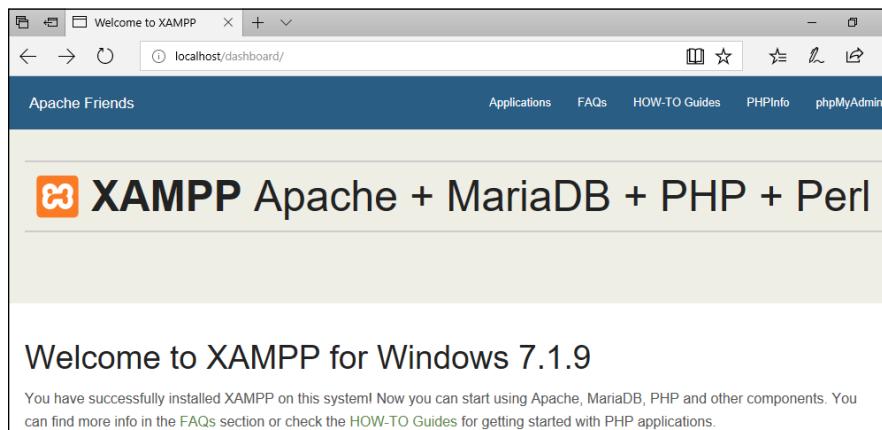


FIGURE 2-5:
The `localhost/` `dashboard/` address gives you access to a few XAMPP tools.

In the page header, you can use the following links:

- » **Apache Friends:** Returns you to the main Dashboard page.
- » **Applications:** Provides information about installing Bitnami applications on the server.
- » **FAQs:** Displays a list of XAMPP frequently asked questions.
- » **How-To Guides:** Displays a list of links to step-by-step guides for a number of XAMPP for Windows tasks.
- » **PHPInfo:** Displays a for-geeks-only page of information about the version of PHP that you have installed.

- » **phpMyAdmin:** Opens the phpMyAdmin tool, which lets you create and manipulate MariaDB/MySQL databases. You can also open phpMyAdmin by navigating directly to `localhost/phpmyadmin/`, or in the XAMPP Control Panel, by clicking the MySQL app's Admin button. However you get there, just be sure to have the MySQL app running before you open phpMyAdmin.

Setting Up the XAMPP for OS X Development Environment

If you'll be doing your web work on a Mac, then I recommend the web development environment XAMPP for OS X, which in its most recent version (at least as I write this in early 2018) requires OS X Snow Leopard (10.6) or later. XAMPP for OS X is packed with programs and features, but you'll probably only concern yourself with the following:

- » **Apache:** This is an open-source web server that runs about half of all the websites on Earth.
- » **MariaDB:** This is an open-source server database that is fully compatible with MySQL (discussed in Book 1, Chapter 1).
- » **PHP:** This is the server-side programming language that I mention in Book 1, Chapter 1.
- » **phpMyAdmin:** This is an interface that enables you to access and work with MariaDB databases.

The best news of all is XAMPP for OS X is completely, utterly, and forever free. Nice! To get the show on the road, surf to the Apache Friends website at www.apachefriends.org, and then download the most recent version of XAMPP for OS X.

Installing XAMPP for OS X

Once the download is done, follow these steps to install XAMPP for OS X:

1. Double-click the installation file that you downloaded.
2. Double-click the XAMPP icon.
3. If macOS warns you about opening an application downloaded from the Internet, say "It's cool, bro" and click Open.
4. Enter your macOS administrator password and then click OK.

- 5. When the XAMPP Setup Wizard appears, click Next.**
- 6. In the Select Components dialog, deselect the XAMPP Developer Files check box, as shown in Figure 2-6, and then click Next.**

The developer files might sound like they're right up your alley, but they're actually for people who want to add to or modify the code for XAMPP itself.

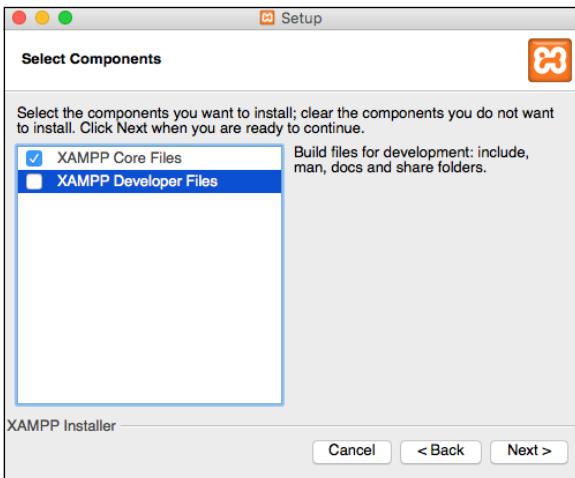


FIGURE 2-6:
Use this Setup Wizard dialog to deselect the check box beside XAMPP Developer Files.

- 7. In the Installation Directory dialog, click Next.**
- 8. The Setup Wizard lets you know that Bitnami for XAMPP can install content management systems such as WordPress and Drupal. Click Next.**
- 9. Click Next to launch the installation.**
- 10. When the install is complete, click Finish.**

If you don't care about any of this, be sure to deselect the Learn More About Bitnami for XAMPP check box before you click Next.

- 9. Click Next to launch the installation.**
- 10. When the install is complete, click Finish.**

If you want to head right into the XAMPP Manager, leave the Launch XAMPP check box selected.

What about the security of your local web server? Fortunately, that's not an issue because people on your network can't access your web server. XAMPP is configured by default to be accessible only from the Mac on which it's installed.



REMEMBER

Running the XAMPP Application Manager

The XAMPP Application Manager enables you to start, stop, and configure the XAMPP servers, particularly the Apache web server and the MySQL database system. To launch the XAMPP Application Manager, you have two choices:

- » If you still have the final Setup Wizard dialog onscreen, leave the Launch XAMPP check box selected and click Finish.
- » In Finder, open the Applications folder, open the XAMPP folder, and then double-click Manager-OSX.

The XAMPP Application Manager appears. To work with the XAMPP servers, click the Manage Servers tab, shown in Figure 2-7.

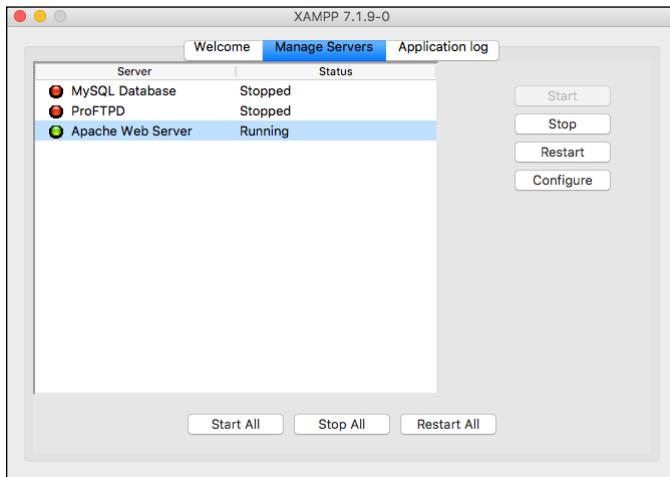


FIGURE 2-7:
You use the XAMPP Control Panel to control and configure services such as Apache and MySQL.

In the Manage Servers tab, you can perform the following actions:

- » **Start a server.** Click the server and then click Start.
- » **Start all the servers.** Click Start All.
- » **Restart a server.** Click the server and then click Restart.
- » **Restart all the servers.** Click Restart All.
- » **Stop a server.** Click the server and then click Stop.
- » **Stop all the servers.** Click Stop All.

Accessing your local web server

With XAMPP for OS X installed and Apache up and running, it's time for high-fives all around because you've got a web server running on your Mac! That's

awesome, but how do you access your web server? There are two ways, depending on what you're doing:

- » **Adding files and folders to the web server:** Place the files and folders in the htdocs subfolder of your main XAMPP install folder. To get there, open Applications, then XAMPP, then double-click htdocs. If you have the XAMPP Application Manager open, click the Welcome tab, click Open Application Folder, then open htdocs.
- » **Viewing the files and folders on the server:** Open your favorite web browser and navigate to the localhost address (or to 127.0.0.1, which gets you to the same place). If you have the XAMPP Application Manager running, click the Welcome tab and then click Go To Application.

By default, your local website is configured to automatically redirect localhost to localhost/dashboard/, shown in Figure 2-8, which gives you access to several XAMPP tools.

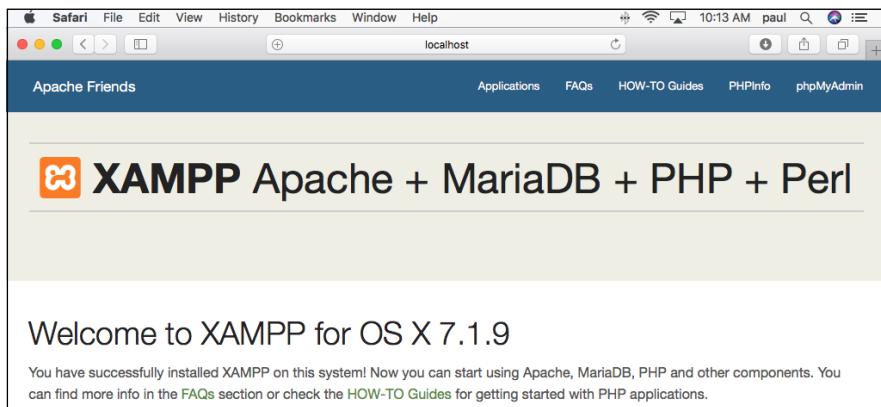


FIGURE 2-8:
The localhost/
dashboard/
address gives you
access to a few
XAMPP for OS X
features.

In the page header, you can use the following links:

- » **Apache Friends:** Returns you to the main Dashboard page.
- » **Applications:** Provides information about installing Bitnami applications on the server.
- » **FAQs:** Displays a list of XAMPP frequently asked questions.
- » **How-To Guides:** Displays a list of links to step-by-step guides for a number of XAMPP for OS X tasks.

- » **PHPInfo:** Displays a for-geeks-only page of information about the version of PHP that you have installed.
- » **phpMyAdmin:** Opens the phpMyAdmin tool, which lets you create and manipulate MariaDB/MySQL databases. You can also open phpMyAdmin by navigating directly to `localhost/phpmyadmin/`. Either way, make sure you have the MySQL Database server running before you open phpMyAdmin.

Choosing Your Text Editor

I mention at the beginning of this chapter that all you need to develop web pages is a text editor. However, saying that all you need to code is a text editor is like saying that all you need to live is food: It's certainly true, but more than a little short on specifics. After all, to a large extent the quality of your life depends on the food you eat. If you survive on nothing but bread and water, well "surviving" is all you're doing. What you really need is a balanced diet that supplies all the nutrients your body needs. And pie.

The bread-and-water version of a text editor is the barebones program that came with your computer: Notepad if you run Windows, orTextEdit if you have a Mac. You can survive as a web developer using these programs, but that's not living, if you ask me. You need the editing equivalent of vitamins and minerals (and, yes, pie) if you want to flourish as a web coder. These nutrients are the features and tools that are crucial to being an efficient and organized developer:

- » **Syntax highlighting:** Syntax refers to the arrangement of characters and symbols that create correct programming code, and *syntax highlighting* is an editing feature that color-codes certain syntax elements for easier reading. For example, while regular text might appear black, all the HTML tags might be shown in blue and the CSS properties might appear red. The best text editors let you choose the syntax colors, either by offering prefab themes, or by letting you apply custom colors.
- » **Line numbers:** It might seem like a small thing, but having a text editor that numbers each line, as shown in Figure 2-9, can be a major timesaver. When the web browser alerts you to an error in your code (see Book 3, Chapter 9), it gives you an error message and, crucially, the line number of the error. This enables you to quickly locate the culprit and (fingers crossed) fix the problem pronto.
- » **Code previews:** A good text editor will let you see a preview of how your code will look in a web browser. The preview might appear in the same window as your code, or in a separate window, and it should update automatically as you modify and save your code.

FIGURE 2-9:
Line numbers, as
seen here down
the left side of
the window, are a
crucial text editor
feature.

```

1  <!DOCTYPE html>
2  <html lang="en">
3      <head>
4          <meta charset="utf-8">
5          <title>Web Coding and Web Dev AIO for Dummies</title>
6          <meta name="viewport" content="width=device-width, initial-scale=1.0">
7          <link rel="stylesheet" href="/css/styles.css">
8          <script src="/js/jquery-1.11.1.min.js"></script>
9          <script src="/js/clipboard.min.js"></script>
10         <script src="/js/my.js"></script>
11     </head>
12     <body>
13         // Load the nav bar
14         $("#navbar-code").load("/includes/navbar-code.txt");
15
16         // Load the footer
17         $("#footer-code").load("/php/write-footer.php");
18
19         // Get the example files
20         $.getJSON('get-examples.php', function(data) {
21             var str = '';
22             var strCode = '';
23             var strExample = '';
24             var currBook = data[0].Book;
25             var currChapter = data[0].Chapter;
26
27             // Write the initial item
28             str += '<div class="wcd-book" id="book' + currBook + '>';
29             str += '    Book ' + data[0].Book + ': ' + data[0].BookTitle;
30             str += '    <div class="wcd-chapters" id="book' + currBook + '_chapters">';
31             str += '        <div class="wcd-chapter" id="book' + currBook + '_chapter' + currChapter + '>';
32             str += '            Chapter ' + data[0].Chapter + ': ' + data[0].ChapterTitle;
33         });

```

- » **Code completion:** This is a handy feature that, when you start typing something, displays a list of possible code items that complete your typing. You can then select the one you want and press Tab or Enter to add it to your code without having to type the whole thing.
- » **Text processing:** The best text editors offer a selection of text processing features, such as automatic indentation of code blocks, converting tabs to spaces and vice versa, shifting chunks of code right or left, removing unneeded spaces at the end of lines, hiding blocks of code, and more.

The good news is that there's no shortage of text editors that support all these features and many more. That's also the bad news, because it means you have a huge range of programs to choose from. To help you get started, here, in alphabetical order, are a few editors to take for test drives:

- » **Atom:** Available for Windows and Mac. Free! <http://atom.io>
- » **Brackets:** Available for Windows and Mac. Also free! <http://brackets.io/>
- » **Coda:** Available for Mac only. \$99, but a free trial is available. www.panic.com/coda
- » **Notepad++:** Available for Windows only. Another freebie. <https://notepad-plus-plus.org/>
- » **Sublime Text:** Available for both Windows and Mac. \$80, but a free trial is available. www.sublimetext.com
- » **TextMate:** Available for Mac only. \$60, but a free trial is available. <http://macromates.com/>

IN THIS CHAPTER

- » Understanding web hosting providers
- » Examining the various choices for hosting your site
- » Choosing the host that's right for you
- » Looking around your new web home
- » Getting your site files to your web host

Chapter 3

Finding and Setting Up a Web Host

You will end up with better software by releasing as early as practically possible, and then spending the rest of your time iterating rapidly based on real-world feedback. So trust me on this one: Even if version 1 sucks, ship it anyway.

— JEFF ATTWOOD

You build your web pages from the comfort of your Mac or PC, and if you've chosen your text editor well (as I describe in Book 1, Chapter 2), then you can even use your computer to preview how your web pages will look in a browser.

That's fine and dandy, but I think you'll agree that the whole point of building a web page is to, you know, put it on the web! First, you need to subject your code to the wilds of the wider web to make sure it works out there. Even if it seems to be running like a champ on your local server, you can't give it the seal of approval until you've proven that it runs champlike on a remote server. Second, once your code is ready, then the only way the public can appreciate your handiwork is to get it out where they can see it.

Whether you're testing or shipping your code, you need somewhere to put it, and that's what this chapter is about. Here you explore the wide and sometimes wacky world of web hosts. You delve into what they offer, investigate ways to choose a good one, and then take a tour of your web home away from home.

Understanding Web Hosting Providers

A common question posed by web development newcomers is “Where the heck do I put my web page when it’s done?” If you’ve asked that question, you’re doing okay because it means you’re clued in to something crucial: Just because you’ve created a web page and you have an Internet connection doesn’t mean your site is automatically a part of the web.

After all, people on the web have no way of getting to your computer. Even if you’re working with a local web development environment (which I discuss in Book 1, Chapter 2), you’re working in splendid isolation because no one either on your network or on the Internet can access that environment.

In other words, your computer isn’t set up to hand out documents (such as web pages) to remote visitors who ask for them. Computers that can do this are called *servers* (because they “serve” stuff out to the web), and computers that specialize in distributing web pages are called *web servers*. So your web page isn’t on the web until you store it on a remote web server. Because this computer is, in effect, playing “host” to your pages, such machines are also called *web hosts*. Companies that run these web hosts are called *web hosting providers*.

Now, just how do you go about finding a web host? Well, the answer to that depends on a bunch of factors, including the type of site you have, how you get connected to the Internet in the first place, and how much money (if any) you’re willing to fork out for the privilege. In the end, you have three choices:

- » Your existing Internet provider
- » A free hosting provider
- » A commercial hosting provider

Using your existing Internet provider

If you access the Internet via a corporate or educational network, your institution might have its own web server you can use. If you get online via an Internet service provider (ISP), phone or email its customer service department to ask

whether the company has a web server available. Almost all ISPs provide space so their customers can put up personal pages free of charge.

Finding a free hosting provider

If cash is in short supply, a few hosting providers will bring your website in from the cold out of the goodness of their hearts. In some cases, these services are open only to specific groups such as students, artists, nonprofit organizations, and so on. However, plenty of providers put up personal sites free of charge.

What's the catch? Well, there are almost always restrictions both on how much data you can store and on the type of data you can store (no ads, no dirty pictures, and so on). You might also be required to display some kind of "banner" advertisement for the hosting provider on your pages.

Signing up with a commercial hosting provider

For personal and business-related websites, many web artisans end up renting a chunk of a web server from a commercial hosting provider. You normally hand over a setup fee to get your account going and then you're looking at a monthly fee.

Why shell out all that dough when there are so many free sites lying around? Because, as with most things in life, you get what you pay for. By paying for your host, you generally get more features, better service, and fewer annoyances (such as the ads that some free sites have to display).

A Buyer's Guide to Web Hosting

Unfortunately, choosing a web host isn't as straightforward as you might like it to be. For one thing, hundreds of hosts are out there clamoring for your business; for another, the pitches and come-ons your average web host employs are strewn with jargon and technical terms. I can't help reduce the number of web hosts, but I can help you understand what those hosts are yammering on about. Here's a list of the terms you're most likely to come across when researching web hosts:

- » **Storage space:** Refers to the amount of room allotted to you on the host's web server to store your files. The amount of acreage you get determines the amount of data you can store. For example, if you get a 1MB (1 megabyte) limit, you can't store more than 1MB worth of files on the server. HTML files

don't take up much real estate, but large graphics sure do, so you need to watch your limit. For example, you could probably store about 200 pages in 1MB of storage (assuming about 5KB per page), but only about 20 images (assuming about 50KB per image). Generally speaking, the more you pay for a host, the more storage space you get.

» **Bandwidth:** A measure of how much of your data the server serves. For example, suppose the HTML file for your page is 1KB (1 kilobyte) and the graphics associated with the page consume 9KB. If someone accesses your page, the server ships out a total of 10KB; if ten people access the page (either at the same time or over a period of time), the total bandwidth is 100KB. Most hosts give you a bandwidth limit (or "cap"), which is most often a certain number of megabytes or gigabytes per month. (A gigabyte is equal to about 1,000 megabytes.) Again, the more you pay, the greater the bandwidth you get.



WARNING

If you exceed your bandwidth limit, users will usually still be able to get to your pages (although some hosts shut down access to an offending site). However, almost all web hosts charge you an extra fee for exceeding your bandwidth, so check this out before signing up. The usual penalty is a set fee per every megabyte or gigabyte over your cap.

» **Domain name:** A general Internet address, such as `wiley.com` or `whitehouse.gov`. They tend to be easier to remember than the long-winded addresses most web hosts supply you by default, so they're a popular feature. Two types of domain names are available:

- A regular domain name (such as `yourdomain.com` or `yourdomain.org`)
- A subdomain name (such as `yourdomain.webhostdomain.com`)

To get a regular domain, you either need to use one of the many domain registration services such as GoDaddy or Register .com. A more convenient route is to choose a web hosting provider that will do this for you. Either way, it will usually cost you \$35 per year (although some hosts offer cheap domains as a "loss leader" and recoup their costs with hosting fees; also, discount domain registrars such as GoDaddy offer domains for as little as \$9.99 per year). If you go the direct route, almost all web hosts will host your domain, which means that people who use your domain name will get directed to your website on the host's web server. For this to work, you must tweak the domain settings on the registrar. This usually involves changing the DNS servers associated with the domain so that they point at the web host's domain name servers. Your web host will give you instructions on how to do this.

With a subdomain name, "`webhostdomain.com`" is the domain name of the web hosting company, and it simply tacks on whatever name you want to the beginning. Many web hosts will provide you with this type of domain, often for free.

- » **Email addresses:** Most hosts offer you one or more email addresses along with your web space. The more you pay, the more mailboxes you get. Some hosts offer *email forwarding*, which enables you to have messages that are sent to your web host address rerouted to some other email address.
- » **Shared server:** If the host offers a *shared server* (or *virtual server*), it means that you'll be sharing the server with other websites — dozens or even hundreds of them. The web host takes care of all the highly technical server management chores, so all you have to do is maintain your site. This is by far the best (and cheapest) choice for individuals or small business types.
- » **Dedicated server:** You get your very own server computer on the host. That may sound like a good thing, but it's usually up to you to manage the server, which can be a dauntingly technical task. Also, dedicated servers are much more expensive than shared servers.
- » **Operating system:** The operating system on the web server. You usually have two choices: Unix (or Linux) and Windows Server. Unix systems have the reputation of being very reliable and fast, even under heavy traffic loads, so they're usually the best choice for a shared server. Windows systems are a better choice for dedicated servers because they're easier to administer than their Unix brethren. Note, too, that Unix servers are case sensitive in terms of file and directory names, while Windows servers are not.
- » **Databases:** The number of databases you get to create with your account. Unix systems usually offer MySQL databases, whereas Windows servers offer SQL Server databases.
- » **Administration interface:** This is the host app that you use to perform tasks on the server, such as uploading files or creating users. Many hosts offer the excellent cPanel interface, and most Unix-based systems offer the phpMyAdmin app for managing your MySQL data.
- » **Ad requirements:** A few free web hosts require you to display some type of advertising on your pages. This could be a banner ad across the top of the page, a "pop-up" ad that appears each time a person accesses your pages, or a "watermark" ad, usually a semitransparent logo that hovers over your page. Fortunately, free hosts that insist on ads are rare these days.
- » **Uptime:** The percentage of time the host's server is up and serving. There's no such thing as 100 percent uptime because all servers require maintenance and upgrades at some point. However, the best hosts have uptime numbers over 99 percent. (If a host doesn't advertise its uptime, it's probably because it's very low. Be sure to ask before committing yourself.)
- » **Tech support:** If you have problems setting up or accessing your site, you want to know that help — in the form of *tech support* — is just around the corner. The best hosts offer 24/7 tech support, which means you can contact the company — either by phone or email — 24 hours a day, 7 days a week.

- » **FTP support:** You usually use the Internet's *FTP* service to transfer your files from your computer to the web host. If a host offers *FTP access* (some hosts have their own method for transferring files), be sure you can use it any time you want and there are no restrictions on the amount of data you can transfer at one time.
- » **Website statistics:** Tell you things such as how many people have visited your site, which pages are the most popular, how much bandwidth you're consuming, which browsers and browser versions surfers are using, and more. Most decent hosts offer a ready-made stats package, but the best ones also give you access to the "raw" log files so you can play with the data yourself.
- » **Ecommerce:** Some hosts offer a service that lets you set up a web "store" so you can sell stuff on your site. That service usually includes a "shopping script," access to credit card authorization and other payment systems, and the ability to set up a secure connection. You usually get this only in the more expensive hosting packages, and you'll most often have to pay a setup fee to get your store built.
- » **Scalability:** The host is able to modify your site's features as required. For example, if your site becomes very popular, you might need to increase your bandwidth limit. If the host is scalable, it can easily change your limit (or any other feature of your site).

Finding a Web Host

Okay, you're ready to start researching the hosts to find one that suits your web style. As I mention earlier, there are hundreds, perhaps even thousands, of hosts, so how is a body supposed to whittle them down to some kind of short list? Here are some ideas:

- » **Ask your friends and colleagues.** The best way to find a good host is that old standby, word of mouth. If someone you trust says a host is good, chances are you won't be disappointed. This is assuming you and your pal have similar hosting needs. If you want a full-blown ecommerce site, don't solicit recommendations from someone who has only a humble home page.
- » **Solicit host reviews from experts.** Ask existing webmasters and other people "in the know" about which hosts they recommend or have heard good things about. A good place to find such experts is Web Hosting Talk (www.webhostingtalk.com), a collection of forums related to web hosting.

- » **Contact web host customers.** Visit sites that use a particular web host, and send an email message to the webmaster asking what she thinks of the host's service.
- » **Peruse the lists of web hosts.** A number of sites track and compare web hosts, so they're an easy way to get in a lot of research. Careful, though, because there are a lot of sketchy lists out there that are only trying to make a buck by getting you to click ads. Here are some reputable places to start:
 - **CNET Web Hosting Solutions:** www.cnet.com/web-hosting
 - **PC Magazine Web Site Hosting Services Reviews:** www.pcmag.com/reviews/web-hosting-services
 - **Review Hell:** www.reviewhell.com
 - **Review Signal Web Hosting Reviews:** <http://reviewsignal.com/webhosting>

Finding Your Way around Your New Web Home

After you sign up with a web hosting provider and your account is established, the web administrator creates two things for you: a directory on the server you can use to store your website files, and your very own web address. (This is also true if you're using a web server associated with your corporate or school network.) The directory — which is known in the biz as your *root directory* — usually takes one of the following forms:

```
/yourname/  
/home/yourname/  
/yourname/public_html/
```

In each case, *yourname* is the login name (or username) the provider assigns to you, or it may be your domain name (with or without the .com part). Remember, your root directory is a slice of the host's web server, and this slice is yours to monkey around with as you see fit. This usually means you can do all or most of the following to the root:

- » Add files to the directory.
- » Add subdirectories to the directory.
- » Move or copy files from one directory to another.

- » Rename files or directories.
- » Delete files from the directory.

Your web address normally takes one of the following shapes:

```
http://provider/yourname/  
http://yourname.provider/  
http://www.yourname.com/
```

Here, *provider* is the host name of your provider (for example, www.hostcompany.com or just hostcompany.com), and *yourname* is your login name or domain name. Here are some examples:

```
http://www.hostcompany.com/mywebsite/  
http://mywebsite.hostcompany.com/  
http://www.mywebsite.com/
```

Your directory and your web address

There's a direct and important relationship between your server directory and your address. That is, your address actually "points to" your directory and enables other people to view the files you store in that directory. For example, suppose I decide to store a file named `thingamajig.html` in my directory and my main address is `http://mywebsite.hostcompany.com/`. This means someone else can view that page by typing the following URL into a web browser:

```
http://mywebsite.hostcompany.com/thingamajig.html
```

Similarly, suppose I create a subdirectory named `stuff` and use it to store a file named `index.html`. A surfer can view that file by convincing a web browser to head for the following URL:

```
http://mywebsite.hostcompany.com/stuff/index.html
```

In other words, folks can surf to your files and directories by strategically tacking on the appropriate filenames and directory names after your main web address.

Making your hard disk mirror your web home

As a web developer, one of the key ways to keep your projects organized is to set up your directories on your computer, and then mirror those directories on your web host. Believe me, this will make your uploading duties immeasurably easier.



REMEMBER

Moving a file from your computer to a remote location (such as your web host's server) is known in the file transfer trade as *uploading*.

This process begins at the root. On the web host, you already have a root directory assigned to you by the hosting provider, so now you need to designate a folder on your computer to be the root mirror. If you're using the XAMPP web development environment (see Book 1, Chapter 2), then the XAMPP installation's `htdocs` subfolder is perfect as your local root. Otherwise, choose or create a folder on your computer to use as the local root.

What you do from here depends on the number of web development projects you're going to build, and the number of files in each project:

- » **A single web development project consisting of just a few files:** In this case, just put all the files into the root directory.
- » **A single web development project consisting of many files:** The more likely scenario for a typical web development project is to have multiple HTML, CSS, JavaScript, and PHP files, plus lots of ancillary files such as images and fonts. Although it's okay to place all your HTML files in the root directory, do yourself a favor and organize all your other files into subfolders by file type: a `css` subfolder for CSS files, a `js` subfolder for JavaScript files, and so on.
- » **Multiple web development projects:** As a web developer, you'll almost certainly create tons of web projects, so it's crucial to organize them. The ideal way to do that is to create a separate root subdirectory for each project. Then within each of these subdirectories, you can create sub-subdirectories for file types such as CSS, JavaScript, images, and so on.

To help you see why mirroring your local and remote directory structures is so useful, suppose you set up a subfolder on your computer named `graphics` that you use to store your image files. To insert into your page a file named `mydog.jpg` from that folder, you'd use the following reference:

```
graphics/mydog.jpg
```

When you send your HTML file to the server and you then display the file in a browser, it looks for `mydog.jpg` in the `graphics` subdirectory. If you don't have such a subdirectory — either you didn't create it or you used a different name, such as `images` — the browser won't find `mydog.jpg` and your image won't show. In other words, if you match the subdirectories on your web server with the subfolders on your computer, your page will work properly without modifications both at home and on the web.



WARNING

One common faux pas beginning web developers make is to include the local drive and all the folder names when referencing a file. Here's an example:

```
C:\xampp\htdocs\graphics\mydog.jpg
```

This image will show up just fine when it's viewed from your computer, but it will fail miserably when you upload it to the server and view it on the web. That's because the C:\xampp\htdocs\ part exists only on your computer.



WARNING

The Unix (or Linux) computers that play host to the vast majority of web servers are downright finicky when it comes to the uppercase and lowercase letters used in file and directory names. It's crucial that you check the file references in your code to be sure the file and directory names you use match the combination of uppercase and lowercase letters used on your server. For example, suppose you have a CSS file on your server that's named `styles.css`. If your HTML references that file as, say, `STYLES.CSS`, the server won't find the file and your styles won't get applied.

Uploading your site files

Once your web page or site is ready for its debut, it's time to get your files to your host's web server. If the server is on your company or school network, you send the files over the network to the directory set up by your system administrator. Otherwise, you upload the files to the root directory created for you on the hosting provider's web server.

How you go about uploading your site files depends on the web host, but here are the four most common scenarios:

- » **Use an FTP program.** It's a rare web host that doesn't offer support for the File Transfer Protocol (FTP, for short), which is the Internet's most popular method for transfer files from here to there. To use FTP, you usually need to get a piece of software called an *FTP client*, which enables you to connect to your web host's FTP server (your host can provide you with instructions for this) and offers an interface for standard file tasks, such as navigating and creating folders, uploading the files, deleting and renaming files, and so on. Popular Windows clients are CuteFTP (www.globalscape.com/cuteftp) and Cyberduck (<https://cyberduck.io>). For the Mac, try Transmit (<https://panic.com/transmit>) or FileZilla (<https://filezilla-project.org>).
- » **Use your text editor's file upload feature.** Some text editors come with an FTP client built-in, so you can edit a file and then immediately upload it with a single command. The Coda text editor (<https://panic.com/coda>) supports this too-handy-for-words feature.

- » **Use the File Manager feature of cPanel.** I mention earlier that lots of web hosts offer an administration tool called cPanel that offers an interface for hosting tasks such as email and domain management. cPanel also offers a File Manager feature that you can use to upload files and perform other file management chores.
- » **Use the web host's proprietary upload tool.** For some reason, a few web hosts only offer their own proprietary interface for uploading and messing around with files and directories. See your host's Help or Support page for instructions.

Making changes to your web files

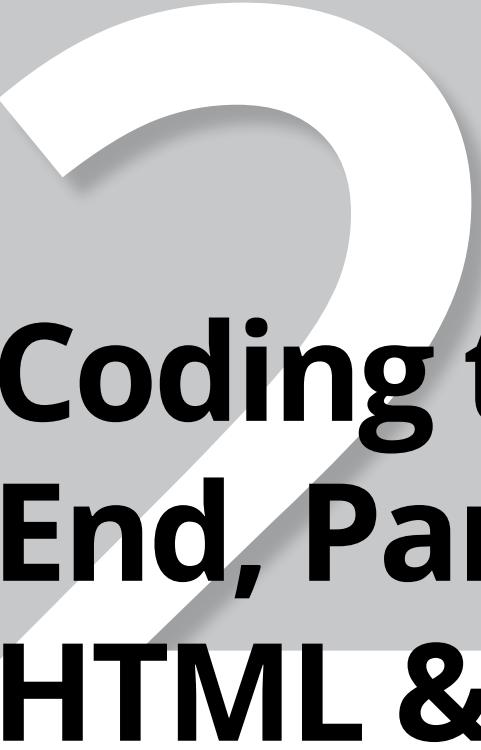
What happens if you send a web development file to your web host and then realize you've made a typing gaffe or you spy a coding mistake? Or what if you have more information to add to one of your web pages? How do you make changes to the files you've already sent?

Well, here's the short answer: You don't. That's right, after you've sent your files, you never have to bother with them again. That doesn't mean you can never update your site, however. Instead, you make your changes to the files that reside on your computer and then send these revised files to your web host. These files replace the old files, and your site is updated just like that.



WARNING

Be sure you send the updated file to the correct directory on the server. Otherwise, you may overwrite a file that happens to have the same name in some other directory.



Coding the Front End, Part 1: HTML & CSS

Contents at a Glance

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IN THIS CHAPTER

- » Getting comfy with HTML
- » Figuring out HTML tags and attributes
- » Understanding the basic blueprint for all web pages
- » Adding text, images, and links to your page
- » Building bulleted and numbered lists

Chapter 1

Structuring the Page with HTML

I am always fascinated by the structure of things; why do things work this way and not that way.

— URSUS WEHRLI

When it comes to web development, it's no exaggeration to say that the one indispensable thing, the *sine qua non* for those of you who studied Latin in school, is HTML. That's because absolutely everything else you make as a web developer — your CSS rules, your JavaScript code, even your PHP scripts — can't hang its hat anywhere but on some HTML. These other web development technologies don't even make sense outside of an HTML context.

So, in a sense, this chapter is the most important for you as a web coder because all the rest of the book depends to a greater or lesser degree on the HTML know-how found in the following pages. If that sounds intimidating, not to worry: One of the great things about HTML is that it's not a huge topic, so you can get up to full HTML speed without a massive investment of time and effort.

Because HTML is so important, you'll be happy to know that I don't rush things. You'll get a thorough grounding in all things HTML, and when you're done you'll be more than ready to tackle the rest of your web development education.

Getting the Hang of HTML

Building a web page from scratch using your bare hands may seem like a daunting task. It doesn't help that the codes you use to set up, configure, and format a web page are called the Hypertext Markup Language (HTML for short), a name that could only warm the cockles of a geek's heart. I take a mercifully brief look at each term:

- » **Hypertext:** In prehistoric times — that is, the 1980s — tall-forehead types referred to any text that, when selected, takes you to a different document, as *hypertext*. So this is just an oblique reference to the links that are the defining characteristic of web pages.
- » **Markup:** Instructions that specify how the content of a web page should be displayed in the web browser.
- » **Language:** The set of codes that comprise all the markup possibilities for a page.

But even though the name HTML is intimidating, the codes used by HTML aren't even close to being hard to learn. There are only a few of them, and in many cases they even make sense!

At its most basic, HTML is nothing more than a collection of markup codes — called *tags* — that specify the structure of your web page. In HTML, “structure” is a rubbery concept that can refer to anything from the overall layout of the page all the way down to a single word or even just a character or two.

You can think of a tag as a kind of container. What types of things can it contain? Mostly text, although lots of tags contain things like chunks of the web page and even other tags.

Most tags use the following generic format:

```
<tag>content</tag>
```

What you have here are a couple codes that define a container. Most of these codes are one- or two-letter abbreviations, but sometimes they're entire words. You always surround these codes with angle brackets `<>`; the brackets tell the web browser that it's dealing with a chunk of HTML and not just some random text.

The first of these codes — `<tag>` — is called the *start tag* and it marks the opening of the container; the second of the codes — `</tag>` — is called the *end tag* and it marks the closing of the container. (Note the extra slash (/) that appears in the end tag.)

In between you have the *content*, which refers to whatever is contained in the tag. For example, I start with a simple sentence that might appear in a web page:

```
Okay, listen up people because this is important!
```

Figure 1-1 shows how this might look in a web browser.

FIGURE 1-1:
The sample sentence as it appears in a web browser.

```
Okay, listen up people because this is important!
```

Ho hum, right? Suppose you want to punch this up a bit by emphasizing “important.” In HTML, the tag for emphasis is ``, so you’d modify your sentence like so:

```
Okay, listen up people because this is <em>important</em>!
```

See how I’ve surrounded the word `important` with `` and ``? The first `` is the start tag and it says to the browser, “Yo, Browser Boy! You know the text that comes after this? Be a good fellow and treat it as emphasized text.” This continues until the browser reaches the end tag ``, which lets the browser know it’s supposed to stop what it’s doing. So the `` tells the browser, “Okay, okay, that’s enough with the emphasis already!”

All web browsers display emphasized text in italics, so that’s how the word now appears, as you can eyeball in Figure 1-2.

FIGURE 1-2:
The sentence revised to italicize the word `important`.

There are tags for lots of other structures, including important text, paragraphs, headings, page titles, links, and lists. HTML is just the sum total of all these tags.



One of the most common mistakes rookie web weavers make is to forget the slash (/) that identifies an end tag. If your page looks wrong when you view it in a browser, look for a missing slash. Also look for a backslash (\) instead of a slash, which is another common error.

Understanding Tag Attributes

You'll often use tags straight up, but all tags are capable of being modified in various ways. This might be as simple as supplying a unique identifier to the tag for use in a script or a style, or it might be a way to change how the tag operates. Either way, you modify a tag by adding one or more *attributes* to the start tag. Most attributes use the following generic syntax:

```
<tag attribute="value">
```

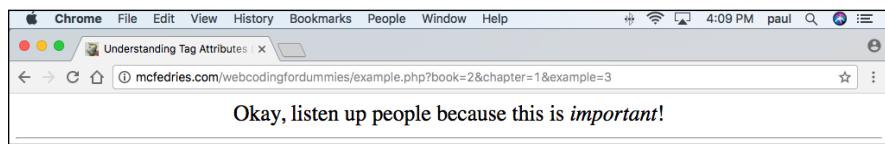
Here, you replace *attribute* with the name of the attribute you want to apply to the tag, and you replace *value* with the value you want to assign the attribute.

For example, the `<hr>` tag adds a horizontal line across the web page (`hr` stands for *horizontal rule*). You use only the start tag in this case (as a simple line, it can't "contain" anything, so no end tag is needed), as demonstrated in the following example:

```
Okay, listen up people because this is <em>important</em>!  
<hr>
```

As you can see in Figure 1-3, the web browser draws a line right across the page.

FIGURE 1-3:
When you add
the `<hr>` tag,
a horizontal line
appears across
the page.

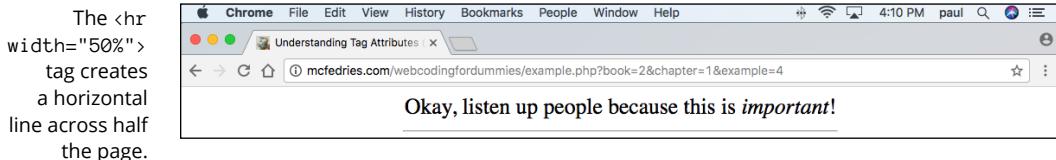


You can also add the `width` attribute to the `<hr>` tag and specify the width you prefer. For example, if you only want the line to traverse half the page width, set the `width` attribute to "50%", as shown here:

```
Okay, listen up people because this is <em>important</em>!  
<hr width="50%">
```

As Figure 1-4 shows, the web browser obeys your command and draws a line that takes up only half the width of the page.

FIGURE 1-4:



Learning the Fundamental Structure of an HTML5 Web Page

In this section, I show you the tags that serve as the basic blueprint you'll use for all your web pages.

Your HTML files will always lead off with the following tag:

```
<!DOCTYPE html>
```

This tag (it has no end tag) is the so-called *Doctype declaration*, and it lets the web browser know what type of document it's about to process (an HTML document, in this case).

Next up you add the `<html lang="en">` tag. This tag doesn't do a whole lot except tell any web browser that tries to read the file that it's dealing with a file that contains HTML doodads. It also uses the `lang` attribute to specify the document's language, which in this case is English.

Similarly, the last line in your document will always be the corresponding end tag: `</html>`. You can think of this tag as the HTML equivalent for "The End." So, each of your web pages will include this on the second line:

```
<html lang="en">
```

and this on the last line:

```
</html>
```

The next items serve to divide the page into two sections: the head and the body. The head section is like an introduction to the page. Web browsers use the head to glean various types of information about the page. A number of items can appear in the head section, but the only one that makes any real sense at this early stage is the title of the page, which I talk about in the next section.

To define the head, add `<head>` and `</head>` tags immediately below the `<html>` tag you typed in earlier. So your web page should now look like this:

```
<!DOCTYPE html>
<html lang="en">
<head>
</head>
</html>
```



REMEMBER

Although technically it makes no difference if you enter your tag names in uppercase or lowercase letters, the HTML powers-that-be prefer to see HTML tags in lowercase letters, so that's the style I use in this book, and I encourage you to do the same.

While you're in the head section, let's add a head-scratcher:

```
<meta charset="utf-8">
```

You place this between the `<head>` and `</head>` tags (indented four spaces for easier reading). It tells the web browser that your web page uses the UTF-8 character set, which you can mostly ignore except to know that UTF-8 contains almost every character (domestic and foreign), punctuation mark, and symbol known to humankind.

The body section is where you enter the text and other fun stuff that the browser will actually display. To define the body, place `<body>` and `</body>` tags after the head section (that is, below the `</head>` tag):

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8">
</head>
<body>
</body>
</html>
```



WARNING

A common page error is to include two or more copies of these basic tags, particularly the `<body>` tag. For best results, be sure you use each of these seven basic structural tags only one time on each page.

Giving your page a title

When you surf the web, you've probably noticed that your browser displays some text in the current tab. That tab text is the web page title, which is a short (or

sometimes long) phrase that gives the page a name. You can give your own web page a name by adding the `<title>` tag to the page's head section.

To define a title, surround the title text with the `<title>` and `</title>` tags. For example, if you want the title of your page to be "My Home Sweet Home Page," enter it as follows:

```
<title>My Home Sweet Home Page</title>
```

Note that you always place the title inside the head section, so your basic HTML document now looks like this:

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8">
    <title>My Home Sweet Home Page</title>
</head>
<body>
</body>
</html>
```

Figure 1-5 shows this HTML file loaded into a web browser. Notice how the title appears in the browser's tab bar.

FIGURE 1-5:
The text you insert into the `<title>` tag shows up in the browser tab.



Here are a few things to keep in mind when thinking of a title for your page:

- » Be sure your title describes what the page is all about.
- » Don't make your title too long. If you do, the browser might chop it off because there's not enough room to display it in the tab. Fifty or 60 characters are usually the max.
- » Use titles that make sense when someone views them out of context. For example, if someone really likes your page, that person might add it to his or her list of favorites or bookmarks. The browser displays the page title in the favorites list, so it's important that the title makes sense when she looks at the bookmarks later on.

- » Don't use cryptic or vague titles. Titling a page "Link #42" or "My Web Page" might make sense to you, but your readers will almost certainly be scratching their heads.

Adding some text

Now it's time to put some flesh on your web page's bones by entering the text you want to appear in the body of the page. For the most part, you can type the text between the `<body>` and `</body>` tags, like this:

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8">
    <title>My Home Sweet Home Page</title>
</head>
<body>
Hello HTML World!
</body>
</html>
```

Figure 1-6 shows how a web browser displays this HTML.

FIGURE 1-6:
Text you add
to the page
body appears
in the browser's
content window.



Before you start typing willy-nilly, however, there are a few things you should know:

- » You might think you can line things up and create some interesting effects by stringing together two or more spaces. Ha! Web browsers chew up all those extra spaces and spit them out into the nether regions of cyberspace. Why? Well, the philosophy of the web is that you can use only HTML tags to lay out a document. So a run of multiple spaces (or *white space*, as it's called) is ignored.
- » Tabs also fall under the rubric of white space. You can enter tabs all day long, but the browser ignores them completely.

- » Browsers also like to ignore the carriage return. It might sound reasonable to the likes of you and me that pressing Enter (or Return on a Mac) starts a new paragraph, but that's not so in the HTML world.
- » If you want to separate two chunks of text, you have multiple ways to go, but here are the two easiest:
 - **If you want no space between the texts:** Place a `
` (for line break) tag between the two bits of text.
 - **If you want some breathing room between the texts:** Surround each chunk of text with the `<p>` and `</p>` (for paragraph) tags.
- » If HTML documents are just plain text, does that mean you're out of luck if you need to use characters such as © and €? Luckily, no. For the most part, you can just add these characters to your file. However, HTML also has special codes for these kinds of characters. I talk about them a bit later in this chapter.
- » If, for some reason, you're using a word processor instead of a text editor, know that it won't help to format your text using the program's built-in commands. The browser cheerfully ignores even the most elaborate formatting jobs because browsers understand only HTML (and CSS and JavaScript). And besides, a document with formatting is, by definition, not a pure text file, so a browser might bite the dust trying to load it.

Some Notes on Structure versus Style

One of the key points of front-end web development is to separate the structure of the web page from its styling. This makes the page faster to build, easier to maintain, and more predictable across a range of browsers and operating systems. HTML provides the structure side, while CSS handles the styling.

That's fine as far as it goes, but HTML performs its structural duties with a couple of quirks you need to understand:

- » **This isn't your father's idea of structure.** That is, when you think of the structure of a document, you probably think of larger chunks such as articles, sections, and paragraphs. HTML does all that, but it also deals with structure at the level of sentences, words, and even characters.
- » **HTML's structures often come with some styling attached.** Or, I should say, all web browsers come with predefined styling that they use when they render some HTML tags. Yes, I know I just said that it's best to separate



REMEMBER

structure and style, so this can be a tad confusing. Think of it this way: When you build a new deck using cedar, your completed deck has a natural “cedar” look to it, but you’re free to apply a coat of varnish or paint. HTML is the cedar, whereas CSS is the paint.

I mention these quirks because they can help to answer some questions that might arise as you work with HTML tags.

Another key to understanding why HTML does what it does, is that much of HTML — especially its most recent incarnation, HTML5 — has been set up so that a web page is “understandable” to an extent by software that analyzes the page. One important example is a screen reader used by some visually impaired surfers. If a screen reader can easily figure out the entire structure of the page from its HTML tags, then it can present the page properly to the user. Similarly, software that seeks to index, read, or otherwise analyze the page will only be able to do this successfully if the page’s HTML tags are a faithful representation of the page’s intended structure.

Applying the Basic Text Tags

HTML has a few tags that enable you to add structure to text. Many web developers use these tags only for the built-in browser formatting that comes with them, but you really should try and use the tags *semantically*, as the geeks say, which means to use them based on the meaning you want the text to convey.

Emphasizing text

One of the most common meanings you can attach to text is emphasis. By putting a little extra oomph on a word or phrase, you tell the reader to add stress to that text, which can subtly alter the meaning of your words. For example, consider the following sentence:

```
You'll never fit in there with that ridiculous thing on your  
head!
```

Now consider the same sentence with emphasis added to one word:

```
You'll never fit in there with that ridiculous thing on your  
head!
```

You emphasize text on a web page by surrounding that text with the `` and `` tags:

```
You'll <em>never</em> fit in there with that ridiculous thing on  
your head!
```

All web browsers render the emphasized text in italics, as shown in Figure 1-7.

FIGURE 1-7:
The web browser renders emphasized text using italics.

```
You'll never fit in there with that ridiculous thing on your head!
```

I should also mention that HTML has a closely related tag: `<i>`. The `<i>` tag's job is to mark up *alternative text*, which refers to any text that you want treated with a different mood or role than regular text. Common examples include book titles, technical terms, foreign words, or a person's thoughts. All web browsers render text between `<i>` and `</i>` in italics.

Marking important text

One common meaning that you'll often want your text to convey is importance. It might be some significant step in a procedure, a vital prerequisite or condition for something, or a crucial passage within a longer text block. In each case, you're dealing with text that you don't want your readers to miss, so it needs to stand out from the regular prose that surrounds it.

In HTML, you mark text as important by surrounding it with the `` and `` tags, as in this example:

```
Dear reader: Do you see the red button in the upper-right  
corner of this page? Never click the red  
button! You have been warned.
```

All web browsers render text marked up with the `` tag in bold, as shown in Figure 1-8.

FIGURE 1-8:
The browser renders important text using bold.

```
Dear reader: Do you see the red button in the upper-right corner of this page?  
Never click the red button! You have been warned.
```

Just to keep us all on our web development toes, HTML also offers a close cousin of the `` tag: the `` tag. You use the `` tag to mark up keywords in the text. A *keyword* is a term that you want to draw attention to because it plays a different role than the regular text. It could be a company name or a person's name (think of those famous "bold-faced names" that are the staple of celebrity gossip columns). The browser renders text between the `` and `` tags in a bold font.

Nesting tags

It's perfectly legal — and often necessary — to combine multiple tag types by nesting one inside the other. For example, check out this code:

```
Dear reader: Do you see the red button in the upper-right  
corner of this page? <strong>Never, I repeat <em>never</em>,  
click the red button!</strong> You have been warned.
```

See what I did there? In the text between the `` and `` tags, I marked up a word with the `` and `` tags. The result? You got it: bold, italic text, as shown in Figure 1-9.

FIGURE 1-9:

The browser usually combines nested tags, such as the bold, italic text shown here.

```
Dear reader: Do you see the red button in the upper-right corner of this page?  
Never, I repeat never, click the red button! You have been warned.
```

Adding headings

Earlier you saw that you can give your web page a title using the aptly named `<title>` tag. However, that title only appears in the browser's title bar and tab. What if you want to add a title that appears in the body of the page? That's almost easier done than said because HTML comes with a few tags that enable you to define *headings*, which are bits of text that appear in a separate paragraph and usually stick out from the surrounding text by being bigger, appearing in a bold typeface, and so on.

There are six heading tags in all, ranging from `<h1>`, which uses the largest type size, down to `<h6>`, which uses the smallest size. Here's some web page code that demonstrates the six heading tags, and Figure 1-10 shows how they look in a web browser:

```
<h1>This is Heading 1</h1>  
<h2>This is Heading 2</h2>
```

```
<h3>This is Heading 3</h3>
<h4>This is Heading 4</h4>
<h5>This is Heading 5</h5>
<h6>This is Heading 6</h6>
```

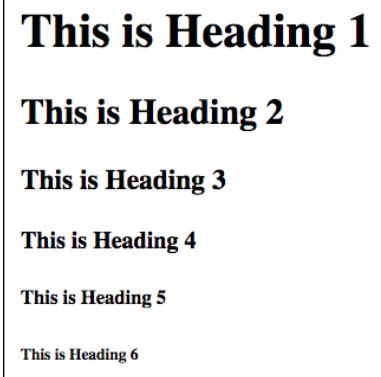


FIGURE 1-10:
The six HTML
heading tags.

What's up with all the different headings? The idea is that you use them to create a kind of outline for your web page. How you do this depends on the page, but here's one possibility:

- » Use `<h1>` for the overall page title.
- » Use `<h2>` for the page subtitle.
- » Use `<h3>` for the titles of the main sections of your page.
- » Use `<h4>` for the titles of the subsections of your page.

Adding quotations

You might have noticed that each chapter of this book begins with a short, apt quotation because, hey, who doesn't love a good quote, right? The readers of your web pages will be quote-appreciators, too, I'm sure, so why not sprinkle your text with a few words from the wise?

In HTML, you designate a passage of text as a quotation by using the `<blockquote>` tag. Here's an example:

```
Here's what the great jurist Oliver Wendell Holmes, Sr. had to
say about puns:
```

```
<blockquote>
A pun does not commonly justify a blow in return.
But if a blow were given for such cause, and death
ensued, the jury would be judges both of the facts
and of the pun, and might, if the latter were of an
aggravated character, return a verdict of justifiable
homicide.
</blockquote>
Clearly, the dude was not a pun fan.
```

The web browser renders the text between `<blockquote>` and `</blockquote>` in its own paragraph that it also indents slightly from the left margin, as shown in Figure 1-11.

FIGURE 1-11:
The web browser renders `<blockquote>` text indented slightly from the left.

Here's what the great jurist Oliver Wendell Holmes, Sr. had to say about puns:

A pun does not commonly justify a blow in return. But if a blow were given for such cause, and death ensued, the jury would be judges both of the facts and of the pun, and might, if the latter were of an aggravated character, return a verdict of justifiable homicide.

Clearly, the dude was not a pun fan.

Creating Links

When all is said and done (actually, long before that), your website will consist of anywhere from 2 to 102 pages (or even more, if you've got lots to say). Here's the thing, though: If you manage to cajole someone onto your home page, how do you get that person to your other pages? That really is what the web is all about, isn't it, getting folks from one page to another? And of course, you already know the answer to the question. You get visitors from your home page to your other pages by creating links that take people from here to there. In this section, you learn how to build your own links and how to finally put the "hypertext" into HTML.

Linking basics

The HTML tags that do the link thing are `<a>` and ``. Here's how the `<a>` tag works:

```
<a href="address">
```

Here, `href` stands for *hypertext reference*, which is just a fancy-schmancy way of saying “address” or “URL.” Your job is to replace `address` with the actual address of the web page you want to use for the link. And yes, you have to enclose the address in quotation marks. Here’s an example:

```
<a href="http://webcodingplayground.io">
```

You’re not done yet, though, not by a long shot (insert groan of disappointment here). What are you missing? Right: You have to give the reader some descriptive link text to click. That’s pretty straightforward because all you do is insert the text between the `<a>` and `` tags, like this:

```
<a href="address">Link text</a>
```

Need an example? You got it:

```
For web coding fun, check out the  
<a href="http://webcodingplayground.io">  
Web Coding Playground</a>!
```

Figure 1-12 shows how it looks in a web browser. Notice how the browser colors and underlines the link text, and when I point my mouse at the link, the address I specified in the `<a>` tag (albeit without the `http://` prefix) appears in the browser’s status area.



FIGURE 1-12:
How the link
appears in the
web browser.

Anchors aweigh: Internal links

When a surfer clicks a standard link, the page loads and the browser displays the top part of the page. However, it’s possible to set up a special kind of link that will force the browser to initially display some other part of the page, such as a section in the middle of the page. For these special links, I use the term *internal links*, because they take the reader directly to some inner part of the page.

When would you ever use an internal link? Most of your HTML pages will probably be short and sweet, and the web surfers who drop by will have no trouble navigating their way around. But if, like me, you suffer from a bad case of terminal verbosity combined with bouts of extreme long windedness, you'll end up with web pages that are lengthy, to say the least. Rather than force your readers to scroll through your tomlike creations, you can set up links to various sections of the document. You could then assemble these links at the top of the page to form a sort of "hypertable of contents," as an example.

Internal links actually link to a specially marked section — called an *anchor* — that you've inserted somewhere in the same page. To understand how anchors work, think of how you might mark a spot in a book you're reading. You might dog-ear the page, attach a note, or place something between the pages, such as a bookmark or your cat's tail.

An anchor performs the same function: It "marks" a particular spot in a web page, and you can then use a regular `<a>` tag to link to that spot. Here's the general format for an anchor tag:

```
<element id="name">
```

As you can see, an anchor tag looks a lot like a regular tag, except that it also includes the `id` attribute, which is set to the name you want to give the anchor. Here's an example:

```
<section id="section1">
```



REMEMBER

You can use whatever you want for the name, but it must begin with a letter and it can include any combination of letters, numbers, underscores (_), and hyphens (-). Also, `id` values are case-sensitive, so the browser treats the `id` value `section1` differently than the `id` value `Section1`.

To set up the anchor link, you create a regular `<a>` tag, but the `href` value becomes the name of the anchor, preceded by a hash symbol (#):

```
<a href="#name">
```

Here's an example that links to the anchor I showed earlier:

```
<a href="#section1">
```

Although you'll mostly use anchors to link to sections of the same web page, there's no law against using them to link to specific sections of other pages. What

you do is add the appropriate anchor to the other page and then link to it by adding the anchor's name (preceded, as usual, by #) to the end of the page's filename. Here's an example:

```
<a href="chapter57.html#section1">
```

Building Bulleted and Numbered Lists

For some reason, people love lists: Best (and Worst) Dressed lists, Top Ten lists, My All-Time Favorite X lists, where X is whatever you want it to be: movies, songs, books, *I Love Lucy* episodes — you name it. People like lists, for whatever reasons.

Okay, so let's make some lists. Easy, right? Well, sure, any website jockey can just plop a Best Tootsie Roll Flavors Ever list on a page by typing each item, one after the other. Perhaps our list maker even gets a bit clever and inserts the `
` tag between each item, which displays them on separate lines. Ooooh.

Yes, you can make a list that way, and it works well enough, I suppose, but there's a better way. HTML has a few tags that are specially designed to give you much more control over your list-building chores. For example, you can create a bulleted list that actually has those little bullets out front of each item. Nice! Want a Top Ten list, instead? HTML has your back by offering special tags for numbered lists, too.

Making your point with bulleted lists

A no-frills, `
`-separated list isn't very useful or readable because it doesn't come with any type of eye candy that helps differentiate one item from the next. An official, HTML-approved bulleted list solves that problem by leading off each item with a bullet — a cute little black dot.

Bulleted lists use two types of tags:

- » The entire list is surrounded by the `` and `` tags. Why "ul"? Well, what the rest of the world calls a bulleted list, the HTML poohbahs call an *unordered list*.
- » Each item in the list is preceded by the `` (list item) tag and is closed with the `` end tag.

The general setup looks like this:

```
<ul>
  <li>Bullet text goes here</li>
  <li>And here</li>
  <li>And here</li>
  <li>You get the idea...</li>
</ul>
```

Notice that I've indented the list items by four spaces, which makes it easier to see that they're part of a `` container. Here's an example to chew on:

```
<h3>My All-Time Favorite Oxymorons</h3>
<ul>
  <li>Pretty ugly</li>
  <li>Military intelligence</li>
  <li>Jumbo shrimp</li>
  <li>Original copy</li>
  <li>Random order</li>
  <li>Act naturally</li>
  <li>Tight slacks</li>
  <li>Freezer burn</li>
  <li>Sight unseen</li>
  <li>Microsoft Works</li>
</ul>
```

Figure 1-13 shows how the web browser renders this code, cute little bullets and all.

FIGURE 1-13:
A typical
bulleted list.

My All-Time Favorite Oxymorons

- Pretty ugly
- Military intelligence
- Jumbo shrimp
- Original copy
- Random order
- Act naturally
- Tight slacks
- Freezer burn
- Sight unseen
- Microsoft Works

Numbered lists: Easy as one, two, three

If you want to include a numbered list of items — it could be a Top Ten list, bowling league standings, steps to follow, or any kind of ranking — don't bother adding in the numbers yourself. Instead, you can use a *numbered list* to make the web browser generate the numbers for you.

Like bulleted lists, numbered lists use two types of tags:

- » The entire list is surrounded by the `` and `` tags. The "ol" here is short for *ordered list*, because those HTML nerds just have to be different, don't they?
- » Each item in the list is surrounded by `` and ``.

Here's the general structure to use:

```
<ol>
    <li>First item</li>
    <li>Second item</li>
    <li>Third item</li>
    <li>You got this...</li>
</ol>
```

I've indented the list items by four spaces to make it easier to see that they're inside an `` container. Here's an example:

```
<h3>My Ten Favorite U.S. College Nicknames</h3>
<ol>
    <li>U.C. Santa Cruz Banana Slugs</li>
    <li>Delta State Fighting Okra</li>
    <li>Kent State Golden Flashes</li>
    <li>Evergreen State College Geoducks</li>
    <li>New Mexico Tech Pygmies</li>
    <li>South Carolina Fighting Gamecocks</li>
    <li>Southern Illinois Salukis</li>
    <li>Whittier Poets</li>
    <li>Western Illinois Leathernecks</li>
    <li>Delaware Fightin' Blue Hens</li>
</ol>
```

Notice that I didn't include any numbers before each list item. However, when I display this document in a browser (see Figure 1-14), the numbers are automatically inserted. Pretty slick, huh?

FIGURE 1-14:
When the web browser renders the ordered list, it's kind enough to add the numbers for you automatically.

My Ten Favorite U.S. College Nicknames

1. U.C. Santa Cruz Banana Slugs
2. Delta State Fighting Okra
3. Kent State Golden Flashes
4. Evergreen State College Geoducks
5. New Mexico Tech Pygmies
6. South Carolina Fighting Gamecocks
7. Southern Illinois Salukis
8. Whittier Poets
9. Western Illinois Leathernecks
10. Delaware Fightin' Blue Hens

Inserting Special Characters

Earlier in this chapter, I talk briefly about a special `<meta>` tag that goes into the head section:

```
<meta charset="utf-8">
```

It might not look like it, but that tag adds a bit of magic to your web page. The voodoo is that now you can add special characters such as © and ™ directly to your web page text and the web browser will display them without complaint.

The trick is how you add these characters directly to your text, and that depends on your operating system. First, if you're using Windows, you have two choices:

- » Hold down the Alt key and then press the character's four-digit ASCII code using your keyboard's numeric keypad. For example, you type an em dash (—) by pressing Alt+0151.
- » Paste the character from the Character Map application that comes with Windows.

If you're a Mac user, you also have two choices:

- » Type the character's special keyboard shortcut. For example, you type an em dash (—) by pressing Option+Shift+- (hyphen).
- » Paste the character from the Symbols Viewer that comes with macOS.

Having said all of that, I should point out that there's another way to add special characters to a page. The web wizards who created HTML came up with special codes called *character entities* (which is surely a name only a true geek would love) that represent these oddball symbols.

These codes come in two flavors: a *character reference* and an *entity name*. Character references are basically just numbers, and the entity names are friendlier symbols that describe the character you’re trying to display. For example, you can display the registered trademark symbol (™) by using either the ® character reference or the ® entity name, as shown here:

```
Print-On-Non-Demand&#174;
```

or

```
Print-On-Non-Demand&reg;
```

Note that both character references and entity names begin with an ampersand (&) and end with a semicolon (;). Don’t forget either character when using special characters in your own pages.



REMEMBER

One very common use of character references is for displaying HTML tags without the web browser rendering them as tags. To do this, replace the tag’s less-than sign (<) with < (or <) and the tag’s greater-than sign (>) with > (or >).

Inserting Images

Whether you want to tell stories, give instructions, pontificate, or just plain rant about something, you can do all of that and more by adding text to your page. But to make it more interesting for your readers, add a bit of eye candy every now and then. To that end, there’s an HTML tag you can use to add one or more images to your page.

However, before we get too far into this picture business, I should tell you that, unfortunately, you can’t use just any old image on a web page. Browsers are limited in the types of images they can display. There are, in fact, three main types of image formats you can use:

- » **GIF:** The original web graphics format (it’s short for Graphics Interchange Format). GIF (it’s pronounced “giff” or “jiff”) is limited to 256 colors, so it’s best for simple images like line art, clip art, text, and so on. GIFs are also useful for creating simple animations.
- » **JPEG:** Gets its name from the Joint Photographic Experts Group that invented it. JPEG (it’s pronounced “jay-peg”) supports complex images that have many millions of colors. The main advantage of JPEG files is that, given the same image, they’re smaller than GIFs, so they take less time to download. Careful,

though: JPEG uses *lossy* compression, which means that it makes the image smaller by discarding redundant pixels. The greater the compression, the more pixels that are discarded, and the less sharp the image will appear. That said, if you have a photo or similarly complex image, JPEG is almost always the best choice because it gives the smallest file size.

» **PNG:** The Portable Network Graphics format supports millions of colors. PNG (and it's pronounced "p-n-g" or "ping") is a compressed format, but unlike JPEGs, PNGs use *lossless* compression. This means images retain sharpness, but the file sizes can get quite big. If you have an illustration or icon that uses solid colors, or a photo that contains large areas of near-solid color, PNG is a good choice. PNG also supports transparency.

Okay, enough of all that. Time to start squeezing some images onto your web page. As I mention earlier, there's an HTML code that tells a browser to display an image. It's the `` tag, and here's how it works:

```

```

Here, `src` is short for source, `filename` is the name of the graphics file you want to display, and `description` is a short description of the image (which is read by screen readers and seen by browsers who aren't displaying images). Note that there's no end tag to add here.

Look at an example. Suppose you have an image named `logo.png`. To add it to your page, you use the following line:

```

```

In effect, this tag says to the browser, "Excuse me? Would you be so kind as to go out and grab the image file named `logo.png` and insert it in the page right here where the `` tag is?" Dutifully, the browser loads the image and displays it in the page.

For this simple example to work, bear in mind that your HTML file and your graphics file need to be sitting in the same directory. Many webmasters create a subdirectory just for images, which keeps things neat and tidy. If you plan on doing this, be sure you study my instructions for using directories and subdirectories in Book 1, Chapter 3.

Here's an example and Figure 1-15 shows how things appear in a web browser:

```
To see a World in a Grain of Sand<br>
And a Heaven in a Wild Flower

```



FIGURE 1-15:
A web page
with an image
thrown in.

Carving Up the Page

Adding a bit of text, some links, and maybe a list or three to the body of the page is a good start, but any web page worth posting will require much more than that. For starters, all your web pages will require a high-level structure. Why? Well, think about the high-level structure of this book, which includes the front and back covers, the table of contents, an index, and eight mini-books, each of which contains several chapters, which, in turn consist of many sections and paragraphs within those sections. It's all nice and neat and well-organized, if I do say so myself.

Now imagine, instead, that this entire book was just page after page of undifferentiated text: no mini-books, no chapters, no sections, no paragraphs, plus no table of contents or index. I've just described a book-reader's worst nightmare, and I'm sure I couldn't even pay you to read such a thing.

Your web pages will suffer from the same fate unless you add some structure to the body section, and for that you need to turn to HTML's high-level structure tags.

The first thing to understand about these tags is that they're designed to infuse meaning — that is, semantics — into your page structures. You'll see what this means as I introduce each tag, but for now get a load of the abstract page shown in Figure 1-16.

I next discuss each of the tags shown in Figure 1-16.

The `<header>` tag

You use the `<header>` tag to create a *page header*, which is usually a strip across the top of the page that includes elements such as the site or page title and a logo. (Don't confuse this with the page's head section that appears between the `<head>` and `</head>` tags.)

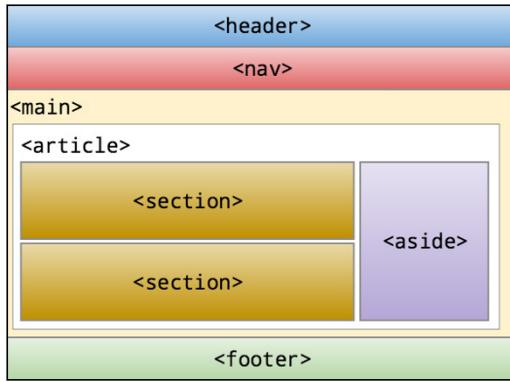


FIGURE 1-16:
An abstract view of HTML5's semantic page structure tags.

Since the header almost always appears at the top of the page, the `<header>` tag is usually seen right after the `<body>` tag, as shown in the following example (and Figure 1-17):

```

<body>
  <header>
    
    <h1>Welcome to "Isn't it Semantic?"</h1>
    <hr>
  </header>
  ...
</body>

```

FIGURE 1-17:
A page header with a logo, title, and horizontal rule.



The `<nav>` tag

The `<nav>` tag defines a page section that includes a few elements that help visitors navigate your site. These elements could be links to the main sections of the site, links to recently posted content, or a search feature. The `<nav>` section typically appears after the header, as shown here (and in Figure 1-18):

```

<body>
  <header>
    

```

```
<h1>Welcome to "Isn't it Semantic?"</h1>
<hr>
</header>
<nav>
  <a href="/">Home</a>
  <a href="semantics.html">Semantics</a>
  <a href="contact.html">Contact</a>
  <a href="about.html">About</a>
</nav>
...
</body>
```

FIGURE 1-18:
The `<nav>`
section usually
appears just after
the `<header>`
section.



The `<main>` tag

The `<main>` tag sets up a section to hold the content that is, in a sense, the point of the page. For example, if you’re creating the page to tell everyone all that you know about Siamese Fighting Fish, then your Siamese Fighting Fish text, images, links, and so on would go into the `<main>` section.

The `<main>` section usually comes right after the `<head>` and `<nav>` sections:

```
<body>
  <header>
    ...
  </header>
  <nav>
    ...
  </nav>
  <main>
    Main content goes here
  </main>
  ...
</body>
```

The <article> tag

You use the `<article>` tag to create a page section that contains a complete composition of some sort: a blog post, an essay, a poem, a review, a diatribe, or a jeremiad.

In most cases, you'll have a single `<article>` tag nested inside your page's `<main>` section:

```
<body>
  <header>
    ...
  </header>
  <nav>
    ...
  </nav>
  <main>
    <article>
      Article content goes here
    </article>
  </main>
  ...
</body>
```

However, it isn't a hard and fast rule that your page can have only one `<article>` tag. In fact, it isn't a rule at all. If you want to have two compositions in your page — and thus two `<article>` sections within your `<main>` tag — be my guest.

The <section> tag

The `<section>` tag indicates a major part of page: usually a heading tag followed by some text. How do you know whether a chunk of the page is “major” or not? The easiest way is to imagine if your page had a table of contents. If you'd want a particular part of your page to be included in that table of contents, then it's major enough to merit the `<section>` tag.

Most of the time, your `<section>` tags will appear within an `<article>` tag:

```
<main>
  <article>

    <section>
      Section 1 heading goes here
      Section 1 text goes here
    </section>
```

```
<section>
    Section 2 heading goes here
    Section 2 text goes here
</section>
...
</article>
</main>
```

The <aside> tag

You use the `<aside>` tag to cordon off a bit of the page for content that, although important or relevant for the site as a whole, is at best tangentially related to the page's `<main>` content. The `<aside>` is often a sidebar that includes site news or links to recent content, but it might also include links to other site pages that are related to current page.

The `<aside>` element most often appears within the `<main>` area, but after the `<article>` content.

```
<body>
    <header>
        ...
    </header>
    <nav>
        ...
    </nav>
    <main>
        <article>
            ...
        </article>
        <aside>
            ...
        </aside>
    </main>
    ...
</body>
```

The <footer> tag

You use the `<footer>` tag to create a *page footer*, which is typically a strip across the bottom of the page that includes elements such as a copyright notice, contact info, and social media links.

Since the footer almost always appears at the bottom of the page, the `<footer>` tag is usually seen right before the `</body>` tag, as shown here:

```
<body>
  <header>
    ...
  </header>
  <nav>
    ...
  </nav>
  <main>
    <article>
      ...
    </article>
    <aside>
      ...
    </aside>
  </main>
  <footer>
    ...
  </footer>
</body>
```

Handling non-semantic content with `<div>`

The `<header>`, `<nav>`, `<main>`, `<article>`, `<section>`, `<aside>`, and `<footer>` elements create meaningful structures within your page, which is why HTML nerds call these *semantic* elements. Even the humble `<p>` tag that I introduced earlier in this chapter is semantic in that it represents a single paragraph, usually within a `<section>` element.

But what's a would-be web weaver to do when she wants to add a chunk of content that just doesn't fit any of the standard semantic tags? That happens a lot, and the solution is to slap that content inside a `<div>` (for “division”) element. The `<div>` tag is a generic container that doesn't represent anything meaningful, so it's the perfect place for any non-semantic stuff that needs a home:

```
<div>
  Non-semantic content goes right here
</div>
```

Here's an example:

```
<div>
    Requisite social media links:
</div>
<div>
    <a href="https://facebook.com/">Facebook</a>
    <a href="https://twitter.com/">Twitter</a>
    <a href="https://instagram.com/">Instagram</a>
    <a href="http://www.hbo.com/silicon-valley">Hooli</a>
</div>
```

Notice in Figure 1-19 that the browser renders the two `<div>` elements on separate lines.

FIGURE 1-19:
The browser
renders each
`<div>` section on
a new line.

Requisite social media links:
[Facebook](https://facebook.com/) [Twitter](https://twitter.com/) [Instagram](https://instagram.com/) [Hooli](http://www.hbo.com/silicon-valley)

Handling words and characters with ``

If you might want to do something with a small chunk of a larger piece of text, such as a phrase, a word, or even a character or three, then you need to turn to a so-called *inline element*, which creates a container that exists within some larger element and flows along with the rest of the content in that larger element.

The most common inline element to use is ``, which creates a container around a bit of text:

```
<p>
Notice how an <span style="font-variant: small-caps">
    inline element</span> flows right along with the
    rest of the text.
</p>
```

What's happening here is that the `` tag is applying a style called *small caps* to the text between `` and `` (inline element). As you can see in Figure 1-20, the `` text flows along with the rest of the paragraph.

FIGURE 1-20:
Using ``
makes the
container
flow with the
surrounding text.

Notice how an INLINE ELEMENT flows right along with the rest of the text.

IN THIS CHAPTER

- » Understanding cascading style sheets
- » Learning the three methods you can use to add a style sheet
- » Applying styles to web page elements
- » Working with fonts and colors
- » Taking advantage of classes and other style sheet timesavers

Chapter 2

Styling the Page with CSS

HTML elements enable Web-page designers to mark up a document's structure, but beyond trust and hope, you don't have any control over your text's appearance. CSS changes that. CSS puts the designer in the driver's seat.

— HÅKON WIUM LIE, THE “FATHER” OF CSS

One of the things that makes web coding with HTML so addictive is that you can slap up a page using a few basic tags and when you look at the result in the browser, it usually works pretty good. A work of art it's not, but it won't make your eyes sore. That basic functionality and appearance are baked in courtesy of the default formatting that all web browsers apply to various HTML elements. For example, `` text appears in a bold font, there's a bit of vertical space between `<p>` elements, and `<h1>` text shows up quite a bit larger than regular text.

The browsers' default formatting means that even a basic page looks reasonable, but I'm betting you're reading this book because you want to shoot for something more than reasonable. In this chapter, you discover that the secret to creating great-looking pages is to override the default browser formatting with your own. You explore custom styling and dig into specific styles for essentials such as fonts, alignment, and colors.

Figuring Out Cascading Style Sheets

If you want to control the look of your web pages, then the royal road to that goal is a web coding technology called *cascading style sheets*, or CSS. As I mention in Book 2, Chapter 1, your design goal should always be to separate structure and formatting when you build any web project. HTML’s job is to take care of the structure part, but to handle the formatting of the page you must turn to CSS. Before getting to the specifics, I answer three simple questions: What’s a style? What’s a sheet? What’s a cascade?

Styles: Bundles of formatting options

If you’ve ever used a fancy-schmancy word processor such as Microsoft Word, Google Docs, or Apple Pages, you’ve probably stumbled over a style or two in your travels. In a nutshell, a *style* is a combination of two or more formatting options rolled into one nice, neat package. For example, you might have a “Title” style that combines four formatting options: bold, centered, 24-point type size, and a Verdana typeface. You can then “apply” this style to any text and the program dutifully formats the text with all four options. If you change your mind later and decide your titles should use an 18-point font, all you have to do is redefine the Title style. The program then automatically trudges through the entire document and updates each bit of text that uses the Title style.

In a web page, a style performs a similar function. That is, it enables you to define a series of formatting options for a given page element, such as a tag like `<div>` or `<h1>`. Like word processor styles, web page styles offer two main advantages:

- » They save time because you create the definition of the style’s formatting once, and the browser applies that formatting each time you use the corresponding page element.
- » They make your pages easier to modify because all you need to do is edit the style definition and all the places where the style is used within the page get updated automatically.

For example, Figure 2-1 shows some `<h1>` text as it appears with the web browser’s default formatting. Figure 2-2 shows the same `<h1>` text, but now I’ve souped up the text with several styles, including a border, a font size of 72 pixels, the Verdana typeface, and page centering.

Sheets: Collections of styles

So far so good, but what the heck is a sheet? The term *style sheet* harkens back to the days of yore when old-timey publishing firms would keep track of their

preferences for things like typefaces, type sizes, margins, and so on. All these so-called “house styles” were stored in a manual known as a *style sheet*. On the web, a style sheet is similar: It’s a collection of styles that you can apply to a web page.

FIGURE 2-1:
An `<h1>` heading
that appears
with the web
browser’s default
formatting.

Hello CSS World!

FIGURE 2-2:
The same text
from Figure 2-1,
except now with
added styles.

Hello CSS World!

Cascading: How styles propagate

The “cascading” part of the name *cascading style sheets* is a bit technical, but it refers to a mechanism that’s built into CSS for propagating styles between elements. For example, suppose you want all your page text to be blue instead of the default black. Does that mean you have to create a “display as blue” CSS instruction for every single text-related tag on your page? No, thank goodness! Instead, you apply it just once, to, say, the `<body>` tag, and CSS makes sure that every text tag in the `<body>` tag gets displayed as blue. This is called *cascading* a style.

Getting the Hang of CSS Rules and Declarations

Before I show you how to actually use CSS in your web pages, let’s take a second to get a grip on just what a style looks like.

The simplest case is where a single formatting option is applied to an element. Here’s the general syntax for this:

```
element {  
    property: value;  
}
```

Here, *element* is a reference to the web page doodad to which you want the style applied. This reference is often a tag name (such as `h1` or `div`), but CSS has a powerful toolbox of ways you can reference things, which I discuss later in this chapter.

The *property* part is the name of the CSS property you want to apply. CSS offers a large collection of properties, each of which is a short, alphabetic keyword, such as `font-family` for the typeface, `color` for the text color, and `border-width` for the thickness of a border. The property name is followed by a colon (`:`), a space for readability, the *value* you want to assign to the property, and then a semi-colon (`;`). This is known in the trade as a *CSS declaration* (although the description *property-value pair* is quite common, as well).



REMEMBER

Always enter the *property* name using lowercase letters. If the *value* includes any characters other than letters or a hyphen, then you need to surround the value with quotation marks.

Notice, too, that the declaration is surrounded by braces (`{` and `}`). All the previous code — from the element name down to the closing brace `}` is called a *style rule*.

For example, the following rule applies a 72-pixel (indicated by the `px` unit) font size to the `<h1>` tag:

```
h1 {  
    font-size: 72px;  
}
```

Your style rules aren't restricted to just a single declaration: You're free to add as many as you need. The following example shows the rule I used to style the `h1` element as shown earlier in Figure 2-2:

```
h1 {  
    border-width: 1px;  
    border-style: solid;  
    border-color: black;  
    font-size: 72px;  
    font-family: Verdana;  
    text-align: center;  
}
```



REMEMBER

Note that the *declaration block* — that is, the part of the rule within the braces (`{` and `}`) — is most easily read if you indent the declarations with a tab or with either two or four spaces. The order of the declarations isn't crucial; some developers use alphabetical order, whereas others group related properties together.

Besides applying multiple styles to a single element, it's also possible to apply a single style to multiple elements. You set up the style in the usual way, but instead of a single element at the beginning of the rule, you list all the elements that you want to style, separated by commas. In the following example, a yellow background color is applied to the `<header>`, `<aside>`, and `<footer>` tags:

```
header,  
aside,  
footer {  
    background-color: yellow;  
}
```

Adding Styles to a Page

With HTML tags, you just plop the tag where you want it to appear on the page, but styles aren't quite so straightforward. In fact, there are three main ways to get your web page styled: inline styles, internal style sheets, and external style sheets.

Inserting inline styles

An *inline style* is a style rule that you insert directly into whatever tag you want to format. Here's the general syntax to use:

```
<element style="property1: value1; property2: value2; ...">
```

That is, you add the `style` attribute to your tag, and then set it equal to one or more declarations, separated by semicolons.

For example, to apply 72-pixel type to an `<h1>` heading, you'd add an inline style that uses the `font-size` CSS property:

```
<h1 style="font-size: 72px;">
```



REMEMBER

Note that an inline style gets applied only to the tag within which it appears. Consider the following code:

```
<h1 style="font-size: 72px;">The Big Kahuna</h1>  
<h1>Kahunas: Always Big?</h1>  
<h1>Wait, What the Heck Is a Kahuna?</h1>
```

As you can see in Figure 2-3, the larger type size only gets applied to the first `<h1>` tag, whereas the other two `h1` elements appear in the browser's default size.

FIGURE 2-3:
Only the top
`<h1>` tag has the
inline style, so
only its text
is styled at
72 pixels.

The Big Kahuna

Kahunas: Always Big?

Wait, What the Heck Is a Kahuna?

Embedding an internal style sheet

Inline styles are a useful tool, but because they get shoehorned inside tags, they tend to be difficult to maintain because they end up scattered all over the page's HTML code. You're also more likely to want a particular style rule applied to multiple page elements.

For easier maintenance of your styles, and to take advantage of the many ways that CSS offers to apply a single style rule to multiple page elements, you need to turn to style sheets, which can be either internal (as I discuss here) or external (as I discuss in the next section).

An *internal style sheet* is a style sheet that resides within the same file as the page's HTML code. Specifically, the style sheet is embedded between the `<style>` and `</style>` tags in the page's head section, like so:

```
<!DOCTYPE html>
<html lang="en">
    <head>
        <style>
            Your style rules go here
        </style>
    </head>
    <body>
        ...
    </body>
</html>
```

Here's the general syntax to use:

```
<style>
    elementA {
        propertyA1: valueA1;
        propertyA2: valueA2;
        ...
    }
```

```
elementB {  
    propertyB1: valueB1;  
    propertyB2: valueB2;  
    ...  
}  
...  
</style>
```

As you can see, an internal style sheet consists of one or more style rules embedded within a `<style>` tag, which is why an internal style sheet is also sometimes called an *embedded style sheet*.

In the following code, I apply border styles to the `h1` and `h2` elements: solid and dotted, respectively. Figure 2-4 shows the result.

CSS:

```
<style>  
    h1 {  
        border-width: 2px;  
        border-style: solid;  
        border-color: black;  
    }  
    h2 {  
        border-width: 2px;  
        border-style: dotted;  
        border-color: black;  
    }  
</style>
```

Wither Solid Colors?

FIGURE 2-4:
An internal style sheet that applies different border styles to the `h1` (top) and `h2` elements.

In Praise of Polka Dots

What's Dot and What's Not

What Dot to Wear

HTML:

```
<h1>Wither Solid Colors?</h1>  
<h2>In Praise of Polka Dots</h2>
```

```
<h2>What's Dot and What's Not</h2>
<h2>What Dot to Wear</h2>
```

Note, in particular, that my single style rule for the `h2` element gets applied to all the `<h2>` tags in the web page. That's the power of an internal style sheet: You only need a single rule to apply one or more styles to every instance of a particular element.

The internal style sheet method is best when you want to apply a particular set of style rules to just a single web page. If you have rules that you want applied to multiple pages, then you need to go the external style sheet route.

Linking to an external style sheet

Style sheets get insanely powerful when you use an *external style sheet*, which is a separate file that contains your style rules. To use these rules within any web page, you add a special `<link>` tag inside the page head. This tag specifies the name of the external style sheet file, and the browser then uses that file to grab the style rules.

Here are the steps you need to follow to set up an external style sheet:

- 1. Use your favorite text editor to create a shiny new text file.**
- 2. Add your style rules to this file.**

Note that you don't need the `<style>` tag or any other HTML tags.

- 3. Save the file.**

It's traditional to save external style sheet files using a `.css` extension (for example, `styles.css`), which helps you remember down the road that this is a style sheet file. You can either save the file in the same folder as your HTML file, or you can create a subfolder (named, say, `css` or `styles`).

- 4. For every page in which you want to use the styles, add a `<link>` tag inside the page's head section.**

Here's the general format to use (where `filename.css` is the name of your external style sheet file):

```
<link rel="stylesheet" href="filename.css">
```

If you created a subfolder for your CSS files, be sure to add the subfolder to the `href` value (for example, `href="styles/filename.css"`).

For example, suppose you create a style sheet file named `styles.css`, and that file includes the following style rules:

```
h1 {  
    color: red;  
}  
p {  
    font-size: 16px;  
}
```

You then refer to that file by using the `<link>` tag, as shown here:

```
<!DOCTYPE html>  
<html lang="en">  
    <head>  
        <link rel="stylesheet" href="styles.css">  
    </head>  
    <body>  
        <h1>This Heading Will Appear Red</h1>  
        <p>This text will be displayed in a 16-pixel font</p>  
    </body>  
</html>
```

Why is this so powerful? You can add the same `<link>` tag to any number of web pages and they'll all use the same style rules. This makes it a breeze to create a consistent look and feel for your site. And if you decide that your `<h1>` text should be green instead, all you have to do is edit the style sheet file (`styles.css`). Automatically, every single one of your pages that link to this file will be updated with the new style!

Styling Page Text

You'll spend the bulk of your CSS development time applying styles to your web page text. CSS offers a huge number of text properties, but those I show in Table 2-1 are the most common. I discuss each of these properties in more detail in the sections that follow.

Setting the type size

When it comes to the size of your page text, the CSS tool to pull out of the box is `font-size`:

```
font-size: value;
```

TABLE 2-1

Some Common CSS Text Properties

| Property | Example | Description |
|-----------------|-----------------------------|---|
| font-size | font-size: 16px; | Sets the size of the text |
| font-family | font-family: serif; | Sets the typeface of the text |
| font-weight | font-weight: bold; | Sets whether the text uses a bold font |
| font-style | font-style: italic; | Sets whether the text uses an italic font |
| text-decoration | text-decoration: underline; | Applies (or removes) underline or strikethrough styles |
| text-align | text-align: center; | Aligns paragraph text horizontally |
| text-indent | text-indent: 8px; | Sets the size of the indent for the first line of a paragraph |

Here, *value* is the size you want to apply to your element, which means a number followed by the unit you want to use. I discuss the units you can use in the next section, but for now we can stick with one of the most common units: pixels. The pixels unit is represented by the letters px, and a single pixel is equivalent to 1/96 of an inch. All browsers set a default size for regular text, and that default is usually 16px. However, if you prefer that, say, all your paragraph (`<p>`) text get displayed at the 20px size, then you'd include the following rule in your style sheet:

```
p {  
    font-size: 20px;  
}
```

Getting comfy with CSS measurement units

CSS offers a few measurement units that you need to know. You use these not only for setting type sizes, but also for setting the sizes of padding, borders, margins, shadows, and many other CSS properties. Table 2-2 lists the most common CSS measurement units.

Here are some notes about these units that I hope will decrease that furrow in your brow:

- » An *absolute* measurement unit is one that has a fixed size: either 1/96 of an inch in the case of a pixel, or 1/72 of an inch in the case of a point.

TABLE 2-2 Some CSS Measurement Units

| Unit | Name | Type | Equals |
|------|-----------------|----------|---|
| px | pixel | Absolute | 1/96 of an inch |
| pt | point | Absolute | 1/72 of an inch |
| em | em | Relative | The element's default, inherited, or defined font size |
| rem | root em | Relative | The font size of the root element of the web page |
| vw | viewport width | Relative | 1/100 of the current width of the browser's content area |
| vh | viewport height | Relative | 1/100 of the current height of the browser's content area |

- » A *relative* unit is one that doesn't have a fixed size. Instead, the size depends on whatever size is supplied to the element. For example, suppose the browser's default text size is 16px, which is equivalent then to 1em. If your page consists of a single `<article>` tag and you set the `article` element's `font-size` property to 1.5em, then the browser will display text within the `<article>` tag at 24px (since 16 times 1.5 equals 24). If, however, the browser user has configured her default text size to 20px, then she'll see your `article` text displayed at 30px (20 times 1.5 equals 30).
- » The `em` unit can sometimes be a head-scratcher because it takes its value from whatever element it's contained within. For example, if your page has an `<article>` tag and you set the `article` element's `font-size` property to 1.5em, then the browser will display text within the `<article>` tag at 24px (assuming a 16px default size). However, if within the `<article>` tag you have a `<section>` tag and you set the `section` element's `font-size` property to 1.25em, then the browser will display text within the `<section>` tag at 30px (since 24 times 1.25 equals 30).
- » If you want more consistency in your text sizes, use `rem` instead of `em`, since `rem` is always based on the default font size defined by either the web browser or the user. For example, if your page uses a 16px default size and it has an `<article>` tag with the `font-size` property set to 1.5rem, then the browser will display text within the `<article>` tag at 24px. If within the `<article>` tag you have a `<section>` tag and you set the `section` element's `font-size` property to 1.25rem, then the browser will display text within the `<section>` tag at 20px (since 16 times 1.25 equals 20).

Applying a font family

You can make a huge difference in the overall look and appeal of your web pages by paying attention to the typefaces you apply to your headings and body text.

A *typeface* is a particular design applied to all letters, numbers, symbols, and other characters. CSS types prefer the term *font family*, hence the property you use to set text in a specific typeface is named `font-family`:

```
font-family: value;
```

Here, `value` is the name of the typeface, which needs to be surrounded by quotation marks if the name contains spaces, numbers, or punctuation marks other than a hyphen (-). Feel free to list multiple typefaces, as long as you separate each with a comma. When you list two or more font families, the browser reads the list from left to right, and uses the first font that's available either on the user's system or in the browser itself.

When it comes to specifying font families, you have three choices:

» **Use a generic font.** This is a font that's implemented by the browser itself and set by using one of the following five keywords: `serif` (offers small cross strokes at the ends of each character), `sans-serif` (doesn't use the cross strokes), `cursive` (looks like handwriting), `fantasy` (a decorative font), or `monospace` (gives equal space to each character). Figure 2-5 shows each of these generic fonts in action.

FIGURE 2-5:

Generic fonts are implemented by all web browsers and come in five flavors: `serif`, `sans-serif`, `cursive`, `fantasy`, and `monospace`.

```
Generic font family: serif  
Generic font family: sans-serif  
Generic font family: cursive  
Generic font family: fantasy  
Generic font family: monospace
```

» **Use a system font.** This is a typeface that's installed on the user's computer. How can you possibly know that? You don't. Instead, you have two choices. One possibility is to use a system font that's installed universally. Examples include Georgia and Times New Roman (serifs), Verdana and Tahoma (sans serifs), and Courier New (monospace). The other way to go is to list several system fonts, knowing that the browser will use the first one that's implemented on the user's PC. Here's a `sans-serif` example:

```
font-family: "Gill Sans", Calibri, Verdana, sans-serif;
```

» **Use a Google font.** Google Fonts offers access to hundreds of free and well-crafted fonts that you can use on your site. Go to <https://fonts.google.com>, find a font you like, then click the plus sign (+) beside it. Click “Family Selected” and then use the Customize tab to add styles such as bold and italic. In the Embed tab, copy the `<link>` tag and then paste it in your HTML file, somewhere in the `<head>` section (before your `<style>` tag, if you’re using an internal style sheet, or before your CSS `<link>` tag, if you’re using an external style sheet). Go back to the Embed tab, copy the `font-family` rule, and then paste that rule into your CSS.

Making text bold

In Book 2, Chapter 1, I talk about how the `` and `` tags have semantic definitions (important text and keywords, respectively), but you’ll often come across situations where you want text to appear bold, but that text isn’t important or a keyword. In that case, you can style the text the CSS way with the `font-weight` property:

```
font-weight: value;
```

Here, `value` is either the word `bold`, or one of the numbers `100, 200, 300, 400, 500, 600, 700` (this is the same as using `bold`), `800`, and `900`, where the higher numbers give bolder text and the lower numbers give lighter text; `400` is regular text, which you can also specify using the word `normal`. Note, however, that depending on the typeface you’re using, not all of these values will give you bolder or lighter text.

Styling text with italics

In Book 2, Chapter 1, I mention that the `` and `<i>` tags have semantic significance (emphasis and alternative text, respectively), but you might have text that should get rendered in italics, but not with emphasis or as alternative text. No problem: Get CSS on the job by adding the `font-style` property to your rule:

```
font-style: italic;
```

Styling links

When you add a link to the page, the web browser displays the link text in a different color (usually blue) and underlined. This might not fit at all with the rest of your page design, so go ahead and adjust the link styling as needed.

You can apply any text style to a link, including changing the font size, the typeface, adding bold or italics, and changing the color (which I discuss later in this chapter).

One common question web coders ask is “Links: underline or not?” Not everyone is a fan of underlined text, and if you fall into that camp, then you can use the following rule to remove the underline from your links:

```
a {  
    text-decoration: none;  
}
```



WARNING

Creating a custom style for links is standard operating procedure for web developers, but a bit of caution is in order because a mistake made by many new web designers is to style links too much like regular text (particularly when they've removed underlining from their links). Your site visitors should be able to recognize a link from ten paces, so be sure to make your links stick out from the regular text in some way.

Aligning paragraph text

By default, your web page paragraphs line up nice and neat along the left margin of the page. Nothing wrong with that, but what if you want things to align along the right margin, instead? Or perhaps you want to center something on the page. Wouldn't that be nice? You can do all that and more by pulling out the `text-align` property:

```
text-align: left|right|center|justify;
```

In case you're wondering, the `justify` value tells the web browser to align the element's text on both the left and right margin.

Indenting a paragraph's first line

You can signal the reader that a new paragraph is being launched by indenting the first line a bit from the left margin. This is easier done than said with CSS by applying the `text-indent` property:

```
text-indent: value;
```

Here, *value* is a number followed by any of the CSS measurement units I mention earlier in this chapter. For example, a common indent value is `1em`, which here I've applied to the `p` element:

```
p {  
    text-indent: 1em;  
}
```

Working with Colors

When rendering the page using their default styles, browsers don't do much with colors, other than showing link text a default and familiar blue. But CSS offers some powerful color tools, so there's no reason not to show the world your true colors.

Specifying a color

I begin by showing you the three main ways that CSS provides for specifying the color you want:

» **Use a color keyword.** CSS defines a bit more than 140 color keywords. Some of these are straightforward, such as `red`, `yellow`, and `purple`, while others are, well, a bit whimsical (and hunger-inducing): `lemonchiffon`, `papayawhip`, and `peachpuff`. The Web Coding Playground (wcpg.io/dummies/2-2-14) lists them all, as shown in Figure 2-6.

| Color | Keyword | RGB Value |
|-----------------|-----------------------|-----------|
| lightpink | <code>#ffb6c1</code> | |
| pink | <code>#fffc0cb</code> | |
| crimson | <code>#dc143c</code> | |
| lavenderblush | <code>#fff0f5</code> | |
| palevioletred | <code>#db7093</code> | |
| hotpink | <code>#ff69b4</code> | |
| deeppink | <code>#ff1493</code> | |
| mediumvioletred | <code>#c71585</code> | |
| orchid | <code>#da70d6</code> | |

FIGURE 2-6:
Go to the
Web Coding
Playground to
see a full list of
the CSS color
keywords.

» **Use the `rgb()` function.** `rgb()` is a built-in CSS function that takes three values: one for red, one for green, and one for blue (separated by commas). Each of these can be a value between 0 and 255, and these combinations can produce any of the 16 million or so colors on the spectrum. For example, the following function produces a nice red:

```
rgb(255, 99, 71)
```

» **Use an RGB code.** An *RGB code* is a six-digit value that takes the form `#rrrggbb`, where *rr* is a two-digit value that specifies the red component of the color, *gg* is a two-digit value that specifies the green component, and *bb* is a two-digit value that specifies the blue component. Alas, these two-digit values are hexadecimal — base 16 — numbers, which run from 0 to 9 and then a to f. As two-digit values, the decimal values 0 through 255 are represented as 00 through ff in hexadecimal. For example, the following RGB code produces the same red as in the previous example:

```
#ff6347
```

Coloring text

To apply a CSS color to some text, you use the `color` property:

```
color: value;
```

Here, *value* can be a color keyword, an `rgb()` function, or an RGB code. The following three rules produce the same color text:

```
color: tomato;  
color: rgb(255, 99, 71);  
color: #ff6347;
```

Coloring the background

For some extra page pizazz, try adding a color to the background of either the entire page or a particular element. You do this in CSS by using the `background-color` property:

```
background-color: value;
```

Here, *value* can be a color keyword, an `rgb()` function, or an RGB code. The following example displays the page with white text on a black background:

```
body {
    color: rgb(255,255,255);
    background-color: rgb(0,0,0);
}
```



WARNING

When you're messing around with text and background colors, make sure you leave enough contrast between the text and background to ensure that your page visitors can still read the text without shaking their fists at you. But I should also warn you that too much contrast isn't conducive to easy reading, either. For example, using pure white for text and pure black for a background (as I did in the preceding code, tsk, tsk) isn't great because there's too much contrast. Darkening the text a shade and lightening the background a notch makes all the difference:

```
body {
    color: rgb(222,222,222);
    background-color: rgb(32,32,32);
}
```

Getting to Know the Web Page Family

One of the prerequisites for becoming a web developer is understanding both the structure of a typical web page and the odd (at least at first) lingo associated with that structure. As an example, I'm going to refer to the semantic HTML elements that I demonstrate in Book 2, Chapter 1 (in Figure 1-16, in particular). Figure 2-7 shows that semantic structure as a tree diagram:

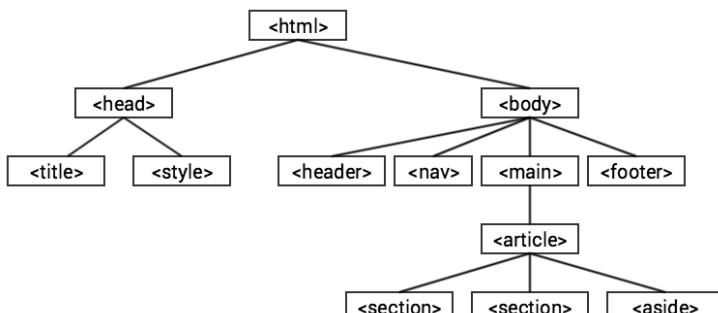


FIGURE 2-7:
The structure of
a semantic HTML
web page.

As you can see, the tree has the `<html>` tag at the top. The second level consists of the `<head>` tag and the `<body>` tag, and the `<head>` tag leads to a third level that consists of the `<title>` and `<style>` tags. For the `<body>` tag, the third level

contains four tags: `<header>`, `<nav>`, `<main>`, and `<footer>`. The `<main>` tag leads to the `<article>` tag, which contains two `<section>` tags and an `<aside>` tag.

Okay, I can see the “So what?” thought bubble over your head, so I’ll get to the heart of the matter. With this structure in mind, you can now identify and define four useful members of the web page family tree:

- » **Parent:** An element that contains one or more other elements in the level below it. For example, in Figure 2-7, the `<html>` tag is the parent of the `<head>` and `<body>` tags, whereas the `<head>` tag is the parent of the `<title>` and `<style>` tags.
- » **Child:** An element that is contained within another element that sits one level above it in the tree. (Which is another way of saying that the element has a parent.) In Figure 2-7, the `<header>`, `<nav>`, `<main>`, and `<footer>` tags are children of the `<body>` tag, whereas the two `<section>` tags and the `<aside>` tag are children of the `<article>` tag.
- » **Ancestor:** An element that contains one or more levels of elements. In Figure 2-7, the `<body>` tag is an ancestor of the `<aside>` tag, whereas the `<html>` tag is an ancestor of everything in the page.
- » **Descendant:** An element that is contained within another element that sits one or more levels above it in the tree. In Figure 2-7, the `<section>` tags are descendants of the `<main>` tag, whereas the `<article>` tag is a descendant of the `<body>` tag.

This no doubt seems far removed from web development, but these ideas play a crucial role not only in CSS, but also JavaScript (see Book 3) and jQuery (see Book 4).

Using CSS Selectors

When you add a CSS rule to an internal or external style sheet, you assemble your declarations into a declaration block (that is, you surround them with the { and } thingies) and then assign that block to an element of the page. For example, the following rule throws a few styles at the page’s `<h1>` tags:

```
h1 {  
    font-size: 72px;  
    font-family: Verdana;  
    text-align: center;  
}
```

But the element you assign to the declaration block doesn't have to be an HTML tag name. In fact, CSS has a huge number of ways to define what parts of the page you want to style. These methods for defining what to style are called *selectors* (because you use them to "select" those parts of the page you want styled). When you use a tag name, you're specifying a *type selector*. However, there are many more — a few dozen, in fact — but lucky for you, only four should cover most of your web development needs:

- » The class selector
- » The id selector
- » The descendant selector
- » The child selector

The class selector

If you master just one CSS selector, make it the class selector, because you'll use it time and again in your web projects. A *class selector* is one that targets its styles at a particular web page class. So, what's a class? I'm glad you asked. A *class* is an attribute assigned to one or more page tags that enables you to create a kind of grouping for those tags. Here's the syntax for adding a class to an element:

```
<element class="class-name">
```

Replace *element* with the tag and replace *class-name* with the name you want to assign. The name must begin with a letter and the rest can be any combination of letters, numbers, hyphens (-), and underscores (_). Here's an example:

```
<div class="caption">
```

With your classes assigned to your tags as needed, you're ready to start selecting those classes using CSS. You do that by preceding the class name with a dot (.) in your style rule:

```
.class-name {  
    property1: value1;  
    property2: value2;  
    ...  
}
```

For example, here's a rule for the `caption` class:

```
.caption {  
    font-size: .75rem;  
    font-style: italic;  
}
```

The advantage here is that you can assign the `caption` class to any tag on the page, and CSS will apply the same style rule to each of those elements.

The id selector

In Book 2, Chapter 1, I talk about creating an anchor by adding a unique `id` attribute to a tag, which enabled you to create a link that targeted the anchor:

```
<element id="id-name">
```

Here's an example:

```
<h2 id="subtitle">
```

You can also use the `id` attribute as a CSS selector, which enables you to target a particular element with extreme precision. You set this up by preceding the `id` value with a hashtag symbol (#) in your CSS rule:

```
#id-name {  
    property1: value1;  
    property2: value2;  
    ...  
}
```

For example, here's a rule for the `subtitle` id:

```
#subtitle {  
    font-size: 2rem;  
    font-style: italic;  
    color: blue;  
}
```

This isn't as useful as the class selector because it can only target a single element, which is why web developers use id selectors only rarely.

The descendant selector

Rather than targeting specific tags, classes, or ids, you might need to target every instance of a particular element that is contained within another element. Those contained elements are called *descendants*, and CSS offers the *descendant selector* for applying styles to them. To set up a descendant selector, you include in your rule the ancestor and the descendant type you want to style, separated by a space:

```
ancestor descendant {  
    property1: value1;  
    property2: value2;  
    ...  
}
```

For example, here's a rule that applies a few styles to every `<a>` tag that's contained with an `<aside>` tag:

```
aside a {  
    color: red;  
    font-style: italic;  
    text-decoration: none;  
}
```

The child selector

The descendant selector that I discuss in the previous section is one of the most powerful in the CSS kingdom because it targets all the descendants of a particular type that reside within an ancestor, no matter how many levels down the page hierarchy those descendants live. However, it's often more suitable and more manageable to target only those descendants that reside one level down: in short, the children of some parent element.

To aim some styles at the child elements of a parent, you use the CSS *child selector*, where you separate the parent and child elements with a greater-than sign (`>`):

```
parent > child {  
    property1: value1;  
    property2: value2;  
    ...  
}
```

For example, here's a rule that targets the links that are the immediate children of an `<aside>` tag:

```
aside > a {  
    color: green;  
    font-style: bold;  
    text-decoration: none;  
}
```

Revisiting the Cascade



TECHNICAL
STUFF

I close this first CSS chapter with a quick look at three important concepts that you need to drill into your brain if you want to write good CSS and troubleshoot the inevitable CSS problems that will crop up in your web development career:

» **Inheritance:** If a parent element is styled with a property, in many cases its child and descendant elements will also be styled with the same property. This is known in the CSS game as *inheritance*: Parents “pass along” some of their properties to their children and descendants. Notice, however, that I said “some” properties are inherited. Lots of properties — such as the padding, borders, and margins I cover in Book 2, Chapter 3 — don’t get inherited, so you need to watch out for inheritance (or its lack) as you code your pages.

» **Weight:** The different ways that you can specify styles for a page have a built-in hierarchy of importance, or *weight* in CSS-speak. Here’s that style source hierarchy in ascending order of weight:

1. Browser styles — The list of default styles that the web browser applies to certain HTML tags. This is known officially as the *user agent style sheet*.
2. User-specified styles — The styles that the web browser user has configured, such as a new default type size. This is known to CSS pros as a *user style sheet*.
3. External style sheets.
4. Internal style sheets.
5. Inline styles.

What this means is that if a web browser comes across the same style property in two or more style sources, it uses the property value from the source that has the greater weight. For example, if you set `font-size: 1.5rem` in an external style sheet and then set `font-size: 2rem` with an

inline style, the inline style “wins” because it has a greater weight than the external style sheet.

» **Specificity:** What happens when two or more style rules from the same source target the same element? You can’t go by weight since they all reside in the same style source, so you have to turn to a concept called *specificity*, instead. This is a score given to each style rule, where the browser implements the rule that garners the highest specificity value. Here’s how the browser determines the specificity for a rule:

1. Add one point for each element (such as `div` or `span`) in the rule’s selector.
2. Add 10 points for each class in the selector.
3. Add 100 points for each ID in the selector.
4. If the selector is part of an inline style, add 1,000 points.

In practice, you can use specificity to figure out why a particular element has styles that don’t seem right. Quite often, the problem turns out to be that the browser is applying some other style rule that has a higher specificity.

IN THIS CHAPTER

- » Wrapping your head around the CSS box model
- » Setting the sizes of page elements
- » Encrusting elements with padding, borders, and margins
- » Letting elements float where they may
- » Positioning elements exactly where you want them

Chapter 3

Sizing and Positioning Page Elements

Every element in web design is a rectangular box. This was my ah-ha moment that helped me really start to understand CSS-based web design and accomplish the layouts I wanted to accomplish.

— CHRIS COYIER

I'm not going to lie to you: When you're just getting started with CSS, the elements on the page will sometimes seem to defy your every command. Like surly teenagers, they ignore your best advice and refuse to understand that you are — or you are supposed to be — the boss of them. Okay, I did lie to you a little: That can happen to even the most experienced web coders. Why the attitude? Because although web browsers are fine pieces of software for getting around the web, by default they're not very adept at laying out a web page. Like overly permissive grandparents, they just let the page elements do whatever they like. Your job as a parent, er, I mean, a web developer, is to introduce some discipline to the page.

Fortunately, CSS comes with a huge number of tools and techniques that you can wield to make stubborn page elements behave themselves. In this chapter, you discover many of these tools and you explore how best to use them to gain mastery of anything you care to add to a web page. You delve into styles that cover properties such as dimensions (the height and width of things), padding and margins (the amount of space around things), borders (lines around things), and position (where things appear on the page).

Learning about the CSS Box Model

Everything in this chapter is based on something called the *CSS box model*. So I begin by discussing what this box model thing is all about and why it's important.

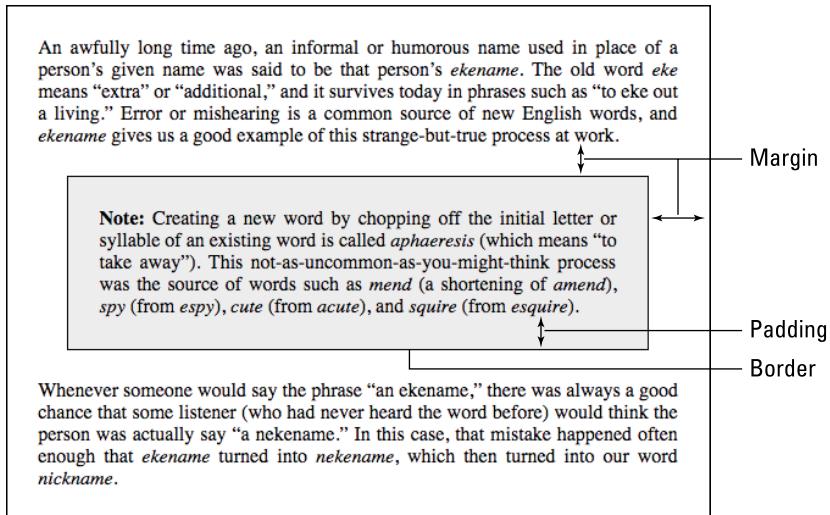
Every web page consists of a series of HTML tags, and each of those tags represents an element on the page. In the strange and geeky world known as Style Sheet Land, each of these elements is considered to have an invisible box around it (okay, it's a very strange world). You might be tempted to think that this invisible box only surrounds block-level elements, which are those elements that start new sections of text: `<p>`, `<blockquote>`, `<h1>` through `<h6>`, `<div>`, all the page layout semantic tags, such as `<header>`, `<article>`, and `<section>`, and so on. That makes sense, but in fact every single tag, even inline elements such as `<a>` and ``, have a box around them.

This box has the following components:

- » **Content:** The stuff inside the box (the text, the images, and so on)
- » **Padding:** The space around the content
- » **Border:** A line that surrounds the box padding
- » **Margin:** The space outside of the border separating the box from other boxes to the left and right, as well as above and below
- » **Dimensions:** The height and width of the box
- » **Position:** The location of the box within the page

Of these, the first four — the content, padding, border, and margin — comprise the box model, and they're illustrated in Figure 3-1.

FIGURE 3-1:
The components
of the CSS box
model.



Styling Sizes

When the web browser renders a page, it examines each element and sets the dimensions of that element. For block-level elements such as `<header>` and `<div>`, the browser sets the dimensions as follows:

- » **Width:** Set to the width of the element's parent. Because by default the width of the `<body>` element is set to the width of the browser's content area, in practice all block-level elements have their widths set to the width of the content area.
- » **Height:** Set just high enough to hold all the element's content.

You can (and should) run roughshod over these defaults by styling the element's width and height properties:

```
width: value;
height: value;
```

In both cases, you replace *value* with a number and one of the CSS measurement units I talk about in Book 2, Chapter 2: px, em, rem, vw, or vh. For example, if you want your page to take up only half the width of the browser's content area, you'd use the following rule:

```
body {
    width: 50vw;
}
```



MAKING WIDTH AND HEIGHT MAKE SENSE

TECHNICAL STUFF

Width and height seem like such straightforward concepts, but you might as well learn now that CSS has a knack for turning the straightforward into the crooked-sideways. A block element's dimensions are a case in point, because you'd think the "size" of a block element would be the size of its box out to the border: that is, the content, plus the padding, plus the border itself. Nope. By default, the size of a block element's box is just the content part of the box.

That may not sound like a cause for alarm, but it does mean that when you're working with an element's dimensions, you have to take into account its padding widths and border sizes if you want to get things right. Believe me, that is no picnic. Fortunately, help is just around the corner. You can avoid all those extra calculations by forcing the web browser to be sensible and define an element's size to include not just the content, but the padding and border, as well. A CSS property called `box-sizing` is the superhero here:

```
element {  
    box-sizing: border-box;  
}
```

The declaration `box-sizing: border-box` tells the browser to set the element's height and width to include the content, padding, and border. You could add this declaration to all your block-level element rules, but that's way too much work. Instead, you can use a trick where you use an asterisk (*) "element," which is a shorthand way of referencing every element on the page:

```
* {  
    box-sizing: border-box;  
}
```

Put this at the top of your style sheet, and then you never have to worry about it again.

Most of the time you'll only mess with an element's width, because getting the height right is notoriously difficult because it depends on too many factors: the content, the browser's window size, the user's default font size, and more.



TECHNICAL STUFF

Height and width apply only to block-level elements such as `<article>`, `<div>`, and `<p>`, and not to inline elements such as `` and `<a>`. However, it's possible to convert inline elements into blocks. CSS offers two methods for this inline-to-block makeover:

» **Make it an inline block.** If you want to set an inline element's width, height, or other block-related properties, but still allow the element to flow along with the surrounding text, add the following to the element's CSS rule:

```
display: inline-block;
```

» **Make it a true block.** If you want to set an inline element's block-related properties and you no longer want the element to flow with the surrounding text, turn it into an honest-to-goodness block-level element by adding the following to the element's CSS rule:

```
display: block;
```

Adding Padding

In the CSS box model, the *padding* is the space that surrounds the content out to the border, if the box has one. Your web pages should always have lots of whitespace (that is, blank, content-free chunks of the page), and one way to do that is to give each element generous padding to ensure the element's content isn't crowded either by its border or by surrounding elements.

There are four sections to the padding — above, to the right of, below, and to the left of the content — so CSS offers four corresponding properties for adding padding to an element:

```
element {  
    padding-top: top-value;  
    padding-right: right-value;  
    padding-bottom: bottom-value;  
    padding-left: left-value;  
}
```

Each value is a number followed by a CSS measurement unit: px, em, rem, vw, or vh. Here's an example:

```
.margin-note {  
    padding-top: 1rem;  
    padding-right: 1.5rem;  
    padding-bottom: .5rem;  
    padding-left: 1.25rem;  
}
```

CSS also offers a shorthand syntax that uses the padding property. There are four different syntaxes you can use with the padding property, and they're all listed in Table 3-1.

TABLE 3-1 The padding Shorthand Property

| Syntax | Description |
|--|--|
| <code>padding: value1;</code> | Applies <i>value1</i> to all four sides |
| <code>padding: value1 value2;</code> | Applies <i>value1</i> to the top and bottom and <i>value2</i> to the right and left |
| <code>padding: value1 value2 value3;</code> | Applies <i>value1</i> to the top, <i>value2</i> to the right and left, and <i>value3</i> to the bottom |
| <code>padding: value1 value2 value3 value4;</code> | Applies <i>value1</i> to the top, <i>value2</i> to the right, <i>value3</i> to the bottom, and <i>value4</i> to the left |

Here's how you'd rewrite the previous example using the padding shorthand:

```
.margin-note {  
    padding: 1rem 1.5rem .5rem 1.25rem;  
}
```

To illustrate what a difference padding can make in your page designs, take a peek at Figure 3-2. Here you see two `<aside>` elements, where the one on top looks cramped and uninviting, whereas the one on the bottom offers ample room for reading. These two elements are styled identically, except the one on the bottom has its padding set with the following declaration:

```
padding: 1rem;
```

FIGURE 3-2:
Without padding (top), your text can look uncomfortably crowded by its surroundings, but when you add padding (bottom), the same text has room to breathe.

Note: Creating a new word by chopping off the initial letter or syllable of an existing word is called *aphaeresis* (which means “to take away”). This not-as-uncommon-as-you-might-think process was the source of words such as *mend* (a shortening of *amend*), *spy* (from *espy*), *cute* (from *acute*), and *squire* (from *esquire*).

Note: Creating a new word by chopping off the initial letter or syllable of an existing word is called *aphaeresis* (which means “to take away”). This not-as-uncommon-as-you-might-think process was the source of words such as *mend* (a shortening of *amend*), *spy* (from *espy*), *cute* (from *acute*), and *squire* (from *esquire*).

Building Borders

Modern web design eschews vertical and horizontal lines as a means of separating content, preferring, instead, to let copious amounts of whitespace do the job. However, that doesn't mean you should never use lines in your designs, particularly borders. An element's *border* is the notional set of lines that enclose the element's content and padding. Borders are an often useful way to make it clear that an element is separate from the surrounding elements in the page.

There are four lines associated with an element's border — above, to the right of, below, and to the left of the padding — so CSS offers four properties for adding borders to an element:

```
element {  
    border-top: top-width top-style top-color;  
    border-right: right-width right-style right-color;  
    border-bottom: bottom-width bottom-style bottom-color;  
    border-left: left-width left-style left-color;  
}
```

As you can see, each border requires three values:

- » **Width:** The thickness of the border line, which you specify using a number followed by a CSS measurement unit: `px`, `em`, `rem`, `vw`, or `vh`. Note, however, that most border widths are measured in pixels, usually `1px`. You can also specify one of the following keywords: `thin`, `medium`, or `thick`.
- » **Style:** The type of border line, which must be one of the following keywords: `dotted`, `dashed`, `solid`, `double`, `groove`, `ridge`, `inset`, or `outset`.
- » **Color:** The color of the border line. You can use a color keyword, an `rgb()` function, or an RGB code, as I describe in Book 2, Chapter 2.

Here's an example that adds a 1-pixel, dashed, red bottom border to the `header` element:

```
header {  
    border-bottom: 1px dashed red;  
}
```

If you want to add a full border around an element and you want all four sides to use the same width, style, and color, CSS mercifully offers a shorthand version that uses the `border` property:

```
border: width style color;
```

Here's the declaration I used to add the borders around the elements you see in Figure 3-2:

```
border: 1px solid black;
```

Making Margins

The final component of the CSS box model is the *margin*, which is the space around the border of the box. Margins are an important detail in web design because they prevent elements from rubbing up against the edges of the browser content area, ensure two elements don't overlap each other, and create separation between elements.

As with padding, there are four sections to the margin — above, to the right of, below, and to the left of the border — so CSS offers four corresponding properties for adding margins to an element:

```
element {  
    margin-top: top-value;  
    margin-right: right-value;  
    margin-bottom: bottom-value;  
    margin-left: left-value;  
}
```

Each value is a number followed by one of the standard CSS measurement units: px, em, rem, vw, or vh. Here's an example:

```
aside {  
    margin-top: 1rem;  
    margin-right: .5rem;  
    margin-bottom: 2rem;  
    margin-left: 1.5rem;  
}
```

Like padding, CSS also offers a shorthand syntax that uses the `margin` property. Table 3-2 lists the four syntaxes you can use with the `margin` property.

Here's the shorthand version of the previous example:

```
aside {  
    margin: 1rem .5rem 2rem 1.5rem;  
}
```

TABLE 3-2

The margin Shorthand Property

| Syntax | Description |
|---|--|
| <code>margin: value1;</code> | Applies <i>value1</i> to all four sides |
| <code>margin: value1 value2;</code> | Applies <i>value1</i> to the top and bottom and <i>value2</i> to the right and left |
| <code>margin: value1 value2 value3;</code> | Applies <i>value1</i> to the top, <i>value2</i> to the right and left, and <i>value3</i> to the bottom |
| <code>margin: value1 value2 value3 value4;</code> | Applies <i>value1</i> to the top, <i>value2</i> to the right, <i>value3</i> to the bottom, and <i>value4</i> to the left |

Resetting the padding and margin

If you see a web developer pulling her hair or gnashing her teeth, it's a good bet that she's battling the web browser's default styles for padding and margins. These defaults are one of the biggest sources of frustration for web coders because they force you to relinquish control over one of the most important aspects of web design: the whitespace on the page.

Most modern web developers have learned not to fight against these defaults, but to eliminate them entirely by resetting everything to zero by adding the following rule to the top of every style sheet they build:

```
* {
    margin: 0;
    padding: 0;
}
```

The downside is that you must now specify the margins and padding for all your page elements yourself, but that extra work is really a blessing in disguise because now you have complete control over the whitespace in your page.

Collapsing margins ahead!

CSS has no shortage of eccentricities, and you'll come across most of them in your web development career. Here's a look at one of the odder things that CSS does. First, here's some HTML and CSS code to chew over:

CSS:

```
nav {
    margin-top: .5rem;
```

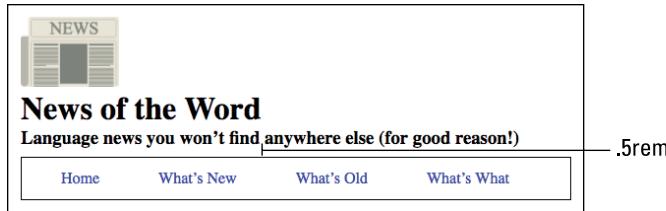
```
padding: .75rem;  
border: 1px solid black;  
}
```

HTML:

```
<header>  
    
  <h1>News of the Word</h1>  
  <h3>Language news you won't find anywhere else (for good  
    reason!)</h3>  
</header>  
<nav>  
  <a href="#">Home</a>  
  <a href="#">What's New</a>  
  <a href="#">What's Old</a>  
  <a href="#">What's What</a>  
</nav>
```

I'd like to draw your attention in particular to the `margin-top: .5rem` declaration in the `nav` element's CSS rule. In Figure 3-3, you can see that, sure enough, the browser has rendered a small margin above the `nav` element.

FIGURE 3-3:
The `nav` element
(with the border)
has a `.5rem` top
border.



Suppose now I decide that I want a bit more space between the `header` and the `nav` elements, so I add a bottom margin to the `header`:

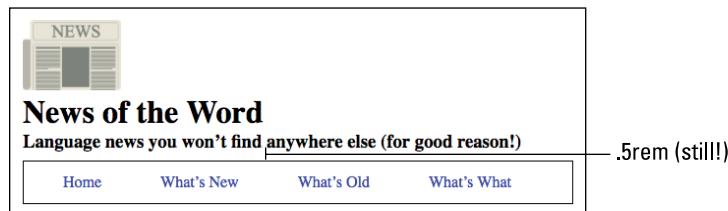
```
header {  
  margin-bottom: .5rem;  
}
```

Figure 3-4 shows the result.

No, you're not hallucinating: The space between the `header` and `nav` elements didn't change one iota! Welcome to the wacky world of CSS! In this case, the wackiness comes courtesy of a CSS "feature" called *collapsing margins*. When one element's bottom margin butts up against another element's top margin,

common sense would dictate that the web browser would add the two margin values together. Hah, you wish! Instead, the browser uses the larger of the two margin values and it throws out the smaller value. That is, it “collapses” the two margin values into a single value.

FIGURE 3-4:
The header element with a bottom margin added (with the border) has a .5rem top border.



So, does that mean you’re stuck? Not at all. To get some extra vertical space between two elements, you have four choices:

- » Increase the margin-top value of the bottom element.
- » Increase the margin-bottom value of the top element.
- » If you already have margin-top defined on the bottom element, and the top element doesn’t use a border, add a padding-bottom value to the top element.
- » If you already have margin-bottom defined on the top element, and the bottom element doesn’t use a border, add a padding-top value to the bottom element.

In the last two bullets, combining a top or bottom margin on one element with a bottom or top padding on the other element works because the browser doesn’t collapse a margin/padding combo.

Getting a Grip on Page Flow

When a web browser renders a web page, one of the really boring things it does is lay out the tags by applying the following rules to each element type:

- » **Inline elements:** Rendered from left to right within each element’s parent container
- » **Block-level elements:** Stacked on top of each other, with the first element at the top of the page, the second element below the first, and so on

This is called the *page flow*. For example, consider the following HTML code:

```
<header>
    The page header goes here.
</header>
<nav>
    The navigation doodads go here.
</nav>
<section>
    This is the first section of the page.
</section>
<section>
    This is—you got it—the second section of the page.
</section>
<aside>
    This is the witty or oh-so-interesting aside.
</aside>
<footer>
    The page footer goes here.
</footer>
```

This code is a collection of six block-level elements — a header, a nav, two section tags, an aside, and a footer — and Figure 3-5 shows how the web browser renders them as a stack of boxes.

| |
|--|
| The page header goes here. |
| The navigation doodads go here. |
| This is the first section of the page. |
| This is—you got it—the second section of the page. |
| This is the witty or oh-so-interesting aside. |
| The page footer goes here. |

FIGURE 3-5:
The web browser
renders the
block-level
elements as a
stack of boxes.

There's nothing inherently wrong with the default page flow, but having your web page render as a stack of boxes lacks a certain flair. Fortunately for your creative spirit, you're not married to the default, one-box-piled-on-another flow. CSS gives you two useful methods for breaking out of the normal page flow and giving your pages some pizzazz: floating and positioning.

Floating Elements

When you *float* an element, the web browser takes the element out of the default page flow. Where the element ends up on the page depends on whether you float it to the left or to the right:

- » **Float left:** The browser places the element as far to the left and as high as possible within the element's parent container.
- » **Float right:** The browser places the element as far to the right and as high as possible within the element's parent container.

In both cases, the non-floated elements flow around the floated element.

You convince the web browser to float an element by adding the `float` property:

```
element {  
    float: left|right|none;  
}
```

For example, consider the following code and its rendering in Figure 3–6.

```
<header>  
      
    <h1>News of the Word</h1>  
    <h3>Language news you won't find anywhere else (for good  
        reason!)</h3>  
</header>  
<nav>  
    <a href="#">Home</a>  
    <a href="#">What's New</a>  
    <a href="#">What's Old</a>  
    <a href="#">What's What</a>  
</nav>
```

In Figure 3–6, you can see that the web browser is up to its usual page flow tricks: stacking all the block-level elements on top of each other. However, I think this page would look better if the title (the `<h1>` tag) appeared to the right of the logo. To do that, I can float the `` to the left:

```
header img {  
    float: left;  
    margin-right: 2em;  
}
```

FIGURE 3-6:
As usual, the browser displays the block-level elements as a stack of boxes.



Figure 3-7 shows the results. With the logo floated to the left, the rest of the content — the `<h1>`, `<h3>`, and `<nav>` tags — now flows around the `` tag.

FIGURE 3-7:
When the logo gets floated left, the rest of the content flows around it.



Clearing your floats

The default behavior for non-floated stuff is to wrap around anything that's floated, which is often exactly what you want. However, there will be times when you want to avoid having an element wrap around your floats. For example, consider the following code and how it gets rendered, as shown in Figure 3-8.

```
<header>
  <h1>Can't You Read the Sign?</h1>
</header>
<nav>
  <a href="/">Home</a>
  <a href="semantics.html">Signs</a>
  <a href="contact.html">Contact Us</a>
  <a href="about.html">Suggest a Sign</a>
</nav>
<article>
  
</article>
<footer>
  &copy; Can't You Read?, Inc.
</footer>
```

With the `` tag floated to the left, the rest of the content flows around it, including the content of the `<footer>` tag, which now appears by the top of the image.



FIGURE 3-8:
When the image is floated left, the footer wraps around it and ends up in a weird place.

You want your footer to appear at the bottom of the page, naturally, so how can you fix this? By telling the web browser to position the footer element so that it *clears* the floated image, which means that it appears after the image in the page flow. You clear an element by adding the clear property:

```
element {
    clear: left|right|both|none;
}
```

Use `clear: left` to clear all left-floated elements, `clear: right` to clear all right-floated elements, or `clear: both` to clear everything. When I add `clear: left` to the footer element, you can see in Figure 3-9 that the footer content now appears at the bottom of the page.

```
footer {
    clear: left;
}
```

Collapsing containers ahead!

The odd behavior of CSS is apparently limitless, and floats offer yet another example. Consider the following HTML and its result in Figure 3-10:

```
<article>

    <section>
        An awfully long time ago...
    </section>
```

```

<aside>
  <b>Note:</b> Creating a new word by...
</aside>
</article>

```

FIGURE 3-9:
Adding clear:
left to the
footer element
causes the footer
to clear the
left-floated image
and appear at
the bottom of
the page.



FIGURE 3-10:
An <article>
tag containing a
<section> tag
and an <aside>
tag, rendered
using the default
page flow.

An awfully long time ago, an informal or humorous name used in place of a person's given name was said to be that person's *eke name*. The old word *eke* means "extra" or "additional," and it survives today in phrases such as "to eke out a living." Error or mishearing is a common source of new English words, and *eke name* gives us a good example of this strange-but-true process at work. Whenever someone would say the phrase "an *eke name*," there was always a good chance that some listener (who had never heard the word before) would think the person was actually say "a *nekename*." In this case, that mistake happened often enough that *eke name* turned into *nekename*, which then turned into our word *nickname*.

Note: Creating a new word by chopping off the initial letter or syllable of an existing word is called *aphaeresis* (which means "to take away"). This not-as-uncommon-as-you-might-think process was the source of words such as *mend* (a shortening of *amend*), *spy* (from *espy*), *cute* (from *acute*), and *squire* (from *esquire*).

Note, in particular, that I've styled the `article` element with a border.

Rather than the stack of blocks shown in Figure 3-10, you might prefer to have the `section` and the `aside` elements side-by-side. Great idea! So you add `width` properties to each, and float the `section` element to the left and the `aside` element to the right. Here are the rules and Figure 3-11 shows the result.

```
section {  
    float: left;  
    width: 25rem;  
}  
aside {  
    float: right;  
    width: 15rem;  
}
```

The article element has collapsed!

FIGURE 3-11:
With its content floated, the <article> element collapses down to just its border.

An awfully long time ago, an informal or humorous name used in place of a person's given name was said to be that person's *ekename*. The old word *eke* means "extra" or "additional," and it survives today in phrases such as "to eke out a living." Error or mishearing is a common source of new English words, and *ekename* gives us a good example of this strange-but-true process at work. Whenever someone would say the phrase "an *ekename*," there was always a good chance that some listener (who had never heard the word before) would think the person was actually say "a *nekename*." In this case, that mistake happened often enough that *ekename* turned into *nekename*, which then turned into our word *nickname*.

Note: Creating a new word by chopping off the initial letter or syllable of an existing word is called *aphaeresis* (which means "to take away"). This not-as-uncommon-as-you-might-think process was the source of words such as *mend* (a shortening of *amend*), *spy* (from *espy*), *cute* (from *acute*), and *squire* (from *esquire*).

Well, that's weird! The line across the top is what's left of the `article` element. What happened? Because I floated both the `section` and the `aside` elements, the browser removed them from the page flow, which made the `article` element behave as though it had no content at all. The result? A CSS bugaboo known as *container collapse*.

To fix this, you have to force the parent container to clear its own children.

CSS:

```
.self-clear::after {  
    content: "";  
    display: block;  
    clear: both;  
}
```

HTML:

```
<article class="self-clear">
```

First, `::after` is a so called *pseudo-element* that, in this case, tells the browser to create an element and add it to the page flow after whatever element gets the class. What's being added here is an empty string (since you don't want to add

anything substantial to the page), and that empty string is displayed as a block that uses `clear: both` to clear the container's children. It's weird, but it works, as you can see in Figure 3-12.

The full article element now appears

FIGURE 3-12: With the `self-clear` class added to the `<article>` tag, the `article` element now clears its own children and is no longer collapsed.

An awfully long time ago, an informal or humorous name used in place of a person's given name was said to be that person's *ekename*. The old word *eke* means "extra" or "additional," and it survives today in phrases such as "to eke out a living." Error or mishearing is a common source of new English words, and *ekename* gives us a good example of this strange-but-true process at work. Whenever someone would say the phrase "an *ekename*," there was always a good chance that some listener (who had never heard the word before) would think the person was actually say "a *nename*." In this case, that mistake happened often enough that *ekename* turned into *nekename*, which then turned into our word *nickname*.

Note: Creating a new word by chopping off the initial letter or syllable of an existing word is called *aphaeresis* (which means "to take away"). This not-as-uncommon-as-you-might-think process was the source of words such as *mend* (a shortening of *amend*), *spy* (from *espy*), *cute* (from *acute*), and *squire* (from *esquire*).

Positioning Elements

The second major method for breaking out of the web browser's default "stacked boxes" page flow is to position an element yourself using CSS properties. For example, you could tell the browser to place an image in the top left corner of the window, no matter where that element's `` tag appears in the page's HTML code. This is known as *positioning* in the CSS world, and it's a very powerful tool, so much so that most web developers use positioning only sparingly.

The first bit of positioning wizardry you need to know is, appropriately, the `position` property:

```
element {  
    position: static|relative|absolute|fixed;  
}
```

- » `static`: Places the element in its default position in the page flow
- » `relative`: Offsets the element from its default position with respect to its parent container while keeping the element in the page flow
- » `absolute`: Offsets the element from its default position with respect to its parent (or sometimes an earlier ancestor) container while removing the element from the page flow
- » `fixed`: Offsets the element from its default position with respect to the browser window while removing the element from the page flow

Because static positioning is what the browser does by default, I won't say anything more about it. For the other three positioning values — relative, absolute, and fixed — notice that each one offsets the element. Where do these offsets come from? From the following CSS properties:

```
element {  
    top: top-value;  
    right: right-value;  
    bottom: bottom-value;  
    left: left-value;  
}
```

- » top: Shifts the element down
- » right: Shifts the element from the right
- » bottom: Shifts the element up
- » left: Shifts the element from the left

In each case, the value you supply is either a number followed by one of the CSS measurement units (px, em, rem, vw, or vh) or a percentage.

Using relative positioning

Relative positioning is a bit weird because not only does it offset an element relative to its parent container, but it still keeps the element's default space in the page flow intact.

Here's an example:

CSS:

```
.offset-image {  
    position: relative;  
    left: 200px;  
}
```

HTML:

```
<h1>  
    holloway  
</h1>
```

```

<div>
  <i>n.</i> A sunken footpath or road; a path that is enclosed
  by high embankments on both sides.
</div>




```

The CSS defines a rule for a class named `offset-image`, which applies relative positioning and offsets the element from the left by `200px`. In the HTML, the `offset-image` class is applied to the middle image. As you can see in Figure 3-13, not only is the middle image shifted from the left, but the space in the page flow where it would have appeared by default remains intact, so the third image's place in the page flow doesn't change. As far as that third image is concerned, the middle image is still right above it.

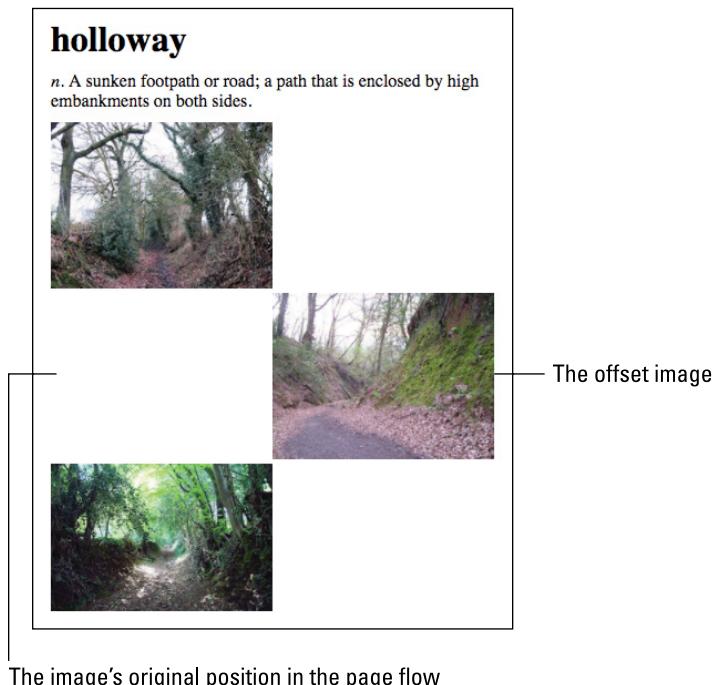


FIGURE 3-13:
The middle image uses relative positioning to shift from the left, but its place in the page flow remains.

Giving absolute positioning a whirl

Absolute positioning not only offsets the element from its default position, but it also removes the element from the page flow. Sounds useful, but if the element

is no longer part of the page flow, from what element is it offset? Good question, and here's the short answer: the closest ancestor element that uses non-static positioning.

If that has you furrowing your brow, I have a longer answer that should help. To determine which ancestor element is used for the offset of the absolutely positioned element, the browser goes through a procedure similar to this:

1. Move one level up the page hierarchy to the previous ancestor.
2. Check the position property of that ancestor element.
3. If the position value of the ancestor is static, go back to Step 1 and repeat the process for the next level up the hierarchy; otherwise (that is, if the position value of the parent is anything other than static), then offset the original element with respect to the ancestor.
4. If, after going through Steps 1 to 3 repeatedly, you end up at the top of the page hierarchy — that is, at the `<html>` tag — then use that to offset the element, which means in practice that the element is offset with respect to the browser's content area.

I mention in the previous section that relative positioning is weird because it keeps the element's default position in the page flow intact. However, now that weirdness turns to goodness because if you want a child element to use absolute positioning, then you add `position: relative` to the parent element's style rule. Because you don't also supply an offset to the parent, it stays put in the page flow, but now you have what CSS nerds called a *positioning context* for the child element.

I think an example would be welcome right about now.

CSS:

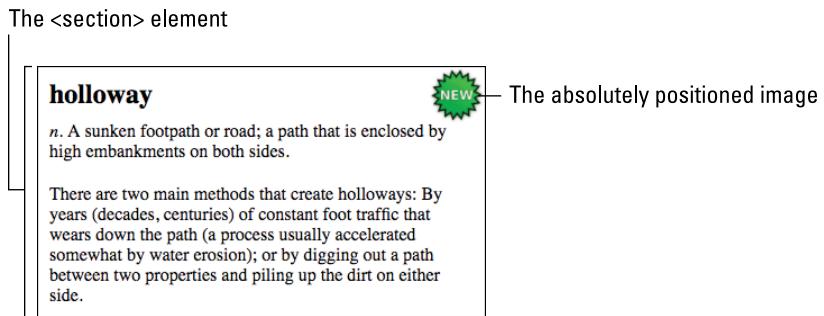
```
section {  
    position: relative;  
    border: 1px double black;  
}  
img {  
    position: absolute;  
    top: 0;  
    right: 0;  
}
```

HTML:

```
<section>
  
  <h1>
    holloway
  </h1>
  <div>
    <i>n.</i> A sunken footpath or road; a path that is
    enclosed by high embankments on both sides.
  </div>
  <div>
    There are two main methods that create holloways: By
    years (decades, centuries) of constant foot traffic that wears
    down the path (a process usually accelerated somewhat by water
    erosion); or by digging out a path between two properties and
    piling up the dirt on either side.
  </div>
</section>
```

In the CSS, the `section` element is styled with the `position: relative` declaration, and the `img` element is styled with `position: absolute` and `top` and `right` offsets set to `0`. In the HTML, you can see that the `<section>` tag is the parent of the ``, so the latter's absolute positioning will be with respect to the former. With `top` and `right` offsets set to `0`, the image will now appear in the top right corner of the `section` element and, indeed, it does, as you can see in Figure 3-14.

FIGURE 3-14:
The `img` element
uses absolute
positioning to
send it to the
top right corner
of the `section`
element.



Trying out fixed positioning

With *fixed positioning*, the element is taken out of the normal page flow and is then offset with respect to the browser's content area, which means the element doesn't move, not even a little, when you scroll the page (that is, the element is "fixed" in its new position).

One of the most common uses of fixed positioning is to plop a header at the top of the page and make it stay there while the user scrolls the rest of the content. Here's an example that shows you how to create such a header:

CSS:

```
header {  
    position: fixed;  
    top: 0;  
    left: 0;  
    width: 100%;  
    height: 64px;  
    border: 1px double black;  
    background-color: rgb(147, 196, 125);  
}  
main {  
    margin-top: 64px;  
}
```

HTML:

```
<header>  
      
    <h1>  
        holloway  
    </h1>  
</header>  
<main>  
    ...  
</main>
```

The HTML includes a `header` element with an image and a heading, followed by a longish `main` section that I don't include here for simplicity's sake. In the CSS code, the `header` element is styled with `position: fixed`, and the offsets `top` and `left` set to `0`. These offsets fix the header to the top left of the browser's

content area. I also added `width: 100%` to give the header the entire width of the window. Note, too, that I set the header height to `64px`. To make sure the main section begins below the header, I styled the `main` element with `margin-top: 64px`. Figure 3-15 shows the results.

The screenshot shows a web page with a header and a main content area. The header is fixed at the top of the screen and contains the title "holloway". The main content area has a green header bar with the word "holloway" in white. Below this, there is a definition: "*n. A sunken footpath or road; a path that is enclosed by high embankments on both sides.*". Underneath the definition, there is a section titled "Notes:" which contains a paragraph about how holloways are created. Below the notes, there is a section titled "Examples:" which contains a quote from William Dalrymple. The quote is: "Down in the depths of the holloway, you could see neither metalled roads nor telegraph poles, nor even the most distant glimpses of the outsized golf balls of the early warning radar up on Fylingdales." The quote is attributed to "—William Dalrymple, ‘Holloway’ by Robert Macfarlane, Stanley Donwood, Dan Richards – review,” *The Guardian*, July 19, 2013".

FIGURE 3-15:
A page with the header element fixed to the top of the screen. When you scroll the rest of the page, the header remains where it is.

IN THIS CHAPTER

- » Understanding page layout basics
- » Using floated elements for page layout
- » Using inline blocks for page layout
- » Learning the fundamentals of Flexbox layouts
- » Getting a grip on Grid layouts

Chapter 4

Creating the Page Layout

Flexbox is essentially for laying out items in a single dimension — in a row OR a column. Grid is for layout of items in two dimensions — rows AND columns.

— RACHEL ANDREWS

Why are some web pages immediately appealing, while others put the “Ugh” in “ugly”? There are lots of possible reasons: colors, typography, image quality, the density of exclamation points. For my money, however, the number one reason why some pages soar while others are eyesores, is the overall look and feel of the page. We’ve all visited enough websites in our lives to have developed a kind of sixth sense that tells us immediately whether a page is worth checking out. Sure, colors and fonts play a part in that intuition, but we all respond viscerally to the “big picture” that a page presents.

That big picture refers to the overall layout of the page, and that’s the subject you explore in this chapter. Here you discover what page layout is all about, and you investigate several CSS-based methods for making your web pages behave the way you want them to. By the time you’re done mastering the nitty-gritty of page layout, you’ll be in a position to design and build beautiful and functional pages that’ll have them screaming for more.

What Is Page Layout?

The *page layout* is the arrangement of the page elements within the browser's content area, including not only what you see when you first open the page, but also the rest of the page that comes into view as you scroll down. The page layout acts as a kind of blueprint for the page, and like any good blueprint, the page layout details how a page looks at two levels:

- » **The macro level:** Refers to the overall layout of the page, which determines how the major sections of the page — header, nav, main, footer, and so on — fit together as a whole.
- » **The micro level:** Refers to the layout within a section or subsection of the page. For example, the page's header element might have one layout, whereas the page's article section might have another.

CSS offers four main layout techniques, each of which you can apply at either the macro level or the micro level:

- » **Floats:** Arranges elements by floating them.
- » **Inline blocks:** Arranges elements by styling them as inline blocks.
- » **CSS Flexible Box (flexbox):** Arranges elements either vertically or horizontally within flexible boxes.
- » **CSS Grid:** Arranges the elements in a row-and-column structure.

The rest of this chapter discusses each of these techniques, with a special emphasis on the newer technologies of flexbox and Grid.

Laying Out Page Elements with Floats

I discuss floating elements in detail in Book 2, Chapter 3, so I won't repeat myself here. From a page layout standpoint, you generally use floats as needed when you want two or more items to appear side-by-side rather than stacked on top of each other in the default page flow.

The general procedure you follow goes something like this:

1. Work your way down the page, allowing the page elements to lay out using the default page flow.

2. When you come to two or more elements that you want to appear side-by-side, float them to the left (usually) or to the right.
3. When you come to the next element that should follow the default page flow, clear the floats for that element.
4. Repeat Steps 1 to 3 until you reach the end of the page.

For example, say you're following the above procedure and you come to the `nav` element, which consists of several links. Because the `<a>` tag is an inline element, you could just toss a bunch of `<a>` tags inside the `nav` element and they'd line up alongside each other. That's fine, but you don't get to control the horizontal spacing since an `<a>` tag isn't a true block.

A common way to work around that problem is to add the links as an unordered list, but with two special additions:

- » The `ul` element's `list-style-type` property set to `none` to hide the bullets.
- » The `li` elements (that is, the list items) are styled with `float: left` so they display side-by-side instead of vertically.

Here's the code, and Figure 4-1 shows the result:

CSS:

```
nav {  
    height: 2.5rem;  
    padding-top: .6rem;  
    background-color: #ccc;  
}  
nav ul {  
    list-style-type: none;  
    padding-left: 1.75rem;  
}  
nav li {  
    float: left;  
    padding-right: 1.75rem;  
}  
main {  
    clear: left;  
    margin-top: 1rem;  
}
```

HTML:

```
<nav>
  <ul>
    <li><a href="#">Home</a></li>
    <li><a href="#">Blog</a></li>
    <li><a href="#">Store</a></li>
    <li><a href="#">About</a></li>
    <li><a href="#">Contact</a></li>
  </ul>
</nav>
<main>
  Main content goes here...
</main>
```

FIGURE 4-1:

These links are unorderd list items and floated left to appear side-by-side.



You can also use floats to make larger page layout decisions. For example, one common page layout is to have a header at the top of the page, a navigation area below the header, and a footer at the bottom of the page, where all three span the width of the page. Between the navigation area and the header, you have the main content of the page, which is split horizontally between an article on one side and a sidebar on the other.

Here's some barebones code that creates such a page layout:

CSS:

```
body {
  margin: 2rem;
  width: 30rem;
}
header {
  height: 2.5rem;
  border: 1px solid black;
}
```

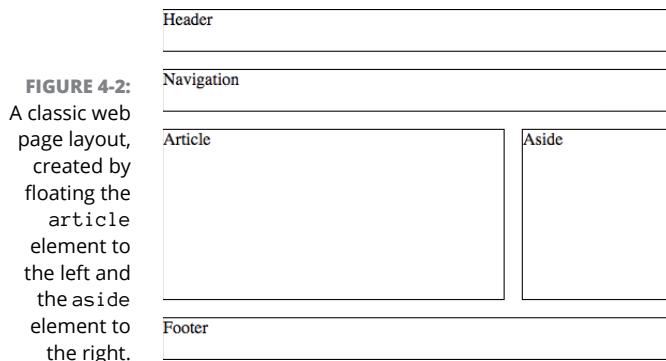
```
nav {  
    height: 2.5rem;  
    margin-top: 1rem;  
    border: 1px solid black;  
}  
main {  
    margin-top: 1rem;  
    height: 10rem;  
}  
article {  
    float: left;  
    margin-right: 1rem;  
    width: 20rem;  
    height: 100%;  
    border: 1px solid black;  
}  
aside {  
    float: right;  
    width: 9rem;  
    height: 100%;  
    border: 1px solid black;  
}  
footer {  
    clear: both;  
    height: 2.5rem;  
    margin-top: 1rem;  
    border: 1px solid black;  
}
```

HTML:

```
<header>  
    Header  
</header>  
<nav>  
    Navigation  
</nav>  
<main>  
    <article>  
        Article  
</article>  
    <aside>  
        Aside  
</aside>
```

```
</main>
<footer>
    Footer
</footer>
```

The key elements to notice here are that the `<article>` and `<aside>` tags are both children of the `<main>` tag, and in the CSS the `article` element is styled with `float: left`, whereas the `aside` element is styled with `float: right`. Figure 4-2 shows the resulting page layout.



Laying Out Page Elements with Inline Blocks

When you turn an element into an inline block (by adding `display: inline-block` to the element's style rule), one of two things happens:

- » If you're working with an inline element, that element becomes a block, but it still flows horizontally with the rest of the surrounding inline content.
- » If you're working with a block-level element, that element is removed from the default vertical page flow and now flows horizontally with the rest of the surrounding inline content.

It's the second of these — that is, the removal of a block-level element from the default page flow so that it now flows inline — that interests us from a page layout point of view. That is, you can use inline blocks as needed when you want two or more items to appear side-by-side rather than stacked.

Here's the general procedure to follow:

1. Work your way down the page, allowing the page elements to lay out using the default page flow.
2. When you come to two or more elements that you want to appear side-by-side, convert them to inline blocks.
3. Repeat Steps 1 and 2 until you reach the end of the page.

This procedure is very similar to the float steps I outline in the previous section, with one notable exception: When you use inline blocks, you don't need to clear the following elements because the browser does that for you automatically.

Here's the inline-block version of the `nav` element layout that I went through in the previous section, and Figure 4-3 shows the result:

CSS:

```
nav {  
    height: 2.5rem;  
    padding-top: .6rem;  
    background-color: #ccc;  
}  
nav ul {  
    list-style-type: none;  
    padding-left: 1.75rem;  
}  
nav li {  
    display: inline-block;  
    padding-right: 1.75rem;  
}  
main {  
    margin-top: 1rem;  
}
```

HTML:

```
<nav>  
  <ul>  
    <li><a href="#">Home</a></li>  
    <li><a href="#">Blog</a></li>  
    <li><a href="#">Store</a></li>  
    <li><a href="#">About</a></li>  
    <li><a href="#">Contact</a></li>  
  </ul>
```

```
</nav>
<main>
    Main content goes here...
</main>
```

FIGURE 4-3:
These links are list items styled as inline blocks to appear side-by-side.



You can also use inline blocks for macro page layouts. For example, to re-create the layout shown earlier in Figure 4-2 using inline blocks, you'd use the following code:

CSS:

```
body {
    margin: 2rem;
    width: 30rem;
}
header {
    height: 2.5rem;
    border: 1px solid black;
}
nav {
    height: 2.5rem;
    margin-top: 1rem;
    border: 1px solid black;
}
main {
    margin-top: 1rem;
    height: 10rem;
}
article {
    display: inline-block;
    margin-right: 1rem;
    width: 20rem;
    height: 100%;
    border: 1px solid black;
}
```

```
aside {  
    display: inline-block;  
    width: 9rem;  
    height: 100%;  
    border: 1px solid black;  
}  
footer {  
    height: 2.5rem;  
    margin-top: 1rem;  
    border: 1px solid black;  
}
```

HTML:

```
<header>  
    Header  
</header>  
<nav>  
    Navigation  
</nav>  
<main>  
    <article>  
        Article  
</article><aside>  
        Aside  
</aside>  
</main>  
<footer>  
    Footer  
</footer>
```

Notice, first, that in the CSS both the `article` element and the `aside` element are styled with `display: inline-block`. More mysteriously, in the HTML, notice that I jammed together the `</article>` and `<aside>` tags. What's up with that? It's an eccentric feature of using inline blocks in this way that there shouldn't be any whitespace between one inline block and another. It's weird, I know, but it works, as you can see in Figure 4-4.

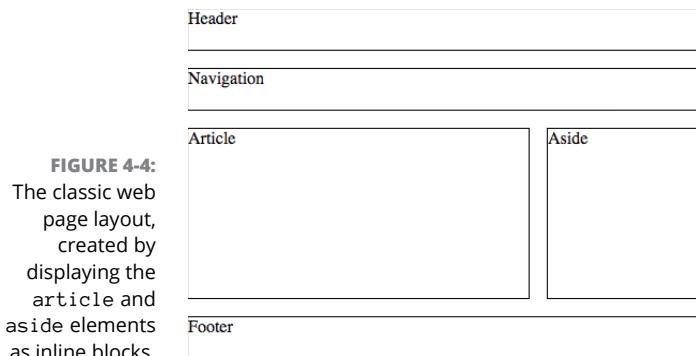


FIGURE 4-4:
The classic web
page layout,
created by
displaying the
article and
aside elements
as inline blocks.

Making Flexible Layouts with Flexbox

When you use either floats or inline blocks for page layout, there are some banana peels in the path that can trip you up, including forgetting to clear your floats and forgetting to ensure there is no whitespace between two inline blocks.

However, beyond these mere annoyances, there are also a few things that float- or inline-block-based layouts have trouble with:

- » It's very hard to get an element's content centered vertically within the element's container.
- » It's very hard to get elements evenly spaced horizontally across the full width (or vertically across the full height) of their parent container.
- » It's very hard to get a footer element to appear at the bottom of the browser's content area.

Fortunately, these troubles vanish if you use a CSS technology called Flexible Box Layout Module, or *flexbox*, for short. The key here is the “flex” part of the name. As opposed to the default page flow and layouts that use floats and inline blocks, all of which render content using rigid blocks, flexbox renders content using containers that can grow and shrink — I’m talking both width and height here — in response to changing content or browser window size. But flexbox also offers powerful properties that make it a breeze to lay out, align, distribute, and size the child elements of a parent container.

The first thing you need to know is that flexbox divides its world into two categories:

- » **Flex container:** This is a block-level element that acts as a parent to the flexible elements inside it.
- » **Flex items:** These are the elements that reside within the flex container.

Setting up the flex container

To designate an element as a flex container, you set its `display` property to `flex`:

```
container {  
    display: flex;  
}
```

With that done, the element's children automatically become flex items.

Flexbox is a one-dimensional layout tool, which means the flex items are arranged within their flex container either horizontally — that is, in a row — or vertically — that is, in a column. This direction is called the *primary axis* and you specify it using the `flex-direction` property:

```
element {  
    display: flex;  
    flex-direction: row|row-reverse|column|column-reverse;  
}
```

- » `row`: The primary axis is horizontal and the flex items are arranged from left to right. This is the default value.
- » `row-reverse`: The primary axis is horizontal and the flex items are arranged from right to left.
- » `column`: The primary axis is vertical and the flex items are arranged from top to bottom.
- » `column-reverse`: The primary axis is vertical and the flex items are arranged from bottom to top.

The axis that is perpendicular to the primary axis is called the *secondary axis*.

As an example, here's some CSS and HTML code, and Figure 4-5 shows how it looks if you let the browser lay it out:

CSS:

```
.container {  
    border: 5px double black;  
}  
.item {  
    border: 1px solid black;  
    padding: .1rem;  
    font-family: "Verdana", sans-serif;  
    font-size: 5rem;  
    text-align: center;  
}  
.item1 {  
    background-color: rgb(240, 240, 240);  
}  
.item2 {  
    background-color: rgb(224, 224, 224);  
}  
.item3 {  
    background-color: rgb(208, 208, 208);  
}  
.item4 {  
    background-color: rgb(192, 192, 192);  
}  
.item5 {  
    background-color: rgb(176, 176, 176);  
}
```

HTML:

```
<div class="container">  
    <div class="item item1">1</div>  
    <div class="item item2">2</div>  
    <div class="item item3">3</div>  
    <div class="item item4">4</div>  
    <div class="item item5">5</div>  
</div>
```

The browser does its default thing where it stacks the `div` blocks on top of each other and makes each one take up the full width of its parent `div` (the one with the `container` class), which, in Figure 4-5, has its boundaries marked by the double border.

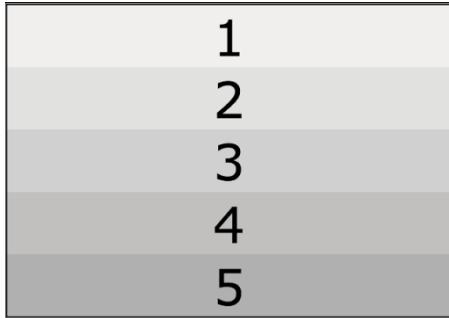


FIGURE 4-5:
If you let the browser lay out the elements, you get the default stack of blocks.

Now configure the parent `div` — again, the one with the `container` class — as a flex container with a horizontal primary axis:

```
.container {
  display: flex;
  flex-direction: row;
  border: 5px double black;
}
```

This automatically configures the child `div` elements — the ones with the `item` class — as flex items. As you can see in Figure 4-6, the flex items are now aligned horizontally and only take up as much horizontal space as their content requires.

FIGURE 4-6:
With their parent as a flex container, the child elements become flex items.



Aligning flex items along the primary axis

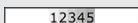
Notice in Figure 4-6 that the flex items are bunched together on the left side of the flex container (which has its boundaries shown by the double border). This is the default alignment along the primary axis, but you can change that by modifying the value of the `justify-content` property:

```
container {
  display: flex;
  justify-content: flex-start|flex-end|center|space-between|space-around;
}
```

Table 4-1 demonstrates each of the possible values of the `justify-content` property when the primary axis is horizontal.

TABLE 4-1

Aligning Flex Items along the Primary Axis

| justify-content | Example |
|-----------------|---|
| flex-start |  |
| flex-end |  |
| center |  |
| space-between |  |
| space-around |  |



REMEMBER

Here are a few notes about Table 4-1 to recite to yourself before going to bed:

- » The `flex-start` alignment is the default, so you can leave out the `justify-content` property if `flex-start` is the alignment you want.
- » The `space-between` alignment works by placing the first flex item at the start of the flex container, the last flex item at the end of the flex container, and then distributing the rest of the flex items evenly in between.
- » The `space-around` alignment works by assigning equal amounts of space before and after each flex item, where the amount of space is calculated to get the flex items distributed evenly along the primary axis. Actually, the distribution isn't quite even, because the inner flex items (2, 3, and 4 in Table 4-1) have two units of space between them, whereas the starting and ending flex items (1 and 5, respectively, in Table 4-1) have only one unit of space to the outside (that is, to the left of item 1 and to the right of item 5).

Aligning flex items along the secondary axis

Besides aligning the flex items along the primary axis, you can also align them along the secondary axis. For example, if you've set `flex-direction` to `row`, which gives you a horizontal primary axis, then the secondary axis is vertical, which means you can also align the flex items vertically. By default, the flex items always take up the entire height of the flex container, but you can get a different secondary axis alignment by changing the value of the `align-items` property:

```
container {  
    display: flex;  
    align-items: stretch|flex-start|flex-end|center|baseline;  
}
```

Table 4-2 demonstrates each of the possible values of the `align-items` property when the secondary axis is vertical.

TABLE 4-2

Aligning Flex Items along the Secondary Axis

| align-items | Example |
|-------------|---|
| stretch |  |
| flex-start |  |
| flex-end |  |
| center |  |
| baseline |  |



REMEMBER

Some notes about Table 4-2:

- » To make the examples useful, I added some height to the flex container (the edges of which are designated by a double border) and I added random amounts of top and bottom padding to each flex item.
- » The `stretch` alignment is the default, so you can leave out the `align-items` property if `stretch` is the alignment you want.
- » The `baseline` value aligns the flex items along the bottom edges of the item text. (Technically, given a line of text, the *baseline* is the invisible line upon which lowercase characters such as o and x appear to sit.)

Centering an element horizontally and vertically

In the olden days of CSS, centering an element both horizontally and vertically within its parent was notoriously difficult. Style wizards stayed up until late at night coming up with ways to achieve this feat. They succeeded, but their techniques were obscure and convoluted. Then flexbox came along and changed

everything by making it almost ridiculously easy to plop something smack dab in the middle of the page:

```
container {  
    display: flex;  
    justify-content: center;  
    align-items: center;  
}
```

Yes, that's all there is to it. Here's an example:

CSS:

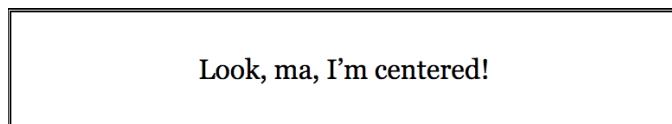
```
.container {  
    display: flex;  
    justify-content: center;  
    align-items: center;  
    height: 25vh;  
    border: 5px double black;  
}  
.item {  
    font-family: "Georgia", serif;  
    font-size: 2rem;  
}
```

HTML:

```
<div class="container">  
    <div class="item">Look, ma, I'm centered!</div>  
</div>
```

As you can see in Figure 4-7, the flex item sits right in the middle of its flex container.

FIGURE 4-7:
To center an item, set the container's justify-content and align-items properties to center.



Laying out a navigation bar with flexbox

Earlier in this chapter, I show some HTML and CSS code for a horizontal layout of a navigation bar. One example uses floats and the other uses inline blocks, but in both cases I had to resort to finicky finagling of vertical and horizontal padding to get the links nicely positioned within the `nav` element.

With flexbox, however, you don't need to resort to such time-consuming tweaking to get things lined up nice and neat. Here's the flexbox version of the navigation bar, and Figure 4-8 shows how it looks in the browser:

CSS:

```
nav {  
    background-color: #ccc;  
}  
nav ul {  
    display: flex;  
    justify-content: space-around;  
    align-items: center;  
    height: 2.5rem;  
    list-style-type: none;  
}  
main {  
    margin-top: 1rem;  
}
```

HTML:

```
<nav>  
    <ul>  
        <li><a href="#">Home</a></li>  
        <li><a href="#">Blog</a></li>  
        <li><a href="#">Store</a></li>  
        <li><a href="#">About</a></li>  
        <li><a href="#">Contact</a></li>  
    </ul>  
</nav>  
<main>  
    Main content goes here...  
</main>
```

FIGURE 4-8:
Using flexbox,
you can modify
flex container
properties
for nicely
spaced links.



Notice that I made the `ul` element the flex container. By setting `justify-content` to `space-around` and `align-items` to `center`, you get the flex items — that is, the navigation links — perfectly spaced within the navigation bar.

Allowing flex items to grow

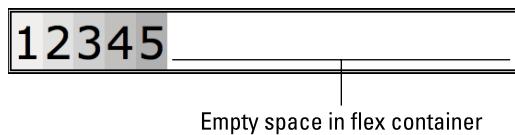
By default, when you set the `justify-content` property to `flex-start`, `flex-end`, or `center`, the flex items take up only as much room along the primary axis as they need for their content, as shown earlier in Figure 4-6 and Table 4-1. This is admirably egalitarian, but it does often leave a bunch of empty space in the flex container. Interestingly, one of the meanings behind the “flex” in flexbox is that you can make one or more flex items grow to fill that empty space.

You configure a flex item to grow by setting the `flex-grow` property on the item:

```
item {  
    flex-grow: value;  
}
```

Here, `value` is a number greater than or equal to `0`. The default value is `0`, which tells the browser not to grow the flex items. That usually results in empty space in the flex container, as shown in Figure 4-9.

FIGURE 4-9:
By default, all
flex items have a
flex-grow value
of `0`, resulting in
empty space.

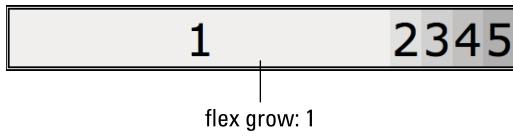


For positive values of `flex-grow`, there are three scenarios to consider:

» You assign a positive **flex-grow** value to just one flex item. The flex item grows until there is no more empty space in the flex container. For example, here's a rule that sets **flex-grow** to 1 for the element with class **item1**, and Figure 4-10 shows that item 1 has grown until there is no more empty space in the flex container:

```
.item1 {
    flex-grow: 1;
}
```

FIGURE 4-10:
With **flex-grow: 1**, an item grows until the container has no more empty space.

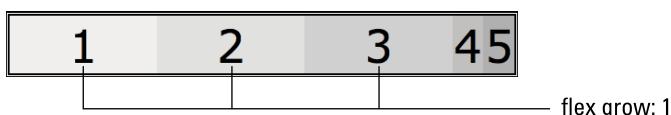


» You assign the same positive **flex-grow** value to two or more flex items.

The flex items grow equally until there is no more empty space in the flex container. For example, here's a rule that sets **flex-grow** to 1 for the elements with the classes **item1**, **item2**, and **item3**, and Figure 4-11 shows that items 1, 2, and 3 have grown until there is no more empty space in the flex container:

```
.item1,
.item2,
.item3 {
    flex-grow: 1;
}
```

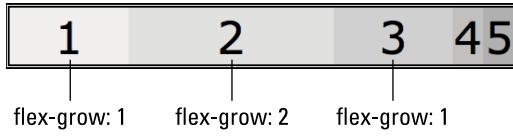
FIGURE 4-11:
When items 1, 2, and 3 are styled with **flex-grow: 1**, the items grow equally.



» You assign a different positive `flex-grow` value to two or more flex items. The flex items grow proportionally based on the `flex-grow` values until there is no more empty space in the flex container. For example, if you give one item a `flex-grow` value of 1, a second item a `flex-grow` value of 2, and a third item a `flex-grow` value of 1, then the proportion of the empty space given to each will be, respectively, 25 percent, 50 percent, and 25 percent. Here's some CSS that supplies these proportions to the elements with the classes `item1`, `item2`, and `item3`, and Figure 4-12 shows the results:

```
.item1 {  
    flex-grow: 1;  
}  
.item2 {  
    flex-grow: 2;  
}  
.item3 {  
    flex-grow: 1;  
}
```

FIGURE 4-12:
Items 1 and 3 get 25 percent of the container's empty space, whereas item 2 gets 50 percent.



TECHNICAL STUFF

To calculate what proportion of the flex container's empty space is assigned to each flex item, add up the `flex-grow` values, then divide the individual `flex-grow` values by that total. For example, values of 1, 2, and 1 add up to 4, so the percentages are 25 percent ($1/4$), 50 percent ($2/4$), and 25 percent ($1/4$), respectively.

Allowing flex items to shrink

The flexibility of flexbox means not only that flex items can grow to fill a flex container's empty space, but also that they can shrink if the flex container doesn't have enough space to fit the items. Shrinking flex items to fit inside their container is the default flexbox behavior, but you gain a measure of control over which items shrink and by how much by using the `flex-shrink` property on a flex item:

```
item {  
    flex-shrink: value;  
}
```

Here, `value` is a number greater than or equal to 0. The default value is 1, which tells the browser to shrink all the flex items equally to get them to fit inside the flex container.

For example, consider the following code:

CSS:

```
.container {
    display: flex;
    width: 500px;
    border: 5px double black;
}
.item {
    width: 200px;
}
```

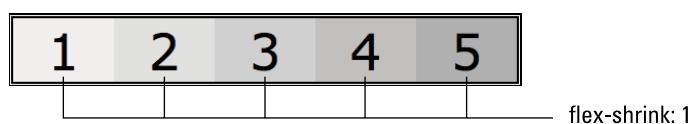
HTML:

```
<div class="container">
    <div class="item item1">1</div>
    <div class="item item2">2</div>
    <div class="item item3">3</div>
    <div class="item item4">4</div>
    <div class="item item5">5</div>
</div>
```

The flex container (the `container` class) is 500px wide, but each flex item (the `item` class) is 200px wide. To get everything to fit, the browser shrinks each item equally, and the result is shown in Figure 4-13.

FIGURE 4-13:

By default, the browser shrinks the items equally along the primary axis until they fit.



TECHNICAL
STUFF

The browser only shrinks each flex item truly equally (that is, by the same amount) when each item has the same size along the primary axis (for example, the same width when the primary axis is horizontal). If the flex items have different sizes, the browser shrinks each item roughly in proportion to its size: Larger items shrink more, whereas smaller items shrink less. I use the word “roughly” here because in fact the calculations the browser uses to determine the shrinkage factor

are brain-numbingly complex. If you want to learn more (don't say I didn't warn you!), see <https://madebymike.com.au/writing/understanding-flexbox>.

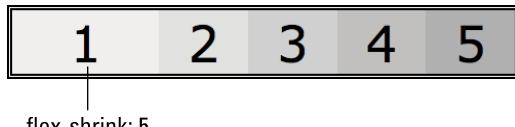
For positive values of `flex-shrink`, you have three ways to control the shrinkage of a flex item:

- » **Assign the item a `flex-shrink` value between 0 and 1.** The browser shrinks the item less than the other flex items. For example, here's a rule that sets `flex-shrink` to .5 for the element with class `item1`, and Figure 4-14 shows that item 1 has shrunk less than the other items in the container:

```
.item1 {  
    flex-shrink: .5;  
}
```

FIGURE 4-14:

Styling item 1 with `flex-shrink: .5` shrinks it less than the other items.

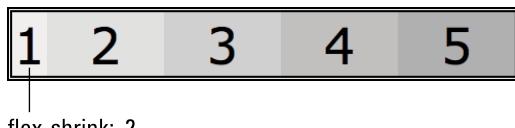


- » **Assign the item a `flex-shrink` value greater than 1.** The browser shrinks the item more than the other flex items. For example, the following rule sets `flex-shrink` to 2 for the element with class `item1`, and Figure 4-15 shows that item 1 has shrunk more than the other items in the container:

```
.item1 {  
    flex-shrink: 2;  
}
```

FIGURE 4-15:

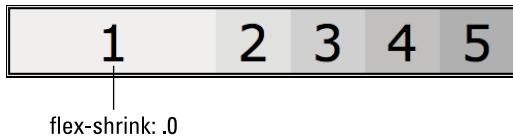
Styling item 1 with `flex-shrink: 2` shrinks the item more than the others.



» **Assign the item a flex-shrink value of 0.** The browser doesn't shrink the item. The following rule sets flex-shrink to 0 for the element with class item1, and Figure 4-16 shows that the browser doesn't shrink item 1:

```
.item1 {  
    flex-shrink: 0;  
}
```

FIGURE 4-16:
Styling item 1
with flex-
shrink: 0
doesn't shrink
the item.



WARNING

If a flex item is larger along the primary axis than its flex container, and you set flex-shrink: 0 on that item, ugliness ensues. That is, the flex item breaks out of the container and, depending on where it sits within the container, might take one or more other items with it. If you don't want a flex item to shrink, make sure the flex container is large enough to hold it.

Laying out content columns with flexbox

Flexbox works best when you use it to lay out components along one dimension, but that doesn't mean you can't use it to lay out an entire page. As long as the page structure is relatively simple, then flexbox works great for laying out elements both horizontally and vertically.

A good example is the classic page layout that I discuss earlier: a header and navigation bar across the top of the page, a main section with an article and a sidebar beside it, and a footer across the bottom of the page. Here's some flexbox code that creates this layout, which is shown in Figure 4-17:

CSS:

```
body {  
    display: flex;  
    flex-direction: column;  
    width: 30rem;  
    min-height: 100vh;  
}
```

```
header {
    height: 2.5rem;
    border: 1px solid black;
}
nav {
    height: 2.5rem;
    margin-top: 1rem;
    border: 1px solid black;
}
main {
    flex-grow: 1;
    display: flex;
    margin-top: 1rem;
}
article {
    flex-grow: 1;
    margin-right: 1rem;
    border: 1px solid black;
    overflow-y: auto;
}
aside {
    flex-grow: 0;
    flex-shrink: 0;
    flex-basis: 10rem;
    border: 1px solid black;
}
footer {
    height: 2.5rem;
    margin-top: 1rem;
    border: 1px solid black;
}
```

HTML:

```
<body>
    <header>
        Header
    </header>
    <nav>
        Navigation
    </nav>
    <main>
        <article>
            Article
        </article>
    </main>
```

```
<aside>
  Aside
</aside>
</main>
<footer>
  Footer
</footer>
</body>
```

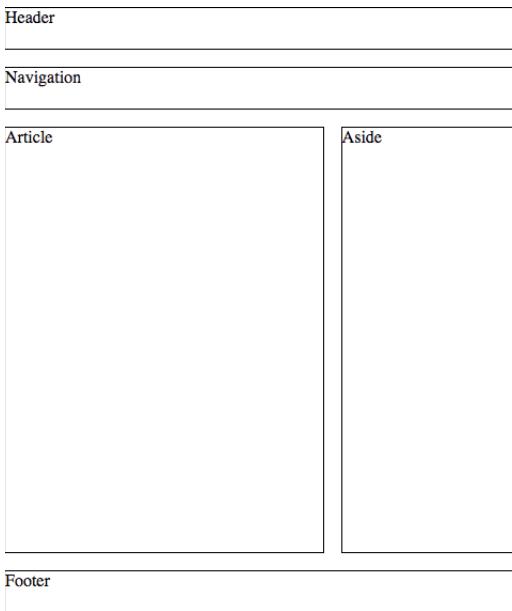


FIGURE 4-17:
The classic page layout, flexbox-style.

Let's take a closer look at what's happening here:

- » The `<body>` tag is set up as a flex container, and that container is styled with `flex-direction: column` to create a vertical primary axis for the page as a whole.
- » The body element has its `min-height` property set to `100vh`, which makes the flex container always take up at least the entire height of the browser's content area.
- » All header, nav, and footer elements are given explicit height values.
- » The `main` element is styled with `flex-grow: 1`, which tells the browser to grow the `main` element vertically until it uses up the empty space in the flex

container. This also ensures that the footer element appears at the bottom of the content area even if there isn't enough content to fill the main element.

- » The main element is also a flex container styled with `flex-direction: row` to create a horizontal primary axis.
- » Inside the main flex container, the article element is given `flex-grow: 1`, so it grows as needed to take up the remaining width of the main element (that is, after the width of the aside element is taken into account).
- » To get a fixed-width sidebar, the aside element's rule has both `flex-grow` and `flex-shrink` set to `0`, and it also includes the declaration `flex-basis: 10rem`. The `flex-basis` property provides the browser with a suggested starting point for the size of the element. In this case, with both `flex-grow` and `flex-shrink` set to `0`, the `flex-basis` value acts like a fixed width.



TIP

There's a shorthand property called `flex` that you can use to combine `flex-grow`, `flex-shrink`, and `flex-basis` into a single declaration:

```
item {  
    flex: grow-value shrink-value basis-value;  
}
```

For example, I could rewrite the aside element's rule in the above example as follows:

```
aside {  
    flex: 0 0 10rem;  
    border: 1px solid black;  
}
```

Flexbox browser support

The good news is that all major web browsers, both desktop and mobile, support flexbox. The bad news is that they haven't always supported flexbox, or, to be accurate, they've supported it, but only with what are known as *vendor prefixes*. A vendor prefix is a label specific to each browser — such as `-webkit-` for browsers that use the WebKit page rendering engine (including Chrome and Safari), `-moz-` for Firefox, and `-ms-` for Microsoft Edge and Internet Explorer — that enabled the browser to implement a CSS feature before knowing the final specification.

So while a declaration such as `display: flex` will work just fine in about 90 percent of today's browsers, to handle the rest you need to include prefixed versions of the same declaration:

```
container {  
    display: -webkit-box;  
    display: -ms-flexbox;  
    display: flex;  
}
```

Yuck. Vendor prefixes are one of the great annoyances of modern web development. However, rather than have you memorize the prefixed versions of every flexbox property, I'm going to suggest, instead, that you wait until your CSS code is complete (or nearly so), then run it through the online Autoprefixer tool, which will add all the required prefixes for you lickety-split:

<https://autoprefixer.github.io>

Shaping the Overall Page Layout with CSS Grid

One of the most exciting and anticipated developments in recent CSS history is the advent of a technology called CSS Grid. The Grid specification gives you a straightforward way to divide up a container into one or more rows and one or more columns — that is, as a *grid* — and then optionally assign the container's elements to specific sections of the grid. With CSS Grid, you can give the web browser instructions such as the following:

- » Set up the `<body>` tag as a grid with four rows and three columns.
- » Place the `header` element in the first row and make it span all three columns.
- » Place the `nav` element in the second row and make it span all three columns.
- » Place the `article` element in the third row, columns one and two.
- » Place the `aside` element in the third row, column three.
- » Place the `footer` element in the fourth row and make it span all three columns.

Before you learn how to do all of this and more, you need to know that a Grid uses two categories of elements:

- » **Grid container:** This is a block-level element that acts as a parent to the elements inside it and that you configure with a set number of rows and columns.

» **Grid items:** These are the elements that reside within the grid container and that you assign (or the browser assigns automatically) to specific parts of the grid.

Setting up the grid container

To designate an element as a grid container, you set its `display` property to `grid`:

```
container {  
    display: grid;  
}
```

With that first step complete, the element's children automatically become grid items.

Specifying the grid rows and columns

Your grid container doesn't do much on its own. To make it useful, you need to create a *grid template*, which specifies the number of rows and columns you want in your grid. You set up your template by adding the `grid-template-columns` and `grid-template-rows` properties to your grid container:

```
container {  
    display: grid;  
    grid-template-columns: column-values;  
    grid-template-rows: row-values  
}
```

The `column-values` and `row-values` are space-separated lists of the sizes you want to use for each column and row in your grid. The sizes can be numbers expressed in any of the standard CSS measurement units (`px`, `em`, `rem`, `vw`, or `vh`), a percentage, or the keyword `auto`, which tells the browser to automatically set the size based on the other values you specify.

Here's an example, and Figure 4-18 shows the result:

CSS:

```
.container {  
    display: grid;  
    grid-template-columns: 100px 300px 200px;  
    grid-template-rows: 100px 200px;  
}
```

HTML:

```
<div class="container">
  <div class="item item1">1</div>
  <div class="item item2">2</div>
  <div class="item item3">3</div>
  <div class="item item4">4</div>
  <div class="item item5">5</div>
  <div class="item item6">6</div>
</div>
```

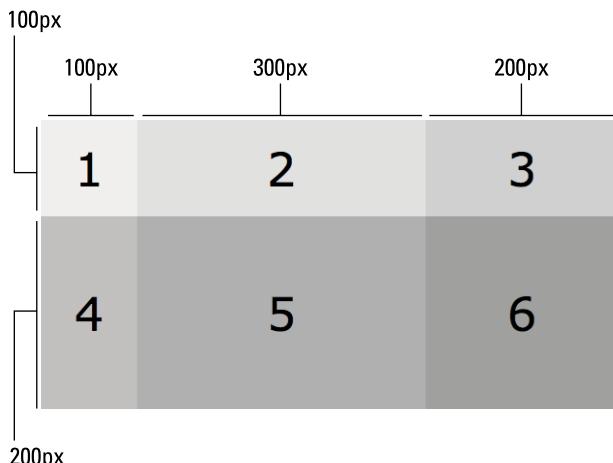


FIGURE 4-18:
A basic grid created by setting just three properties: `display`, `grid-template-columns`, and `grid-template-rows`.



TECHNICAL STUFF

You can also specify a column or row size using a new unit called `fr`, which is specific to Grid and represents a fraction of the free space available in the grid container, either horizontally (for columns) or vertically (for rows). For example, if you assign one column `1fr` of space and another column `2fr`, the browser gives one third of the horizontal free space to the first column and two thirds of the horizontal free space to the second column.



TIP

Creating grid gaps

By default, the browser doesn't include any horizontal space between each column, or any vertical space between each row. If you'd prefer some daylight

between your grid items, you can add the `grid-column-gap` and `grid-row-gap` properties to your grid container:

```
container {  
    display: grid;  
    grid-column-gap: column-gap-value;  
    grid-row-gap: row-gap-value  
}
```

In both properties, the value is a number expressed in any of the standard CSS measurement units (`px`, `em`, `rem`, `vw`, or `vh`). Here's an example:

```
.container {  
    display: grid;  
    grid-template-columns: 100px 300px 200px;  
    grid-template-rows: 100px 200px;  
    grid-column-gap: 10px;  
    grid-row-gap: 15px;  
}
```



TIP

There's a shorthand property called `grid-gap` that you can use to combine `grid-column-gap` and `grid-row-gap` into a single declaration:

```
container {  
    display: grid;  
    grid-gap: column-gap-value row-gap-value;  
}
```



WARNING

While I was writing this book, the CSS Grid overlords declared that the names of the gap-related properties are going to change in the future:

| Current Name | Future Name |
|------------------------------|-------------------------|
| <code>grid-column-gap</code> | <code>column-gap</code> |
| <code>grid-row-gap</code> | <code>row-gap</code> |
| <code>grid-gap</code> | <code>gap</code> |

As I write these words, no browser supports the new names, so for now you should include both the current name and the new name when you're styling your grid gaps.

Assigning grid items to rows and columns

Rather than letting the web browser populate the grid automatically, you can take control of the process and assign your grid items to specific rows and columns. For each grid item, you specify four values:

```
item {  
    grid-column-start: column-start-value;  
    grid-column-end: column-end-value;  
    grid-row-start: row-start-value;  
    grid-row-end: row-end-value;  
}
```

- » **grid-column-start:** A number that specifies the column where the item begins.
- » **grid-column-end:** A number that specifies the column before which the item ends. For example, if `grid-column-end` is set to 4, the grid item ends in column 3. Some notes:
 - If you omit this property, the item uses only the starting column.
 - If you use the keyword `end`, then the item runs from its starting column through to the last column in the grid.
 - You can use the keyword `span` followed by a space and then a number that specifies the number of columns you want the item to span across the grid. For example, the following two sets of declarations are equivalent:

```
grid-column-start: 1;  
grid-column-end: 4;  
grid-column-start: 1;  
grid-column-end: span 3;
```
- » **grid-row-start:** A number that specifies the row where the item begins.
- » **grid-row-end:** A number that specifies the row before which the item ends. For example, if `grid-row-end` is set to 3, the grid item ends in row 2. Some notes:
 - If you omit this property, the item uses only the starting row.
 - If you use the keyword `end`, then the item runs from its starting row through to the last row in the grid.

- You can use the keyword `span` followed by a space and then a number that specifies the number of rows you want the item to span down the grid. For example, the following two sets of declarations are equivalent:

```
grid-row-start: 2;  
grid-row-end: 4;  
grid-row-start: 2;  
grid-row-end: span 2;
```

Here's an example, and the results are shown in Figure 4-19:

CSS:

```
.container {  
    display: grid;  
    grid-template-columns: repeat(5, 100px);  
    grid-template-rows: repeat(3, 150px);  
}  
.item1 {  
    grid-column-start: 1;  
    grid-column-end: 3;  
    grid-row-start: 1;  
    grid-row-end: 1;  
}  
.item2 {  
    grid-column-start: 3;  
    grid-column-end: span 3;  
    grid-row-start: 1;  
    grid-row-end: 1;  
}  
.item3 {  
    grid-column-start: 1;  
    grid-column-end: 1;  
    grid-row-start: 2;  
    grid-row-end: end;  
}  
.item4 {  
    grid-column-start: 2;  
    grid-column-end: 4;  
    grid-row-start: 2;  
    grid-row-end: end;  
}
```

```
.item5 {  
    grid-column-start: 4;  
    grid-column-end: span 2;  
    grid-row-start: 2;  
    grid-row-end: 2;  
}  
.item6 {  
    grid-column-start: 4;  
    grid-column-end: span 2;  
    grid-row-start: 3;  
    grid-row-end: 3;  
}
```

HTML:

```
<div class="container">  
    <div class="item item1">1</div>  
    <div class="item item2">2</div>  
    <div class="item item3">3</div>  
    <div class="item item4">4</div>  
    <div class="item item5">5</div>  
    <div class="item item6">6</div>  
</div>
```

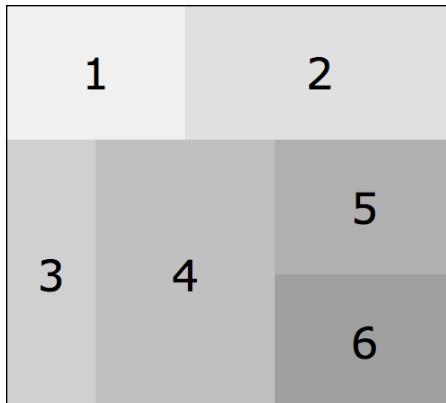


FIGURE 4-19:
Some grid items assigned
to different
columns and
rows in the grid.



TIP

In the example, notice that I used a function named `repeat` to specify multiple columns and rows that are the same size. Here's the syntax to use:

```
repeat(number, size)
```

Replace *number* with the number of columns or rows you want to create, and replace *size* with the size you want to use for each of those columns or rows. For example, the following two declarations are equivalent:

```
grid-template-rows: 150px 150px 150px;  
grid-template-rows: repeat(3, 150px);
```



TIP

CSS also offers two shorthand properties that you can use to make the process of assigning items to columns and rows a bit more streamlined:

```
item {  
    grid-column: column-start-value / column-end-value;  
    grid-row: row-start-value / row-end-value;  
}
```

Aligning grid items

CSS Grid offers several properties that you can use to align your grid items. For the grid container, you have the `justify-items` and `align-items` properties:

```
container {  
    justify-items: start|end|center|stretch;  
    align-items: start|end|center|stretch;  
}
```

- » `justify-items`: Aligns the content inside each grid item horizontally. You can align items to the left (`start`), the right (`end`), in the middle (`center`), or across the width of the item (`stretch`; this is the default value).
- » `align-items`: Aligns the content inside each grid item vertically. You can align items to the top (`start`), the bottom (`end`), in the middle (`center`), or across the height of the item (`stretch`; this is the default value).

For a grid item, you have the `justify-self` and `align-self` properties:

```
item {  
    justify-self: start|end|center|stretch;  
    align-self: start|end|center|stretch;  
}
```

- » `justify-self`: Aligns the content inside the grid item horizontally. You can align the item to the left (`start`), the right (`end`), in the middle (`center`), or across the width of the item (`stretch`; this is the default value).

» align-self: Aligns the content inside the grid item vertically. You can align the item to the top (`start`), the bottom (`end`), in the middle (`center`), or across the height of the item (`stretch`; this is the default value).

Laying out content columns with Grid

As a two-dimensional layout system, Grid is perfect for laying out an entire page. This includes the classic page layout that I talk about earlier: a header and navigation bar across the top of the page, an article with a sidebar beside it, and a footer across the bottom of the page. Here's some Grid code that creates this layout, which is shown in Figure 4-20:

CSS:

```
body {  
    display: grid;  
    grid-template-columns: 1fr 10rem;  
    grid-template-rows: 2.5rem 2.5rem 1fr 2.5rem;  
    grid-gap: 1rem 1rem;  
    min-height: 100vh;  
}  
  
header {  
    grid-column: 1 / end;  
    grid-row: 1;  
    border: 1px solid black;  
}  
  
nav {  
    grid-column: 1 / end;  
    grid-row: 2;  
    border: 1px solid black;  
}  
  
article {  
    grid-column: 1;  
    grid-row: 3;  
    border: 1px solid black;  
}
```

```
aside {  
    grid-column: 2 / end;  
    grid-row: 3;  
    border: 1px solid black;  
}  
  
footer {  
    grid-column: 1 / end;  
    grid-row: 4;  
    border: 1px solid black;  
}
```

HTML:

```
<body>  
    <header>  
        Header  
    </header>  
    <nav>  
        Navigation  
    </nav>  
    <article>  
        Article  
    </article>  
    <aside>  
        Aside  
    </aside>  
    <footer>  
        Footer  
    </footer>  
</body>
```

Take a closer look at what the code does:

- » The `<body>` tag is set up as a grid container, and that container is styled with two columns and four rows.
- » The `body` element has its `min-height` property set to `100vh`, which makes the grid container always take up at least the entire height of the browser's content area.
- » All `header`, `nav`, and `footer` elements span from the first column to the end of the grid, and they're assigned rows 1, 2, and 4, respectively.

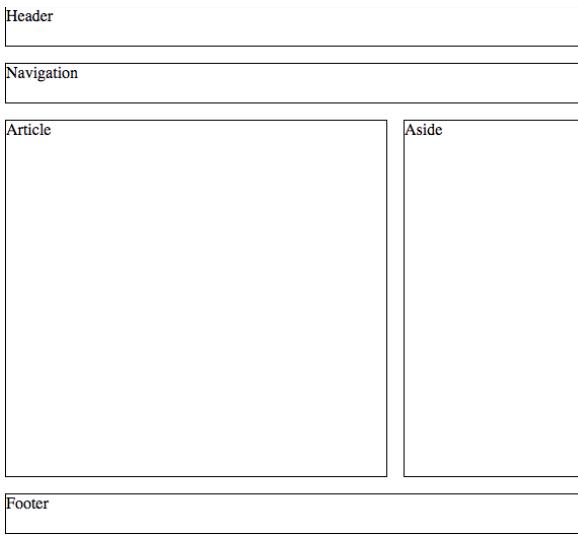


FIGURE 4-20:
The classic page layout, Grid-style.

- » This version of the classic layout doesn't include a `main` element, because CSS Grid doesn't offer a mechanism for nesting grids.
- » The `article` element uses only column 1 and row 3, both of which were defined with the size `1fr`, which allows the `article` element to take up the free space in the grid.
- » The `aside` element uses column 2, which was assigned a width of `10rem`, so its width is fixed.

Grid browser support

CSS Grid offers two pieces of very good news when it comes to browser support:

- » All major web browsers, both on the desktop and in mobile devices, support CSS Grid.
- » No oddball vendor prefixes are needed in your CSS code.

The fly in the Grid ointment is that, yes, all major browsers are now Grid-friendly, but that support is relatively new, having been implemented in each browser at various points throughout 2017. This means that although Grid has strong browser market share — nearly 80 percent, as I write this — it's not enough for you to write Grid-only layouts. I talk about how you work around this problem in the next section.



TIP

You can take advantage of the handy CanIUse service to track the browser market share for CSS Grid:

<https://caniuse.com/#search=grid>

Providing Fallbacks for Page Layouts

Here's a summary of the current state of page layout in today's world:

- » Nearly 80 percent of browsers support Grid. This is too small a number to build a Grid-only layout.
- » About 85 percent of browsers fully support flexbox, although vendor prefixes are required. This is great support, but if you do a flexbox-only layout, about one in seven visitors will see your page in an ugly light.
- » All browsers support both the `float` property and `display: inline-block`.

Does this mean you should just use floats or inline blocks and ignore flexbox and Grid until they have 100-percent browser support? No way! Through a technique called *progressive enhancement*, you can build a layout that uses a newer technology, but also includes an older page layout system that gets used with browsers that don't support the newer CSS. An older technology that a browser uses when it doesn't understand a newer technology is called a *fallback*.

The easiest way to implement fallbacks is to add *feature queries*, which use the `@supports` rule to check whether the web browser supports a CSS feature:

```
@supports (property: value) {  
    Code to run if the browser supports the property-value  
}
```

Replace *property* and *value* with the name of the CSS property and its value you want to check. For example, the following feature query-checks for Grid support:

```
@supports (display: grid) {  
    Grid CSS goes here  
}
```

To put this all together, here's some pseudo-code that shows how you'd implement your progressive enhancement:

```
Float or inline-block CSS comes first

@supports (display: flexbox) {
    Flexbox CSS goes here
}

@supports (display: grid) {
    Grid CSS goes here
}
```

The browser first implements the float or inline-block layout. If the browser supports flexbox, then it will implement the flexbox CSS, which automatically overrides the floats and inline-blocks (although you might have to apply `width: auto` to some elements to override explicit width settings from earlier in your code). If the browser supports Grid, it implements the Grid CSS, which overrides the flexbox code.

3

Coding the Front End, Part 2: JavaScript

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IN THIS CHAPTER

- » Understanding programming in general, and JavaScript in particular
- » Getting a taste of what you can (and can't) do with JavaScript
- » Learning the tools you need to get coding
- » Adding JavaScript code to a web page
- » Storing your code in a separate JavaScript file

Chapter **1**

An Overview of JavaScript

What's in your hands, I think and hope, is intelligence: the ability to see the machine as more than when you were first led up to it, that you can make it more.

— ALAN PERLIS

When we talk about web coding, what we're really talking about is JavaScript. Yep, you need HTML and CSS to create a web page, and you need tools such as PHP and MySQL to convince a web server to give your page some data, but the glue — and sometimes the duct tape — that binds all these technologies together is JavaScript. The result is that JavaScript is now (and has been for a while) the default programming language for web development. If you want to control a page using code (and I know you do), then you must use JavaScript to do it.

It also means that JavaScript is (and has been for a while) universal on the web. Sure, there are plenty of barebones home pages out there that are nothing but HTML and a sprinkling of CSS, but everything else — from humble personal blogs

to fancy-pants designer portfolios to bigtime corporate ecommerce operations — relies on JavaScript to make things look good and work the way they're supposed to (most of the time, anyway).

So, when it comes to the care and feeding of your web development education, JavaScript is one of the most important — arguably *the* most important — of all the topics you need to learn. Are you excited to start exploring JavaScript? I knew it!

JavaScript: Controlling the Machine

When a web browser is confronted with an HTML file, it goes through a simple but tedious process: It reads the file one line at a time, starting from (usually) the `<html>` tag at the top and finishing with the `</html>` tag at the bottom. Along the way, it might have to break out of this line-by-line monotony to perform some action based on what it has read. For example, if it stumbles over the `` tag, the browser will immediately ask the web server to ship out a copy of the graphics file specified in the `src` attribute.

The point here is that, at its core, a web browser is really just a page-reading machine that doesn't know how to do much of anything else besides follow the instructions (the markup) in an HTML file. (For my own convenience, I'm ignoring the browser's other capabilities, such as saving bookmarks.)

One of the reasons that many folks get hooked on creating web pages is that they realize from the very beginning that they have control over this page-reading machine. Slap some text between a `` tag and its corresponding `` end tag and the browser dutifully displays the text as bold. Create a CSS grid structure and the browser displays your formerly haphazard text in nice, neat rows and columns, no questions asked. In other words, instead of just viewing pages from the outside, you now have a key to get *inside* the machine and start working its controls. *That* is the hook that grabs people and gets them seriously interested in web page design.

Imagine if you could take this idea of controlling the page-reading machine to the next level. Imagine if, instead of ordering the machine to process mere tags and text, you could issue much more sophisticated commands that could actually control the inner workings of the page-reading machine. Who wouldn't want that?

Well, that's the premise behind JavaScript. It's essentially just a collection of commands that you can wield to control the browser. Like HTML tags, JavaScript commands are inserted directly into the web page file. When the browser does its line-by-line reading of the file and it comes across a JavaScript command, it executes that command, just like that.

However, the key here is that the amount of control JavaScript gives you over the page-reading machine is much greater than what you get with HTML tags. The reason is that JavaScript is a full-fledged *programming language*. The “L” in HTML might stand for “language,” but there isn’t even the tiniest hint of a programming language associated with HTML. JavaScript, though, is the real programming deal.

What Is a Programming Language?

So what does it mean to call something a “programming language”? To understand this term, you need look no further than the language you use to speak and write. At its most fundamental level, human language is composed of two things — words and rules:

- » The words are collections of letters that have a common meaning among all the people who speak the same language. For example, the word “book” denotes a type of object, the word “heavy” denotes a quality, and the word “read” denotes an action.
- » The rules are the ways in which words can be combined to create coherent and understandable concepts. If you want to be understood by other speakers of the language, then you have only a limited number of ways to throw two or more words together. “I read a heavy book” is an instantly comprehensible sentence, but “book a I read heavy” is gibberish.

The key goal of human language is being understood by someone else who is listening to you or reading something you wrote. If you use the proper words to refer to things and actions, and if you combine words according to the rules, then the other person will understand you.

A programming language works in more or less the same way. That is, it, too, has words and rules:

- » The words are a set of terms that refer to the specific things that your program works with (such as the browser window) or the specific ways in which those things can be manipulated (such as sending the browser to a specified address). They’re known as *reserved words* or *keywords*.
- » The rules are the ways that the words can be combined so as to produce the desired effect. In the programming world, these rules are known as the language’s *syntax*.

In JavaScript, many of the words you work with are very straightforward. There are some that refer to aspects of the browser, others that refer to parts of the web page, and some that are used internally by JavaScript. For example, in JavaScript the word `document` refers to a specific object (the web page as a whole), and the word `write()` refers to a specific action (writing data to the page).

The crucial concept here is that just as the fundamental purpose of human language is to be understood by another person, the fundamental purpose of a programming language is to be understood by whatever machine is processing the language. With JavaScript, that machine is the page-reading machine: the web browser.

You can make yourself understood by the page-reading machine by using the proper JavaScript words and by combining them using the proper JavaScript syntax. For example, JavaScript's syntax rules tell you that you can combine the words `document` and `write()` like so: `document.write()`. If you use `write().document` or `document write()` or any other combination, the page-reading machine won't understand you.

The key, however, is that being “understood” by the page-reading machine really means being able to *control* the machine. That is, your JavaScript “sentences” are actually commands that you want the machine to carry out. For example, if you want to add the text “Hello World!” to a web page using JavaScript, you include the following statement in your code:

```
document.write("Hello World!");
```

When the page-reading machine trudges through the HTML file and it comes upon this statement, it will go right ahead and insert it into the page.

Is JavaScript Hard to Learn?

I think there’s a second reason why many folks get jazzed about creating web pages: It’s not that hard. HTML sounds like it’s a hard thing, and certainly if you look at the source code of a typical web page without knowing anything about HTML, the code appears about as intimidating as anything you can imagine.

However, I’ve found that anyone can learn HTML as long as a person starts with the basic tags, sees lots of examples of how they work, and slowly works one’s way up to more complex pages. It’s just a matter of creating a solid foundation and then building on it.

I'm convinced that JavaScript can be approached in much the same way. I'm certainly not going to tell you that JavaScript is as easy to learn as HTML. That would be a bald-faced lie. However, I will tell you that there is nothing inherently difficult about JavaScript. Using our language analogy, it just has a few more words to know and a few more rules to learn. But I believe that if you begin with the basic words and rules, see lots of examples of how they work, and then slowly build up to more complex scripts, you can learn JavaScript programming. By the time you finish this book, I predict here and now that you'll even be a little bit amazed at yourself and at what you can do.

What Can You Do with JavaScript?

The people I've taught to create web pages are a friendly bunch who enjoy writing to me to tell me how their pages are coming along. In many cases, they tell me they've hit the web page equivalent of a roadblock. That is, there's a certain thing they want to do, but they don't know how to do it in HTML. So I end up getting lots of questions like these:

- » How do I display one of those pop-up boxes?
- » How do I add content to the page on-the-fly?
- » How can I make something happen when a user clicks a button?
- » How can I make an image change when the mouse hovers over it?
- » How can I calculate the total for my order form?

For each question, the start of the answer is always this: "Sorry, but you can't do that using HTML; you have to use JavaScript instead." I then supply them with a bit of code that they can "cut and paste" into their web pages and then get on with their lives.

If you're just getting started with JavaScript, then my goal in this book is to help you to move from "cut-and-paste" to "code-and-load." That is, you'll end up being able to create your own scripts to solve your own unique HTML and web page problems. I hope to show you that learning JavaScript is worthwhile because there are many other things you can do with it:

- » You can ask a web server for data and then display that data on your page.
- » You can add, modify, or remove page text, HTML tags, and even CSS properties.

- » You can display messages to the user and ask the user for info.
- » You can “listen” for and then perform actions based on events such as visitors clicking their mouse or pressing a key.
- » You can send the user’s browser to another page.
- » You can validate the values in a form before submitting it to the server. For example, you can make sure that certain fields are filled in.
- » You can collect, save, and retrieve data for each of your users, such as site customizations.

In this book, you learn how to do all these things and many more.

What Can’t You Do with JavaScript?

JavaScript is good, but it’s not that good. JavaScript can do many things, but there’s a long list of things that it simply can’t do. Here’s a sampling:

- » It can’t write data permanently to an existing file. For example, you can’t take the data from a guest book and add it to a page that displays the messages.
- » It can’t access files on the server.
- » It can’t glean any information about the user, including email or IP addresses.
- » It can’t submit credit card-based purchases for authorization and payment.
- » It can’t create multiplayer games.
- » It can’t get data directly from a server database.
- » It can’t handle file uploads.

The reason JavaScript can’t do most of these things is that it’s what’s known in the trade as a *client-side* programming language, which means that it runs on the user’s browser (which programming types like to call a *client*).

There are so-called *server-side* JavaScript tools that can do some of these things, but they’re super-sophisticated and therefore beyond the scope here. The good news is that many of the items in the above list are doable using PHP and MySQL, which I discuss later on. For now, though, just know that there are so many things that client-side JavaScript can do that you’ll have no trouble being as busy as you want to be.

What Do You Need to Get Started?

One of the nicest things about HTML and CSS is that the hurdles you have to leap to get started are not only short, but few in number. In fact, you really need only two things, both of which are free: a text editor to enter the text, tags, and properties, and a browser to view the results. (You'll also need a web server to host the finished pages, but the server isn't necessary when you're creating the pages.) Yes, there are high-end HTML editors and fancy graphics programs, but these fall into the "Bells and Whistles" category and you can create perfectly respectable web pages without them.

The basic requirements for JavaScript programming are exactly the same as for HTML: a text editor and a browser. Again, there are programs available to help you write and test your scripts, but you don't need them.

To learn more, check out Book 1, Chapter 2.

Basic Script Construction

Okay, that's more than enough theory. It's time to roll up your sleeves, crack your knuckles, and start coding. This section describes the standard procedure for constructing and testing a script. You'll see a working example that you can try out, and later you'll move on to other examples that illustrate some JavaScript techniques that you'll use throughout this book.

The `<script>` tag

The basic container for a script is, naturally enough, the HTML `<script>` tag and its associated `</script>` end tag:

```
<script>
    JavaScript statements go here
</script>
```



TECHNICAL
STUFF

In HTML5 you can use `<script>` without any attributes, but before HTML5 the tag would look like this:

```
<script type="text/javascript">
```

The `type` attribute told the browser the programming language being used in the script, but JavaScript is the default now, so you no longer need it. You still see the

`<script>` tag with the `type` attribute used on a ton of pages, so I thought I better let you know what it means.

Handling browsers with JavaScript turned off

You don't have to worry about web browsers not being able to handle JavaScript, because all modern browsers have supported JavaScript for a very long time. However, you might want to worry about people who don't support JavaScript. Although rare, some folks have turned off their browser's JavaScript functionality. Why would someone do such a thing? Many people disable JavaScript because they're concerned about security, they don't want cookies written to their hard drives, and so on.

To handle these iconoclasts, place the `<noscript>` tag within the body of the page:

```
<noscript>
  <p>
    Hey, your browser has JavaScript turned off!
  </p>
  <p>
    Okay, cool, perhaps you'll prefer this <a href="no-js.
    html">non-JavaScript version</a> of the page.
  </p>
</noscript>
```

If the browser has JavaScript enabled, the user sees none of the text within the `<noscript>` tag. However, if JavaScript is disabled, the text and tags within the `<noscript>` tag are displayed to the user.

Where do you put the `<script>` tag?

With certain exceptions, it doesn't matter a great deal where you put your `<script>` tag. Some people place the tag between the page's `</head>` and `<body>` tags. The HTML standard recommends placing the `<script>` tag within the page header (that is, between `<head>` and `</head>`), so that's the style I use in this book:

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf-8">
    <title>Where do you put the script tag?</title>
```

```
<script>
    JavaScript statements go here
</script>
</head>
<body>
</body>
</html>
```

Here are the exceptions to the put-your-script-anywhere technique:

- » If your script is designed to write data to the page, the `<script>` tag must be positioned within the page body (that is, between the `<body>` and `</body>` tags) in the exact position where you want the text to appear.
- » If your script refers to an item on the page (such as a form object), then the script must be placed *after* that item.
- » With many HTML tags, you can add one or more JavaScript statements as attributes directly within the tag.



REMEMBER

It's perfectly acceptable to insert multiple `<script>` tags within a single page, as long as each one has a corresponding `</script>` end tag, and as long as you don't put one `<script>` block within another one.

Example #1: Displaying a message to the user

You're now ready to construct and try out your first script. This example shows you the simplest of all JavaScript actions: displaying a simple message to the user. The following code shows the script within an HTML file.

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8">
    <title>Displaying a Message to the User</title>
    <script>
        alert("Hello Web Coding World!");
    </script>
</head>
<body>
</body>
</html>
```

As shown in here, place the script within the header of a page, save the file, and then open the HTML file within your browser.

This script consists of just a single line:

```
alert("Hello Web Coding World");
```

This is called a *statement*, and each statement is designed to perform a single JavaScript task. You might be wondering about the semicolon (;) that appears at the end of the statement. Good eye. You use the semicolon to mark the end of each of your JavaScript statements.

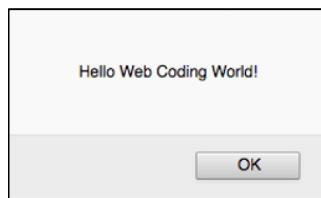
Your scripts will range from simple programs with just a few statements, to huge projects consisting of hundreds of statements. In the example, the statement runs the JavaScript `alert()` method, which displays to the user whatever message is enclosed within the parentheses (which could be a welcome message, an announcement of new features on your site, an advertisement for a promotion, and so on). Figure 1-1 shows the message that appears when you open the file.



TECHNICAL STUFF

A *method* is a special kind of JavaScript feature. I discuss methods in detail in Book 3, Chapter 8. For now, however, think of a method as a kind of action you want your code to perform.

FIGURE 1-1:
This “alert” message appears when you open the HTML file containing the example script.



How did the browser know to run the JavaScript statement? When a browser processes (*parses*, in the vernacular) a page, it basically starts at the beginning of the HTML file and works its way down, one line at a time, as I mention earlier. If it trips over a `<script>` tag, then it knows one or more JavaScript statements are coming, and it automatically executes those statements, in order, as soon as it reads them. The exception is when JavaScript statements are enclosed within a *function*, which I explain in Book 3, Chapter 5.



WARNING

One of the cardinal rules of JavaScript programming is “one statement, one line.” That is, each statement must appear on only a single line, and there should be no more than one statement on each line. I said “should” in the second part of the previous sentence because it is possible to put multiple statements on a single

line, as long as you separate each statement with a semicolon (;). There are rare times when it's necessary to have two or more statements on one line, but you should avoid it for the bulk of your programming because multiple-statement lines are difficult to read and to troubleshoot.

Example #2: Writing text to the page

One of JavaScript's most powerful features is the capability to write text and even HTML tags and CSS properties to the web page on-the-fly. That is, the text (or whatever) gets inserted into the page when a web browser loads the page. What good is that? For one thing, it's ideal for time-sensitive data. For example, you might want to display the date and time that a web page was last modified so that visitors know how old (or new) the page is. Here's some code that shows just such a script:

```
<!DOCTYPE html>
<html lang="en">
    <head>
        <meta charset="utf-8">
        <title>Writing Data to the Page</title>
    </head>
    <body>
        This is a regular line of text.<br>
        <script>
            document.write("This page was last modified on " +
            document.lastModified)
        </script>
        <br>This is another line of regular text.
    </body>
</html>
```

Notice how the script appears within the body of the HTML document, which is necessary whenever you want to write data to the page. Figure 1-2 shows the result.

FIGURE 1-2:
When you open the file, the text displays the date and time the file was last modified.

This is a regular line of text.
This page was last modified on 02/18/2018 15:35:47
This is another line of regular text.

This script makes use of the *Document object*, which is a built-in JavaScript construct that refers to whatever HTML file (document) the script resides in (see Book 3, Chapter 8 for more about this). The `document.write()` statement tells the browser to insert whatever is within the parentheses to the web page. The `document.lastModified` portion returns the date and time the file was last changed and saved.

Adding Comments to Your Code

A script that consists of just a few lines is usually easy to read and understand. However, your scripts won't stay that simple for long, and these longer and more complex creations will be correspondingly more difficult to read. (This difficulty will be particularly acute if you're looking at the code a few weeks or months after you first programmed it.) To help you decipher your code, it's good programming practice to make liberal use of comments throughout the script. A *comment* is text that describes or explains a statement or group of statements. Comments are ignored by the browser, so you can add as many as you deem necessary.

For short, single-line comments, use the double-slash (//). Put the // at the beginning of the line, and then type in your comment after it. Here's an example:

```
// Display the date and time the page was last modified
document.write("This page was last modified on " + document.
    lastModified)
```

You can also use // comments for two or three lines of text. If you have more than that, however, then you're better off using multiple-line comments that begin with the /* symbol and end with the */ symbol. Here's an example:

```
/*
This script demonstrates JavaScript's ability
to write text to the web page by using the
document.write() method to display the date and time
the web page file was last modified.

This script is Copyright 2018 Paul McFedries.
*/
```



WARNING

Although it's fine to add quite a few comments when you're just starting out, you don't have to add a comment to everything. If a statement is trivial or if what a statement does is glaringly obvious, forget the comment and move on.

Creating External JavaScript Files

Putting a script inside the page header isn't a problem if the script is relatively short. However, if your script (or scripts) take up dozens or hundreds of lines, it can make your HTML code look cluttered. Another problem you might run into is needing to use the same code on multiple pages. Sure, you can just copy the code into each page that requires it, but if you make changes down the road, you need to update every page that uses the code.

The solution to both problems is to move the code out of the HTML file and into an external JavaScript file. Moving the code reduces the JavaScript presence in the HTML file to a single line (as you'll see shortly), and means that you can update the code by editing only the external file.

Here are some things to note about using an external JavaScript file:

- » The file must use a plain text format.
- » Use the `.js` extension when you name the file.
- » Don't use the `<script>` tag within the file. Just enter your statements exactly as you would within an HTML file.
- » The rules for when the browser executes statements within an external file are identical to those used for statements within an HTML file. That is, statements outside of functions are executed automatically when the browser sees your file reference, and statements within a function aren't executed until the function is called.

To let the browser know that an external JavaScript file exists, add the `src` attribute to the `<script>` tag. For example, if the external file is named `myscripts.js`, then your `<script>` tag is set up as follows:

```
<script src="myscripts.js">
```

This example assumes the `myscripts.js` file is in the same directory as the HTML file. If the file resides in a different directory, adjust the `src` value accordingly. For example, if the `myscripts.js` file is in a subdirectory named `scripts`, you'd use this:

```
<script src="scripts/myscripts.js">
```

You can even specify a file from another site (presumably your own!) by specifying a full URL as the `src` value:

```
<script src="http://www.host.com/myscripts.js">
```

As an example, the following code shows a one-line external JavaScript file named `footer.js`:

```
document.write("Copyright " + new Date().getFullYear());
```

This statement writes the text “Copyright” followed by the current year. (I know: This code looks like some real gobbledegook right now. Don’t sweat it, because you learn exactly what’s going on here when I discuss the JavaScript Date object in Book 3, Chapter 8.)

The following code shows an HTML file that includes a reference for the external JavaScript file:

```
<!DOCTYPE html>
<html lang="en">
    <head>
        <meta charset="utf-8">
        <title>Using an External JS File</title>
    </head>
    <body>
        <hr>
        <footer>
            <script src="footer.js">
            </script>
        </footer>
    </body>
</html>
```

When you load the page, the browser runs through the HTML line by line. When it gets to the `<footer>` tag, it sees the external JavaScript file that’s referenced by the `<script>` tag. The browser loads that file and then runs the code within the file, which writes the Copyright message to the page, as you can see in Figure 1-3.

FIGURE 1-3:
This page uses
an external
JavaScript file to
display a footer
message.

Copyright 2018

IN THIS CHAPTER

- » Getting your head around variables
- » Assigning names to variables
- » Introducing JavaScript data types
- » Figuring out numbers
- » Stringing strings together

Chapter **2**

Understanding Variables

You should imagine variables as tentacles, rather than boxes. They do not contain values; they grasp them.

— MARIJN HAVERBEKE

You might have heard about — or perhaps even know — people who, through mishap or misfortune, have lost the ability to retain short-term memories. If you introduce yourself to one of these poor souls, he'll be asking you your name again five minutes later. These unfortunates live in a perpetual present, seeing the world anew every minute of every day.

What, I'm sure you're asking yourself by now, can any of the above possibly have to do with coding? Just that, by default, your JavaScript programs also live a life without short-term memory. The web browser executes your code one statement at a time, until there are no more statements left to process. It all happens in the perpetual present. Ah, but notice that, above, I said this lack of short-term memory was the “default” state of your scripts. It's not the only state, so that means things can be different. You have the power to give your scripts the gift of short-term memory, and you do that by using handy little chunks of code called variables. In this chapter, you delve into variables, which is a fundamental and crucial programming topic. You investigate what variables are, what you can do with them, and how to wield them in your JavaScript code.

What Is a Variable?

Why would a script need short-term memory? Because one of the most common concepts that crops up when coding is the need to store a temporary value for use later on. In most cases, you want to use that value a bit later in the same script. However, you might also need to use it in some other script, to populate an HTML form, or to get data from a server.

For example, your page might have a button that toggles the page text between a larger font size and the regular font size, so you need some way to “remember” that choice. Similarly, if your script performs calculations, you might need to set aside one or more calculated values to use later. For example, if you’re constructing a shopping cart script, you might need to calculate taxes on the order. To do that, you must first calculate the total value of the order, store that value, and then later take a percentage of it to work out the tax.

In programming, the way you save a value for later use is by storing it in a *variable*. A variable is a small chunk of computer memory that’s set aside for holding program data. The good news is that the specifics of how the data is stored and retrieved from memory happen well behind the scenes, so it isn’t something you ever have to worry about. As a coder, working with variables involves just three things:

1. Creating (or *declaring*) variables
2. Assigning values to those variables
3. Including the variables in other statements in your code

The next three sections fill in the details.

Declaring a variable

The process of creating a variable is called *declaring* in programming terms. All declaring really means is that you’re supplying the variable with a name and telling the browser to set aside a bit of room in memory to hold whatever value you end up storing in the variable. To declare a variable in JavaScript, you use the `var` keyword, followed by a space, the name of the variable, and the usual line-ending semicolon. For example, to declare a variable named `interestRate`, you’d use the following statement:

```
var interestRate;
```



REMEMBER

Although you're free to use a variable as many times as you need to within a script, only declare the variable once, and make sure that declaration occurs before any other uses of the variable. Declaring a variable more than once won't cause an error, but doing so is bad programming practice.

Storing a value in a variable

After your variable is declared, your next task is to give it a value. You use the assignment operator — the equal (=) sign — to store a value in a variable, as in this general statement:

```
variableName = value;
```

Here's an example that assigns the value `0.03` to a variable named `interestRate`:

```
interestRate = 0.03;
```

Note, too, that if you know the initial value of the variable in advance, you can combine the declaration and initial assignment into a single statement, like this:

```
var interestRate = 0.03;
```

It's important to remember that you're free to change a variable's value any time you want. (That's why it's called a *variable*, because its value can vary.) For example, if the value you assign to the `interestRate` variable is an annual rate, later on your code might need to work with a monthly rate, which is the annual rate divided by 12. Rather than calculate that by hand, just put it in your code using the division operator (/):

```
interestRate = 0.03 / 12;
```

As a final note about using variable assignment, take a look at a variation that often causes some confusion among new programmers. Specifically, you can set up a statement that assigns a new value to a variable by changing its existing value. Here's an example:

```
interestRate = interestRate / 12;
```

If you've never seen this kind of statement before, it probably looks a bit illogical. How can something equal itself divided by 12? The secret to understanding such a statement is to remember that the browser always evaluates the right side of the statement — that is, the expression to the right of the equal sign (=) — first. In other words, it takes the current value of `interestRate`, which is `0.03`, and divides it by 12. The resulting value is what's stored in `interestRate` when all is

said and done. For a more in-depth discussion of operators and expressions, see Book 3, Chapter 3.



REMEMBER

Because of this evaluate-the-expression-and-then-store-the-result behavior, JavaScript assignment statements shouldn't be read as "variable *equals* expression." Instead, it makes more sense to think of them as "variable *is set to* expression" or "variable *assumes the value given by* expression." Reading assignment statements this way helps to reinforce the important concept that the expression result is being stored in the variable.

Using variables in statements

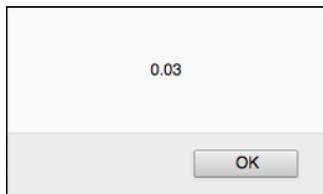
With your variable declared and assigned a value, you can then use that variable in other statements. When the browser sees the variable, it goes to the computer's memory, retrieves the current value of the variable, and then substitutes that value into the statement. The following code presents an example:

```
var interestRate;  
interestRate = 0.03;  
alert(interestRate);
```

This code declares a variable named `interestRate` and assigns the value `0.03` to that variable. The `alert()` statement then displays the current value of the variable, as shown in Figure 2-1.

FIGURE 2-1:

When you use a variable in a statement, such as the `alert()` statement in the example code, the browser substitutes the current value of that variable.



The following code shows a slightly different example:

```
var firstName;  
firstName = prompt("Please tell me your first name:");  
alert("Welcome to my website, " + firstName);
```

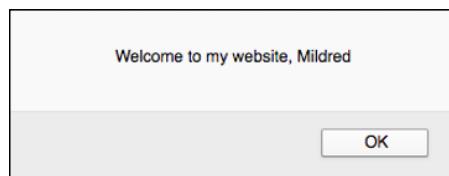
This script uses the `prompt()` method to ask the user to enter her first name, as shown in Figure 2-2. (To learn more about the `prompt()` method, see Book 3,

Chapter 7.) When the user clicks OK, her name is stored in the `firstName` variable. The script then uses an `alert()` statement to display a personalized welcome message using the value of the `firstName` variable, as shown in Figure 2-3.

FIGURE 2-2:
The script first prompts the user for her first name.



FIGURE 2-3:
The script then uses the name to display a personalized welcome message.



WARNING

In these early chapters, I use the `alert()` method quite often because it gives you an easy way to see the results of my example scripts. In practice, however, you'll use `alert()` only rarely because few users want to be pestered by dialog boxes throughout a site.

Naming Variables: Rules and Best Practices

If you want to write clear, easy-to-follow, and easy-to-debug scripts (and who doesn't?), you can go a long way toward that goal by giving careful thought to the names you use for your variables. This section helps by running through the rules you need to follow and by giving you some tips and guidelines for creating good variable names.

Rules for naming variables

JavaScript has only a few rules for variable names:

- » The first character must be a letter or an underscore (`_`). You can't use a number as the first character.

- » The rest of the variable name can include any letter, any number, or the underscore. You can't use any other characters, including spaces, symbols, and punctuation marks.
- » As with the rest of JavaScript, variable names are case sensitive. That is, a variable named `InterestRate` is treated as an entirely different variable than one named `interestRate`.
- » There's no limit to the length of the variable name.
- » You can't use one of JavaScript's *reserved words* as a variable name (such as `var`, `alert`, or `prompt`). All programming languages have a supply of words that are used internally by the language and that can't be used for variable names, because doing so would cause confusion (or worse).

Ideas for good variable names

The process of declaring a variable doesn't take much thought, but that doesn't mean you should just type in any old variable name that comes to mind. Take a few extra seconds to come up with a good name by following these guidelines:



REMEMBER

- » Make your names descriptive. Sure, using names that are just a few characters long makes them easier to type, but I guarantee you that you won't remember what the variables represent when you look at the script down the road. For example, if you want a variable to represent an account number, use `accountNumber` or `accountNum` instead of, say, `acnm` or `accnum`.
- » Although it's best to avoid single-letter variable names, such short names are accepted in some places, such as when constructing loops as described in Book 3, Chapter 4.
- » The best way to create a descriptive variable name is to use multiple words. However, because JavaScript doesn't take kindly to spaces in names, you need some way of separating the words to keep the name readable. The two standard conventions for using multi-word variable names are *camelCase*, where you cram the words together and capitalize all but the first word (for example, `lastName`), or to separate each word with a dash (for example, `last-name`). I prefer the former style, so I use it throughout this book.
- » Use one naming convention for JavaScript variables and a different one for HTML identifiers and CSS classes. For example, if you use *camelCase* for JavaScript variables, use dashes for `id` values and class names.
- » Try to make your variable names look as different from JavaScript's keywords and other built-in terms (such as `alert`) as possible. Differentiating variable

names helps avoid the confusion that can arise when you look at a term and you can't remember if it's a variable or a JavaScript word.

- » Although short, cryptic variable names are to be shunned in favor of longer, descriptive names, that doesn't mean you should be using entire sentences. Extremely long names are inefficient because they take so long to type, and they're dangerous because the longer the name, the more likely you are to make a typo. Names of 2 to 4 words and 8 to 20 characters should be all you need.

Understanding Literal Data Types

In programming, a variable's *data type* specifies what kind of data is stored within the variable. The data type is a crucial idea because it determines not only how two or more variables are combined (for example, mathematically), but also whether they can be combined at all. *Literals* are a special class of data type, and they cover those values that are fixed (even if only temporarily). For example, consider the following variable assignment statement:

```
todaysQuestion = "What color is your parachute?";
```

Here, the text "What color is your parachute?" is a literal string value. JavaScript supports three kinds of literal data types: numeric, string, and Boolean. The next three sections discuss each type.

Working with numeric literals

Unlike many other programming languages, JavaScript treats all numbers the same, so you don't have to do anything special when working with the two basic numeric literals, which are integers and floating-point numbers:

- » **Integers:** These are numbers that don't have a fractional or decimal part. So you represent an integer using a sequence of one or more digits, as in these examples:

```
0
42
2001
-20
```

» **Floating-point numbers:** These are numbers that do have a fractional or decimal part. Therefore, you represent a floating-point number by first writing the integer part, followed by a decimal point, followed by the fractional or decimal part, as in these examples:

```
0.07  
3.14159  
-16.666667  
7.6543e+21  
1.234567E-89
```

Exponential notation

The last two floating-point examples require a bit more explanation. These two use *exponential notation*, which is an efficient way to represent really large or really small floating-point numbers. Exponential notation uses an e (or E) followed by a plus sign (+) or a minus sign (-), followed by a number, which is called the *exponent*.

If the notation contains a plus sign, then you multiply the first part of the number (that is, the part before the e or E) by 10 to the power of the exponent. Here's an example:

```
9.87654e+5;
```

The exponent is 5, and 10 to the power of 5 is 100,000. So multiplying 9.87654 by 100,000 results in the value 987,654.

If the notation contains a minus sign, instead, then you divide the rest of the number by 10 to the power of the exponent. Here's an example:

```
3.4567e-4;
```

The exponent is 4, and 10 to the power of 4 is 10,000. So dividing 3.4567 by 10,000 results in the value .00034567.

JavaScript has a ton of built-in features for performing mathematical calculations. To get the scoop on these, head for Book 3, Chapter 8.



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When I mentioned earlier that JavaScript treats all numeric literals the same, what I really meant was that JavaScript treats the numeric literals as floating-point values. This is fine (after all, there's no practical difference between 2 and 2.0), but it does put a limit on the maximum and minimum integer values that you can work with safely. The maximum is 9007199254740992 and the minimum

is `-9007199254740992`. If you use numbers outside of this range (unlikely, but you never know), JavaScript won't be able to maintain accuracy.

Hexadecimal integer values

You'll likely deal with the usual decimal (base-10) number system throughout most of your JavaScript career. However, just in case you have cause to work with hexadecimal (base-16) numbers, this section shows you how JavaScript deals with them.

The hexadecimal number system uses the digits 0 through 9 and the letters A through F (or a through f), where these letters represent the decimal numbers 10 through 15. So, what in the decimal system would be 16 is actually 10 in hexadecimal. To specify a hexadecimal number in JavaScript, begin the number with a `0x` (or `0X`), as shown in the following examples:

```
0x23;  
0xff;  
0X10ce;
```

Working with string literals

A *string literal* is a sequence of one or more letters, numbers, or punctuation marks, enclosed either in double quotation marks (`"`) or single quotation marks (`'`). Here are some examples:

```
"Web Coding and Development";  
'August 23, 1959';  
"";  
"What's the good word?";
```



REMEMBER

Using quotation marks within strings

The last example in the previous section shows that it's okay to insert one or more instances of one of the quotation marks (such as `'`) inside a string that's enclosed by the other quotation mark (such as `"`). Being able to nest quotation marks comes in handy when you need to embed one string inside another, which is very common (particularly when using bits of JavaScript within HTML tags). Here's an example:

```
onsubmit="processForm('testing');
```

However, it's illegal to insert in a string one or more instances of the same quotation mark that encloses the string, as in this example:

```
"This is "illegal" in JavaScript.";
```

Understanding escape sequences

However, what if you must include, say, a double quotation mark within a string that's enclosed by double quotation marks? Having to nest the same type of quotation mark is rare, but it is possible if you precede the double quotation mark with a backslash (\), like this:

```
"The double quotation mark (\") encloses this string.";
```

The \" combination is called an *escape sequence*. You can combine the backslash with a number of other characters to form other escape sequences, and each one enables the browser to represent a character that, by itself, would be illegal or not representable otherwise. Table 2-1 lists the most commonly used escape sequences.

TABLE 2-1

Common JavaScript Escape Sequences

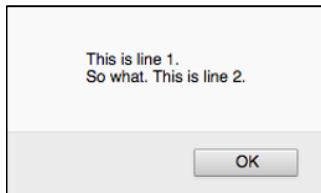
| Escape Sequence | Character It Represents |
|-----------------|-------------------------|
| \' | Single quotation mark |
| \" | Double quotation mark |
| \b | Backspace |
| \f | Form feed |
| \n | New line |
| \r | Carriage return |
| \t | Tab |
| \\" | Backslash |

The following code shows an example script that uses the \n escape sequence to display text on multiple lines with an alert box.

```
alert("This is line 1.\nSo what. This is line 2.");
```

Figure 2-4 shows the result.

FIGURE 2-4:
Using the `\n` escape sequence
enables you to
format text so
that it displays on
different lines.



To learn how to combine two or more string literals, check out Book 3, Chapter 3. Also, JavaScript has a nice collection of string manipulation features, which I discuss in Book 3, Chapter 8.

Working with Boolean literals

Booleans are the simplest of all the literal data types because they can assume only one of two values: `true` or `false`. That simplicity might make it seem as though Booleans aren't particularly useful, but the capability to test whether a particular variable or condition is true or false is invaluable in JavaScript programming.

You can assign Boolean literals directly to a variable, like this:

```
taskCompleted = true;
```

Alternatively, you can work with Boolean values implicitly using expressions:

```
currentMonth === "August"
```

The comparison expression `currentMonth === "August"` asks the following: Does the value of the `currentMonth` variable equal the string "August"? If it does, the expression evaluates to the Boolean value `true`; if it doesn't, the expression evaluates to `false`. I discuss much more about comparison expressions in Book 3, Chapter 3.

JavaScript Reserved Words

As I mention earlier, JavaScript has a bunch of reserved words that you need to avoid when naming your variables. Table 2-2 presents a list of the JavaScript keywords. It's illegal to use any of these words as variable or function names.

TABLE 2-2 JavaScript's Reserved Words

| | | | |
|----------|------------|----------|--------------|
| abstract | boolean | break | byte |
| case | catch | char | class |
| const | continue | debugger | default |
| delete | do | double | else |
| enum | export | extends | false |
| final | finally | float | for |
| function | goto | if | import |
| in | instanceof | int | long |
| native | new | null | return |
| short | super | switch | synchronized |
| this | throw | throws | transient |
| true | try | typeof | var |
| void | volatile | while | with |
| yield | | | |

JavaScript Keywords

Table 2-3 presents the complete list of keywords used in JavaScript and HTML that you should avoid using for variable and function names.

TABLE 2-3 JavaScript and HTML Keywords

| | | | |
|--------------------|---------------|---------------|--------------|
| alert | all | anchor | anchors |
| area | Array | assign | blur |
| button | checkbox | clearInterval | clearTimeout |
| clientInformation | close | closed | confirm |
| constructor | crypto | Date | decodeURI |
| decodeURIComponent | defaultStatus | document | element |
| elements | embed | embeds | encodeURI |

| | | | |
|--------------------|-------------|---------------|-------------|
| encodeURIComponent | escape | eval | event |
| fileUpload | focus | form | forms |
| frame | frameRate | frames | function |
| hasOwnProperty | hidden | history | image |
| images | Infinity | innerHeight | innerWidth |
| isFinite | isNaN | isPrototypeOf | layer |
| layers | length | link | location |
| Math | mimeTypes | name | NaN |
| navigate | navigator | Number | Object |
| offscreenBuffering | onblur | onclick | onerror |
| onfocus | onkeydown | onkeypress | onkeyup |
| onload | onmousedown | onmouseover | onmouseup |
| onsubmit | open | opener | option |
| outerHeight | outerWidth | packages | pageXOffset |
| pageYOffset | parent | parseFloat | parseInt |
| password | pkcs11 | plugin | prompt |
| propertyIsEnum | prototype | radio | reset |
| screenX | screenY | scroll | secure |
| select | self | setInterval | setTimeout |
| status | String | submit | taint |
| text | textarea | top | toString |
| undefined | unescape | untaint | valueOf |

IN THIS CHAPTER

- » Understanding what expressions are
- » Figuring out numeric expressions
- » Tying up string expressions
- » Getting the hang of comparison expressions
- » Learning about logical expressions

Chapter 3

Building Expressions

It's not at all important to get it right the first time. It's vitally important to get it right the last time.

— DAVID THOMAS

The JavaScript variables described in the previous chapter can't do all that much by themselves. They don't become useful members of your web code community until you give them something productive to do. For example, you can assign values to them, use them to assign values to other variables, use them in calculations, and so on.

This productive side of variables in particular, and JavaScript-based web code in general, is brought to you by a JavaScript feature known as the expression. This chapter takes you through everything you need to know about expressions. You discover some expression basics and then you explore a number of techniques for building powerful expressions using numbers, strings, and Boolean values.

Understanding Expression Structure

To be as vague as I can be, an *expression* is a collection of symbols, words, and numbers that performs a calculation and produces a result. That's a nebulous definition, I know, so I'll make it more concrete.

When your check arrives after a restaurant meal, one of the first things you probably do is take out your smartphone and use the calculator to figure out the tip amount. The service and food were good, so you're thinking 20 percent is appropriate. With phone in hand, you tap in the bill total, tap the multiplication button, tap 20%, and then tap Equals. Voila! The tip amount appears on the screen and you're good to go.

A JavaScript expression is something like this kind of procedure because it takes one or more inputs, such as a bill total and a tip percentage, and combines them in some way — for example, by using multiplication. In expression lingo, the inputs are called *operands*, and they're combined by using special symbols called *operators*.

- » **Operand:** An input value for an expression. It is, in other words, the raw data that the expression manipulates to produce its result. It could be a number, a string, a variable, a function result (see Book 3, Chapter 5), or an object property (see Book 3, Chapter 8).
- » **Operator:** A symbol that represents a particular action performed on one or more operands. For example, the `*` operator represents multiplication, and the `+` operator represents addition. I discuss the various JavaScript operators throughout this chapter.

For example, here's an expression that calculates a tip amount and assigns the result to a variable:

```
tipAmount = billTotal * tipPercentage;
```

The expression is everything to the right of the equals sign (`=`). Here, `billTotal` and `tipPercentage` are the operands, and the multiplication sign (`*`) is the operator.



Expression results always have a particular data type — numeric, string, or Boolean. So when you're working with expressions, always keep in mind what type of result you need and then choose the appropriate operands and operators accordingly.



Another analogy I like to use for operands and operators is a grammatical one — that is, if you consider an expression to be a sentence, then the operands are the nouns (the things) of the sentence, and the operators are the verbs (the actions) of the sentence.

Building Numeric Expressions

Calculating a tip amount on a restaurant bill is a mathematical calculation, so you may be thinking that JavaScript expressions are going to be mostly mathematical. If I was standing in front of you and I happened to have a box of gold stars on me, then I'd certainly give you one because, yes, math-based expressions are probably the most common type you'll come across.

This type of calculation is called a *numeric expression*, and it combines numeric operands and arithmetic operators to produce a numeric result. This section discusses all the JavaScript arithmetic operators and shows you how best to use them to build useful and handy numeric expressions.

A quick look at the arithmetic operators

JavaScript's basic arithmetic operators are more or less the same as those found in your smartphone's calculator app or on the numeric keypad of your computer's keyboard, plus a couple of extra operators for more advanced work. Table 3-1 lists the basic arithmetic operators you can use in your JavaScript expressions. (In subsequent sections, I discuss each one in more detail.)

TABLE 3-1 The JavaScript Arithmetic Operators

| Operator | Name | Example | Result |
|----------|----------------|---------|--------|
| + | Addition | 10 + 4 | 14 |
| ++ | Increment | 10++ | 11 |
| - | Subtraction | 10 - 4 | 6 |
| - | Negation | -10 | -10 |
| -- | Decrement | 10-- | 9 |
| * | Multiplication | 10 * 4 | 40 |
| / | Division | 10 / 4 | 2.5 |
| % | Modulus | 10 % 4 | 2 |

JavaScript also comes with a few extra operators that combine some of the arithmetic operators and the assignment operator, which is the humble equal sign (=) that assigns a value to a variable. Table 3-2 lists these so-called *arithmetic assignment* operators.

TABLE 3-2

The JavaScript Arithmetic Assignment Operators

| Operator | Example | Equivalent |
|-----------------|---------------------|------------------------|
| <code>+=</code> | <code>x += y</code> | <code>x = x + y</code> |
| <code>-=</code> | <code>x -= y</code> | <code>x = x - y</code> |
| <code>*=</code> | <code>x *= y</code> | <code>x = x * y</code> |
| <code>/=</code> | <code>x /= y</code> | <code>x = x / y</code> |
| <code>^=</code> | <code>x ^= y</code> | <code>x = x ^ y</code> |
| <code>%=</code> | <code>x %= y</code> | <code>x = x % y</code> |

Using the addition (+) operator

You use the addition operator (+) to calculate the sum of two operands. The operands are usually of the numeric data type, which means they can be numeric literals, variables that store numeric values, or methods or functions that return numeric values. Here's an example:

```
widthMax = widthContent + widthSidebar + 100;
```

You could use such an expression in a web app when you need to know the maximum width to assign the app's container. In this case, you take the width of the app's content (represented by the `widthContent` variable), add the width of the app's sidebar (the `widthSidebar` variable), and then add the literal value 100 (which may be a value in pixels).

Using the increment (++) operator

One of the most common programming operations involves adding 1 to an existing value, such as a variable. This operation is called *incrementing* the value, and the standard way to write such a statement is as follows:

```
someVariable = someVariable + 1;
```

However, JavaScript offers a much more compact alternative that uses the increment operator (++):

```
++someVariable;
```

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THE PRE- AND POST-INCREMENT OPERATORS

If you need to increment the variable and then assign this new value to another variable, use the following form:

```
someVariable = ++anotherVariable;
```

This is exactly the same as the following two statements:

```
anotherVariable = anotherVariable + 1;  
someVariable = anotherVariable;
```

Because the `++` appears before the variable, it is often called the *pre-increment operator*. So far, so good. However, just to confuse you, JavaScript also supports a variation on this theme called the *post-increment operator*:

```
someVariable = anotherVariable++;
```

In this case, the `++` operator appears after the variable. Big whoop, right? Actually, there is a subtle but crucial difference. Take a look at the following two statements that do exactly the same thing as the post-increment operator:

```
someVariable = anotherVariable;  
anotherVariable = anotherVariable + 1;
```

As you can see, the first variable is set equal to the second variable and then the second variable is incremented.

Using the subtraction and negation (-) operators

The subtraction operator (`-`) subtracts the numeric value to the right of the operator from the numeric value to the left of the operator. For example, consider the following statements:

```
var targetYear = 2020;  
var birthYear = 1985;  
var yearsDifference = targetYear - birthyear;
```

The third statement subtracts 1985 from 2020 and the result — 35 — is stored in the `yearsDifference` variable.

The negation operator (-) is the same symbol, but it works in a totally different way. You use it as a kind of prefix by appending it to the front of an operand. The result is a new value that has the opposite sign of the original value. In other words, applying the negation operator to an operand is exactly the same as multiplying the operand by -1. This means the following two statements are identical:

```
negatedValue = -originalValue;  
negatedValue = originalValue * -1;
```

Using the decrement (--) operator

Another common programming operation is subtracting 1 from an existing variable or other operand. This operation is called *decrementing* the value, and the usual way to go about this is with a statement like this one:

```
thisVariable = thisVariable - 1;
```

However (you just knew there was going to be a however), JavaScript offers a much more svelte alternative that takes advantage of the decrement operator (--):

```
--thisVariable;
```

Using the multiplication (*) operator

The multiplication operator (*) multiplies two operands together. Here's an example:

```
var totalColumns = 8;  
var columnWidth = 100;  
var totalWidth = totalColumns * columnWidth;
```

You might use this code when you want to calculate the width taken up by a web page layout that uses multiple columns. This code assigns literal numeric values to the variables `totalColumns` and `columnWidth`. It then uses a numeric expression to multiply these two values together and assign the result to the `totalWidth` variable.

Using the division (/) operator

The division operator (/) divides one numeric value by another. You can show off at parties by remembering that the number to the left of the slash (/) is called the *dividend*, and the number to the right of the / is called the *divisor*:

```
dividend / divisor
```



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THE PRE- AND POST-DECREMENT OPERATORS

If you need to decrement the variable and then assign this new value to another variable, use the *pre-decrement* form:

```
thisVariable = --thatVariable;
```

This is the same as the following two statements:

```
thatVariable = thatVariable - 1;
thisVariable = thatVariable;
```

To assign the value of a variable to another variable and then decrement the first variable, use the *post-decrement* form:

```
thisVariable = thatVariable--;
```

Again, the following two statements do exactly the same thing:

```
thisVariable = thatVariable;
thatVariable = thatVariable - 1;
```

As you can see, the first variable is set equal to the second variable and then the second variable is decremented.

Here's an example:

```
var contentWidth = 600;
var windowHeight = 1200;
var contentRatio = contentWidth / windowHeight;
```

You can use this code to calculate the portion of the browser's window width that the page content is currently using. In this code, the variables `contentWidth` and `windowHeight` are assigned literal numeric values, and then a numeric expression divides the first of the values by the second, the result of which is stored in the `contentRatio` variable.



WARNING

Whenever you use the division operator, you must guard against cases where the divisor is 0. If that happens, your script will produce an `Infinity` result, which is almost certain to wreak havoc on your calculations. Before performing any division, your script should use an `if()` statement (see Book 3, Chapter 4) to

check whether the divisor is 0 and, if it is, to cancel the division or perform some kind of work-around.

Using the modulus (%) operator

The modulus operator (%) divides one number by another and then returns the remainder as the result:

```
dividend % divisor
```

For example, the following code stores the value 1 in the variable named myModulus because 5 (the myDivisor value) divides into 16 (the myDividend value) three times and leaves a remainder of 1:

```
var myDividend = 16;
var myDivisor = 5;
var myModulus = myDividend % myDivisor;
```

On a more practical level, suppose that you're trying to come up with a web page color scheme, and you want to use two colors that are complements of each other. Complementary means that the two hues are on the opposite side of the color wheel, so one way to calculate the second color is by adding 180 to the first color's hue value. That approach works when the hue of the first color is between 0 and 179, which give second color hue values between 180 and 359. However, an initial hue of 180, 181, and so on produces a second hue of 360, 361, and so on, which are illegal values. You can work around that issue by using a modulus expression like this:

```
complementaryColor = (originalColor + 180) % 360;
```

This statement adds 180 to the original color, but then uses % 360 to return the remainder when divided by 360 to avoid illegal values.

Using the arithmetic assignment operators

Your web coding scripts will often update the value of a variable by adding to it the value of some other operand. Here's an example:

```
totalInterestPaid = totalInterestPaid + monthlyInterestPaid
```

Coders are an efficiency-loving bunch, so the fact that the `totalInterestPaid` variable appears twice in that statement is like chewing tin foil to your average programmer. The JavaScript brain trust hate that kind of thing, too, so they came up with the addition assignment operator (`+=`):

```
totalInterestPaid += monthlyInterestPaid
```

Yep, this statement does exactly the same thing as the first one, but it does it with 19 fewer characters. Sweet!

If you need to subtract one operand from another, again you can do it the old-fashioned way:

```
housePrincipleOwing = housePrincipleOwing - monthlyPrincipalPaid
```

To avoid other coders laughing behind your back at your inefficiency, use the subtraction assignment operator (`-=`):

```
housePrincipleOwing -= monthlyPrincipalPaid
```



REMEMBER

Like the increment and decrement operators, the arithmetic assignment operators are designed to save wear-and-tear on your typing fingers and to reduce the size of your scripts, particularly if you use long variable names.

Building String Expressions

A string expression is one where at least one of the operands is a string, and the result of the expression is another string. String expressions are straightforward in the sense that there is only one operator to deal with: *concatenation* (`+`). You use this operator to combine (or *concatenate*) strings within an expression. For example, the expression `"Java" + "Script"` returns the string `"JavaScript"`. Note, however, that you can also use strings with the comparison operators discussed in the next section.

It's unfortunate that the concatenation operator is identical to the addition operator because this similarity can lead to some confusion. For example, the expression `2 + 2` returns the numeric value 4 because the operands are numeric. However, the expression `"2" + "2"` returns the string value 22 because the two operands are strings.



TIP

BREAKING UP LONG STATEMENTS

All your JavaScript statements should appear on a single line (see Book 3, Chapter 1). An exception to that rule is any statement that contains a long expression, which you can break into multiple lines as long as the break occurs immediately before or after an operator. For example, you can display a string expression in multiple lines as long as the break occurs immediately before or after the + operator, as in the following examples:

```
var message1 = "How did the fool and his money " +
    "get together in the first place?";
var message2 = "Never put off until tomorrow that which you "
    + "can put off until the day after tomorrow.;"
```

To further complicate matters, JavaScript will often convert numbers into strings depending on the context:

- » If the first operand in an expression is a string, JavaScript converts any number in the expression to a string. For example, the following expression returns the string 222:

```
"2" + 2 + 2
```

- » If the first two or more operands in an expression are numbers and the rest of the expression contains a string, JavaScript handles the numeric part of the expression first and then converts the result into a string. For example, the following expression returns the string 42 because the result of 2 + 2 is 4, which is then concatenated as a string to "2":

```
2 + 2 + "2"
```

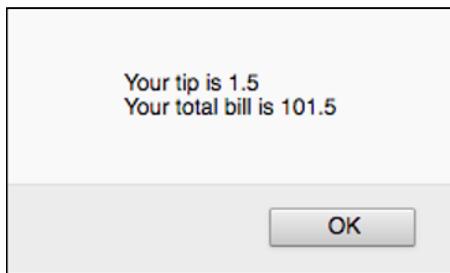
As an example of how this conversion can be a problem, consider the script in the following code.

```
var preTipTotal = 10.00;
var tipAmount = preTipTotal * 0.15;
var message1 = "Your tip is ";
var message2 = "\nYour total bill is ";
alert(message1 + tipAmount + message2 + preTipTotal +
    tipAmount);
```

The `preTipTotal` variable stores a total for a restaurant bill, and the `tipAmount` variable stores 15 percent of the total. The variables `message1` and `message2` are

initialized with strings, and then an alert box is displayed with the results. In particular, the expression `preTipTotal + tipAmount` is included in the `alert()` method to display the total bill. However, as you can see in Figure 3-1, the “total” displayed is actually 101.5 instead of 11.5 (10 plus 1.5 for the tip).

FIGURE 3-1:
When the result
is displayed,
the
`preTipTotal`
and `tipAmount`
values are
concatenated
instead of added.



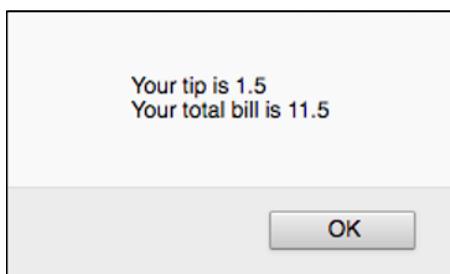
What happened here is that because the first part of the expression in the `alert()` method was a string, JavaScript converted the `preTipTotal` and `tipAmount` values to strings and concatenated them instead of adding them.

To fix this, you could perform the addition in a separate statement and then use only this sum in the `alert()` expression. The following code demonstrates this approach:

```
var preTipTotal = 10.00;
var tipAmount = preTipTotal * 0.15;
var totalBill = preTipTotal + tipAmount;
var message1 = "Your tip is ";
var message2 = "\nYour total bill is ";
alert(message1 + tipAmount + message2 + totalBill);
```

A new variable named `totalBill` is declared and is used to store the `preTipTotal + tipAmount` sum. `totalBill` is then used to display the sum in the `alert()` expression, which, as you can see in Figure 3-2, now displays the correct answer.

FIGURE 3-2:
Calculating
`preTipTotal`
and `tipAmount`
separately fixes
the problem.



Building Comparison Expressions

You use comparison expressions to compare the values of two or more numbers, strings, variables, properties, or function results. If the expression is true, the expression result is set to the Boolean value `true`; if the expression is false, the expression result is set to the Boolean value `false`. You'll use comparisons with alarming frequency in your JavaScript code, so it's important to understand what they are and how you use them.

The comparison operators

Table 3-3 summarizes JavaScript's comparison operators.

TABLE 3-3 The JavaScript Comparison Operators

| Operator | Name | Example | Result |
|--------------------|-----------------------|--------------------------|--------------------|
| <code>==</code> | Equal | <code>10 == 4</code> | <code>false</code> |
| <code>!=</code> | Not equal | <code>10 != 4</code> | <code>true</code> |
| <code>></code> | Greater than | <code>10 > 4</code> | <code>true</code> |
| <code><</code> | Less than | <code>10 < 4</code> | <code>false</code> |
| <code>>=</code> | Greater than or equal | <code>10 >= 4</code> | <code>true</code> |
| <code><=</code> | Less than or equal | <code>10 <= 4</code> | <code>false</code> |
| <code>===</code> | Identity | <code>"10" === 10</code> | <code>false</code> |
| <code>!==</code> | Non-identity | <code>"10" !== 10</code> | <code>true</code> |

Using the equal (==) operator

You use the equal operator (`==`) to compare the values of two operands. If both have the same value, then the comparison returns `true`; if the operands have different values, the comparison returns `false`.

For example, in the following statements the variables `booksRead` and `weeksPassed` contain the same value, so the expression `booksRead == weeksPassed` returns `true`:

```
var booksRead = 48;
var weeksPassed = 48;
var bookAWeek = booksRead == weeksPassed;
```



WARNING

One of the most common mistakes made by beginning and experienced JavaScript programmers alike is to use `=` instead of `==` in a comparison expression. If your script isn't working properly or is generating errors, one of the first things you should check is that your equal operator has two equal signs.

Using the not equal (`!=`) operator

You also use the not equal operator (`!=`) to compare the values of two operands, but in the opposite way. That is, if the operands have different values, the comparison returns `true`; if both operands have the same value, the comparison returns `false`.

In the following statements, for example, the variables `currentFontSize` and `defaultFontSize` contain different values, so the expression `currentFontSize != defaultFontSize` returns `true`:

```
var currentFontSize = 19;
var defaultFontSize = 16;
var weirdoFontSize = currentFontSize != defaultFontSize;
```

Using the greater than (`>`) operator

You use the greater than operator (`>`) to compare two operands to see if the operand to the left of `>` has a greater value than the operand to the right of `>`. If it does, then the expression returns `true`; otherwise, it returns `false`.

In the statements below, the value of the `contentWidth` variable is more than that of the `windowWidth` variable, so the expression `contentWidth > windowWidth` returns `true`:

```
var contentWidth = 1000;
var windowWidth = 800;
var tooBig = contentWidth > windowWidth;
```

Using the less than (`<`) operator

You use the less than operator (`<`) to compare two operands to see if the operand to the left of `<` has a lesser value than the operand to the right of `<`. If it does, then the expression returns `true`; otherwise, it returns `false`.

For example, in the statements that follow, the values of the kumquatsInStock and kumquatsSold variables are the same, so the expression kumquatsInStock < kumquatsSold returns false:

```
var kumquatsInStock = 3;  
var kumquatsSold = 3;  
var backordered = kumquatsInStock < kumquatsSold;
```

Using the greater than or equal (\geq) operator

You use the greater than or equal operator (\geq) to compare two operands to see if the operand to the left of \geq has a greater value than or an equal value to the operand to the right of \geq . If either or both of those comparisons get a thumbs up, then the expression returns true; otherwise, it returns false.

In the following statements, for example, the value of the score variable is more than that of the prize1Minimum variable and is equal to that of the prize2Minimum variable. Therefore, both the expressions score \geq prize1Minimum and score \geq prize2Minimum return true:

```
var score = 90;  
var prize1Minimum = 80;  
var prize2Minimum = 90;  
var getsPrize1 = score  $\geq$  prize1Minimum;  
var getsPrize2 = score  $\geq$  prize2Minimum;
```

Using the less than or equal (\leq) operator

You use the less than or equal operator (\leq) to compare two operands to see if the operand to the left of \leq has a lesser value than or an equal value to the operand to the right of \leq . If either or both of those comparisons get a nod of approval, then the expression returns true; otherwise, it returns false.

For example, in the following statements, the value of the defects variable is less than that of the defectsMaximumA variable and is equal to that of the defectsMaximumB variable. Therefore, both the expressions defects \leq defectsMaximumA and defects \leq defectsMaximumB return true:

```
var defects = 5  
var defectsMaximumA = 10  
var defectsMaximumB = 5
```

```
var getsBonus = defects <= defectsMaximumA  
var getsRaise = defects <= defectsMaximumB
```

The comparison operators and data conversion

In the previous examples, I used only numbers to demonstrate the various comparison operators. However, you can also use strings and Boolean values. These comparisons are straightforward if your expressions include only operands of the same data type; that is, if you compare two strings or two Booleans. (Although see my discussion of using strings in comparison expressions a bit later in this chapter.)



TECHNICAL STUFF

Things become less straightforward if you mix data types within a single comparison expression. In this case, you need to remember that JavaScript always attempts to convert each operand into a number before running the comparison. Here's how it works:

- » If one operand is a string and the other is a number, JavaScript attempts to convert the string into a number. For example, in the following statements the string "5" gets converted to the number 5, so the comparison `value1 == value2` returns true:

```
var value1 = "5"  
var value2 = 5  
var result = value1 == value2
```

If the string can't be converted to a number, then the comparison always returns false.

- » If one operand is a Boolean and the other is a number, JavaScript converts the Boolean to a number as follows:
 - `true` — This value is converted to 1.
 - `false` — This value is converted to 0.

For example, in the following statements, the Boolean `true` gets converted to the number 1, so the comparison `value1 == value2` returns true:

```
var value1 = true  
var value2 = 1  
var result = value1 == value2
```

- » If one operand is a Boolean and the other is a string, JavaScript converts the Boolean to a number as in the previous item, and it attempts to convert the string into a number. For example, in the following statements, the Boolean `false` is converted to the number 0 and the string "`0`" is converted to the number 0, so the comparison `value1 == value2` returns `true`:

```
var value1 = false  
var value2 = "0"  
var result = value1 == value2
```

If the string can't be converted to a number, then the comparison always returns `false`.

Using the identity (==) operator

The identity operator (`==`) checks whether two operands are identical, which means it checks not only that the operands' values are equal, but also that the operands are of the same data type. (Which is why the identity operator is also sometimes called the *strict equality operator*.)

For example, in the following statements, variable `albumName` contains a string and variable `albumReleaseDate` contains a number. These values are of different data types, so the expression `albumName == albumReleaseDate` returns `false`:

```
var albumName = "1984";  
var albumReleaseDate = 1984;  
var result = albumName == albumReleaseDate;
```

By comparison, if instead you used the equal operator (`=`), which doesn't check the operand data types, the expression `albumName = albumReleaseDate` would return `true`.



REMEMBER

So when should you use equal (`=`) and when should you use identity (`==`)? Many pro JavaScript coders ignore this question entirely and just use the identity operator all the time. You should, too.

Using the non-identity (!==) operator

The non-identity operator (`!=`) performs the opposite function, sort of. That is, it checks to see not only if the values of two operands are different, but it also checks to see whether the operand are of different data types. (Which is why the non-identity operator is also sometimes called the *strict inequality operator*.)

In the statements below, variable `hasBugs` contains the Boolean value `true` and variable `totalBugs` contains a number. These values are of different data types, so the expression `hasBugs !== totalBugs` returns `true`:

```
var hasBugs = true;
var totalBugs = 1;
var result = hasBugs !== totalBugs;
```

Using strings in comparison expressions

Comparison expressions involving only numbers hold few surprises, but comparisons involving only strings can sometimes raise an eyebrow or two. The comparison is based on alphabetical order, as you might expect, so “A” comes before “B” and “a” comes before “b.” Ah, but this isn’t your father’s alphabetical order. In JavaScript’s world, all the uppercase letters come before all the lowercase letters, which means that, for example, “B” comes before “a,” so the following expression would return `false`:

```
"a" < "B"
```

Another thing to keep in mind is that most string comparisons involve multiple-letter operands. In these situations, JavaScript compares each string letter-by-letter. For example, consider the following expression:

```
"Smith" < "Smyth"
```

The first two letters in each string are the same, but the third letters are different. The internal value of the `i` in `Smith` is less than the internal value of the `y` in `Smyth`, so the comparison above would return `true`. (Notice, too, that after a point of difference is found, JavaScript ignores the rest of the letters in each string.)

Also, a space is a legitimate character for comparison purposes, and its internal value comes before all other letters and symbols. In particular, if you compare two strings of different lengths, JavaScript will pad the shorter string with spaces so that it’s the same length as the longer string. Therefore, the following two expressions are equivalent:

```
"Marg" > "Margaret"
"Marg      " > "Margaret"
```

The second statement returns `false` because the fifth “letter” of the left operand is a space, whereas the fifth letter of “`Margaret`” is a.

Using the ternary (?:) operator



TECHNICAL
STUFF

Knowing the comparison operators also enables you to use one of my favorite expression tools, a complex but oh-so-handy item called the *ternary operator* (?:). Here's the basic syntax for using the ternary operator in an expression:

```
expression ? result_if_true : result_if_false
```

The *expression* is a comparison expression that results in a true or false value. In fact, you can use any variable, function result, or property that has a true or false Boolean value. The *result_if_true* is the value that the expression returns if the *expression* evaluates to true; the *result_if_false* is the value that the expression returns if the *expression* evaluates to false.



TIP

In JavaScript, by definition, the following values are the equivalent of false:

- » 0 (the number zero)
- » "" (the empty string)
- » null
- » undefined (which is, say, the “value” of an uninitialized variable)

Everything else is the equivalent of true.

Here's a simple example:

```
var screenWidth = 768;
var maxPortableWidth = 1024;
var screenType = screenWidth > maxPortableWidth ? "Desktop" :
    "Portable";
```

The variable `screenWidth` is initialized to 768, the variable `maxPortableWidth` is initialized to 1024, and the variable `screenType` stores the value returned by the conditional expression. For the latter, `screenWidth > maxPortableWidth` is the comparison expression, "Desktop!" is the string that is returned given a true result, and "Portable!" is the string that is returned given a false result. Since `screenWidth` is less than `maxPortableWidth`, the comparison will be false, so "Portable!" will be the result.

Building Logical Expressions

You use logical expressions to combine or manipulate Boolean values, particularly comparison expressions. For example, if your code needs to test whether two different comparison expressions are both true before proceeding, you can do that with a logical expression.

The logical operators

Table 3–4 lists JavaScript’s logical operators.

TABLE 3-4 The JavaScript Logical Operators

| Operator | Name | General Syntax | Returned Value |
|----------|------|-------------------------------------|---|
| && | AND | <code>expr1 && expr2</code> | true if both <code>expr1</code> and <code>expr2</code> are true; false otherwise. |
| | OR | <code>expr1 expr2</code> | true if one or both of <code>expr1</code> and <code>expr2</code> are true; false otherwise. |
| ! | NOT | <code>!expr</code> | true if <code>expr</code> is false; false if <code>expr</code> is true. |

Using the AND (&&) operator

You use the AND operator (`&&`) when you want to test two Boolean operands to see if they’re both true. For example, consider the following statements:

```
var finishedDinner = true;
var clearedTable = true;
var getsDessert = finishedDinner && clearedTable;
```

Since both `finishedDinner` and `clearedTable` are true, the logical expression `finishedDinner && clearedTable` evaluates to true.

On the other hand, consider these statements:

```
var haveWallet = true;
var haveKeys = false;
var canGoOut = haveWallet && haveKeys;
```

In this example, since `haveKeys` is `false`, the logical expression `haveWallet && haveKeys` evaluates to `false`. The logical expression would also return `false` if just `haveWallet` was `false` or if both `haveWallet` and `haveKeys` were `false`.

Table 3-5 lists the various operands you can enter and the results they generate (this is called a *truth table*).

TABLE 3-5 Truth Table for the AND (`&&`) Operator

| left_operand | right_operand | left_operand <code>&&</code> right_operand |
|--------------|---------------|--|
| true | true | true |
| true | false | false |
| false | true | false |
| false | false | false |

Using the OR (`||`) operator

You use the OR (`||`) operator when you want to test two Boolean operands to see if at least one of them is `true`. For example, consider the following statements:

```
var hasFever = true;
var hasCough = false;
var missSchool = hasFever || hasCough;
```

Since `hasFever` is `true`, the logical expression `hasFever || hasCough` evaluates to `true` since only one of the operands needs to be `true`. You get the same result if only `hasCough` is `true` or if both operands are `true`.

On the other hand, consider these statements:

```
var salesOverBudget = false;
var expensesUnderBudget = false;
var getsBonus = salesOverBudget || expensesUnderBudget;
```

In this example, since both `salesOverBudget` and `expensesUnderBudget` are `false`, the logical expression `salesOverBudget || expensesUnderBudget` evaluates to `false`.

Table 3-6 displays the truth table for the various operands you can enter.

TABLE 3-6**Truth Table for the OR (||) Operator**

| left_operand | right_operand | left_operand right_operand |
|--------------|---------------|-------------------------------|
| true | true | true |
| true | false | true |
| false | true | true |
| false | false | false |

Using the NOT (!) Operator

The NOT (!) operator is the logical equivalent of the negation operator (–) I cover earlier in this chapter. In this case, NOT returns the opposite Boolean value of an operand. For example, consider the following statements:

```
var dataLoaded = false;
var waitingForData = !dataLoaded;
```

dataLoaded is false, so !dataLoaded evaluates to true.

Table 3-7 displays the truth table for the various operands you can enter.

TABLE 3-7**Truth Table for the NOT (!) Operator**

| Operand | !Operand |
|---------|----------|
| true | false |
| false | true |

Advanced notes on the && and || operators

TECHNICAL
STUFF

I mention earlier that JavaScript defines various values that are the equivalent of false — including `0` and `""` — and that all other values are the equivalent of true. These equivalences means that you can use both the AND operator and the OR operator with non-Booleans values. However, if you plan on using non-Booleans, then you need to be aware of exactly how JavaScript evaluates these expressions.

Let's begin with an AND expression:

1. Evaluate the operand to the left of the AND operator.
2. If the left operand's value is `false` or is equivalent to `false`, return that value and stop; otherwise, continue with Step 3.
3. If the left operand's value is `true` or is equivalent to `true`, evaluate the operand to the right of the AND operator.
4. Return the value of the right operand.

This is quirky behavior, indeed, and there are two crucial concepts you need to bear in mind:

- » If the left operand evaluates to `false` or its equivalent, the right operand is *never* evaluated.
- » The logical expression returns the result of either the left or right operand, which means the expression might *not* return `true` or `false`; instead, it might return a value that's equivalent to `true` or `false`.

To try these concepts out, use the following code:

```
var v1 = true;
var v2 = 10;
var v3 = "testing";
var v4 = false;
var v5 = 0;
var v6 = "";
var leftOperand =
    eval(prompt("Enter the left operand (a value or
expression):", true));
var rightOperand =
    eval(prompt("Enter the right operand (a value or
expression):", true));
var result = leftOperand && rightOperand;
alert(result);
```

The script begins by declaring and initializing six variables. The first three (`v1`, `v2`, and `v3`) are given values equivalent to `true` and the last three (`v4`, `v5`, and `v6`) are given values equivalent to `false`. The script then prompts for a left operand and a right operand, which are then entered into an AND expression. The key here is that you can enter any value for each operand, or you can use the `v1` through `v6` variables to enter a comparison expression, such as `v2 > v5`. The use of `eval()` on the `prompt()` result ensures that JavaScript uses the expressions as they're entered.

Table 3-8 lists some sample inputs and the results they generate.

TABLE 3-8

Some Sample Results for the Previous Code

| left_operand | right_operand | left_operand && right_operand |
|--------------|---------------|-------------------------------|
| true | true | true |
| true | false | false |
| 5 | 10 | 10 |
| false | "Yo" | false |
| v2 | v5 | 0 |
| true | v3 | testing |
| v5 | v4 | 0 |
| v2 > v5 | v5 == v4 | true |

Like the AND operator, the logic of how JavaScript evaluates an OR expression is strange and needs to be understood, particularly if you'll be using operands that are true or false equivalents:

1. Evaluate the operand to the left of the OR operator.
2. If the left operand's value is true or is equivalent to true, return that value and stop; otherwise, continue with Step 3.
3. If the left operand's value is false or is equivalent to false, evaluate the operand to the right of the AND operator.
4. Return the value of the right operand.

Understanding Operator Precedence

Your JavaScript code will often use expressions that are blissfully simple: just one or two operands and a single operator. But, alas, “often” here doesn’t mean “mostly,” because many expressions you use will have a number of values and operators. In these more complex expressions, the order in which the calculations are performed becomes crucial. For example, consider the expression `3+5*2`. If you calculate from left to right, the answer you get is 16 (3+5 equals 8, and 8*2 equals 16). However, if you perform the multiplication first and then the addition,

the result is 13 (5*2 equals 10, and 3+10 equals 13). In other words, a single expression can produce multiple answers depending on the order in which you perform the calculations.

To control this ordering problem, JavaScript evaluates an expression according to a predefined *order of precedence*. This order of precedence lets JavaScript calculate an expression unambiguously by determining which part of the expression it calculates first, which part second, and so on.

The order of precedence

The order of precedence that JavaScript uses is determined by the various expression operators covered so far in this chapter. Table 3-9 summarizes the complete order of precedence used by JavaScript.

TABLE 3-9 The JavaScript Order of Precedence for Operators

| Operator | Operation | Order of Precedence | Order of Evaluation |
|--------------------------|--------------------------------------|---------------------|---------------------|
| <code>++</code> | Increment | First | R → L |
| <code>--</code> | Decrement | First | R → L |
| <code>-</code> | Negation | First | R → L |
| <code>!</code> | NOT | First | R → L |
| <code>*, /, %</code> | Multiplication, division, modulus | Second | L → R |
| <code>+,-</code> | Addition, subtraction | Third | L → R |
| <code>+</code> | Concatenation | Third | L → R |
| <code><, <=</code> | Less than, less than, or equal | Fourth | L → R |
| <code>>, >=</code> | Greater than, greater than, or equal | Fourth | L → R |
| <code>==</code> | Equal | Fifth | L → R |
| <code>!=</code> | Not equal | Fifth | L → R |
| <code>==!=</code> | Identity | Fifth | L → R |
| <code>!==</code> | Non-identity | Fifth | L → R |
| <code>&&</code> | AND | Sixth | L → R |
| <code> </code> | OR | Sixth | L → R |

| Operator | Operation | Order of Precedence | Order of Evaluation |
|---------------------------------|-----------------------|---------------------|---------------------|
| <code>:</code> | Ternary | Seventh | $R \rightarrow L$ |
| <code>=</code> | Assignment | Eighth | $R \rightarrow L$ |
| <code>+=, -=, and so on.</code> | Arithmetic assignment | Eighth | $R \rightarrow L$ |

For example, Table 3-9 tells you that JavaScript performs multiplication before addition. Therefore, the correct answer for the expression `=3+5*2` (just discussed) is 13.

Notice, as well, that some operators in Table 3-9 have the same order of precedence (for example, multiplication and division). Having the same precedence means that the order in which JavaScript evaluates these operators doesn't matter. For example, consider the expression `5*10/2`. If you perform the multiplication first, the answer you get is 25 (`5*10` equals 50, and `50/2` equals 25). If you perform the division first, you also get an answer of 25 (`10/2` equals 5, and `5*5` equals 25).

However, JavaScript does have a predefined order for these kinds of expressions, which is what the Order of Evaluation column tells you. A value of $L \rightarrow R$ means that operations with the same order of precedence are evaluated from left-to-right; $R \rightarrow L$ means the operations are evaluated from right-to-left.

Controlling the order of precedence

Sometimes you want to take control of the situation and override the order of precedence. That might seem like a decidedly odd thing to do, so perhaps an example is in order. As you probably know, you calculate the total cost of a retail item by multiplying the retail price by the tax rate, and then adding that result to the retail price:

```
Total Price = Retail Price + Retail Price * Tax Rate
```

However, what if you want to reverse this calculation? That is, suppose you know the final price of an item and, given the tax rate, you want to know the original (that is, pre-tax) price. Applying a bit of algebra to the preceding equation, it turns out that you can calculate the original price by dividing the total price by 1 plus the tax rate. So if the total price is \$11.00 and the tax rate is 10%, then you divide 11 by 1.1 and get an answer of \$10.00.

Okay, now I'll convert this calculation to JavaScript code. A first pass at the new equation might look something like this:

```
retailPrice = totalPrice / 1 + taxRate;
```

The following code implements this formula and Figure 3-3 shows the result:

```
var totalPrice = 11.00;
var taxRate = .1;
var retailPrice = totalPrice / 1 + taxRate;
alert("The pre-tax price is " + retailPrice);
```

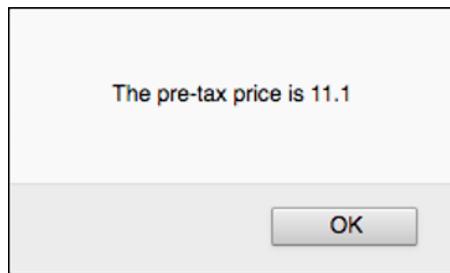


FIGURE 3-3:
The result of
our first stab at
calculating the
pre-tax cost
of an item.

As you can see, the result is incorrect. What happened? Well, according to the rules of precedence, JavaScript performs division before addition, so the totalPrice value first is divided by 1 and then is added to the taxRate value, which isn't the correct order.

To get the correct answer, you have to override the order of precedence so that the addition `1 + taxRate` is performed first. You override precedence by surrounding that part of the expression with parentheses, as shown in the following code. Using this revised script, you get the correct answer, as shown in Figure 3-4.

```
var totalPrice = 11.00;
var taxRate = .1;
var retailPrice = totalPrice / (1 + taxRate);
alert("The pre-tax price is " + retailPrice);
```



WARNING

One of the most common mistakes when using parentheses in expressions is to forget to close a parenthetical term with a right parenthesis. To make sure you've closed each parenthetical term, count all the left parentheses and count all the right parentheses. If these totals don't match, you know you've left out a parenthesis.

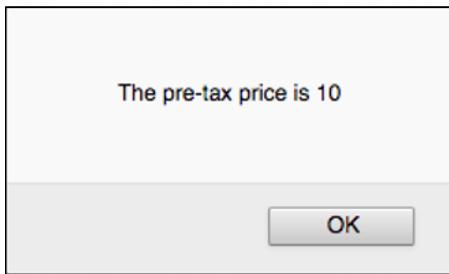


FIGURE 3-4:
The revised
script calculates
the pre-tax cost
correctly.

In general, you can use parentheses to control the order that JavaScript uses to calculate expressions. Terms inside parentheses are always calculated first; terms outside parentheses are calculated sequentially (according to the order of precedence). To gain even more control over your expressions, you can place parentheses inside one another; this is called *nesting* parentheses, and JavaScript always evaluates the innermost set of parentheses first.

Using parentheses to determine the order of calculations allows you to gain full control over JavaScript expressions. This way, you can make sure that the answer given by an expression is the one you want.

IN THIS CHAPTER

- » Understanding how you control the flow of JavaScript
- » Setting up your code to make decisions
- » Understanding code looping
- » Setting up code loops
- » Avoiding the dreaded infinite loop

Chapter 4

Controlling the Flow of JavaScript

In a minute there is time

For decisions and revisions which a minute will reverse.

— T. S. ELIOT

When the web browser comes across a `<script>` tag, it puts on its JavaScript hat and starts processing the statements. Not surprisingly, the browser doesn't just leap randomly around the script, parsing the statements willy-nilly. That would be silly. No, the browser puts its head down and starts processing the statements one at a time: the first statement, the second statement, and so on until there's no more JavaScript left to parse.

That linear statement-by-statement progression through the code makes sense, but it doesn't fit every situation. Sometimes you want your code to test some condition and then run different chunks of code depending on the result of that test. Sometimes you want your code to repeat a collection of statements over and over again, with some subtle or significant change occurring with each repetition. Code that runs tests and code that repeats itself all fall under the rubric of controlling the flow of JavaScript. In this chapter, you dive into this fascinating and powerful subject.

Understanding JavaScript's Control Structures

There are lots of sites on the web that offer widgets and doodads that you can link to (or sometimes download) to add functionality to your web pages. Easy? For sure. Fast? Absolutely. Recommended? Nope. That's because those doohickeys are black boxes where the code is hidden and unchangeable (at least by the likes of you and me). That, in turn, means you lose out on one of the main advantages of writing your own JavaScript code: that you end up with complete and exquisite control over what your code does and how it performs its tasks.

There are many ways to exert such control over your code, but there are two that you'll find to be the most useful and powerful. The first of these are JavaScript statements that make decisions based on certain conditions, and then depending on the results of those decisions, send your code branching one way or another. The second are JavaScript statements that perform loops, which means that they run one or more statements over and over again, and you control the number of times this happens. The JavaScript statements that handle this kind of processing are known as *control structures* to those in the trade.

Making True/False Decisions with if() Statements

A smart script performs tests on its environment and then decides what to do next based on the results of each test. For example, suppose you've written a function that uses one of its arguments as a divisor in an expression. You should test the argument before using it in the expression to make sure that it isn't 0.

The most basic test is the simple true/false decision (which could also be seen as a yes/no or an on/off decision). In this case, your program looks at a certain condition, determines whether it's currently true or false, and acts accordingly. Comparison and logical expressions (covered in Book 3, Chapter 3) play a big part here because they always return a true or false result.

In JavaScript, simple true/false decisions are handled by the `if()` statement. You can use either the *single-line* syntax:

```
if (expression) { statement };
```

or the *block* syntax:

```
if (expression) {
    statement1;
    statement2;
    ...
}
```

In both cases, *expression* is a comparison or logical expression that returns true or false, and *statement(s)* represent the JavaScript statement or statements to run if *expression* returns true. If *expression* returns false, JavaScript skips over the statements.



TIP



REMEMBER

This is a good place to note that JavaScript defines the following values as the equivalent of false: 0, "" (that is, the empty string), null, and undefined. Everything else is the equivalent of true.

This is the first time you've seen JavaScript's braces ({ and }), so let's take a second to understand what they do because they come up a lot. The braces surround one or more statements that you want JavaScript to treat as a single entity. This entity is a kind of statement itself, so the whole caboodle — the braces and the code they enclose — is called a *block statement*. Also, any JavaScript construction that consists of a statement (such as if()) followed by a block statement is called a *compound statement*. And, just to keep you on your toes, note that the lines that include the braces don't end with semicolons.

Whether you use the single-line or block syntax depends on the statements you want to run if the *expression* returns a true result. If you have only one statement, you can use either syntax. If you have multiple statements, use the block syntax.

Consider the following example:

```
if (totalSales != 0) {
    var grossMargin = (totalSales - totalExpenses) / totalSales;
}
```

This code assumes that earlier the script has calculated the total sales and total expenses, which are stored in the totalSales and totalExpenses variables, respectively. The code now calculates the gross margin, which is defined as gross profit (that is, sales minus expenses) divided by sales. The code uses if() to test whether the value of the totalSales variable is not equal to zero. If the total Sales != 0 expression returns true, then the grossMargin calculation is executed; otherwise, nothing happens. The if() test in this example is righteous because it ensures that the divisor in the calculation — totalSales — is never zero.

Branching with if()...else Statements

Using the `if()` statement to make decisions adds a powerful new weapon to your JavaScript arsenal. However, the simple version of `if()` suffers from an important drawback: A `false` result only bypasses one or more statements; it doesn't execute any of its own. This is fine in many cases, but there will be times when you need to run one group of statements if the condition returns `true` and a different group if the result is `false`. To handle this, you need to use an `if()...else` statement:

```
if (expression) {  
    statements-if-true  
} else {  
    statements-if-false  
}
```

The `expression` is a comparison or logical expression that returns `true` or `false`. `statements-if-true` represents the block of statements you want JavaScript to run if `expression` returns `true`, and `statements-if-false` represents the block of statements you want executed if `expression` returns `false`.

As an example, consider the following code:

```
var discountRate;  
if (currMonth === "December") {  
    discountRate = 0.2;  
} else {  
    discountRate = 0.1;  
}  
var discountedPrice = regularPrice * (1 - discountRate);
```

This code calculates a discounted price of an item, where the discount depends on whether the current month is December. The code assumes that earlier the script set the value of the current month (`currMonth`) and the item's regular price (`regularPrice`). After declaring the `discountRate` variable, an `if()...else` statement checks to see if `currMonth` equals December. If it does, `discountRate` is set to `0.2`; otherwise, `discountRate` is set to `0.1`. Finally, the code uses the `discountRate` value to calculate `discountedPrice`.



TIP

`if()...else` statements are much easier to read when you indent the statements within each block, as I've done in my examples. This lets you easily identify which block will run if there is a `true` result and which block will run if the result is `false`. I find that an indent of four spaces does the job, but many programmers prefer either two spaces or a tab.

The `if()...else` statements are very similar to the ternary operator (`?:`) that I discuss in Book 3, Chapter 3. In fact, for a very specific subset of `if()...else` statements, the two are identical.

The `:` operator evaluates a comparison expression and then returns one value if the expression is true, or another value if it's false. For example, if you have a variable named `currentHour` that contains the hour part of the current time of day, then consider the following statement:

```
var greeting = currentHour < 12 ? "Good morning!" : "Good day!";
```

If `currentHour` is less than 12, then the string `"Good morning!"` is stored in the `greeting` variable; otherwise, the string `"Good day!"` is returned. This statement does exactly the same thing as the following `if()...else` statements:

```
if (currentHour < 12) {
    greeting = "Good morning!";
} else {
    greeting = "Good day!";
}
```

The ternary operator version is clearly more efficient, both in terms of total characters typed and total lines used. So any time you find yourself testing a condition only to store something in a variable depending on the result, use a ternary operator statement instead of `if()...else`.

Making Multiple Decisions

The `if()...else` control structure makes only a single decision. The `if()` part calculates a single logical result and performs one of two actions. However, plenty of situations require multiple decisions before you can decide which action to take.

For example, to calculate the pre-tax price of an item given its total price and its tax rate, you divide the total price by the tax rate plus 1. In real-world web coding, one of your jobs as a developer is to make sure you're dealing with numbers that make sense. What makes sense for a tax rate? Probably that it's greater than or equal to 0 and less than 1 (that is, 100%). That's two things to test about any tax rate value in your code, and JavaScript offers multiple ways to handle this kind of thing.

Using the AND (??) and OR (||) operators

One solution to a multiple-decision problem is to combine multiple comparison expressions in a single `if()` statement. As I discuss in Book 3, Chapter 3, you can combine comparison expressions by using JavaScript's AND (??) and OR (||) operators.

The following code shows an example `if()` statement that combines two comparison expressions using the `&&` operator:

```
var retailPrice;
if (taxRate >= 0 && taxRate < 1) {
    retailPrice = totalPrice / (1 + taxRate);
    alert(retailPrice);
} else {
    alert("Please enter a tax rate between 0 and 1.");
}
```

The key here is the `if()` statement:

```
if (taxRate >= 0 && taxRate < 1);
```

This tells the browser that only if the `taxRate` value is greater than or equal to `0` and less than `1` should the statements in the true block be executed. If either one is `false` (or if both are `false`), the user sees the message in the false block instead.

Nesting multiple `if()` statements

There is a third syntax for the `if()...else` statement that lets you string together as many logical tests as you need:

```
if (expression1) {
    statements-if-expression1-true
} else if (expression2) {
    statements-if-expression2-true
}
etc.
else {
    statements-if-false
}
```

JavaScript first tests `expression1`. If `expression1` returns `true`, JavaScript runs the block represented by `statements-if-expression1-true` and skips over everything else. If `expression1` returns `false`, JavaScript then tests `expression2`. If

`expression2` returns `true`, JavaScript runs the block represented by `statements-if-expression2-true` and skips over everything else. Otherwise, JavaScript runs the block represented by `statements-if-false`. The second `if()` statement is said to be *nested* within the first `if()` statement.

The following code shows a script that uses a nested `if()` statement:

```
var greeting;
if (currentHour < 12) {
    greeting = "Good morning!";
} else if (currentHour < 18) {
    greeting = "Good afternoon!";
} else {
    greeting = "Good evening!";
}
alert(greeting);
```

The code assumes that earlier in the script the current hour value was stored in the `currentHour` variable. The first `if()` checks to see if `currentHour` is less than 12. If so, then the string "Good morning!" is stored in the `greeting` variable; if not, the next `if()` checks to see if `currentHour` less than 18 (that is, less than 6:00 PM). If so, then `greeting` is assigned the string "Good afternoon!"; if not, `greeting` is assigned "Good evening" instead.

Using the `switch()` statement

Performing multiple tests with `if()...else if` is a handy technique — it's a JavaScript tool you'll reach for quite often. However, it quickly becomes unwieldy as the number of tests you need to make gets larger. It's okay for two or three tests, but any more than that makes the logic harder to follow.

For situations where you need to make a whole bunch of tests (say, four or more), JavaScript's `switch()` statement is a better choice. The idea is that you provide an expression at the beginning and then list a series of possible values for that expression. For each possible result — called a *case* — you provide one or more JavaScript statements to execute should the case prove to be true. Here's the syntax:

```
switch(expression) {
    case Case1:
        Case1 statements
        break;
    case Case2:
        Case2 statements
        break;
```

```
etc.  
default:  
    Default statements  
}
```

The *expression* is evaluated at the beginning of the structure. It must return a value (numeric, string, or Boolean). *Case1*, *Case2*, and so on are possible values for *expression*. JavaScript examines each case value to see whether one matches the result of *expression*. If *expression* returns the *Case1* value, the code represented by *Case1 statements* is executed, and the `break` statement tells JavaScript to stop processing the rest of the `switch()` statement. Similarly, if *expression* returns the *Case2* value, the code represented by *Case2 statements* is executed, JavaScript stops processing the rest of the `switch()` statement. Finally, the optional `default` statement is used to handle situations where none of the cases matches *expression*, so JavaScript executes the code represented by *Default statements*.

If you do much work with dates in JavaScript, it's likely that your code will eventually need to figure out how many days are in any month. There's no built-in JavaScript property or method that tells you this, so you need to construct your own code, as shown here:

```
var daysInMonth;  
switch(monthName) {  
    case "January":  
        daysInMonth = 31;  
        break;  
    case "February":  
        if (yearValue % 4 === 0) {  
            daysInMonth = 29;  
        }  
        else {  
            daysInMonth = 28;  
        }  
        break;  
    case "March":  
        daysInMonth = 31;  
        break;  
    case "April":  
        daysInMonth = 30;  
        break;  
    case "May":  
        daysInMonth = 31;  
        break;
```

```
case "June":  
    daysInMonth = 30;  
    break;  
case "July":  
    daysInMonth = 31;  
    break;  
case "August":  
    daysInMonth = 31;  
    break;  
case "September":  
    daysInMonth = 30;  
    break;  
case "October":  
    daysInMonth = 31;  
    break;  
case "November":  
    daysInMonth = 30;  
    break;  
case "December":  
    daysInMonth = 31;  
}
```

This code assumes that the variable `monthName` is the name of the month you want to work with, and `yearValue` is the year. (You need the latter to know when you're dealing with a leap year.) The `switch()` is based on the name of the month:

```
switch(monthName)
```

Then case statements are set up for each month. For example:

```
case "January":  
    daysInMonth = 31;  
    break;
```

If `monthName` is "January", this case is true and the `daysInMonth` variable is set to 31. All the other months are set up the same, with the exception of February:

```
case "February":  
    if (yearValue % 4 === 0) {  
        daysInMonth = 29;  
    }  
    else {  
        daysInMonth = 28;  
    }  
    break;
```

Here you need to know whether you're dealing with a leap year, so the modulus (%) operator checks to see if `yearValue` is divisible by four. If so, it's a leap year, so `daysInMonth` is set to 29; otherwise, it's set to 28.



TECHNICAL STUFF

Time geeks will no doubt have their feathers ruffled by my assertion that a year is a leap year if it's divisible by four. In fact, that only works for the years 1901 to 2099, which should take care of most people's needs. The formula doesn't work for 1900 and 2100 because, despite being divisible by 4, these years aren't leap years. The general rule is that a year is a leap year if it's divisible by 4 and it's not divisible by 100, unless it's also divisible by 400.

Understanding Code Looping

There are some who would say that the only real goal of the programmer should be to get the job done. As long as the code produces the correct result or performs the correct tasks in the correct order, everything else is superfluous. Perhaps, but *real* programmers know that the true goal of programming is not only to get the job done, but to get it done *as efficiently as possible*. Efficient scripts run faster, take less time to code, and are usually (not always, but usually) easier to read and troubleshoot.

One of the best ways to introduce efficiency into your coding is to avoid reinventing too many wheels. For example, consider the following code fragment:

```
var sum = 0;
var num = prompt("Type a number:", 1);
sum += Number(num);
num = prompt("Type a number:", 1);
sum += Number(num);
num = prompt("Type a number:", 1);
sum += Number(num);
alert("The total of your numbers is " + sum);
```

This code first declares a variable named `sum`. The code prompts the user for a number (see Book 3, Chapter 7 for a discussion of `prompt()` method) that gets stored in the `num` variable, adds that value to `sum`, and then repeats this prompt-and-sum routine two more times. (Note my use of the `Number()` function, which ensures that the value returned by `prompt()` is treated as a number rather than a string.) Finally, the sum of the three numbers is displayed to the user.

Besides being a tad useless, this code just reeks of inefficiency because most of the code consists of the following two lines appearing three times:

```
num = prompt("Type a number:", 1);
sum += Number(num);
```

Wouldn't it be more efficient if you put these two statements just once in the code and then somehow get JavaScript to repeat these statements as many times as necessary?

Why, yes, it would, and the good news is that not only is it possible to do this, but JavaScript also gives you a number of different methods to perform this so-called *looping*. I spend the rest of this chapter investigating each of these methods.

Using while() Loops

The most straightforward of the JavaScript loop constructions is the `while()` loop, which uses the following syntax:

```
while (expression) {
    statements
}
```

Here, *expression* is a comparison or logical expression (that is, an expression that returns `true` or `false`) that determines how many times the loop gets executed, and *statements* represents a block of statements to execute each time through the loop.

Essentially, JavaScript interprets a `while()` loop as follows: “Okay, as long as *expression* remains `true`, I’ll keep running through the loop statements, but as soon as *expression* becomes `false`, I’m out of there.”

Take a closer look at this. Here’s how a `while()` loop works:

1. Evaluate the *expression* in the `while()` statement.
2. If *expression* is `true`, continue with Step 3; if *expression* is `false`, skip to Step 5.
3. Execute each of the statements in the block.
4. Return to Step 1.
5. Exit the loop (that is, execute the next statement that occurs after the `while()` block).

The following code demonstrates how to use `while()` to rewrite the inefficient code I show in the previous section:

```
var sum = 0;
var counter = 1;
var num;
while (counter <= 3) {
    num = prompt("Type a number:", 1);
    sum += Number(num);
    counter++;
}
alert("The total of your numbers is " + sum);
```

To control the loop, the code declares a variable named `counter` and initializes it to 1, which means the expression `counter <= 3` is true, so the code enters the block, does the prompt-and-sum thing, and then increments `counter`. This is repeated until the third time through the loop when `counter` is incremented to 4, at which point the expression `counter <= 3` becomes false and the loop is done.



TIP

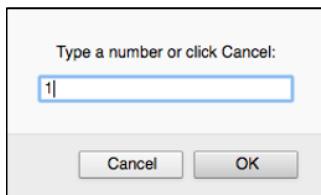
To make your loop code as readable as possible, always use a two- or four-space indent for each statement in the `while()` block. This also applies to the `for()` and `do...while()` loops that I talk about later in this chapter.

The `while()` statement isn't the greatest loop choice when you know exactly how many times you want to run through the loop. (For that, use the `for()` statement, described in the next section.) The best use of the `while()` statement is when your script has some naturally occurring condition that you can turn into a comparison expression. A good example is when you're prompting the user for input values. You'll often want to keep prompting the user until she clicks the Cancel button. The easiest way to set that up is to include the prompt inside a `while()` loop, as shown here:

```
var sum = 0;
var num = prompt("Type a number or click Cancel:", 1);
while (num != null) {
    sum += Number(num);
    num = prompt("Type a number or click Cancel:", 1);
}
alert("The total of your numbers is " + sum);
```

The first `prompt()` method displays a dialog box like the one shown in Figure 4-1 to get the initial value, and stores it in the `num` variable.

FIGURE 4-1:
When prompting the user for multiple values, set up your `while()` expression so that the prompting stops when the user clicks the Cancel button.



Then the `while()` statement checks the following expression:

```
while (num != null);
```

Two things can happen here:

- » If the user enters a number, this expression returns `true` and the loop continues. In this case, the value of `num` is added to the `sum` variable, and the user is prompted for the next number.
- » If the user clicks `Cancel`, the value returned by `prompt()` is `null`, so the expression becomes `false` and the looping stops.

Using `for()` Loops

Although `while()` is the most straightforward of the JavaScript loops, the most common type by far is the `for()` loop. This is slightly surprising when you consider (as you will shortly) that the `for()` loop's syntax is a bit more complex than that of the `while()` loop. However, the `for()` loop excels at one thing: looping when you know exactly how many times you want to repeat a group of statements. This is extremely common in all types of programming, so it's no wonder `for()` is so often seen in scripts.

The structure of a `for()` loop looks like this:

```
for (var counter = start; counterExpression; counter++) {  
    statements  
}
```

There's a lot going on here, so I take it one bit at a time:

- » *counter*: A numeric variable used as a *loop counter*. The loop counter is a number that counts how many times the procedure has gone through the loop. (Note that you only need to include `var` if this is the first time you've used the variable in the script.)
- » *start*: The initial value of *counter*. This is usually 1, but you can use whatever value makes sense for your script.
- » *counterExpression*: A comparison or logical expression that determines the number of times through the loop. This expression usually compares the current value of *counter* to some maximum value.
- » *counter++*: The increment operator applied to the *counter* variable. This can be any expression that changes the value of *counter*, and this expression is run after each turn through the loop.
- » *statements*: The statements you want JavaScript to execute each time through the loop.

When JavaScript sees the `for()` statement, it changes into its for-loop outfit and follows this seven-step process:

1. Set *counter* equal to *start*.
2. Evaluate the *counterExpression* in the `for()` statement.
3. If *counterExpression* is true, continue with Step 4; if *counterExpression* is false, skip to Step 7.
4. Execute each of the statements in the block.
5. Increment (or whatever) *counter*.
6. Return to Step 2.
7. Exit the loop (that is, execute the next statement that occurs after the `for()` block).

As an example, the following code shows how to use `for()` to rewrite the inefficient code shown earlier in this chapter:

```
var sum = 0;
var num;
for (var counter = 1; counter <= 3; counter++) {
    num = prompt("Type a number:", 1);
    sum += Number(num);
}
alert("The total of your numbers is " + sum);
```



REMEMBER

This is the most efficient version yet because the declaring, initializing, and incrementing of the counter variable all take place within the `for()` statement.

To keep the number of variables declared in a script to a minimum, always try to use the same name in all your `for()` loop counters. The letters `i` through `n` traditionally are used for counters in programming. For greater clarity, you might prefer full words such as `count` or `counter`.

Here's a slightly more complex example:

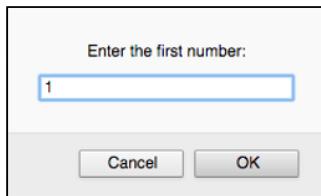
```
var sum = 0;
var num, ordinal;
for (var counter = 1; counter < 4; counter++) {
    switch (counter) {
        case 1:
            ordinal = "first";
            break;
        case 2:
            ordinal = "second";
            break;
        case 3:
            ordinal = "third";
    }
    num = prompt("Enter the " + ordinal + " number:", 1);
    sum += Number(num);
}
alert("The average is " + sum / 3);
```

The purpose of this script is to ask the user for three numbers and then to display the average of those values. The `for()` statement is set up to loop three times. (Note that `counter < 4` is the same as `counter <= 3`.) The first thing the loop block does is use `switch` to determine the value of the `ordinal` variable: If `counter` is 1, `ordinal` is set to "first", if `counter` is 2, `ordinal` becomes "second", and so on. These values enable the script to customize the `prompt()` message with each pass through the loop (see Figure 4-2). With each loop, the user enters a number and that value is added to the `sum` variable. When the loop exits, the average is displayed.

It's also possible to use `for()` to count down. You do this by using the decrement operator instead of the increment operator:

```
for (var counter = start; counterExpression; counter--) {
    statements
}
```

FIGURE 4-2:
This script uses the current value of the counter variable to customize the prompt message.



In this case, you must initialize the *counter* variable to the maximum value you want to use for the loop counter, and use the *counterExpression* to compare the value of *counter* to the minimum value you want to use to end the loop.

In the following example, I use a decrementing counter to ask the user to rank, in reverse order, his top three CSS colors:

```
var ordinal, color;
for (var rank = 3; rank >= 1; rank--) {
    switch (rank) {
        case 1:
            ordinal = "first";
            break;
        case 2:
            ordinal = "second";
            break;
        case 3:
            ordinal = "third";
    }
    color = prompt("What is your " + ordinal + "-favorite
CSS color?", "");
    document.write(rank + ". " + color + "<br>");
}
```

The `for()` loop runs by decrementing the `rank` variable from 3 down to 1. Each iteration of the loop prompts the user to type a favorite CSS color, and that color is written to the page, with the current value of `rank` being used to create a reverse-ordered list, as shown in Figure 4-3.

FIGURE 4-3:
The decrementing value of the rank variable is used to create a reverse-ordered list.

- 3. rebeccapurple
- 2. lemonchiffon
- 1. peachpuff



TIP

There's no reason why the `for()` loop counter has to be only incremented or decremented. You're actually free to use any expression to adjust the value of the loop counter. For example, suppose you want the loop counter to run through only the odd numbers 1, 3, 5, 7, and 9. Here's a `for()` statement that will do that:

```
for (var counter = 1; counter <= 9; counter += 2)
```

The expression `counter += 2` tells JavaScript to increment the counter variable by 2 each time.

Using `do...while()` Loops

JavaScript also has a third and final type of loop that I've left until the last because it isn't one that you'll use all that often. To understand when you might use it, consider this code snippet:

```
var num = prompt("Type a number or click Cancel:", 1);
while (num != null) {
    sum += Number(num);
    num = prompt("Type a number or click Cancel:", 1);
}
```

The code needs the first `prompt()` statement so that the `while()` loop's expression can be evaluated. The user may not feel like entering *any* numbers, and they can avoid it by clicking Cancel in the first prompt box so that the loop will be bypassed.

That seems reasonable enough, but what if your code requires that the user enter at least one value? The following presents one way to change the code to ensure that the loop is executed at least once:

```
var sum = 0;
var num = 0;
while (num !== null || sum === 0) {
    num = prompt("Type a number; when you're done, click
Cancel:", 1);
    sum += Number(num);
}
alert("The total of your numbers is " + sum);
```

The changes here are that the code initializes both `sum` and `num` as 0. This ensures that the `while()` expression — `num !== null || sum === 0` — returns true

the first time through the loop, so the loop will definitely execute at least once. If the user clicks Cancel right away, `sum` will still be `0`, so the `while()` expression — `num !== null || sum === 0` — still returns `true` and the loop repeats once again.

This works fine, but you can also turn to JavaScript's third loop type, which specializes in just this kind of situation. It's called a `do...while()` loop, and its general syntax looks like this:

```
do {  
    statements  
}  
while (expression);
```

Here, `statements` represents a block of statements to execute each time through the loop, and `expression` is a comparison or logical expression that determines how many times JavaScript runs through the loop.

This structure ensures that JavaScript executes the loop's statement block at least once. How? Take a closer look at how JavaScript processes a `do...while()` loop:

1. Execute each of the statements in the block.
2. Evaluate the `expression` in the `while()` statement.
3. If `expression` is `true`, return to Step 1; if `expression` is `false`, continue with Step 4.
4. Exit the loop.

For example, the following shows you how to use `do...while()` to restructure the prompt-and-sum code I show you earlier:

```
var sum = 0;  
var num;  
do {  
    num = prompt("Type a number; when you're done, click  
Cancel:", 1);  
    sum += Number(num);  
}  
while (num !== null || sum === 0);  
alert("The total of your numbers is " + sum);
```

This code is very similar to the `while()` code I show earlier in this section. All that's really changed is that the `while()` statement and its expression have been moved after the statement block so that the loop must be executed once before the expression is evaluated.

Controlling Loop Execution

Most loops run their natural course and then the procedure moves on. There might be times, however, when you want to exit a loop prematurely or skip over some statements and continue with the next pass through the loop. You can handle each situation with, respectively, the `break` and `continue` statements.

Exiting a loop using the `break` statement

You use `break` when your loop comes across some value or condition that would either prevent the rest of the statements from executing properly, or that satisfies what the loop was trying to accomplish. The following code demonstrates `break` with a simple example:

```
var sum = 0;
var num;
for (var counter = 1; counter <= 3; counter++) {
    num = prompt("Type a positive number:", 1);
    if (num < 0) {
        sum = 0;
        break;
    }
    sum += Number(num);
}
if (sum > 0) {
    alert("The average of your numbers is " + sum / 3);
}
```

This script sets up a `for()` loop to prompt the user for positive numbers. For the purposes of this section, the key code is the `if()` test:

```
if (num < 0) {
    sum = 0;
    break;
}
```

If the user enters a negative number, the `sum` variable is reset to 0 (to prevent the alert box from appearing later in the script). Also, a `break` statement tells JavaScript to bail out of the loop altogether.

Here's a more complex example:

```
var numberToGuess = Math.ceil(Math.random() * 10);
var promptMessage = "Guess a number between 1 and 10:";
```

```

var totalGuesses = 1;
var guess;

do {
    guess = Number(prompt(promptMessage, ""));
    if (guess === null) {
        break;
    } else if (guess === numberToGuess) {
        alert("You guessed it in " + totalGuesses +
            (totalGuesses === 1 ? " try." : " tries."));
        break;
    } else if (guess < numberToGuess) {
        promptMessage = "Sorry, your guess was too low. Try
again:";
    } else {
        promptMessage = "Sorry, your guess was too high. Try
again:";
    }
    totalGuesses++;
}
while (true);

```

This script is a game in which a number between 1 and 10 is generated and the user has to try and guess what it is. The first four lines set up some variables. The head-scratcher here is the expression for the `numberToGuess` variable. This uses a couple of methods of the `Math` object, which I discuss in Book 3, Chapter 8. For now, suffice it to say that this expression generates a random integer between (and including) 1 and 10.

Then a `do...while()` loop is set up with the following structure:

```

do {
    statements
}
while (true);

```

This tells JavaScript just to run the loop without bothering with a comparison expression. As you'll see, the loop itself will take care of exiting the loop by using the `break` statement.

Next the user is prompted to enter a guess, which is stored in the `guess` variable. The script then checks to see if `guess` equals `null`, which would mean the user clicked Cancel. If so, then `break` is used to stop the game by exiting the loop:

```
guess = Number(prompt(promptMessage, ""));
if (guess === null) {
    break;
}
```

Otherwise, a series of `if()` statements tests the guessed number against the actual number. The first one checks to see if they're the same. If so, a message is displayed and then another `break` statement exits the loop because the game is finished:

```
else if (guess === numberToGuess) {
    alert("You guessed it in " + totalGuesses +
        (totalGuesses === 1 ? " try." : " tries."));
    break;
}
```



TIP

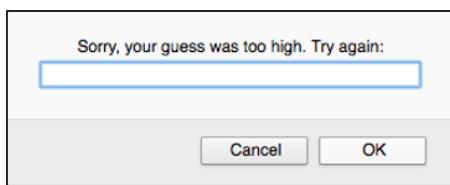
Notice that the `alert()` statement contains a ternary operator expression:

```
totalGuesses === 1 ? " try." : " tries."
```

This illustrates an extremely common programming situation: You have to display a word to the user, but that word may be either singular or plural depending on the value of some variable or expression. In this case, if `totalGuesses` equals 1, you want to display the word `try` (as in 1 `try`); if `totalGuesses` is more than 1, you want to display the word `tries` (as in 2 `tries`). This is what the conditional expression does.

The other two tests check to see if the guess was lower or higher than the actual number, and a message to that effect is displayed, as shown in Figure 4-4.

FIGURE 4-4:
When the user clicks Cancel or guesses the correct number, the `break` statement exits the loop.



Bypassing loop statements using the `continue` statement

The `continue` statement is similar to `break`, but instead of exiting a loop entirely, `continue` tells JavaScript to bypass the rest of the statements in the loop block and begin a new iteration of the loop.

A good use for `continue` is when you want the user to enter one or more values no matter what. If they click Cancel in the prompt box, you want the script to keep on looping until the user enters the correct number of values. The following code shows one way to do this:

```
var counter = 0;
var sum = 0;
var num;
while (counter < 3) {
    num = prompt("Type a number:", 1);
    if (num === null) {
        continue;
    }
    sum += Number(num);
    counter++;
}
alert("The average of your numbers is " + sum / 3);
```

Because you don't know in advance how many times the code will have to run through the loop, a `while()` loop is a better choice than a `for()` loop. You need to count the number of values entered, however, so a variable named `counter` is initialized for that purpose. The script requires three numbers, so the `while()` statement is set up to continue looping as long as `counter` is less than 3. The `prompt()` result is stored in the `num` variable, which is then tested:

```
if (num === null) {
    continue;
}
```

If the user enters a number, the `if()` expression returns `false` and the rest of the loop executes: `sum` is updated and `counter` is incremented.

However, if the user clicks Cancel, `num` equals `null`, so the `if()` expression returns `true`. What you want here is to keep looping, but you don't want the rest of the loop statements to execute. That's exactly what the `continue` statement accomplishes.

Avoiding Infinite Loops

Whenever you use a `while()`, `for()`, or `do...while()` loop, there's always the danger that the loop will never terminate. This is called an *infinite loop*, and it has been the bugbear of programmers for as long as people have been programming. Here are some notes to bear in mind to help you avoid infinite loops:

- » The statements in the `for()` block should never change the value of the loop counter variable. If they do, then your loop may either terminate prematurely or it may end up in an infinite loop.
- » In `while()` and `do...while()` loops, make sure you have at least one statement within the loop that changes the value of the comparison variable. (That is, the variable you use in the loop's comparison statement.) Otherwise, the statement might always return `true` and the loop will never end.
- » In `while()` and `do...while()` loops, never rely on the user to enter a specific value to end the loop. She might cancel the prompt box or do something else that prevents the loop from terminating.
- » If you have an infinite loop and you're not sure why, insert one or more `debugger` and/or `console.log()` statements within the loop statement block to display the current value of the counter or comparison variable. (Wondering what the heck "debugger" and "console.log" might be? I cover them in Book 3, Chapter 9.) This enables you to see what happens to the variable with each pass through the loop.

IN THIS CHAPTER

- » Getting to know JavaScript functions
- » Creating and using custom functions
- » Passing and returning function values
- » Understanding recursive functions
- » Introducing JavaScript's built-in functions

Chapter 5

Harnessing the Power of Functions

To iterate is human, to recurse divine.

— L. PETER DEUTSCH

As I demonstrate throughout this book, JavaScript comes with a huge number of built-in features that perform specific tasks. For example, something called the `Math` object has a built-in method for calculating the square root of a number. Similarly, a feature called the `String` object has a ready-made method for converting a string value to all lowercase letters.

There are, in fact, hundreds of these ready-to-roll features that perform tasks that range from the indispensable to the obscure. But JavaScript can't possibly do everything that you'd like or need it to do. What happens if your web development project requires a particular task or calculation that isn't part of the JavaScript language? Are you stuck? Not even close! The solution is to roll up your sleeves and then roll your own code that accomplishes the task or runs the calculation.

This chapter shows you how to create such do-it-yourself code. In the pages that follow, you explore the powerful and infinitely useful realm of custom functions, where you craft reusable code that performs tasks that out-of-the-box JavaScript can't do.

What Is a Function?

A *function* is a group of related JavaScript statements that are separate from the rest of the script and that perform a designated task. (Technically, a function can perform any number of chores, but as a general rule it's best to have each function focus on a specific task.) When your script needs to perform that task, you tell it to run the function.

Functions are also useful for those times when you need to control exactly when a particular task occurs (if ever). If you just enter some statements between your web page's `<script>` and `</script>` tags, the browser executes those statements automatically when the page loads. However, the statements within a function aren't executed by the browser automatically. Instead, the function doesn't execute until either your code asks the function to run, or some event occurs — such as the user clicking a button — and you've set up your page to run the function in response to that event.

The Structure of a Function

The basic structure of a function looks like this:

```
function functionName([arguments]) {  
    JavaScript statements  
}
```

Here's a summary of the various parts of a function:

- » **function**: Identifies the block of code that follows it as a function.
- » **functionName**: A unique name for the function. The naming rules and guidelines that I outline for variables in Book 3, Chapter 2 also apply to function names.
- » **arguments**: One or more optional values that are passed to the function and that act as variables within the function. Arguments (or *parameters*, as they're sometimes called) are typically one or more values that the function uses as the raw materials for its tasks or calculations. You always enter arguments between parentheses after the function name, and you separate multiple arguments with commas. If you don't use arguments, you must still include the parentheses after the function name.
- » **JavaScript statements**: This is the code that performs the function's tasks or calculations.



TIP

Notice how the *JavaScript statements* line in the example is indented slightly from the left margin. This is a standard and highly recommended programming practice because it makes your code easier to read. This example is indented four spaces, which is enough to do the job, but isn't excessive.

Note, too, the use of braces ({ and }). These are used to enclose the function's statements within a block, which tells you (and the browser) where the function's code begins and ends. There are only two rules for where these braces appear:

- » The opening brace must appear after the function's parentheses and before the first function statement.
- » The closing brace must appear after the last function statement.

There is no set-in-stone rule that specifies exactly where the braces appear. The positions used in the previous function syntax are the traditional ones, but you're free to try other positions, if you want. For example:

```
function functionName( [arguments] )
{
    JavaScript statements
}
```

Where Do You Put a Function?

For most applications, it doesn't matter where you put your functions, as long as they reside within a `<script>` block. However, one of the most common uses of functions is to handle events when they're triggered. It's possible that a particular event might fire when the page is loading, and if that happens before the browser has parsed the corresponding function, you could get strange results or an error. To prevent that, it's good practice to place the script containing all your functions within the page's header section (or within an external JavaScript file).

Note, as well, that you can add as many functions as you want within a single `<script>` block, but there are two things to watch out for:

- » Each function must have a unique name. In fact, all the functions that exist in or are referenced by a page must have unique names.
- » You can't embed one function inside another function.

Calling a Function

After your function is defined, you'll eventually need to tell the browser to execute it, or *call* it. There are three main ways to do this:

- » When the browser parses the `<script>` tag.
- » After the page is loaded.
- » In response to an event, such as the user clicking a button.

The next three sections cover each of these scenarios.

Calling a function when the `<script>` tag is parsed

The simplest way to call a function is to include in your script a statement consisting of only the function name, followed by parentheses (assuming for the moment that your function uses no arguments.) The following code provides an example. (I've listed the entire page so you can see where the function and the statement that calls it appear in the page code.)

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8">
    <title>Calling a function when the <script> tag is
parsed</title>
    <script>
        function displayGreeting() {
            var currentHour = new Date().getHours();
            if (currentHour < 12) {
                console.log("Good morning!");
            } else {
                console.log("Good day!");
            }
        }
        displayGreeting();
    </script>
</head>
<body>
</body>
</html>
```

The `<script>` tag includes a function named `displayGreeting`, which determines the current hour of the day, and then writes a greeting to the console based on whether it's currently morning. The function is called by the `displayGreeting()` statement that appears just after the function.

Calling a function after the page is loaded

If your function references a page element, then calling the function from within the page's head section won't work because when the browser parses the script, the rest of the page hasn't loaded yet, so your element reference will fail.

To work around this problem, place another `<script>` tag at the end of the body section, just before the closing `</body>` tag, as shown here:

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8">
    <title>Calling a function after the page is loaded</title>
    <script>
        function makeBackgroundRed() {
            document.body.style.backgroundColor = "red";
            console.log("The background is now red.");
        }
    </script>
</head>
<body>
    <!-- Other body elements go here -->

    <script>
        makeBackgroundRed();
    </script>
</body>
</html>
```

The `makeBackgroundRed()` function does two things: It uses `document.body.style.backgroundColor` to change the background color of the `body` element to red, and it uses `console.log()` to write a message to that effect on the console.

In the function, `document.body` is a reference to the `body` element, which doesn't "exist" until the page is fully loaded. That means if you try to call the function with the initial script, you'll get an error. To execute the function properly, a

second `<script>` tag appears at the bottom of the `body` element and that script calls the function with the following statement:

```
makeBackgroundRed();
```

Since by the time the browser executes that statement the `body` element exists, the function runs without an error.

Calling a function in response to an event

One of the most common ways that JavaScript functions are called is in response to some event. This is such an important topic that I devote an entire chapter to it later in the book (see Book 4, Chapter 2). For now, take a look at a relatively straightforward application: executing the function when the user clicks a button. The following code shows one way to do it.

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8">
    <title>Calling a function in response to an event</title>;
    <script>
        function makeBackgroundRed() {
            document.body.style.backgroundColor= "red";
        }

        function makeBackgroundWhite() {
            document.body.style.backgroundColor= "white";
        }
    </script>
</head>
<body>
    <button onclick="makeBackgroundRed()">
        Make Background Red
    </button>
    <button onclick="makeBackgroundWhite()">
        Make Background White
    </button>
</body>
</html>
```

What I've done here is place two functions in the script: `makeBackgroundRed()` changes the page background to red, as before, and `makeBackgroundWhite()` changes the background color back to white.

The buttons are standard HTML button elements, each of which includes the `onclick` attribute. This attribute defines a *handler* — that is the function to execute — for the event that occurs when the user clicks the button. For example, consider the first button:

```
<button onclick="makeBackgroundRed()">
```

The `onclick` attribute here says, in effect, “When somebody clicks this button, call the function named `makeBackgroundRed()`.”

Passing Values to Functions

One of the main reasons to use functions is to gain control over when some chunk of JavaScript code gets executed. The previous section, for example, discusses how easy it is to use functions to set things up so that code doesn't run until the user clicks a button.

However, there's another major reason to use functions: to avoid repeating code unnecessarily. To see what I mean, consider the two functions from the previous section:

```
function makeBackgroundRed() {
    document.body.style.backgroundColor= "red";
}
function makeBackgroundWhite() {
    document.body.style.backgroundColor= "white";
}
```

These functions perform the same task — changing the background color — and the only difference between them is one changes the color to red and the other changes it to white. Whenever you end up with two or more functions that do essentially the same thing, then you know that your code is inefficient.

So how do you make the code more efficient? That's where the arguments that I mention earlier come into play. An *argument* is a value that is “sent” — or *passed*, in programming terms — to the function. The argument acts just like a variable, and it automatically stores whatever value is sent.

Passing a single value to a function

As an example, you can take the previous two functions, reduce them to a single function, and set up the color value as an argument. Here's a new function that does just that:

```
function changeBackgroundColor(newColor) {  
    document.body.style.backgroundColor = newColor;  
}
```

The argument is named `newColor` and it's added between the parentheses that occur after the function name. JavaScript declares `newColor` as a variable automatically, so there's no need for a separate `var` statement. The function then uses the `newColor` value to change the background color. So how do you pass a value to the function? The following code presents a sample file that does this.

```
<!DOCTYPE html>  
<html lang="en">  
<head>  
    <meta charset="utf-8">  
    <title>Passing a single value to a function</title>;  
    <script>  
        function changeBackgroundColor(newColor) {  
            document.body.style.backgroundColor = newColor;  
        }  
    </script>  
</head>  
<body>  
    <button onclick="changeBackgroundColor('red')">  
        Make Background Red  
    </button>  
    <button onclick="changeBackgroundColor('white')">  
        Make Background White  
    </button>  
</body>  
</html>
```

The key here is the `onclick` attribute that appears in both `<button>` tags. For example:

```
onclick="changeBackgroundColor('red')"
```

The string 'red' is inserted into the parentheses after the function name, so that value is passed to the function itself. The other button passes the value 'white', and the function result changes accordingly.



In the two `onclick` attributes in the example code, notice that the values passed to the function are enclosed in single quotation marks (''). This is necessary because the `onclick` value as a whole is enclosed in double quotation marks ("").

Passing multiple values to a function

For more complex functions, you might need to use multiple arguments so that you can pass different kinds of values. If you use multiple arguments, separate each one with a comma, like this:

```
function changeColors(newBackColor, newForeColor) {  
    document.body.style.backgroundColor = newBackColor;  
    document.body.style.color = newForeColor;  
}
```

In this function, the `document.body.style.color` statement changes the foreground color (that is, the color of the page text). The following code shows a revised page where the buttons pass two values to the function.

```
<!DOCTYPE html>  
<html lang="en">  
<head>  
    <meta charset="utf-8">  
    <title>Passing multiple values to a function</title>  
    <script>  
        function changeColors(newBackColor, newForeColor) {  
            document.body.style.backgroundColor = newBackColor;  
            document.body.style.color = newForeColor;  
        }  
    </script>  
</head>  
<body>  
    <h1>Passing Multiple Values to a Function</h1>  
    <button onclick="changeColors('red', 'white')">  
        Red Background, White Text  
    </button>  
    <button onclick="changeColors('white', 'red')">  
        White Background, Red Text  
    </button>  
</body>  
</html>
```



WARNING

If you define a function to have multiple arguments, then you must always pass values for each of those arguments to the function. If you don't, then the "value" `undefined` is passed, instead, which can cause problems.



TECHNICAL STUFF

If you use a variable to pass data to a function, only the current value of that variable is sent, not the variable itself. Therefore, if you change the value of the argument within the function, the value of the original variable isn't changed. Here's an example:

```
var passThis = 10;
function sendMe(acceptThis) {
    acceptThis = 5;
}
sendMe(passThis);
console.log(passThis);
```

The variable `passThis` starts off with a value of `10`. The function `sendMe()` is then defined to accept an attribute named `acceptThis`, and to then change the value of that attribute to `5`. `sendMe()` is then called and the value of the `passThis` variable is passed to it. Then a `console.log()` statement displays the value of `passThis`. If you run this code, the displayed value will be `10`, the original value of `passThis`. In other words, changing the value of `acceptThis` within the function had no effect on the value of the `passThis` variable.

Returning a Value from a Function

So far I've outlined two major advantages of using functions:

- » You can use them to control when code is executed.
- » You can use them to consolidate repetitive code into a single routine.

The third major benefit that functions bring to the JavaScript table is that you can use them to perform calculations and then return the result. As an example, I construct a function that calculates the tip on a restaurant bill:

```
var preTipTotal = 100.00;
var tipPercentage = 0.15;
function calculateTip(preTip, tipPercent) {
```

```
    var tipResult = preTip * tipPercent;
    return (tipResult);
}

var tipCost = calculateTip(preTipTotal, tipPercentage);
var totalBill = preTipTotal + tipCost;
console.log("Your total bill is $" + totalBill);
```

The function named `calculateTip()` takes two arguments: `preTip` is the total of the bill before the tip, and `tipPercent` is the percentage used to calculate the tip. The function then declares a variable named `tipResult` and uses it to store the calculation — `preTip` multiplied by `tipPercent`. The key for this example is the second line of the function:

```
return (tipResult);
```

The `return` statement is JavaScript's way of sending a value *back* to the statement that called the function. That statement comes after the function:

```
tipCost = calculateTip(preTipTotal, tipPercentage);
```

This statement first passes the value of `preTipTotal` (initialized as `100.00` earlier in the script) and `tipPercentage` (initialized as `0.15` earlier) to the `calculateTip()` function. When that function returns its result, the entire expression `calculateTip(preTipTotal, tipPercentage)` is replaced by that result, meaning that it gets stored in the `tipCost` variable. Then `preTipTotal` and `tipCost` are added together, the result is stored in `totalBill`, and a `console.log` statement displays the final calculation.

Understanding Local versus Global Variables

In the example I give in the previous section, notice that there are four variables declared outside the function (`preTipTotal`, `tipPercentage`, `tipCost`, and `totalBill`) and one variable declared inside the function (`tipPercent`). That might not seem like an important distinction, but there's a big difference between variables declared outside of functions and those declared inside of functions. This section explains this crucial difference.

In programming, the *scope* of a variable defines where in the script a variable can be used and where it can't be used. To put it another way, a variable's scope

determines which statements and functions can access and work with the variable. There are two main reasons you need to be concerned with scope:

» **You might want to use the same variable name in multiple functions.**

If these variables are otherwise unrelated, you'll want to make sure that there is no confusion about which variable you're working with. In other words, you'll want to restrict the scope of each variable to the function in which it is declared.

» **You might need to use the same variable in multiple functions.** For

example, your function might use a variable to store the results of a calculation, and other functions might also need to use that result. In this case, you'll want to set up the scope of the variable so that it's accessible to multiple functions.

JavaScript lets you establish two types of scope for your variables:

- » Local (or function-level) scope
- » Global (or page-level) scope

The next two sections describe each type in detail.

Working with local scope

When a variable has *local* scope, it means the variable was declared inside a function and the only statements that can access the variable are the ones in that same function. (That's why local scope also is referred to as *function-level* scope.) Statements outside the function and statements in other functions can't access the local variable.

To demonstrate this, consider the following code:

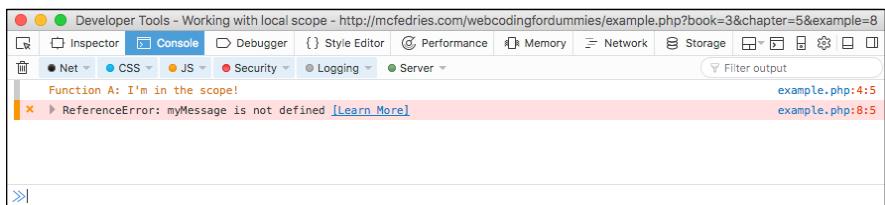
```
function A() {  
    var myMessage;  
    myMessage = "I'm in the scope!";  
    console.log("Function A: " + myMessage);  
}  
  
function B() {  
    console.log("Function B: " + myMessage);  
}
```

```
A();  
B();
```

There are two functions here, named A() and B(). Function A() declares a variable named myMessage, sets its value to a text string, and uses JavaScript's console.log() method to display the string in the console.

Function B() also uses console.log() to attempt to display the myMessage variable. However, as you can see in Figure 5-1, JavaScript generates an error that says myMessage is not defined. Why? Because the scope of the myMessage variable extends only to function A(); function B() can't "see" the myMessage variable,

FIGURE 5-1:
Attempting to display the myMessage variable in function B() results in an error.



so it has nothing to display. In fact, after function A() finishes executing, JavaScript removes the myMessage variable from memory entirely, so that's why the myMessage variable referred to in function B() is undefined.

The same result occurs if you attempt to use the myMessage variable outside of any function, as in the following code:

```
function A() {  
    var myMessage;  
    myMessage = "I'm in the scope!";  
    console.log("Function A: " + myMessage);  
}  
A();  
// The following statement generates an error:  
console.log(myMessage);
```

Working with global scope

What if you want to use the same variable in multiple functions or even in multiple script blocks within the same page? In that case, you need to use *global scope*, which makes a variable accessible to any statement or function on a page. (That's

why global scope is also called *page-level* scope.) To set up a variable with global scope, declare it outside any function. The following code gives this a whirl:

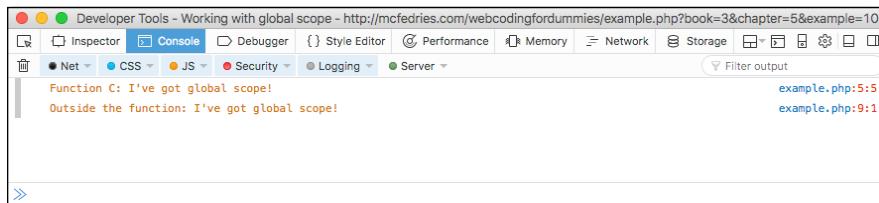
```
var myMessage = "I've got global scope!";

function C() {
    console.log("Function C: " + myMessage);
}

C();
console.log("Outside the function: " + myMessage);
```

The script begins by declaring the `myMessage` variable and setting it equal to a string literal. Then a function named `C()` is created and it displays a console message that attempts to display the value of `myMessage`. After the function is called, another `console.log()` statement attempts to display the `myMessage` value outside of the function. Figure 5-2 shows the results. As you can see, both `console.log()` statements display the value of `myMessage` without a problem.

FIGURE 5-2:
When you declare a global variable, you can access its value both inside and outside of a function.



Using Recursive Functions

One of the stranger things you can do with a function is have it execute itself. That is, you place a statement within the function that calls the function. This is called *recursion*, and such a function is called a *recursive function*.

Before trying out a practical example, I begin with a simple script that demonstrates the basic procedure:

```
var counter = 0;
addOne();

function addOne() {
    counter++;
    if (confirm("counter is now " + counter + ". Add another
one?")) {
```

```

        addOne();
    }
}

console.log("Counter ended up at " + counter);

```

The script begins by declaring a variable named `counter` and initializing it to `0`. Then a function named `addOne()` is called. This function increments the value of `counter`. It then displays the current value of `counter` and asks if you want to add another. If you click `OK`, the `addOne()` function is called again, but this time it's called from within `addOne()` itself! This just means that the whole thing repeats itself until you eventually click `Cancel` in the dialog box. After the function is exited for good, a `console.log()` statement shows the final `counter` total.

What possible use is recursion in the real world? That's a good question. Consider a common business problem: calculating a profit-sharing plan contribution as a percentage of a company's net profits. This isn't a simple multiplication problem, because the net profit is determined, in part, by the profit-sharing figure. For example, suppose that a company has sales of \$1,000,000 and expenses of \$900,000, which leaves a gross profit of \$100,000. The company also sets aside 10 percent of net profits for profit sharing. The net profit is calculated with the following formula:

$$\text{Net Profit} = \text{Gross Profit} - \text{Profit Sharing Contribution};$$

That looks straightforward enough, but it's really not because the Profit Sharing Contribution value is derived with the following formula:

$$\text{Profit Sharing Contribution} = \text{Net Profit} * 10\%;$$

In other words, the Net Profit value appears on both sides of the equation, which complicates things considerably.

One way to solve the Net Profit formula is to guess at an answer and see how close you come. For example, because profit sharing should be 10 percent of net profits, a good first guess might be 10 percent of gross profits, or \$10,000. If you plug this number into the Net Profit formula, you get a value of \$90,000. This isn't right, however, because you'd end up with a profit sharing value — 10 percent of \$90,000 — of \$9,000. Therefore, the original profit-sharing guess is off by \$1,000.

So you can try again. This time, use \$9,000 as the profit-sharing number. Plugging this new value into the Net Profit formula returns a value of \$91,000. This number translates into a profit-sharing contribution of \$9,100. This time you're off by only \$100, so you're getting closer.

If you continue this process, your profit-sharing guesses will get closer to the calculated value (this process is called *convergence*). When the guesses are close enough (for example, within a dollar), you can stop and pat yourself on the back for finding the solution.

This process of calculating a formula and then continually recalculating it using different values is what recursion is all about, so let's see how you'd go about writing a script to do this for you. Take a look at the following code.

```
var grossProfit = 100000;
var netProfit;
var profitSharingPercent = 0.1;

// Here's the initial guess
var profitSharing = grossProfit * profitSharingPercent;

calculateProfitSharing (profitSharing);

function calculateProfitSharing(guess) {

    // First, calculate the new net profit
    netProfit = grossProfit - guess;

    // Now use that to guess the profit sharing value again
    profitSharing = Math.ceil(netProfit * profitSharingPercent);

    // Do we have a solution?
    if ((netProfit + profitSharing) != grossProfit) {
        // If not, plug it in again
        calculateProfitSharing (profitSharing);
    }
}

console.log("Gross Profit:\t" + grossProfit + "\nNet Profit:
\t" + netProfit + "\nProfit Sharing:\t" + profitSharing);
```

The `grossProfit` variable is initialized at `100000`, the `netProfit` variable is declared, the `profitSharingPercent` variable is set to `0.1` (10 percent), and the `profitSharing` variable is set to the initial guess of 10 percent of gross profits. Then the `calculateProfitSharing()` function is called, and the `profitSharing` guess is passed as the initial value of the `guess` argument.



TECHNICAL
STUFF

AVOIDING INFINITE RECURSION

If you're trying to call a function recursively, you might see error messages such as `Stack overflow` or `Too much recursion`. These error messages indicate that you have no "brakes" on your recursive function so, if not for the errors, it would call itself forever. This is called *infinite recursion*, and the actual maximum number of recursive calls depends on the browser and operating system, but the range is between about 75 and about 1,000.

In any case, it's important to build in some kind of test that ensures the function will stop calling itself after a certain number of calls:

- The `addOne()` function in the previous section avoided infinite recursion by asking the user if she wanted to continue or stop.
- The `calculateProfitSharing()` function in the previous section avoided infinite recursion by testing the sum of `netProfit` and `profitSharing` to see if this sum was equal to `grossProfit`.

If you don't have a convenient or obvious method for stopping the recursion, then you can set up a counter that tracks the number of function calls. When that number hits a predetermined maximum, the script should bail out of the recursion process. The following code presents such a script:

```
var currentCall = 1;
var maximumCalls = 3;

recursionTest();

function recursionTest() {
    if (currentCall <= maximumCalls) {
        console.log(currentCall);
        currentCall++;
        recursionTest();
    }
}
```

The `currentCall` variable is the counter, and the `maximumCalls` variable specifies the maximum number of times the recursive function can be called. In the function, the following statement compares the value of `currentCall` and `maximumCalls`:

```
if (currentCall <= maximumCalls);
```

(continued)

(continued)

If `currentCall` is less than or equal to `maximumCalls`, then all is well and the script can continue. In this case, a console message displays the value of `currentCall`, that value is incremented, and the `recursionTest()` function is called again. When `currentCall` becomes greater than `maximumCalls`, the function exits and the recursion is done.

The function first calculates the `netProfit` and then uses that value to calculate the `new profitSharing` number. Remember your goal here is to end up with the sum of `netProfit` and `profitSharing` being equal to `grossProfit`. The `if` statement tests that, and if the sum is not equal to `grossProfit`, the `calculateProfitSharing()` function is called again (here's the recursion), and this time the `new profitSharing` value is passed. When the correct values are finally found, the function exits and a console message displays the results, as shown in Figure 5-3.



REMEMBER

Note that all the variables in previous example are declared as globals. That's because if you declared them within the `calculateProfitSharing()` function, they would get wiped out and reset with each call, which is not what you want when doing recursion.

FIGURE 5-3:
Using recursion
to calculate a
profit sharing
value.

```
Gross Profit: 100000
Net Profit: 90999
Profit Sharing: 9091
```

IN THIS CHAPTER

- » Understanding objects
- » Messing with object properties
- » Running object methods
- » Giving the Windows object a whirl
- » Interacting with your site visitors

Chapter 6

Working with Objects

The problem with object-oriented languages is they've got all this implicit environment that they carry around with them. You wanted a banana but what you got was a gorilla holding the banana and the entire jungle.

— JOE ARMSTRONG

JavaScript derives most of its power, flexibility, and utility from its extensive collection of methods for reading, changing, adding, and deleting web page doodads and bric-a-brac. It could be HTML elements, CSS properties, form controls, or internal programming resources such as strings and numbers. Whatever it is, JavaScript has an amazing and seemingly endless collection of powerful tools — called objects — that enable you to monitor and control almost every aspect of the web page. This chapter represents a major step forward in your JavaScript education as you explore the wide and fascinating world of objects. You discover what objects are and how to use them in your code. You also get your object feet wet by taking an up close and personal look at one of the most important webpage objects.

What Is an Object?

Only the simplest JavaScript programs will do nothing but assign values to variables and calculate expressions. To go beyond these basic script beginnings — that is, to write truly useful scripts — you have to do what JavaScript was designed

to do from the start: Manipulate the web page that it's displaying. That's what JavaScript is all about, and that manipulation can come in many different forms:

- » Add text and HTML tags to an **element**.
- » Modify a CSS **property** of a class or other selector.
- » Store some data in the browser's internal **storage**.
- » Read **JSON** data returned by the server.
- » Validate a **form's** data before submitting it.

The bold items in this list are examples of the “things” that you can work with, and they’re special for no other reason than they’re programmable. In JavaScript parlance, these “programmable things” are called *objects*.

You can manipulate objects in JavaScript in any of the following three ways:

- » You can make changes to the object’s *properties*.
- » You can make the object perform a task by activating a *method* associated with the object.
- » You can define a procedure that runs whenever a particular *event* happens to the object.

To help you understand objects and their properties, methods, and events, I put things in real-world terms. Specifically, consider your computer as though it were an object:

- » If you wanted to describe your computer as a whole, you’d mention things like the name of the manufacturer, the price, and the amount of RAM. Each of these items is a *property* of the computer.
- » You also can use your computer to perform tasks such as writing letters, crunching numbers, and coding web pages. These are the *methods* associated with your computer.
- » There are also a number of things that happen to the computer that cause it to respond in predefined ways. For example, when the On button is pressed, the computer runs through its Power On Self-Test, initializes its components, and so on. The actions to which the computer responds automatically are its *events*.

The sum total of all these properties, methods, and events gives you an overall description of your computer.

But your computer is also a collection of objects, each with its own properties, methods, and events. The hard drive, for example, has various properties, including its speed and data transfer rate. The hard drive's methods would be actions such as storing and retrieving data. A hard drive event might be a scheduled maintenance task, such as defragmenting the drive's data or checking the drive for errors.

In the end, you have a complete description of the computer: what it looks like (its properties), how you interact with it (its methods), and to what actions it responds (its events).

The JavaScript Object Hierarchy

Sticking with the computer metaphor for just a moment longer, when you think about how the computer's hardware is put together, you see there is a kind of hierarchy to the organization. The computer itself is at the top, and then below that are major components such as the system unit and the monitor. Drilling down, you see that these also have their own subcomponents. For example, the system unit has the motherboard, the hard drive, and the power supply, to name just a few. Taking things down just one more level, the motherboard (for example) also holds smaller components such as the microprocessor and the memory chips.

JavaScript's objects are also organized in a hierarchical way. The top-level represents the main JavaScript objects, including the `Array` object (which I cover in Book 3, Chapter 7), and the `Date`, `Math`, `Number`, and `String` objects (which I talk about in Book 3, Chapter 8). These are shown in Figure 6-1, which represents only a partial view of the JavaScript object hierarchy.

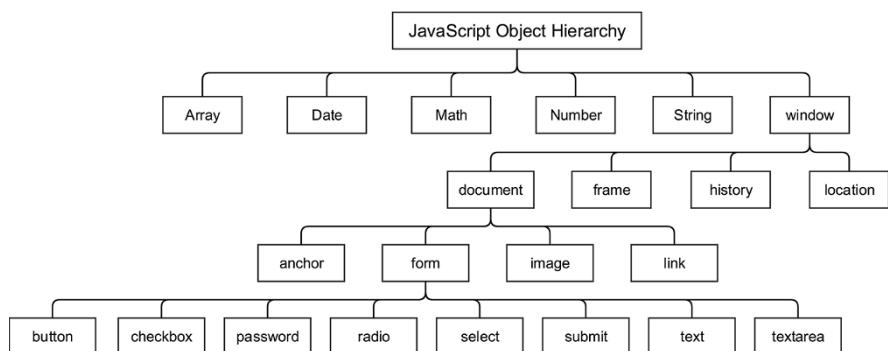


FIGURE 6-1:
A partial look at
the JavaScript
object hierarchy.

Also in the first level of Figure 6-1 is the `window` object, which represents the browser window. Notice that the `window` object has four “subobjects”:

- » `document`: Refers to whatever document is currently loaded in the browser window. Because you use this object to control such fundamental page items as links, images, and forms, this is probably the object you’ll use most often in your JavaScript career.
- » `frame`: Represents a frame (if any) that’s used to display multiple pages in the browser window. For example, you can use this object to display a different page inside a particular frame.
- » `history`: Represents an item in the list of pages that the user has visited in the current browser session. One common use for this object is to send the user back to the page she was on before coming to the current page.
- » `location`: Represents the address of the page that’s displayed in the browser. You can use this object to determine the current address, send the user to a different address, refresh the browser display, and more.

The `document` object has its own objects, which are displayed in the third level in Figure 6-1. There are four in all:

- » `anchor`: Represents an anchor in the document, created using the `<a id>` tag. For example, you can use this object to check if a document contains an anchor that uses a particular name.
- » `form`: Represents a form in the document, created with the `<form>` tag. You can use this object to work with all the various form controls, as well as to submit a form.
- » `image`: Represents an image in the document, created using the `` tag. You can use this object to change the image that’s displayed within a particular `` tag.
- » `link`: Represents a link in the document, created using the `<a href>` tag. You can gather information about a link (such as its address) and you can handle events such as the user clicking a link.

The `form` object has a number of its own objects, and these are displayed as the fourth level in Figure 6-1. These objects represent all the fields you can insert within a form, including buttons, text boxes, text areas, password boxes, checkboxes, radio buttons, and selection lists. JavaScript can access the values in form fields, insert new values in form fields, and even submit the form for the user.

Manipulating Object Properties

All these JavaScript objects have at least one property, and some of them have a couple of dozen or more. What you do with these properties depends on the object, but you generally use them for the following tasks:

- » **Gathering information about an object's current settings:** With the text object, for example, you can use the value property to get whatever string is currently in the text box.
- » **Changing an object's current settings:** For example, you can use the window object's location property to send the web browser to a different URL.
- » **Changing an object's appearance:** With the document object, for example, you can use the backgroundColor property to change the background color of the page.

Referencing a property

Whatever the task, you refer to a property by using the syntax in the following generic expression:

object.property

- » *object*: The object that has the property.
- » *property*: The name of the property you want to work with.

The dot (.) in between is called the *property access operator*.

For example, consider the following expression:

`window.location`

This refers to the `window` object's `location` property, which holds the address of the document currently displayed in the browser window. (In conversation, you'd pronounce this expression as "window dot location.") The following code shows a simple one-line script that displays this property in the console, as shown in Figure 6-2.

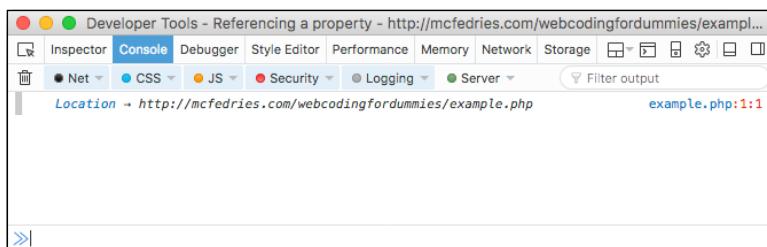
```
console.log(window.location);
```

Because the property always contains a value, you're free to use property expressions in just about any type of JavaScript statement and as an operand in a

JavaScript expression. For example, the following statement assigns the current value of the `window.location` property to a variable named `currentUrl`:

```
var currentUrl = window.location;
```

FIGURE 6-2:
This script displays the `window.location` property in a console message.



Similarly, the following statement includes `window.location` as part of a string expression:

```
var message = "The current address is " + window.location + ".";
```

Some objects are properties

You might be wondering if the `window` object's `location` property is related to the `location` object that I discuss earlier. Yep, it is. Good eye! In fact, they're the same thing! This is one of the most confusing aspects of the relationship between objects and properties, but it's also one of the most important, so I'll dive into this a bit deeper to make sure you understand what's going on.

The basic idea is that in the JavaScript object hierarchy shown in Figure 6-1, any object that is subordinate to another object is automatically a property of that other object. So, for example, the `location` object is subordinate to the `window` object; therefore, it's a property of the `window` object. This means you can reference the `location` object by using the `object.property` syntax.

Because `location` is an object, it also has its own properties. For example, it has a `hostname` property that references just the host name part of the address (for example, `mcfedries.com`). To work with this property, you extend the expression syntax accordingly:

```
window.location.hostname
```



When you're dealing with the four second-level objects — `document`, `frame`, `history`, and `location` — it's understood that these are properties of the `window` object. Therefore, you don't have to include `window` at the front of the property expression. For example, the following two statements are equivalent:

```
window.location.hostname  
location.hostname
```

Changing the value of a property

Some properties are “read-only,” which means your code can only read the current value and can’t change it. However, many properties are “read/write,” which means you can also change their values. To change the value of a property, use the following generic syntax:

```
object.property = value
```

- » *object*: The object that has the property
- » *property*: The name of the property you want to change
- » *value*: A literal value (such as a string or number) or an expression that returns the value to which you want to set the property

Here’s an example:

```
var newAddress = prompt("Enter the address you want to surf  
to:");  
window.location = newAddress;
```

This script prompts the user for a web page address and stores the result in the `newAddress` variable. This value is then used to change the `window.location` property, which in this case tells the browser to open the specified address.

Working with Object Methods

Each one of the JavaScript objects I mention earlier has at least one or two methods that you can wield to make the object do something. These actions generally fall into the following categories:

- » **Simulate a user’s action.** For example, the `form` object’s `submit()` method submits a form to the server just as though the user clicked the form’s submit button.
- » **Perform a calculation.** For example, the `Math` object’s `sqrt()` method calculates the square root of a number.

» **Manipulate an object.** For example, the String object's `toLowerCase()` method changes all of a string's letters to lowercase.

To run a method, begin with the simplest case, which is a method that takes no arguments:

```
object.method()
```

- » *object*: The object that has the method you want to work with
- » *method*: The name of the method you want to execute

For example, consider the following statement:

```
history.back();
```

This runs the `history` object's `back()` method, which tells the browser to go back to the previously visited page. The following code shows this method at work:

```
var goBack = confirm("Do you want to go back?");
if (goBack === true) {
    history.back();
}
```

The user is first asked if she wants to go back. If she clicks OK, the Boolean value `true` is stored in the `goBack` variable, the comparison expression `goBack === true` becomes `true`, so the `history.back()` method runs.

I mention in Book 3, Chapter 5 that it's possible to define a function so that it accepts one or more arguments, and that these arguments are then used as input values for whatever calculations or manipulations the function performs. Methods are similar in that they can take one or more arguments and use those values as raw data.

If a method requires arguments, you use the following generic syntax:

```
object.method (argument1, argument2, ...)
```

For example, consider the `confirm()` method, used in the following statement, which takes a single argument — a string that specifies the text to display to the user:

```
confirm("Do you want to go back?")
```

Finally, as with properties, if the method returns a value, you can assign that value to a variable (as I did with the `confirm()` method in the earlier example) or you can incorporate the method into an expression.

Playing Around with the window Object

It's time you get practical with all this object stuff by tackling some actual objects. This section gets you started by examining one of the top-level objects in the hierarchy of the JavaScript object model: the `window` object. This object refers to the browser window *viewport*, which is the content area where the web page appears (not the full window of the browser application). This makes the `window` object the topmost object in the web page object hierarchy, so you'll be using the `window` object a great deal as you progress in web development.

Referencing the window object

When you need to reference the `window` object, the fact that it's the topmost item in the web page hierarchy gives you far greater flexibility than with the other objects on the lower levels.

For starters, you can combine the `window` keyword with the standard notation for properties and methods:

```
window.propertyName  
window.methodName()
```

However, the `window` object is the default object in JavaScript. This means that if JavaScript comes across a property or method that doesn't have a specified object, it automatically assumes the property or method is part of the `window` object. Therefore, you can almost always get away with not using the `window` keyword. In other words, the previous two statements are equivalent to the following two:

```
propertyName  
methodName()
```

Some window object properties you should know

The `window` object comes with a few dozen properties, most of which are too obscure or arcane to worry about. However, several `window` object properties are essential to all web developers, and those are listed in Table 6-1.

TABLE 6-1 Useful Properties of the window Object

| Property | What It Does |
|----------------|--|
| console | Returns a reference to the console object, which you use to log text to the console with <code>console.log()</code> . |
| document | Returns a reference to the document object (that is, the web page) contained in the window. |
| frames | Returns a reference to the frames (if any) that are used to display multiple pages in the browser window. |
| history | Returns a reference to the list of pages that the user has visited in the current browser session. Your code can navigate these pages — for example, by calling the <code>back()</code> method to go back one page — but your code can't access the URLs of these pages. |
| innerHeight | Returns the height, in pixels, of the browser window viewport. |
| innerWidth | Returns the width, in pixels, of the browser window viewport. |
| localStorage | Returns a reference to the local Storage object, which you can use to store and retrieve data in the browser indefinitely. |
| location | Returns a reference to the location object, which contains info about the current web page URL. |
| navigator | Returns a reference to the navigator object, which provides data on the browser application the visitor is using. |
| scrollX | Returns the distance, in pixels, that the window's document has been scrolled horizontally. |
| scrollY | Returns the distance, in pixels, that the window's document has been scrolled vertically. |
| sessionStorage | Returns a reference to the session Storage object, which you can use to store and retrieve data in the browser temporarily (that is, the data gets deleted automatically when the user shuts down the current browser session). |

Rather than providing you with a similar table for the `window` object's methods, I use the rest of the chapter to discuss a few useful methods in detail.

Working with JavaScript timeouts and intervals

In the scripts I've presented so far in this book, the code has executed in one of three ways:

- » Automatically when the page loads
- » When your script calls a function

- » In response to some event, such as the user clicking a button

JavaScript also offers a fourth execution method that's based on time. There are two possibilities:

- » Have some code run once after a specified number of milliseconds. This is called a *timeout*.
- » Have some code run after a specified number of milliseconds, and then repeat each time that number of milliseconds expires. This is called an *interval*.

The next couple of sections show you how to set up both procedures.

Using a timeout to perform a future action once

To set up a JavaScript timeout, use the `window` object's `setTimeout()` method:

```
setTimeout(function, delay, arg1, arg2, ...)
```

- » *function*: The name of a function that you want JavaScript to run when the timeout expires. Instead of a function, you can also use a JavaScript statement, surrounded by quotation marks.
- » *delay*: The number of milliseconds that JavaScript waits before executing *function*.
- » *arg1, arg2, ...*: Optional arguments to pass to *function*.

Note that `setTimeout()` returns a value that uniquely identifies the timeout. You can store this value just in case you want to cancel the timeout (as described later in this section).

Here's some code that shows how `setTimeout()` works:

```
// Create a message
var str = "Hello World!";

// Set the timeout
var timeoutId = setTimeout(logIt, 2000, str);

// Run this function when the timeout occurs
function logIt(msg) {
```

```
// Display the message  
console.log(msg);  
}
```

The script begins by creating a message string and storing it in the `str` variable. Then the `setTimeout()` method runs:

```
setTimeout(logIt, 2000, str);
```

This tells JavaScript to run the function named `logIt()` after two seconds (2,000 milliseconds) have elapsed, and to pass the `str` variable to that function. The `logIt()` function takes the `msg` argument and displays it in the console.

If you've set up a timeout and then decide that you don't want the code to execute after all for some reason, you can cancel the timeout by running the `clearTimeout()` method:

```
clearTimeout(id);
```

» `id`: The name of the variable that was used to store the `setTimeout()` method's return value

For example, suppose you set a timeout with the following statement:

```
var timeoutId = setTimeout(logIt, 2000, str);
```

Then you'd cancel the timeout using the following statement:

```
clearTimeout(timeoutId);
```

Using an interval to perform a future action repeatedly

Running code once after a specified number of seconds is only an occasionally useful procedure. A much more practical skill is being able to repeat code at a specified interval. This enables you to set up countdowns, timers, animations, image slide shows, and more. To set up an interval, use the `window` object's `setInterval()` method:

```
setInterval(function, delay, arg1, arg2, ...)
```

» `function`: The name of a function that you want JavaScript to run at the end of each interval. Instead of a function, you can also use a JavaScript statement, surrounded by quotation marks.

- » *delay*: The number of milliseconds in each interval, after which JavaScript executes *function*
- » *arg1, arg2, ...*: Optional arguments to pass to *function*

As with `setTimeout()`, the `setInterval()` method returns a value that uniquely identifies the interval. You use that value to cancel the interval with the `clearInterval()` method:

```
clearInterval(id);
```

- » *id*: The name of the variable that was used to store the `setInterval()` method's return value

For example, suppose you set an interval with the following statement:

```
var intervalId = setInterval(countdown, 5000);
```

Then you'd cancel the interval using the following statement:

```
clearInterval(intervalId);
```

Note that although the `clearTimeout()` method is optional with `setTimeout()`, you should always use `clearInterval()` with `setInterval()`. Otherwise, the interval will just keep executing.

The following code demonstrates both `setInterval()` and `clearInterval()`.

```
var counter = 10;

// Set the interval
var intervalId = setInterval(countdown, 1000);

// Run this function at the end of each interval
function countdown() {

    // Display the countdown and then decrement the counter
    console.log(counter--);

    // Cancel the interval when we hit 0
    if (counter < 0) {
        clearInterval(intervalId);
        console.log("All done!");
    }
}
```

The purpose of this script is to display a countdown from 10 to 0 in the console. The script begins by declaring a variable named `counter` and initializing it to 10. Then the `setInterval()` method sets up a function named `countdown()` to run at intervals of one second (1,000 milliseconds). The `countdown()` function displays the current value of `counter` in the console and then decrements `counter`. Then an `if()` test checks the value of `counter`. If it's negative, it means that `counter` was just 0, so it's done. The `clearInterval()` method cancels the interval, and then a final console message is logged.

Interacting with the user

Many of your scripts will do all of their work “behind the scenes,” and your page visitors will probably never even know what programming wonders are happening beneath their noses. That’s a good thing because a well-crafted script should neither be seen nor heard.

However, that’s not to say that all your scripts must remain mute servants who blend into the background. There are plenty of good reasons to interact with the user:

- » **To display a message to the user:** This message might include navigation instructions, help information, or warnings about improperly entered data.
- » **To ask the user a simple yes/no question:** Such a question could be used to confirm a pending action, ask permission to perform a task, or cancel a form submission.
- » **To get data from the user:** This data could be used to populate form fields, personalize the page, or gather information about the user.

For all these purposes and many more, JavaScript has three tools you can use: the `alert()`, `confirm()`, and `prompt()` methods. I discuss each one in the sections that follow.

Displaying messages using the `alert()` method

When you need to display a simple text message to the user, the `alert()` method is your best choice:

```
alert(string);
```

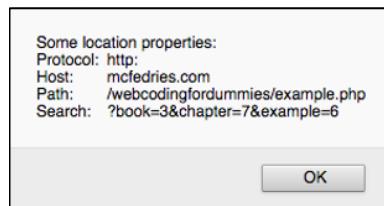
- » *string*: A string literal or string expression containing the message you want to display

The *string* argument must be plain text; you can't format the text using HTML tags. The only formatting control you have is to use the \n escape character to start a new line, and the \t escape character to insert a tab character. The following code demonstrates the use of both characters, and Figure 6-3 shows the result.

```
// Build the message
var msg = "Some location properties:\n";
msg += "Protocol:\t" + location.protocol + "\n";
msg += "Host:\t" + location.hostname + "\n";
msg += "Path:\t" + location.pathname + "\n";
msg += "Search:\t" + location.search + "\n";

// Display the message
alert(msg);
```

FIGURE 6-3:
An alert box
formatted
with the
\n and \t
escape
characters.



Asking questions using the confirm() method

When you need to ask the user a yes/no question or have the user accept or reject an action, use the `confirm()` method:

```
confirm(string);
```

- » *string*: A string literal or string expression containing the question or action you need the user to confirm

The *string* argument must be plain text, so don't use HTML tags. However, as with `alert()`, you can use the \n and \t escape characters to format the string.

The `confirm()` method displays a dialog box with OK and Cancel buttons:

- » If the user clicks OK, `confirm()` returns the value `true`.
- » If the user clicks Cancel, `confirm()` returns `false`.

If you need the `confirm()` result later in your script, include it as part of a variable assignment statement to save the result:

```
var goOrWhoa = confirm("Do you want to proceed?");
```

Alternatively, if you only need to use the `confirm()` result immediately after it's displayed, include it in a comparison or logical expression. The following code provides a simple example, and Figure 6-4 shows the dialog box that appears.

```
if (confirm("Are you sure about this?") === true) {  
    console.log("You clicked OK.");  
} else {  
    console.log("You clicked Cancel.");  
}
```

FIGURE 6-4:
Use the `confirm` method to ask the user for yes/no input.



Actually, since `confirm()` returns `true` or `false`, you don't have to set up a full comparison expression to test if the result equals one of those values. Instead, just use `confirm()` by itself. For example, this `if()` test returns `true` if `confirm()` returns `true`:

```
if (confirm("Are you sure about this?"))
```

Similarly, the following `if()` test returns `true` if `confirm()` returns `false`:

```
if (!confirm("Are you sure about this?"))
```

Getting input using the `prompt()` method

When you need to get data from the user, run the `prompt()` method:

```
prompt(string, default);
```

» `string`: A string literal or string expression that instructs the user what to enter into the prompt box

- » *default*: An optional string literal or string expression that represents the initial value that appears in the prompt box

Both the *string* and *default* arguments must be plain text, so don't use HTML tags. For the *string* argument, you can include the \n and \t escape characters.

If you don't include the *default* argument, the browser leaves the text box blank. If your code requires a non-blank return value, then you should include a default value.

The `prompt()` method always returns a value:

- » If the user clicks OK, `prompt()` returns the value entered into the prompt text box.
- » If the user clicks Cancel, `prompt()` returns `null`.

As with `confirm()`, you can either store the `prompt()` method's return value in a variable or use it in an expression. In most cases, you'll want to set up your script to check the return value and make sure that it isn't `null`, as shown in the following code:

```
var bgColor = prompt("Type a color to use for the background:  
\\nSome examples: azure, linen, gainsboro");  
  
if (bgColor !== null) {  
    document.body.style.backgroundColor = bgColor;  
} else {  
    document.body.style.backgroundColor = "white";  
}
```



TIP

Prompt boxes are fine if you just need a single bit of data from the user. If you need multiple items from the user, don't bother using multiple prompt boxes. Instead, set up a form and use JavaScript to read and manipulate the form data. My coverage of forms appears in Book 6, Chapter 2.

Don't overdo it

There are few things in this world as annoying as an unnecessary dialog box, and a page that includes a number of such annoyances will likely cause much disgruntlement. So when designing your scripts, bear in mind the following points concerning the `alert()`, `confirm()`, and `prompt()` methods:

- » Don't set up an alert box or other dialog box to display automatically when your page loads. If people realize that the dialog box is going to show up every

time they load your page, there's a good chance they won't load the page again.

- » Similarly, don't set up a message to display when the user leaves your site. When they're leaving, most people just want to leave and be done with it.
- » If you must display a message automatically when a page loads or unloads, use the browser's local storage to record that the user has seen it once. Then check for that stored value as part of your script: If the value tells you that the user has already seen the message, don't display it again. I talk about local storage in Book 8, Chapter 1.
- » Don't use alert boxes to display welcome messages, "This site works best with..." recommendations, or other unnecessary notes to the user. If you have something to say, put it on your page.
- » Make your dialog box text as short and as clear as possible. Assume every user is a busy person with a quick mouse trigger finger. If what you make users read is too long or too convoluted, they'll head for the next site.

Programming the document Object

One of JavaScript's most fundamental features is the capability it offers you as a web developer to read and change the elements of a web page, even after the page is loaded. I show you how this works in detail in Book 4, Chapter 1, but that material uses jQuery to manipulate the web page elements. jQuery is a fantastic tool, but you should also know how to program page stuff using vanilla JavaScript. To that end, this section presents you with a quick tour of some extremely useful and powerful JavaScript techniques for dealing with the document object.

Specifying an element

Elements represent the tags in a document, so you'll be using them constantly in your code. This section shows you several methods for referencing an element.

Specifying an element by id

If it's a specific element you want to work with in your script, you can reference the element directly by assigning it an "id" using the `id` attribute:

```
<div id="my-div">
```

With that done, you can then refer to the element in your code by using the document object's `getElementById()` method:

```
document.getElementById(id)
```

- » *id*: A string representing the `id` attribute of the element you want to work with

For example, the following statement returns a reference to the previous `<div>` tag (the one that has `id="my-div"`):

```
document.getElementById("my-div")
```



WARNING

When you're coding the `document` object, don't put your `<script>` tag in the web page's head section (that is, between the `<head>` and `</head>` tags). If you place your code there, the web browser will run the code before it has had a chance to create the `document` object, which means your code will fail, big-time. Instead, place your `<script>` tag at the bottom of the web page, just before the `</body>` tag.

Specifying elements by tag name

Besides working with individual elements, it's also possible to work with collections of elements. One such collection is the set of all elements in a page that use the same tag name. For example, you could reference all the `<a>` tags or all the `<div>` tags. This is a handy way to make large-scale changes to these tags (such as changing all the target attributes in your links).

The mechanism for returning a collection of elements that have the same tag is the `getElementsByName()` method:

```
document.getElementsByTagName(tag)
```

- » *tag*: A string representing the HTML name used by the tags you want to work with

This method returns an arraylike collection that contains all the elements in the document that use the specified tag. (See Book 3, Chapter 7 to learn how arrays work.) The collection order is the same as the order in which the elements appear in the document. For example, consider the following HTML pseudo-code:

```
<div id="div1">  
Other elements go here
```

```
</div>
<div id="div2">
Other elements go here
</div>
<div id="div3">
Other elements go here
</div>
```

Now consider the following statement:

```
divs = document.getElementsByTagName("div");
```

In the resulting collection, the first item (`divs[0]`) will be the `<div>` element with `id` equal to `div1`, the second item (`divs[1]`) will be the `<div>` element with `id` equal to `div2`, and the third item (`divs[2]`) will be the `<div>` element with `id` equal to `div3`.

Specifying elements by class name

Another collection you can work with is the set of all elements in a page that use the same class. The JavaScript tool for returning all the elements that share a specific class name is the `getElementsByClassName()` method:

```
document.getElementsByClassName(class)
```

» `class`: A string representing the class name used by the elements you want to work with

This method returns an arraylike collection that contains all the elements in the document that use the specified class name. The collection order is the same as the order in which the elements appear in the document. Here's an example:

```
var keywords = document.getElementsByClassName("keyword");
```

Specifying elements by selector

In Book 2, Chapter 2, I discuss CSS selectors, including the `id`, `tag`, `class`, `descendant`, and `child` selectors. You can use those same selectors in your JavaScript code to reference page elements by using the `document` object's `querySelector()` and `querySelectorAll()` methods:

```
document.querySelector(selector)
document.querySelectorAll(selector)
```

- » *selector*: A string representing the selector for the element or elements you want to work with

The difference between these methods is that `querySelectorAll()` returns a collection of all the elements that match your selector, whereas `querySelector()` returns only the first element that matches your selector.

For example, the following statement returns the collection of all `section` elements that are direct children of an `article` element:

```
var articles = document.querySelectorAll("article > section");
```



REMEMBER

Rather than using three distinct `document` object methods to reference page elements by `id`, `tag`, and `class` — that is, `getElementById()`, `getElementsByTagName()`, and `getElementsByClassName()` — many web developers prefer the more generic approach offered by `querySelector()` and `querySelectorAll()`.

Working with elements

Once you've got a reference to one or more elements, you can then use code to manipulate those elements in various ways, as shown in the next few sections.

Adding an element to the page

To add an element to the page, you follow three steps:

1. Create an object for the type of element you want to add.
2. Add the new object from Step 1 as a child element of an existing element.
3. Insert some text and tags into the new object from Step 1.

Step 1: Creating the element

For Step 1, you use the `document` object's `createElement()` method:

```
document.createElement(elementName)
```

- » *elementName*: A string containing the HTML tag name for the type of the element you want to create

This method creates the element and then returns it, which means you can store the new element in a variable. Here's an example:

```
newArticle = createElement("article");
```

Step 2: Appending the new element as a child

With your element created, Step 2 is to append it to an existing parent element using the `appendChild()` method:

```
parent.appendChild(child)
```

- » `parent`: A reference to the parent element to which the new element will be appended
- » `child`: A reference to the child element you're adding

Here's an example that creates a new `article` element and then appends it to the `main` element:

```
newArticle = document.createElement("article");
document.querySelector("main").appendChild(newArticle);
```

Note that the child element is added to the *end* of the parent element's collection of child elements, so be sure to add the child elements in the appropriate order.

Step 3: Adding text and tags to the new element

With your element created and appended to a parent, the final step is to add some text and tags using the `innerHTML` property:

```
element.innerHTML = text
```

- » `element`: A reference to the new element within which you want to add the text and tags
- » `text`: A string containing the text and HTML tags you want to insert

In this example, the code creates a new `article` element, appends it to the `main` element, and then adds some text and tags:

```
newArticle = document.createElement("article");
document.querySelector("main").appendChild(newArticle);
newArticle.innerHTML = "Hello <code>document</code> Object
World!";
```

Changing an element's styles

Most HTML tags can have a `style` attribute that you use to set inline styles. Since standard attributes all have corresponding element object properties, you won't

be surprised to learn that most elements also have a `style` property that enables you to get and modify a tag's styles. The way it works is that the `style` property actually returns a `style` object that has properties for every CSS property. When referencing these style properties, you need to keep two things in mind:

- » For single-word CSS properties (such as `color` and `visibility`), use all-lowercase letters.
- » For multiple-word CSS properties, drop the hyphen and use uppercase for the first letter of the second word and for each subsequent word if the property has more than two. For example, the `font-size` and `border-left-width` CSS properties become the `fontSize` and `borderLeftWidth` style object properties.

Here's an example:

```
var pageTitle = document.querySelector("h1");
pageTitle.style.fontSize = "64px";
pageTitle.style.color = "maroon";
pageTitle.style.textAlign = "center";
pageTitle.style.border = "1px solid black";
```

This code gets a reference to the page's first `<h1>` element. With that reference in hand, the code then uses the `style` object to style four properties of the heading: `fontSize`, `color`, `text-align`, and `border`.

Adding a class to an element

Besides changing an element's styles, you can also assign a class to an element. First, you can get a list of an element's assigned classes by using the `classList` property:

```
element.classList
```

- » `element`: The element you're working with

The returned list of classes is an arraylike object that includes an `add` method that you can use to add a new class to the element's existing classes:

```
element.classList.add(class)
```

- » `element`: The element you're working with.
- » `class`: A string representing the name of the class you want to add to `element`. You can add multiple classes by separating each class name with a comma.

Here's an example:

```
var articleSections = document.querySelectorAll("article > section");
for (var i = 0; i < articleSections.length; i++) {
    articleSections[i].classList.add("sectionText");
}
```

This code uses `querySelectorAll` to return all the `section` elements that are direct children of an `article` element, and those `section` elements are stored in the `articleSections` variable. `articleSections` is an arraylike object, so we can iterate through it using a `for` loop. Inside the loop, the code uses `classList.add` to add the class named `sectionText` to each `section` element.

IN THIS CHAPTER

- » Learning what arrays can do for you
- » Declaring an array variable
- » Populating an array with data
- » Trying out multidimensional arrays
- » Working with JavaScript's Array object

Chapter 7

Working with Arrays

I choose a lazy person to do a hard job. Because a lazy person will find an easy way to do it.

— BILL GATES

In this chapter, you discover one of JavaScript's most important concepts: the array. Arrays are important not only because they're extremely powerful, but because once you know how to use them, you'll think of a thousand and one uses for them. To make sure you're ready for your new array-filled life, this chapter explains what they are and why they're so darn useful, and then explores all the fantastic ways that arrays can make your coding life easier.

What Is an Array?

I talk quite a bit about efficient programming in this book because I believe (okay, I know) that efficient scripts run faster and take less time to program and debug. As I've said, efficiency in programming really means eliminating unnecessary repetition, whether it's consolidating statements into a loop that can be repeated as often as required, or moving code into a function that can be called as often as you need.

Another source of unnecessary repetition involves variables. For example, consider the following declarations:

```
var dog1 = "dog-1";
var dog2 = "dog-2";
var dog3 = "dog-3";
var dog4 = "dog-4";
var dog5 = "dog-5";
```

These are string variables and they store the names of some dog photos. Now suppose you want to write a script that asks the user for a dog number and then displays the corresponding photo as the page background. The following code shows such a script:

```
var dog1 = "dog-1";
var dog2 = "dog-2";
var dog3 = "dog-3";
var dog4 = "dog-4";
var dog5 = "dog-5";

var promptNum = prompt("Enter the dog you want to see
(1-5):", "");

if (promptNum !== "" && promptNum !== null) {
    var promptDog = "dog-" + promptNum;
    if (promptDog === dog1) {
        document.body.style.backgroundImage = "url('/images/" +
dog1 + ".png')";
    } else if (promptDog === dog2) {
        document.body.style.backgroundImage = "url('/images/" +
dog2 + ".png')";
    } else if (promptDog === dog3) {
        document.body.style.backgroundImage = "url('/images/" +
dog3 + ".png')";
    } else if (promptDog === dog4) {
        document.body.style.backgroundImage = "url('/images/" +
dog4 + ".png')";
    } else if (promptDog === dog5) {
        document.body.style.backgroundImage = "url('/images/" +
dog5 + ".png')";
    }
}
```

After declaring and initializing the variables, the script uses `prompt()` to get a number between 1 and 5, which is stored in the `promptNum` variable. An `if()` test

ensures that `promptNum` isn't the empty string (no value entered) or `null` (Cancel was clicked). The code then adds the number to the string `dog-`, which is then stored in the `promptDog` variable.

Now the code runs through five separate `if()` tests, each of which checks to see if `promptDog` is equal to one of the variables. If a match is found, the `document.body.style.backgroundImage` property is set to the URL of the image.

This might not seem outrageously inefficient, but what if instead of five images you actually had to take 10 or 20 or even 100 images into account? I'm sure the idea of typing 100 `if()` tests isn't your idea of a good time.

To understand the solution to this problem, first understand that the variables `dog1` through `dog5` all contain related values. That is, each variable holds part of the filename of a dog photo, which in turn is part of the full URL for that image. In JavaScript (or, indeed, in just about any programming language), whenever you have a collection of variables with related data, it's possible to group them together into a single variable called an *array*. You can enter as many values as you want into the array, and JavaScript tracks each value by the use of an *index number*. For example, the first value you add is given the index `0`. (For obscure reasons, programmers since time immemorial have started numerical lists with `0` instead of `1`.) The second value you put into the array is given the index `1`, the third value gets `2`, and so on. You can then access any value in the array by specifying the index number you want.

The next couple of sections flesh out this theory with the specifics of creating and populating an array, and then you'll see how to rewrite a much more efficient version of the above code using arrays.

Declaring an Array

Because an array is a type of variable, you need to declare it before using it. In fact, unlike regular numeric, string, or Boolean variables that don't really need to be declared (but always should be), JavaScript insists that you declare an array in advance. You use the `var` statement again, but this time with a slightly different syntax. Actually, there are four syntaxes you can use. Let's start with the simplest:

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

Here, `arrayName` is the name you want to use for the array variable.

In JavaScript, an array is actually an object, so what the `new` keyword is doing here is creating a new `Array` object. The `Array()` part of the statement is called

a *constructor* because its job is to construct the object in memory. For example, to create a new array named `dogPhotos`, you'd use the following statement:

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

The second syntax is useful if you know in advance the number of values (or *elements*) you'll be putting into the array:

```
var arrayName = new Array(num);
```

- » *arrayName*: The name you want to use for the array variable
- » *num*: The number of values you'll be placing into the array

For example, here's a statement that declares a new `dogPhotos` array with 5 elements:

```
var dogPhotos = new Array(5);
```

If you're not sure how many elements you need, don't worry about it because JavaScript is happy to let you add elements to and delete elements from the array as needed, and it will grow or shrink the array to compensate. I talk about the other two array declaration syntaxes in the next section.

Populating an Array with Data

Once your array is declared, you can start populating it with the data values you want to store. Here's the general syntax for doing this:

```
arrayName[index] = value;
```

- » *arrayName*: The name of the array variable
- » *index*: The array index number where you want the value stored
- » *value*: The value you're storing in the array

JavaScript is willing to put just about any type of data inside an array, including numbers, strings, Boolean values, and even other arrays! You can even mix multiple data types within a single array.

As an example, here are a few statements that declare a new array named `dogPhotos` and then enter five string values into the array:

```
var dogPhotos = new Array(5);
dogPhotos[0] = "dog-1";
dogPhotos[1] = "dog-2";
dogPhotos[2] = "dog-3";
dogPhotos[3] = "dog-4";
dogPhotos[4] = "dog-5";
```

To reference an array value (say, to use it within an expression), you specify the appropriate index:

```
strURL + dogPhotos[3]
```

The following code offers a complete example:

HTML:

```
<div id="output">
</div>
```

JavaScript:

```
// Declare the array
var dogPhotos = new Array(5);

// Initialize the array values
dogPhotos[0] = "dog-1";
dogPhotos[1] = "dog-2";
dogPhotos[2] = "dog-3";
dogPhotos[3] = "dog-4";
dogPhotos[4] = "dog-5";

// Display an example
document.getElementById('output').innerHTML = '/images/' +
    dogPhotos[0] + '.png';
```

Declaring and populating an array at the same time

Earlier I mention that JavaScript has two other syntaxes for declaring an array. Both enable you to declare an array *and* populate it with values by using just a single statement.

The first method uses the `Array()` constructor in the following general format:

```
var arrayName = new Array(value1, value2, ...);
```

- » `arrayName`: The name you want to use for the array variable
- » `value1, value2, ...`: The initial values with which you want to populate the array

Here's an example:

```
var dogPhotos = new Array("dog-1", "dog-2", "dog-3", "dog-4",  
    "dog-5");
```

JavaScript also supports the creation of *array literals*, which are similar to string, numeric, and Boolean literals. In the same way that you create, say, a string literal by enclosing a value in quotation marks, you create an array literal by enclosing one or more values in square brackets. Here's the general format:

```
var arrayName = [value1, value2, ...];
```

- » `arrayName`: The name you want to use for the array variable
- » `value1, value2, ...`: The initial values with which you want to populate the array

An example:

```
var dogPhotos= ["dog-1", "dog-2", "dog-3", "dog-4", "dog-5"];
```

Using a loop to populate an array

So far, you probably don't think arrays are all that much more efficient than using separate variables. That's because you haven't yet learned about the single most powerful aspect of working with arrays: using a loop and some kind of counter variable to access an array's index number programmatically.

For example, here's a `for()` loop that replaces the six statements I used earlier to declare and initialize the `dogPhotos` array:

```
var dogPhotos = new Array(5);  
for (var counter = 0; counter < 5; counter++) {  
    dogPhotos[counter] = "dog-" + (counter + 1);  
}
```

The statement inside the `for()` loop uses the variable counter as the array's index. For example, when counter is 0, the statement looks like this:

```
dogPhotos[0] = "dog-" + (0 + 1);
```

In this case, the expression to the right of the equals sign evaluates to "dog-1", which is the correct value. The following code shows this loop technique at work:

HTML:

```
<div id="output">  
</div>
```

JavaScript:

```
// Declare the array
var dogPhotos = new Array(5);

// Initialize the array values using a loop
for (var counter = 0; counter < 5; counter++) {
    dogPhotos[counter] = "dog-" + (counter + 1);
}

// Display an example
document.getElementById('output').innerHTML = '/images/' +
    dogPhotos[0] + '.png';
```

Using a loop to insert data into an array works best in two situations:

- » When the array values can be generated using an expression that changes with each pass through the loop
 - » When you need to assign the same value to each element of the array



REMEMBER

If you declare your array with a specific number of elements, JavaScript doesn't mind at all if you end up populating the array with more than that number.

Using a loop to work with array data

The real problem with using a large number of similar variables isn't so much declaring them, but working with them in your code. In this chapter's original code example, the script had to use five separate `if()` tests to check the input value against all five variables.

Arrays can really help make your code more efficient by enabling you to reduce these kinds of long-winded checking procedures to a much shorter routine that fits inside a loop. As with populating the array, you use the loop counter or some other expression to generate new array values to work with.

For example, here's a `for()` loop that replaces all those `if()` tests from the earlier script:

```
for (var counter = 0; counter < 5; counter++) {
    if (promptDog === dogPhotos[counter]) {
        document.body.style.backgroundImage = "url('/images/" +
            dogPhotos[counter] + ".png')";
        break;
    }
}
```

Each time through the loop, a new array value is generated by `dogPhotos[counter]`, and this value is compared with `promptDog`. If a match is found, `dogPhotos[counter]` is used in an expression to generate the new `backgroundImage` property, and then `break` takes the code out of the loop.

Putting it all together, the following code presents the full and very efficient replacement for the earlier script:

```
// Declare the array
var dogPhotos = new Array(5);

// Initialize the array values using a loop
for (var counter = 0; counter < 5; counter++) {
    dogPhotos[counter] = "dog-" + (counter + 1);
}

// Get the photo number
var promptNum = prompt("Enter the dog you want to see
    (1-5):", "");

if (promptNum !== "" && promptNum !== null) {

    // Construct the primary part of the filename
    var promptDog = "dog-" + promptNum;

    // Work with the array values using a loop
    for (counter = 0; counter < 5; counter++) {
```

```
        if (promptDog === dogPhotos[counter] {  
            document.body.style.backgroundImage =  
                "url('/images/" + dogPhotos[counter] + ".png')";  
            break;  
        }  
    }  
}
```

Creating Multidimensional Arrays

A *multidimensional array* is one where two or more values are stored within each array element. For example, if you wanted to create an array to store user data, you might need each element to store a first name, a last name, a user name, a password, and more. The bad news is that JavaScript doesn't support multidimensional arrays. The good news is that it's possible to use a trick to simulate a multidimensional array.

The trick is to populate your array in such a way that each element is itself an array. To see how such an odd idea might work, first recall the general syntax for an array literal:

```
[value1, value2, ...]
```

Now recall the general syntax for assigning a value to an array element:

```
arrayName[index] = value;
```

In a one-dimensional array, the *value* is usually a string, number, or Boolean. Now imagine, instead, that *value* is an array literal. For a two-dimensional array, the general syntax for assigning an array literal to an array element looks like this:

```
arrayName[index] = [value1, value2];
```

As an example, say you want to store an array of background and foreground colors. Here's how you might declare and populate such an array:

```
var colorArray = new Array(3);  
colorArray[0] = ['white', 'black'];  
colorArray[1] = ['aliceblue', 'midnightblue'];  
colorArray[2] = ['honeydew', 'darkgreen'];
```

Alternatively, you can declare and populate the array using only the array literal notation:

```
var colorArray = [['white', 'black'], ['aliceblue',
    'midnightblue'], ['honeydew', 'darkgreen']];
```

Either way, you can then refer to individual elements using double square brackets, as in these examples:

```
colorArray[0][0]; // Returns 'white'
colorArray[0][1]; // Returns 'black'
colorArray[1][0]; // Returns 'aliceblue'
colorArray[1][1]; // Returns 'midnightblue'
colorArray[2][0]; // Returns 'honeydew'
colorArray[2][1]; // Returns 'darkgreen'
```

The number in the left set of square brackets is the index of the overall array, and the number in the right set of square brackets is the index of the element array.

Using the Array Object

In JavaScript, an array is actually an object. That's what the `Array()` constructor does: It creates a new object based on the arguments (if any) that you supply within the parentheses. So, like any good object, `Array` comes with a collection of properties and methods that you can work with and manipulate. The rest of this chapter takes a look at these properties and methods.

The `length` property

The `Array` object has just a couple of properties, but the only one of these that you'll use frequently is the `length` property:

```
array.length
```

The `length` property returns the number of elements that are currently in the specified array. This is very useful when looping through an array because it means you don't have to specify a literal as the maximum value of the loop counter. For example, consider the following `for()` statement:

```
for (var counter = 0; counter < 5; counter++) {
    dogPhotos[counter] = "dog-" + (counter + 1);
}
```

This statement assumes the `dogPhotos` array has five elements, which might not be the case. To enable the loop to work with any number of elements, replace `5` with `dogPhotos.length`:

```
for (var counter = 0; counter < dogPhotos.length; counter++)
    dogPhotos[counter] = "dog-" + (counter + 1);
}
```

Note, too, that the loop runs while the `counter` variable is *less than* `dogPhotos.length`. That's because array indexes run from `0` to the array's `length` value minus `1`. In other words, the previous `for()` loop example is equivalent to the following:

```
for (var counter = 0; counter <= dogPhotos.length - 1;
    counter++)
```

Concatenating to create a new array: `concat()`

The `concat()` method takes the elements of an existing array and concatenates one or more specified values onto the end to create a new array:

```
array.concat(value1, value2, ...)
```

- » `array`: The name of the array you want to work with.
- » `value1, value2, ...`: The values you want to concatenate to `array`. This can also be another array.

Note that the original array remains unchanged. The following code demonstrates using `concat()` to concatenate two arrays into a third array, each element of which is printed to the page, as shown in Figure 7-1.

HTML:

```
<div id="output">
</div>
```

JavaScript:

```
var array1 = new Array("One", "Two", "Three");
var array2 = new Array("A", "B", "C");
var array3 = array1.concat(array2);
var str = "";
```

```
for (var counter = 0; counter < array3.length; counter++) {  
    str += array3[counter] + "<br>";  
}  
document.getElementById("output").innerHTML = str;
```

FIGURE 7-1:
Concatenating
array1 and
array2 produces
array3 with the
values shown
here.

```
One  
Two  
Three  
A  
B  
C
```

Creating a string from an array's elements: join()

The `join()` method enables you to take the existing values in an array and concatenate them together to form a string. Check out the syntax:

```
array.join(separator)
```

- » `array`: The name of the array you want to work with.
- » `separator`: An optional character or string to insert between each array element when forming the string. If you omit this argument, a comma is inserted between each element.

In the following code, three arrays are created and then `join()` is applied to each one using a space as a separator, then the null string (""), and then no separator. Figure 7-2 shows the resulting page output.

HTML:

```
<div id="output">  
</div>
```

JavaScript:

```
var array1 = new Array("Make", "this", "a", "sentence.");  
var array2 = new Array("antid", "isest", "ablis", "hment",  
    "arian", "ism");  
var array3 = new Array("John", "Paul", "George", "Ringo");  
var string1 = array1.join(" ");
```

```
var string2 = array2.join("");
var string3 = array3.join();

document.getElementById('output').innerHTML = string1 + '<br>' +
    string2 + '<br>' + string3;
```

FIGURE 7-2:
Joining the arrays with a space, null string (" "), and default comma.

Make this a sentence.
antidisestablishmentarianism
John, Paul, George, Ringo



REMEMBER

The Array object's `toString()` method performs a similar function to the `join()` method. Using `array.toString()` takes the values in `array`, converts them all to strings, and then concatenates them into a single, comma-separated string. In other words, `array.toString()` is identical to `array.join(",")`, or just `array.join()`.

Removing an array's last element: `pop()`

The `pop()` method removes the last element from an array and returns the value of that element. Here's the syntax:

```
array.pop()
```

For example, consider the following statements:

```
var myArray = new Array("First", "Second", "Third");
var myString = myArray.pop();
```

The last element of `myArray` is "Third", so `myArray.pop()` removes that value from the array and stores it in the `myString` variable.



REMEMBER

Adding elements to the end of an array: `push()`

The `push()` method is the opposite of `pop()`: It adds one or more elements to the end of an array. Here's the syntax to use:

```
array.push(value1, value2, ...)
```

- » `array`: The name of the array you want to work with.
- » `value1, value2, ...`: The values you want to add to the end of `array`. This can also be another array.

`push()` differs from the `concat()` method in that it doesn't return a new array. Instead, it changes the existing array by adding the new values to the end of the array. For example, consider the following statements:

```
var myArray = new Array("First", "Second", "Third");
var pushArray = new Array("Fourth", "Fifth", "Sixth");
for (var i = 0; i < pushArray.length; i++) {
    myArray.push(pushArray[i]);
}
```

After these statements, `myArray` contains six values: "First", "Second", "Third", "Fourth", "Fifth", and "Sixth". Why didn't I just add the entire `pushArray` in one fell swoop? That is, like so:

```
myArray.push(pushArray);
```

That's perfectly legal, but it would mean `myArray` would contain the following four elements: "First", "Second", "Third", and `pushArray`, which means you've created a kind of hybrid multidimensional array, which is probably not what you want in this situation.



REMEMBER

Reversing the order of an array's elements: `reverse()`

The `reverse()` method takes the existing elements in an array and reverses their order: The first moves to the last, the last moves to the first, and so on. The syntax takes just a second to show:

```
array.reverse()
```

The following code puts the `reverse()` method to work, and Figure 7-3 shows what happens.

```
var myArray = new Array("Show", "Place", "Win");
myArray.reverse();
```

```
var str = "";
for (var counter = 0; counter < myArray.length; counter++) {
    str += myArray[counter] + "<br>";
}
document.getElementById("output").innerHTML = str;
```

FIGURE 7-3:

Use the `reverse()` method to reverse the order of elements in an array.

Win
Place
Show

Removing an array's first element: `shift()`

The `shift()` method removes the first element from an array and returns the value of that element:

```
array.shift()
```

For example, consider the following statements:

```
var myArray = new Array("First", "Second", "Third");
var myString = myArray.shift();
```

The first element of `myArray` is "First", so `myArray.shift()` removes that value from the array and stores it in the `myString` variable.



REMEMBER

After you run the `shift()` method, JavaScript reduces the value of the array's `length` property by one.

Returning a subset of an array: `slice()`

The `slice()` method returns a new array that contains a subset of the elements in an existing array. Take a look at the syntax:

```
array.slice(start, end);
```

» `array`: The name of the array you want to work with.

» `start`: A number that specifies the index of the first element in `array` that you want to include in the subset. If this number is negative, the subset

starting point is counted from the end of *array* (for example, -1 is the last element of the array).

- » *end*: An optional number that specifies the index of the element in *array before which* you want the subset to end. If you leave out this value, the subset includes all the elements in *array* from *start* to the last element. This value can be negative.



WARNING

If you use a negative number for the *start* value, the *end* value must also be negative, but it must be larger than *start*. For example, if you use -4 for *start*, then *end* can only be -1, -2, or -3.

The following code defines an array and then tries out various values for the `slice()` arguments. The results are shown in Figure 7-4.

```
var myArray = new Array("A", "B", "C", "D", "E", "F");
var array1 = myArray.slice(0, 4);
var array2 = myArray.slice(3);
var array3 = myArray.slice(-3, -1);
var str = "array1: " + array1 + "<br>";
str += "array2: " + array2 + "<br>";
str += "array3: " + array3;
document.getElementById('output').innerHTML = str;
```

FIGURE 7-4:
The `slice()` method creates a new array from a subset of another array.

```
array1: A,B,C,D
array2: D,E,F
array3: D,E
```

Ordering array elements: `sort()`

The `sort()` method is an easy way to handle a common programming problem: rearranging an array's elements to put them in alphabetical, numerical, or some other order. Here's the syntax:

```
array.sort(function)
```

- » *array*: The name of the array you want to work with.
- » *function*: An optional name of a function that specifies the sort order. If you leave out this argument, the elements of *array* are sorted alphabetically.

Using `sort()` without an argument gives you a straightforward alphabetical sort:

```
myArray.sort();
```

If you want to sort the array based on some other criterion, then you need to create a function to define the sort order. Your function must be set up as follows:

- » The function must accept two arguments. For the purposes of this list, I'll call these arguments `a` and `b`.
- » Using these arguments, the function must define an expression that returns a numeric value.
- » For those cases where you want `a` sorted before `b`, the function must return a negative value.
- » For those cases where you want `a` sorted after `b`, the function must return a positive value.
- » For those cases where you want `a` and `b` to be treated equally, the function must return zero.

The following code shows a function named `numericSort` that you can use if you want a numeric sort from lowest to highest. Figure 7-5 displays the original array and then the sorted array.

```
// This function sorts numbers from lowest to highest
function numericSort(a, b) {
    return (a - b);
}

var myArray = [3, 5, 1, 6, 2, 4];

// Write the array before sorting it
var str = "myArray (before sorting): " + myArray + "<br>";

// Sort the array
myArray.sort(numericSort);

// Write the array after sorting it
str+= "myArray (after sorting): " + myArray;

document.getElementById('output').innerHTML = str;
```



TIP

To get a numeric sort from highest to lowest, use the following return expression, instead:

```
return (b - a);
```

FIGURE 7-5:
Using `sort()`
and a function
to sort items
numerically from
lowest to highest.

```
myArray (before sorting): 3,5,1,6,2,4  
myArray (after sorting): 1,2,3,4,5,6
```



TIP

What if you want a reverse alphabetical sort? Here's a function that will do it:

```
function reverseAlphaSort(a, b) {  
    if (a > b) {  
        return -1  
    }  
    else if (a < b) {  
        return 1  
    }  
    else {  
        return 0  
    }  
}
```

Removing, replacing, and inserting elements: `splice()`

The `splice()` method is a complex function that comes in handy in all kinds of situations. First, here's the syntax:

```
array.splice(start, elementsToDelete, value1, value2, ...)
```

- » `array`: The name of the array you want to work with.
- » `start`: A number that specifies the index of the element where the splice takes place.
- » `elementsToDelete`: An optional number that specifies how many elements to delete from `array` beginning at the `start` position. If you don't include this argument, elements are deleted from `start` to the end of the array.

» *value1, value2, ...*: Optional values to insert into *array* beginning at the *start* position.

With `splice()` at your side, you can perform one or more of the following tasks:

- » **Deletion:** If *elementsToDelete* is greater than zero or unspecified and no insertion values are included, `splice()` deletes elements beginning at the index *start*. The deleted elements are returned in a separate array.
- » **Replacement:** If *elementsToDelete* is greater than zero or unspecified and one or more insertion values are included, `splice()` first deletes elements beginning at the index *start*. It then inserts the specified values before the element with index *start*.
- » **Insertion:** If *elementsToDelete* is 0, `splice()` inserts the specified values before the element with index *start*.

The following code demonstrates all three tasks, and the results are shown in Figure 7-6.

```
var array1 = new Array("A", "B", "C", "D", "E", "F");
var array2 = new Array("A", "B", "C", "D", "E", "F");
var array3 = new Array("A", "B", "C", "D", "E", "F");

// DELETION
// In array1, start at index 2 and delete to the end
// Return the deleted elements to the delete1 array
var delete1 = array1.splice(2);

// Write array1
var str = "array1: " + array1 + "<br>";

// Write delete1
str += "delete1: " + delete1 + "<br>";

// REPLACEMENT
// In array2, start at index 3 and delete 2 elements
// Insert 2 elements to replace them
// Return the deleted elements to the delete2 array
var delete2 = array2.splice(3, 2, "d", "e");

// Write array2
str += "array2: " + array2 + "<br>";
```

```

// Write delete2
str += "delete2: " + delete2 + "<br>";

// INSERTION
// In array3, start at index 1 and insert 3 elements
array3.splice(1, 0, "1", "2", "3")

// Write array3
str += "array3: " + array3;

document.getElementById('output').innerHTML = str;

```

FIGURE 7-6:
The `splice()` method can delete, replace, and insert array elements.

```

array1: A,B
delete1: C,D,E,F
array2: A,B,C,d,e,F
delete2: D,E
array3: A,1,2,3,B,C,D,E,F

```

Inserting elements at the beginning of an array: `unshift()`

The `unshift()` method is the opposite of the `shift()` method: It inserts one or more values at the beginning of an array. When it's done, `unshift()` returns the new length of the array. Here's the syntax:

```
array.unshift(value1, value2, ...)
```

- » `array`: The name of the array you want to work with
- » `value1, value2, ...`: The values you want to add to the beginning of `array`

For example, consider the following statements:

```

var myArray = new Array("First", "Second", "Third");
var newLength = myArray.unshift("Fourth", "Fifth", "Sixth");

```

After these statements, `myArray` contains six values — "Fourth", "Fifth", and "Sixth", "First", "Second", and "Third" — and the value of `newLength` is 6.

IN THIS CHAPTER

- » Manipulating strings
- » Working with dates and times
- » Performing math calculations

Chapter 8

Manipulating Strings, Dates, and Numbers

First learn computer science and all the theory. Next develop a programming style. Then forget all that and just hack.

— GEORGE CARRETTE

Although your JavaScript code will spend much of its time dealing with web page knickknacks such as HTML tags and CSS properties, it will also perform lots of behind-the-scenes chores that require manipulating strings, dealing with dates and times, and performing mathematical calculations. To help you through these tasks, in this chapter you explore three of JavaScript's built-in objects: the String object, the Date object, and the Math object. You investigate the most important properties of each object, master the most used methods, and see lots of useful examples along the way.

Manipulating Text with the String Object

I've used dozens of examples of strings so far in this book. These have included not only string literals (such as "Web Coding and Development for Dummies"), but also methods that return strings (such as the `prompt()` method). So it should

be clear by now that strings play a major role in all JavaScript programming, and it will be a rare script that doesn't have to deal with strings in some fashion.

For this reason, it pays to become proficient at manipulating strings, which includes locating text within a string and extracting text from a string. You learn all of that and more in this section.

Any string you work with — whether it's a string literal or the result of a method or function that returns a string — is a `String` object. So, for example, the following two statements are equivalent:

```
var bookName = new String("Web Coding and Development for  
Dummies");  
var bookName = "Web Coding and Development for Dummies";
```

This means that you have quite a bit of flexibility when applying the properties and methods of `String` objects. For example, the `String` object has a `length` property that I describe in the next section. The following are all legal JavaScript expressions that use this property:

```
bookName.length;  
"Web Coding and Development for Dummies".length;  
prompt("Enter the book name:").length;  
myFunction().length;
```

The last example assumes that `myFunction()` returns a string value.

Determining the length of a string

The most basic property of a `String` object is its `length`, which tells you how many characters are in the string:

```
string.length
```

All characters within the string — including spaces and punctuation marks — are counted toward the length. The only exceptions are escape sequences (such as `\n`), which always count as one character. The following code grabs the `length` property value for various `String` object types.

```
function myFunction() {  
    return "filename.htm";  
}
```

```

var bookName = "Web Coding and Development for Dummies";

length1 = myFunction().length; // Returns 12
length2 = bookName.length; // Returns 38
length3 = "123\n5678".length; // Returns 8

```

What the `String` object lacks in properties it more than makes up for in methods. There are over two dozen, and they enable your code to perform many useful tasks, from converting between uppercase and lowercase letters, to finding text within a string, to extracting parts of a string.

Finding substrings

A *substring* is a portion of an existing string. For example, substrings of the string "JavaScript" would be "Java", "Script", "vaSc", and "v". When working with strings in your scripts, you'll often have to determine whether a given string contains a given substring. For example, if you're validating a user's email address, you should check that it contains an @ symbol.

Table 8-1 lists the two `String` object methods that find substrings within a larger string.

TABLE 8-1

String Object Methods for Finding Substrings

| Method | What It Does |
|---|---|
| <code>string.indexOf(substring, start)</code> | Searches <i>string</i> for the first instance of <i>substring</i> |
| <code>string.lastIndexOf(substring, start)</code> | Searches <i>string</i> for the last instance of <i>substring</i> |

You'll use both of these methods quite often in your scripts, so I take a closer look at each one.

When you want to find the first instance of a substring, or if all you want to know is whether a string contains a particular substring, use the `indexOf()` method; if you need to find the last instance of a substring, use the `lastIndexOf()` method:

```

string.indexOf(substring, start)
string.lastIndexOf(substring, start)

```

» *string*: The string in which you want to search.

» *substring*: The substring that you want to search for in *string*.

- » *start*: An optional character position from which the search begins. If you omit this argument, JavaScript starts the search from the beginning of the string.

Here are some notes you should keep in mind when using `indexOf()` or `lastIndexOf()`:

- » Each character in a string is given an index number, which is the same as the character's position within the string.
- » Strings, like arrays, are *zero-based*, which means that the first character has index 0, the second character has index 1, and so on.
- » Both methods are case-sensitive. For example, if you search for B, neither method will find any instances of b.
- » If either method finds *substring*, they return the index position of the first character of *substring*.
- » If either method doesn't find *substring*, they return -1.

The following code tries out these methods in a few different situations.

HTML:

```
<pre>
Web Coding and Development for Dummies
01234567890123456789012345678901234567
</pre>
<div id="output"></div>
```

JavaScript:

```
var bookName = "Web Coding and Development for Dummies";

var str = "\"C\" is at index " + bookName.indexOf("C") + "<br>";
str += "\"v\" is at index " + bookName.indexOf("v") + "<br>";
str += "The first space is at index " + bookName.indexOf(" ") +
      "<br>";
str += "The first \"D\" is at index " + bookName.indexOf("D") +
      "<br>";
str += "The last \"D\" is at index " + bookName.lastIndexOf("D") +
      "<br>";
str += "The first \"e\" after index 2 is at index " + bookName.
      indexOf("e", 2) + "<br>";
```

```
str += "The substring \"Develop\" begins at index " + bookName.  
indexOf("Develop");  
  
document.getElementById("output").innerHTML = str;
```

As you can see in Figure 8-1, the numbers show you the index positions of each character in the script.

FIGURE 8-1:
The `indexOf()`
and `last
IndexOf()`
methods search
for substrings
within a string.

```
Web Coding and Development for Dummies  
01234567890123456789012345678901234567  
  
"C" is at index 4  
"v" is at index 17  
The first space is at index 3  
The first "D" is at index 15  
The last "D" is at index 31  
The first "e" after index 2 is at index 16  
The substring "Develop" begins at index 15
```

On a more practical note, the following code presents a simple validation script that uses `indexOf()`.

```
var emailAddress = "";  
do {  
    emailAddress = prompt("Enter a valid email address:");  
}  
while (emailAddress.indexOf("@") === -1);
```

The script prompts the user for a valid email address, which is stored in the `emailAddress` variable. Any valid address will contain the @ symbol, so the `while()` portion of a `do...while()` loop checks to see if the entered string contains @:

```
while (emailAddress.indexOf("@") === -1);
```

If not (that is, if `emailAddress.indexOf("@")` returns -1), the loop continues and the user is prompted again.

Methods that extract substrings

Finding a substring is one thing, but you'll often have to extract a substring, as well. For example, if the user enters an email address, you might need to extract just the username (the part to the left of the @ sign) or the domain name (the part to the right of @). For these kinds of operations, JavaScript offers six methods, listed in Table 8-2.

TABLE 8-2

String Object Methods for Extracting Substrings

| Method | What It Does |
|---|---|
| <code>string.charAt(index)</code> | Returns the character in <code>string</code> that's at the index position specified by <code>index</code> |
| <code>string.charCodeAt(index)</code> | Returns the code of the character in <code>string</code> that's at the index position specified by <code>index</code> |
| <code>string.slice(start, end)</code> | Returns the substring in <code>string</code> that starts at the index position specified by <code>start</code> and ends immediately before the index position specified by <code>end</code> |
| <code>string.split(separator, limit)</code> | Returns an array where each item is a substring in <code>string</code> , where those substrings are separated by the <code>separator</code> character |
| <code>string.substr(start, length)</code> | Returns the substring in <code>string</code> that starts at the index position specified by <code>start</code> and is <code>length</code> characters long |
| <code>string.substring(start, end)</code> | Returns the substring in <code>string</code> that starts at the index position specified by <code>start</code> and ends at the index position specified by <code>end</code> |

The `charAt()` method

You use the `charAt()` method to return a single character that resides at a specified position within a string:

```
string.charAt(index)
```

- » `string`: The string that contains the character
- » `index`: The position within `string` of the character you want

Here are some notes about this method:

- » To return the first character in `string`, use the following:

```
string.charAt(0)
```
- » To return the last character in `string`, use this:

```
string.charAt(string.length - 1)
```
- » If the `index` value is negative or if it's greater than or equal to `string.length`, JavaScript returns the empty string ("").

The following code presents an example.

HTML:

```
<div id="output"></div>
```

JavaScript:

```
// Set up an array of test strings
var stringArray = new Array(4);
stringArray[0] = "Not this one.";
stringArray[1] = "Not this one, either.";
stringArray[2] = "1. Step one.";
stringArray[3] = "Shouldn't get this far.";

var firstChar;

// Loop through the array
for (var i = 0; i < 4; i++) {

    // Get the first character of the string;
    firstChar = stringArray[i].charAt(0);

    // If it's a number, break because that's the one we want
    if (!isNaN(firstChar)) { break }

}
document.getElementById("output").innerHTML = "Here's the one:
"" + stringArray[i] + """;
```

The idea here is to examine a collection of strings and find the one that starts with a number. The collection is stored in the array named `stringArray`, and a `for()` loop is set up to run through each item in the array. The `charAt()` method is applied to each array item to return the first character, which is stored in the `firstChar` variable. In the `if()` test, the logical expression `!isNaN(firstChar)` returns true if the first character is a number, at which point the loop breaks and the correct string is displayed in the web page.

| |
|---|
| Web Coding and Development for Dummies 01234567890123456789012345678901234567 slice(0, 3) = Web slice(4, 10) = Coding slice(15) = Development for Dummies slice(0, -12) = Web Coding and Development |
|---|

FIGURE 8-2:
Some examples
of the `slice()`
method in action.

The slice() method

Use the `slice()` method to carve out a piece of a string:

```
string.slice(start, end)
```

- » `string`: The string you want to work with.
- » `start`: The position within `string` of the first character you want to extract.
- » `end`: An optional position within `string` immediately after the last character you want to extract. If you leave out this argument, JavaScript extracts the substring that runs from `start` to the end of the string. Also, this argument can be negative, in which case it specifies an offset from the end of the string.

To be clear, `slice()` extracts a substring that runs from the character at `start` up to, but not including, the character at `end`.

The following code runs through a few examples (see Figure 8–2).

HTML:

```
<pre>
Web Coding and Development for Dummies
01234567890123456789012345678901234567
</pre>
<div id="output"></div>
```

JavaScript:

```
var bookName = "Web Coding and Development for Dummies";

var str = "slice(0, 3) = " + bookName.slice(0, 3) + "<br>";
str += "slice(4, 10) = " + bookName.slice(4, 10) + "<br>";
str += "slice(15) = " + bookName.slice(15) + "<br>";
str += "slice(0, -12) = " + bookName.slice(0, -12);
document.getElementById("output").innerHTML = str;
```

The split() method

The `split()` method breaks up a string and stores the pieces inside an array:

```
string.split(separator, limit)
```

- » *string*: The string you want to work with.
- » *separator*: The character used to mark the positions at which *string* is split. For example, if *separator* is a comma, the splits will occur at each comma in *string*.
- » *limit*: An optional value that sets the maximum number of items to store in the array. For example, if *limit* is 5, `split()` stores the first 5 pieces in the array and then ignores the rest of the string.



TIP

If you want each character in the string stored as an individual array item, use the empty string ("") as the *separator* value.

The `split()` method is useful for those times when you have a “well-structured” string. This means that the string contains a character that acts as a delimiter between each string piece that you want set up as an array item. For example, it’s fairly common to have to deal with *comma-delimited* strings:

```
string1 = "Sunday,Monday,Tuesday,Wednesday,Thursday,Friday,  
Saturday";
```

As you can see, each day in the string is separated by a comma. This makes using the `split()` method a no-brainer:

```
var string1Array = string1.split(",");
```

When you run this statement, `string1Array[0]` will contain "Sunday", `string1Array[1]` will contain "Monday", and so on. Note, too, that JavaScript sets up the array for you automatically. You don’t have to declare the array using `new Array()`.

The following code tries out `split()` with a couple of example strings.

HTML:

```
<div id="output"></div>
```

JavaScript:

```
var string1 = "Sunday,Monday,Tuesday,Wednesday,Thursday,Friday,  
Saturday";  
var string2 = "ABCDEF";  
var str = "";
```

```

var string1Array = string1.split(",");
for (var i = 0; i < string1Array.length; i++) {
    str += "string1Array[" + i + "] = " + string1Array[i] +
    "<br>";
}

var string2Array = string2.split("", 4);
for (i = 0; i < string2Array.length; i++) {
    str += "string2Array[" + i + "] = " + string2Array[i] +
    "<br>";
}

document.getElementById("output").innerHTML = str;

```

After `string1` is split into `string1Array`, a `for()` loop runs through the array and writes the items to the web page. For `string2`, the empty string is used as the separator and a limit of `4` is placed on the size of the `string2Array`. Again, a `for()` writes the array values to the page. Figure 8-3 shows what happens.

FIGURE 8-3:
Some examples
of the `split()`
method.

```

string1Array[0] = Sunday
string1Array[1] = Monday
string1Array[2] = Tuesday
string1Array[3] = Wednesday
string1Array[4] = Thursday
string1Array[5] = Friday
string1Array[6] = Saturday
string2Array[0] = A
string2Array[1] = B
string2Array[2] = C
string2Array[3] = D

```

The `substr()` method

If you want to extract a substring and you know how long you want that substring to be, then the `substr()` method is often the best approach:

`string.substr(index, length)`

- » `string`: The string you want to work with.
- » `index`: The position within `string` of the first character you want to extract.
- » `length`: An optional value that specifies the length of the substring. If you omit this argument, JavaScript extracts all the way to the end of the string.

The following code runs `substr()` through some examples; the results appear in Figure 8-4.

HTML:

```
<pre>
Web Coding and Development for Dummies
01234567890123456789012345678901234567
</pre>
<div id="output"></div>
```

JavaScript:

```
var bookName = "Web Coding and Development for Dummies";

var str = "substr(0, 10) = " + bookName.substr(0, 10)+"<br>";
str += "substr(15, 11) = " + bookName.substr(15, 11) + "<br>";
str += "substr(27) = " + bookName.substr(27);

document.getElementById("output").innerHTML = str;
```

```
Web Coding and Development for Dummies
01234567890123456789012345678901234567

substr(0, 10) = Web Coding
substr(15, 11) = Development
substr(27) = for Dummies
```

FIGURE 8-4:
Some examples
of the `substr()`
method.

The `substring()` method

Use the `substring()` method to extract a substring from a string:

`string.substring(start, end)`

- » `string`: The string you want to work with.
- » `start`: The position within `string` of the first character you want to extract.
- » `end`: An optional value that specifies the position within `string` immediately after the last character you want to extract. If you leave out this argument, JavaScript extracts the substring that runs from `start` to the end of the string.

The following code gives the `substring()` method a whirl, and the results are shown in Figure 8-5.

HTML:

```
<pre>
Web Coding and Development for Dummies
01234567890123456789012345678901234567
</pre>

<div id="output"></div>
```

JavaScript:

```
var bookName = "Web Coding and Development for Dummies";

var str = "substring(0, 10) = " + bookName.substring(0, 10) +
    "<br>";
str += "substring(11, 14) = " + bookName.substring(11, 14) +
    "<br>";
str += "substring(31) = " + bookName.substring(31);

document.getElementById("output").innerHTML = str;
```

FIGURE 8-5:
Some examples of the `substring()` method.

```
Web Coding and Development for Dummies
01234567890123456789012345678901234567
substring(0, 10) = Web Coding
substring(11, 14) = and
substring(31) = Dummies
```

Understanding the differences between `splice()`, `substr()`, and `substring()`

The `splice()`, `substr()`, and `substring()` methods are very similar and are often confused by even experienced JavaScript programmers. Here are some notes to help you understand the differences between these three string extraction methods:

- » The `splice()` and `substring()` methods perform the same task. The only difference is that `splice()` enables you to use a negative value for the `end` argument. This is handy if you want to leave out a certain number of characters from the end of the original string. For example, if you want to extract everything but the last three characters, you'd use this:

```
string.splice(0, -3)
```

- » Use either `splice()` or `substring()` when you're not sure how long the extracted string will be. This usually means that you'll use the `indexOf()` and `lastIndexOf()` methods to find particular characters that mark the starting and ending points of the substring you want. You then use those values as the `start` and `end` arguments of `splice()` or `substring()`. For example, suppose you have a string of the form `www.domain.com` and you want to extract just the domain part. Here's a short routine that will do it:

```
var hostName = "www.domain.com";
var firstDot = hostName.indexOf(".");
var lastDot = hostName.lastIndexOf(".");
var domainName = hostName.substring(firstDot + 1, lastDot);
```

- » On the other hand, if you know in advance exactly how long the extracted string must be, use the `substr()` method.

Dealing with Dates and Times

Dates and times seem like the kind of things that ought to be straightforward programming propositions. After all, there are only 12 months in a year, 28 to 31 days in a month, seven days in a week, 24 hours in a day, 60 minutes in an hour, and 60 seconds in a minute. Surely something so set in stone couldn't get even the least bit weird, could it?

You'd be surprised. Dates and times *can* get strange, but they get much easier to deal with if you always keep three crucial points in mind:

- » JavaScript time is measured in milliseconds, or thousandths of a second. More specifically, JavaScript measures time by counting the number of milliseconds that elapsed between January 1, 1970 and the date and time in question. So, for example, you might see the date January 1, 2001 and think, "Ah, yes, the start the new millennium." JavaScript, however, sees that date and thinks "978307200000."
- » In the JavaScript world, time began on January 1, 1970, at midnight Greenwich Mean Time. Dates before that have *negative* values in milliseconds.
- » Since your JavaScript programs run inside a user's browser, dates and times are almost always the user's *local* dates and times. That is, the dates and times your scripts will manipulate will *not* be those of the server on which your page resides. This means that you can never know what time the user is viewing your page.

Arguments used with the Date object

Before getting to the nitty-gritty of the Date object and its associated methods, I'll take a second to run through the various arguments that JavaScript requires for many date-related features. This will save me from repeating these arguments tediously later on. Table 8-3 has the details.

TABLE 8-3 Arguments Associated with the Date Object

| Argument | What It Represents | Possible Values |
|--------------|--------------------------------|--|
| <i>date</i> | A variable name | A Date object |
| <i>yyyy</i> | The year | Four-digit integers |
| <i>yy</i> | The year | Two-digit integers |
| <i>month</i> | The month | The full month name from "January" to "December" |
| <i>mth</i> | The month | Integers from 0 (January) to 11 (December) |
| <i>dd</i> | The day of the month | Integers from 1 to 31 |
| <i>hh</i> | The hour of the day | Integers from 0 (midnight) to 23 (11:00 PM) |
| <i>mm</i> | The minute of the hour | Integers from 0 to 59 |
| <i>ss</i> | The second of the minute | Integers from 0 to 59 |
| <i>ms</i> | The milliseconds of the second | Integers from 0 to 999 |

Working with the Date object

Whenever you work with dates and times in JavaScript, you work with an instance of the Date object. More to the point, when you deal with a Date object in JavaScript, you deal with a specific moment in time, down to the millisecond. A Date object can never be a block of time, and it's not a kind of clock that ticks along while your script runs. Instead, the Date object is a temporal snapshot that you use to extract the specifics of the time it was taken: the year, month, date, hour, and so on.

Specifying the current date and time

The most common use of the Date object is to store the current date and time. You do that by invoking the `Date()` function, which is the constructor function for creating a new Date object. Here's the general format:

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

Specifying any date and time

If you need to work with a specific date or time, you need to use the `Date()` function's arguments. There are five versions of the `Date()` function syntax (see the list of arguments near the beginning of this chapter):

```
var date = new Date("month dd, yyyy hh:mm:ss");
var date = new Date("month dd, yyyy");
var date = new Date(yyyy, mth, dd, hh, mm, ss);
var date = new Date(yyyy, mth, dd);
var date = new Date(ms);
```

The following statements give you an example for each syntax:

```
var myDate = new Date("August 23, 2018 3:02:01");
var myDate = new Date("August 23, 2018");
var myDate = new Date(2018, 8, 23, 3, 2, 1);
var myDate = new Date(2018, 8, 23);
var myDate = new Date(1408777321000);
```

Extracting information about a date

When your script just coughs up whatever `Date` object value you stored in the variable, the results aren't particularly appealing. If you want to display dates in a more attractive format, or if you want to perform arithmetic operations on a date, then you need to dig a little deeper into the `Date` object to extract specific information such as the month, year, hour, and so on. You do that by using the `Date` object methods listed in Table 8-4.

One of the ways you can take advantage of these methods is to display the time or date to the user using any format you want. Here's an example:

HTML:

```
<div id="output"></div>
```

TABLE 8-4**Date Object Methods That Extract Date Values**

| Method Syntax | What It Returns |
|-------------------------------------|--|
| <code>date.getFullYear()</code> | The year as a four-digit number (1999, 2000, and so on) |
| <code>date.getMonth()</code> | The month of the year; from 0 (January) to 11 (December) |
| <code>date.getDate()</code> | The date in the month; from 1 to 31 |
| <code>date.getDay()</code> | The day of the week; from 0 (Sunday) to 6 (Saturday) |
| <code>date.getHours()</code> | The hour of the day; from 0 (midnight) to 23 (11:00 PM) |
| <code>date.getMinutes()</code> | The minute of the hour; from 0 to 59 |
| <code>date.getSeconds()</code> | The second of the minute; from 0 to 59 |
| <code>date.getMilliseconds()</code> | The milliseconds of the second; from 0 to 999 |
| <code>date.getTime()</code> | The milliseconds since January 1, 1970 GMT |

JavaScript:

```

var timeNow = new Date();
var hoursNow = timeNow.getHours();
var minutesNow = timeNow.getMinutes();
var message = "It's ";
var hoursText;

if (minutesNow <= 30) {
    message += minutesNow + " minutes past ";
    hoursText = hoursNow;
} else {
    message += (60 - minutesNow) + " minutes before ";
    hoursText = hoursNow + 1;
}

if (hoursNow == 0 && minutesNow <= 30) {
    message += "midnight.";
} else if (hoursNow == 11 && minutesNow > 30) {
    message += "noon.";
} else if (hoursNow < 12) {
    message += hoursText + " in the morning.";
} else if (hoursNow == 12 && minutesNow <= 30) {
    message += "noon.";
} else if (hoursNow < 18) {
    message += parseInt(hoursText - 12) + " in the afternoon.";
}

```

```

} else if (hoursNow == 23 && minutesNow > 30) {
    message += "midnight.";
} else {
    message += parseInt(hoursText - 12) + " in the evening.";
}
document.getElementById("output").innerHTML = message;

```

This script begins by storing the user's local time in the `timeNow` variable. Then the current hour is extracted using `getHours()` and stored in the `hoursNow` variable, and the current minute is extracted using `getMinutes()` and stored in the `minutesNow` variable. A variable named `message` is initialized and will be used to store the message that's displayed in the web page. The variable `hoursText` will hold the non-military hour (for example, 4 instead of 16).

Then the value of `minutesNow` is checked to see if it's less than or equal to 30, because this determines the first part of the message, as well as the value of `hoursText`. Here are two examples of what the message will look like:

```

It's 20 minutes past 10 // minutesNow is less than or equal to
30 (10:20)
It's 20 minutes to 11 // minutesNow is greater than 30 (10:40)

```

Then the script checks the value of `hoursNow`:

- » If it equals 0 and `minutesNow` is less than or equal to 30, then the string `midnight` is added to the message.
- » If it equals 11 and `minutesNow` is greater than 30, then the string `noon` is added to the message.
- » If it's less than 12, the value of `hoursText` and the string `in the morning` are added to the message.
- » If it equals 12 and `minutesNow` is less than or equal to 30, then the string `noon` is added to the message.
- » If it's less than 18 (6:00 PM), the result of `hoursText - 12` and the string `in the afternoon` are added.
- » If it equals 23 and `minutesNow` is greater than 30, then the string `midnight` is added to the message.
- » Otherwise, `hoursText - 12` and the string `in the evening` are added.

Finally, the result is written to the page, as shown in Figure 8–6.

FIGURE 8-6:

The results
of the script.

It's 5 minutes before 4 in the afternoon.

Converting getMonth() into a month name

If you want to use the month in a nicer format than the standard Date object display, there's one problem: The `getMonth()` method returns a number instead of the actual name of the month: 0 for January, 1 for February, and so on. If you prefer to use the name, you need some way to convert the number returned by `getMonth()`.

There are two ways you can go about this: an array or a function. The following code shows the array route:

HTML:

```
<div id="output"></div>
```

JavaScript:

```
var monthNames =
    ["January", "February", "March", "April", "May", "June", "July",
     "August", "September", "October", "November", "December"];
var dateNow = new Date();
var monthNow = dateNow.getMonth();
document.getElementById("output").innerHTML = "getMonth() is " +
    monthNow + "; the name is " + monthNames[monthNow];
```

The script declares a 12-item array named `monthNames` that stores the names of the months. The key here is that the array index matches the return value of `getMonth()`. For example, `getMonth()` returns 0 for January, so the array index 0 is assigned the string "January". Then the current date is stored in `dateNow`, and the month is stored in `monthNow`. Finally, in the `getElementById()` statement, the month name is displayed by using the `monthNow` value as the array index: `monthNames[monthNow]`.

The following code shows how to do it using a function.

HTML:

```
<div id="output"></div>
```

JavaScript:

```
function monthName(monthValue) {
    switch (monthValue) {
        case 0 : return "January";
        case 1 : return "February";
        case 2 : return "March";
        case 3 : return "April";
        case 4 : return "May";
        case 5 : return "June";
        case 6 : return "July";
        case 7 : return "August";
        case 8 : return "September";
        case 9 : return "October";
        case 10 : return "November";
        case 11 : return "December";
    }
}

var dateNow = new Date();
var monthNow = dateNow.getMonth();
document.getElementById("output").innerHTML = "getMonth() is " +
    monthNow + "; the name is " + monthName(monthNow);
```

With this technique, you pass the `getMonth()` value as an argument to the `monthName()` function, which then uses a `switch()` statement to test the value and return the appropriate string.

So which method should you use? Neither one has any glaringly obvious benefits over the other. The array method is a bit quicker to set up and it probably executes a bit faster than the function, so it's probably the (slightly) better choice.

Converting `getDay()` into a day name

You face a similar problem with `getDay()` as you do with `getMonth()`: converting the returned number into a “friendly” name such as, in this case, Sunday for 0, Monday for 1, and so on. The solution, as you can imagine, is also similar. The following code shows how to return a day name from a `getDay()` value using an array.

HTML:

```
<div id="output"></div>
```

JavaScript:

```
var dayNames = ["Sunday", "Monday", "Tuesday",
    "Wednesday", "Thursday", "Friday", "Saturday"];

var dateNow = new Date();
var dayNow = dateNow.getDay();
document.getElementById("output").innerHTML = "getDay() is " +
    dayNow + "; the name is " + dayNames[dayNow];
```

This time, the script declares a seven-item array named `dayNames` and initializes each item to a name of a day (again, making sure each array index corresponds with the return value of `getDay()`).

A function to return the day name from a `getDay()` value would be almost identical to the one I listed earlier for month names, so I'll leave that as an exercise.

Setting the date

When you perform date arithmetic, you often have to change the value of an existing `Date` object. For example, an ecommerce script might have to calculate a date that is 90 days from the date that a sale occurs. It's usually easiest to create a `Date` object and then use an expression or literal value to change the year, month, or some other component of the date. You do that by using the `Date` object methods listed in Table 8-5.

TABLE 8-5 Date Object Methods That Set Date Values

| Method Syntax | What It Sets |
|---------------------------------------|--|
| <code>date.setFullYear(yyyy)</code> | The year as a four-digit number (1999, 2000, and so on) |
| <code>date.setMonth(mth)</code> | The month of the year; from 0 (January) to 11 (December) |
| <code>date.setDate(dd)</code> | The date in the month; from 1 to 31 |
| <code>date.setHours(hh)</code> | The hour of the day; from 0 (midnight) to 23 (11:00 PM) |
| <code>date.setMinutes(mm)</code> | The minute of the hour; from 0 to 59 |
| <code>date.setSeconds(ss)</code> | The second of the minute; from 0 to 59 |
| <code>date.setMilliseconds(ms)</code> | The milliseconds of the second; from 0 to 999 |
| <code>date.setTime(ms)</code> | The milliseconds since January 1, 1970 GMT |

To try out some of these methods, the following code presents a script that specifies a date (year, month, and day in the month) and then displays what day of the week it was, is, or will be.

HTML:

```
<div id="output"></div>
```

JavaScript:

```
var monthNames =
  ["January", "February", "March", "April", "May", "June", "July",
  "August", "September", "October", "November", "December"];

var dayNames = ["Sunday", "Monday", "Tuesday",
  "Wednesday", "Thursday", "Friday", "Saturday"];

// Set the year, month, and day
var userYear = 2018;
var userMonth = 11;
var userDay = 31;

// Make a date object then use the data to change the date
var userDate = new Date();
userDate.setFullYear(userYear);
userDate.setMonth(userMonth);
userDate.setDate(userDay);

// Convert the numbers into names
var dayName = dayNames[userDate.getDay()];
var monthName = monthNames[userDate.getMonth()];

// Display the message
document.getElementById("output").innerHTML = "The date you
  entered was: "
monthName + " " + userDay + ", " + userYear + "<br>The day of
  the week is: " + dayName;
```

The script opens by declaring and initializing the arrays for converting the values returned by `getMonth()` and `getDate()`. Then three variables are declared to store the year, month (as a number), and day.

The next four statements are the keys to this example. A new `Date` object is stored in the `userDate` variable. It begins with the current date, but, as you'll see,

this doesn't matter. Then the script runs the `setFullYear()`, `setMonth()`, and `setDate()` methods.

At this point, the `userDate` variable contains a new date that corresponds to the supplied date. This means you can apply any of the “get” methods to that date. In particular, you can figure out which day of the week corresponds to the new date by running the `getDay()` method — `userDate.getDay()`. So the next two statements in the script use `getDay()` and `getMonth` to return the day and month values, and the arrays are used to convert them into names. Once that's done, the script displays the date and the day of the week that it corresponds to (see Figure 8-7).

FIGURE 8-7:

The script displays the day of the week for a given year, month, and day.

```
The date you entered was: December 31, 2018  
The day of the week is: Monday
```



REMEMBER

All the “set” methods also return values. Specifically, they return the number of milliseconds from January 1, 1970 GMT to whatever new date is the result of the method. Therefore, you can use the return value of a “set” method to create a new `Date` object:

```
newDate = new Date(userDate.SetFullYear(userYear));
```

Performing date calculations

Many of your date-related scripts will need to make arithmetic calculations. For example, you might need to figure out the number of days between two dates, or you might need to calculate the date that is six weeks from today. The methods you've seen so far and the way JavaScript represents dates internally serve to make most date calculations straightforward.

The simplest calculations are those that involve whole numbers of the basic JavaScript date and time units: years, months, days, hours, minutes, and seconds. For example, suppose you need to calculate a date that's five years from the current date. Here's a code snippet that will do it:

```
var myDate = new Date();  
var myYear = myDate.getFullYear() + 5;  
myDate.setFullYear(myYear);
```

You use `getFullYear()` to get the year, add 5 to it, and then use `setFullYear()` to change the date.

Determining a person's age

As a practical example, the following code presents a script that calculates a person's age.

HTML:

```
<div id="output"></div>
```

JavaScript:

```
var userAge;

// Set the birth date: year, month, and day
var userYear = 1990;
var userMonth = 7;
var userDay = 23;

// Make a Date object and change it
// to the user's birthday this year
var birthdayDate = new Date();
birthdayDate.setMonth(userMonth);
birthdayDate.setDate(userDay);

// Store the current date
var currentDate = new Date();
var currentYear = currentDate.getFullYear();

// Check to see if the birthday has yet to occur this year
if (currentDate < birthdayDate) {
    userAge = currentYear - userYear - 1;
} else {
    userAge = currentYear - userYear;
}

document.getElementById("output").innerHTML = "You are " +
    userAge + " years old.";
```

The script prompts the user for the year, month, and day of her birth date. Then it creates a new Date object and stores it in `birthdayDate`. The date is changed using `setMonth()` and `setDate()`, but *not* `setFullYear()`. This gives you the user's birthday for this year. Then the current date is stored in `currentDate` and the year is stored in `currentYear`.

Now the script compares `currentDate` and `birthdayDate`: If `currentDate` is less, it means the user's birthday hasn't happened, so her age is the difference between `currentYear` and `userYear` (the year she was born), minus one. Otherwise, her age is the difference between `currentYear` and `userYear`.

Performing complex date calculations

Other date calculations are more complex. For example, you might need to calculate the number of days between two dates. For this kind of calculation, you need to take advantage of the fact that JavaScript stores dates internally as millisecond values. They're stored, in other words, as numbers, and once you're dealing with numeric values, you can use numeric expressions to perform calculations on those values.

The key here is converting the basic date units — seconds, minutes, hours, days, and weeks — into milliseconds. Here's some code that will do it:

```
var ONESECOND = 1000;
var ONEMINUTE = ONESECOND * 60;
var ONEHOUR = ONEMINUTE * 60;
var ONEDAY = ONEHOUR * 24;
var ONEWEEK = ONEDAY * 7;
```



REMEMBER

In programming, whenever you have variables that are *constants* — that is, they have values that will never change throughout the script — it's traditional to write them entirely in uppercase letters to help differentiate them from regular variables.

Because one second equals 1,000 milliseconds, the `ONESECOND` variable is given the value `1000`; because one minute equals 60 seconds, the `ONEMINUTE` variable is given the value `ONESECOND * 60`, or 60,000 milliseconds. The other values are derived similarly.

Calculating the days between two dates

A common date calculation involves figuring out the number of days between any two dates. The following code presents a function that performs this calculation.

```
function daysBetween(date1, date2) {  
  
    // The number of milliseconds in one day  
    var ONEDAY = 1000 * 60 * 60 * 24;  
  
    // Convert both dates to milliseconds  
    var date1Ms = date1.getTime();  
    var date2Ms = date2.getTime();  
  
    // Calculate the difference in milliseconds  
    var differenceMs = Math.abs(date1Ms - date2Ms);  
  
    // Convert to days and return  
    return Math.round(differenceMs/ONEDAY);  
}
```

This function accepts two `Date` object arguments — `date1` and `date2`. Note that it doesn't matter which date is earlier or later because this function calculates the absolute value of the difference between them. The constant `ONEDAY` stores the number of milliseconds in a day, and then the two dates are converted into milliseconds using the `getTime()` method. The results are stored in the variables `date1Ms` and `date2Ms`.

Next, the following statement calculates the absolute value, in milliseconds, of the difference between the two dates:

```
var differenceMs = Math.abs(date1Ms - date2Ms);
```

This difference is then converted into days by dividing it by the `ONEDAY` constant. `Math.round()` (which I discuss in the next section) ensures an integer result.

Working with Numbers: The `Math` Object

It's a rare JavaScript programmer who never has to deal with numbers. Most of us have to cobble together scripts that process order totals, generate sales taxes and shipping charges, calculate mortgage payments, and perform other number-crunching duties. To that end, it must be said that JavaScript's numeric tools aren't the greatest in the programming world, but there are plenty of features to keep most scripters happy. This section tells you about those features, with special emphasis on the `Math` object.

The first thing you need to know is that JavaScript likes to keep things simple, particularly when it comes to numbers. For example, JavaScript is limited to dealing with just two numeric data types: *integers* — numbers without a fractional or decimal part, such as 1, 759, and -50 — and *floating-point numbers* — values that have a fractional or decimal part, such as 2.14, 0.01, and -25.3333.

Converting between strings and numbers

When you're working with numeric expressions in JavaScript, it's important to make sure that all your operands are numeric values. For example, if you prompt the user for a value, you need to check the result to make sure it's not a letter or `undefined` (the default `prompt()` value). If you try to use the latter, for example, JavaScript will report that its value is `Nan` (not a number).

Similarly, if you have a value that you know is a string representation of a number, then you need some way of converting that string into its numerical equivalent.

For these situations, JavaScript offers several techniques that ensure your operands are numeric.

The `parseInt()` function

I begin with the `parseInt()` function, which you use to convert a string into an integer:

```
parseInt(string, base);
```

» `string`: The string value you want to convert.

» `base`: An optional base used by the number in `string`. If you omit this value, JavaScript uses base 10.

Note that if the `string` argument contains a string representation of a floating-point value, `parseInt()` returns only the integer portion. Also, if the string begins with a number followed by some text, `parseInt()` returns the number (or, at least, its integer portion). The following table shows you the `parseInt()` results for various `string` values.

| <code>string</code> | <code>parseInt(string)</code> |
|---------------------|-------------------------------|
| "5" | 5 |
| "5.1" | 5 |

| string | parseInt(string) |
|----------|------------------|
| "5.9" | 5 |
| "5 feet" | 5 |
| "take 5" | NaN |
| "five" | NaN |

The `parseFloat()` function

The `parseFloat()` function is similar to `parseInt()`, but you use it to convert a string into a floating-point value:

```
parseFloat(string);
```

Note that if the `string` argument contains a string representation of a integer value, `parseInt()` displays just an integer. Also, like `parseInt()`, if the string begins with a number followed by some text, `parseInt()` returns the number. The following table shows you the `parseFloat()` results for some `string` values.

| string | parseFloat(string) |
|------------------|--------------------|
| "5" | 5 |
| "5.1" | 5.1 |
| "5.9" | 5.9 |
| "5.2 feet" | 5.2 |
| "take 5.0" | NaN |
| "five-point-one" | NaN |

The `+` operator

For quick conversions from a string to a number, I most often use the `+` operator, which tells JavaScript to treat a string that contains a number as a true numeric value. For example, consider the following code:

```
var numOfShoes = '2';
var numOfSocks = 4;
var totalItems = +numOfShoes + numOfSocks;
```

By adding `+` in front of the `numOfShoes` variable, I force JavaScript to set that variable's value to the number 2, and the result of the addition will be 6.

The Math object's properties and methods

The `Math` object is a bit different than most of the other objects you come across in this book. That's because you never create an instance of the `Math` object that gets stored in a variable. Instead, the `Math` object is a built-in JavaScript object that you use as-is. The rest of this chapter explores some properties and methods associated with the `Math` object.

Properties of the Math object

The `Math` object's properties are all constants that are commonly used in mathematical operations. Table 8-6 lists all the available `Math` object properties.

TABLE 8-6 Some Properties of the Math Object

| Property Syntax | What It Represents | Approximate Value |
|--------------------------|-----------------------------|--------------------|
| <code>Math.E</code> | Euler's constant | 2.718281828459045 |
| <code>Math.LN2</code> | The natural logarithm of 2 | 0.6931471805599453 |
| <code>Math.LN10</code> | The natural logarithm of 10 | 2.302585092994046 |
| <code>Math.LOG2E</code> | Base 2 logarithm of E | 1.4426950408889633 |
| <code>Math.LOG10E</code> | Base 10 logarithm of E | 0.4342944819032518 |
| <code>Math.PI</code> | The constant pi | 3.141592653589793 |
| <code>Math.SQRT12</code> | The square root of 1/2 | 0.7071067811865476 |
| <code>Math.SQRT2</code> | The square root of 2 | 1.4142135623730951 |

Methods of the Math object

The `Math` object's methods enable you to perform mathematical operations such as square roots, powers, rounding, trigonometry, and more. Many of the `Math` object's methods are summarized in Table 8-7.

TABLE 8-7 Some Methods of the Math Object

| Method Syntax | What It Returns |
|---|---|
| <code>Math.abs(<i>number</i>)</code> | The absolute value of <i>number</i> (that is, the number without any sign) |
| <code>Math.ceil(<i>number</i>)</code> | The smallest integer greater than or equal to <i>number</i> |
| <code>Math.cos(<i>number</i>)</code> | The cosine of <i>number</i> ; returned values range from -1 to 1 radians |
| <code>Math.exp(<i>number</i>)</code> | E raised to the power of <i>number</i> |
| <code>Math.floor(<i>number</i>)</code> | The largest integer that is less than or equal to <i>number</i> |
| <code>Math.log(<i>number</i>)</code> | The natural logarithm (base E) of <i>number</i> |
| <code>Math.max(<i>number1</i>, <i>number2</i>)</code> | The larger of <i>number1</i> and <i>number2</i> |
| <code>Math.min(<i>number1</i>, <i>number2</i>)</code> | The smaller of <i>number1</i> and <i>number2</i> |
| <code>Math.pow(<i>number1</i>, <i>number2</i>)</code> | <i>number1</i> raised to the power of <i>number2</i> |
| <code>Math.random()</code> | A random number between 0 and 1 |
| <code>Math.round(<i>number</i>)</code> | The integer closest to <i>number</i> |
| <code>Math.sin(<i>number</i>)</code> | The sine of <i>number</i> ; returned values range from -1 to 1 radians |
| <code>Math.sqrt(<i>number</i>)</code> | The square root of <i>number</i> (which must be greater than or equal to 0) |
| <code>Math.tan(<i>number</i>)</code> | The tangent of <i>number</i> , in radians |

IN THIS CHAPTER

- » Learning JavaScript's error types
- » Debugging errors using the Console
- » Setting breakpoints
- » Watching variable and expression values
- » Learning JavaScript's most common errors and error messages

Chapter 9

Debugging Your Code

Sometimes it pays to stay in bed on Monday, rather than spending the rest of the week debugging Monday's code.

— CHRISTOPHER THOMPSON

t usually doesn't take too long to get short scripts and functions up and running. However, as your code grows larger and more complex, errors inevitably creep in. In fact, it has been proven mathematically that any code beyond a minimum level of complexity will contain at least one error, and probably quite a bit more than that.

Many of the bugs that creep into your code will be simple syntax problems you can fix easily, but others will be more subtle and harder to find. For the latter — whether the errors are incorrect values being returned by functions or problems with the overall logic of a script — you'll need to be able to look "inside" your code to scope out what's wrong. The good news is that JavaScript and modern web browsers offer a ton of top-notch debugging tools that can remove some of the burden of program problem-solving. In this chapter, you delve into these tools to explore how they can help you find and fix most programming errors. You also investigate a number of tips and techniques that can go a long way to helping you avoid coding errors in the first place.

Understanding JavaScript's Error Types

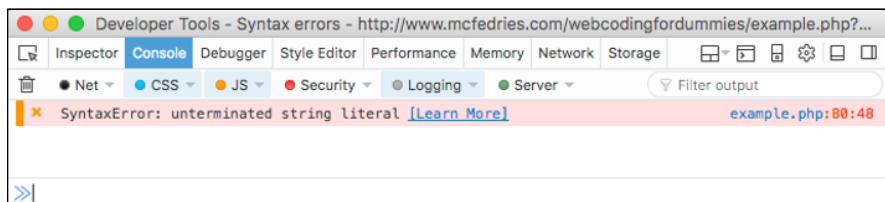
When a problem occurs, the first thing you need to determine is what kind of error you're dealing with. There are three basic types: syntax errors, runtime errors, and logic errors.

Syntax errors

Syntax errors arise from misspelled or missing keywords or incorrect punctuation. JavaScript almost always catches these errors when you load the page (which is why syntax errors are also known as *load-time errors*). That is, as JavaScript reads the script's statements, it checks each one for syntax errors. If it finds an error, it stops processing the script and displays an error message. Here's an example statement with a typical syntax error (can you spot it?) and Figure 9-1 shows how the error gets flagged in the Firefox Console window.

```
pageFooter = document.querySelector("footer");
```

FIGURE 9-1:
The Firefox
Console window
displaying data
about a typical
syntax error.



Runtime errors

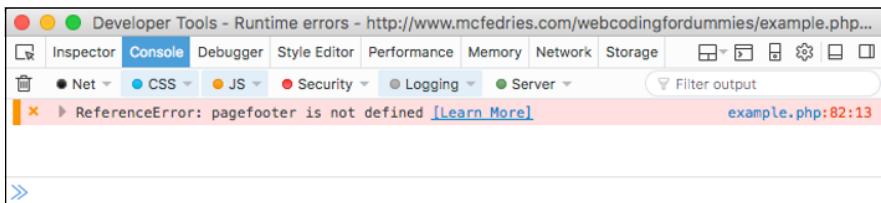
Runtime errors occur during the execution of a script. They generally mean that JavaScript has stumbled upon a statement that it can't figure out. It might be caused by trying to use an uninitialized variable in an expression or by using a property or method with the wrong object.

If your script has statements that execute as the page loads, and there have been no syntax errors, JavaScript will attempt to run those statements. If it comes across a statement with a problem, it halts execution of the script and displays the error. If your script has one or more functions, JavaScript doesn't look for runtime errors in those functions until you call them.

Here's some code where I misspelled a variable name in the third line (page-footer instead of pageFooter), and Figure 9-2 shows the Firefox Console window displaying the runtime error that results.

```
pageFooter = document.querySelector("footer");
currDate = new Date();
pagefooter.innerHTML = "Copyright " + currDate.getFullYear() +
    " Logophilia Limited.";
```

FIGURE 9-2:
The Firefox
Console
displaying data
about a typical
runtime error.



Logic errors

If your code zigs instead of zags, the cause is usually a flaw in the logic of your script. It might be a loop that never ends or a `switch` test that doesn't switch to anything.

Logic errors are the toughest to pin down because you don't get any error messages to give you clues about what went wrong and where. What you usually need to do is set up *debugging code* that helps you monitor values and trace the execution of your program. I go through the most useful debugging techniques later in this chapter.

WHY ARE PROGRAM ERRORS CALLED BUGS?



TECHNICAL
STUFF

The computer scientist Edsger Dijkstra once quipped, "If debugging is the process of removing bugs, then programming must be the process of putting them in." But why on Earth do we call programming errors "bugs"? There's a popular and appealing tale that claims to explain how the word "bug" came about. Apparently, the early computer pioneer Grace Hopper was working on a machine called the Mark II in 1947. While investigating a glitch, she found a moth among the vacuum tubes, so from then on glitches were called *bugs*. Appealing, yes, but true? Not quite. In fact, engineers had already been referring to mechanical defects as "bugs" for at least 60 years before Ms. Hopper's discovery. As proof, the *Oxford English Dictionary* offers the following quotation from an 1889 edition of the Pall Mall Gazette:

Mr. Edison, I was informed, had been up the two previous nights discovering 'a bug' in his phonograph — an expression for solving a difficulty, and implying that some imaginary insect has secreted itself inside and is causing all the trouble.

Getting to Know Your Debugging Tools

All the major web browsers come with a sophisticated set of debugging tools that can make your life as a web developer much easier and much saner. Most web developers debug their scripts using either Google Chrome or Mozilla Firefox, so I focus on those two browsers in this chapter. But in this section, I give you an overview of the tools that are available in all the major browsers and how to get at them.

Here's how you open the web development tools in Chrome, Firefox, Microsoft Edge, and Safari:

- » **Chrome for Windows:** Click Customize and Control Google Chrome (the three vertical dots to the right of the address bar), then choose More Tools⇒Developer Tools. Shortcut: Ctrl+Shift+I.
- » **Chrome for Mac:** Choose View⇒Developer⇒Developer Tools. Shortcut: Option+⌘+I.
- » **Firefox for Windows:** Choose Menu⇒Developer⇒Toggle Tools. Shortcut: Ctrl+Shift+I.
- » **Firefox for Mac:** Choose Tools⇒Web Developer⇒Toggle Tools. Shortcut: Option+⌘+I.
- » **Microsoft Edge:** Choose Settings and More⇒Developer Tools. Shortcut: F12.
- » **Safari:** Choose Develop⇒Show Web Inspector. Shortcut: Option+⌘+I. If you don't see the Develop menu, choose Safari⇒Preferences, click the Advanced tab, and then select the Show Develop Menu in Menu Bar checkbox.

These development tools vary in the features they offer, but each one offers the same set of basic tools, which are the tools you'll use most often. These basic web development tools include the following:

- » **HTML viewer:** This tab (it's called Inspector in Firefox and Elements in the other browsers) shows the HTML tags used in the web page. When you hover the mouse pointer over a tag, the browser highlights the element in the displayed page and shows its width and height, as shown in Figure 9-3. When you click a tag, the browser shows the CSS styles applied with the tag, as well as the tag's box dimensions (again, see Figure 9-3).
- » **Console:** This tab enables you to view error messages, log messages, test expressions, and execute statements. I cover the Console in more detail in the next section.

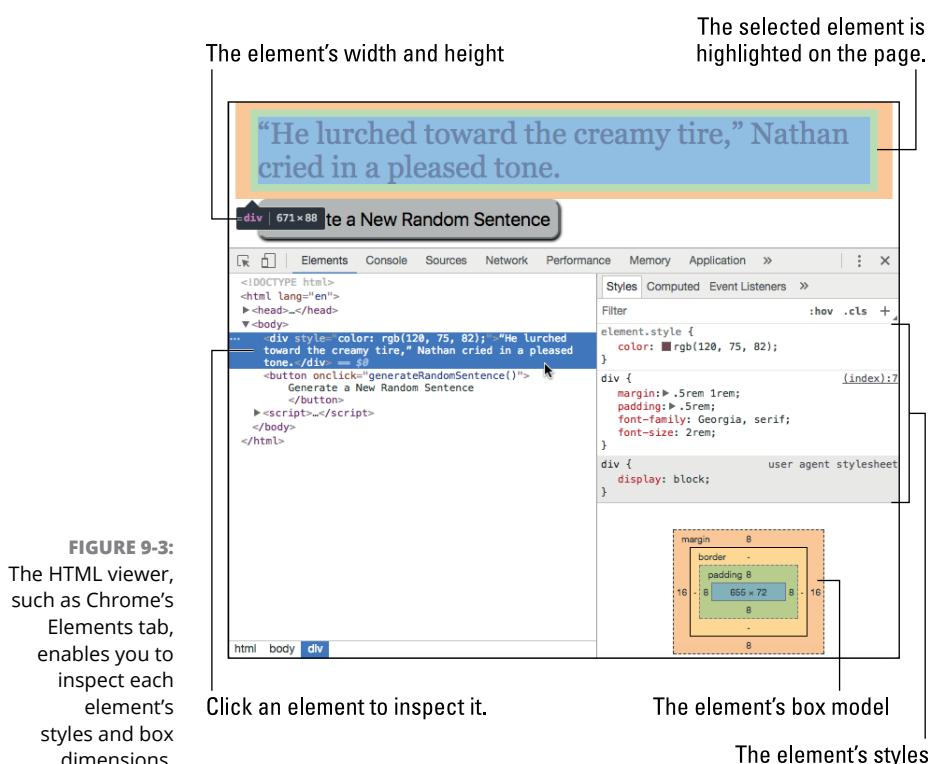


FIGURE 9-3:
The HTML viewer, such as Chrome’s Elements tab, enables you to inspect each element’s styles and box dimensions.

- » **Debugging tool:** This tab (it’s called Debugger in Firefox and Safari, and Sources in Chrome and Edge) enables you to pause code execution, step through your code, watch the values of variables and properties, and much more. This is the most important JavaScript debugging tool, so I cover it in detail later in this chapter.
- » **Network:** This tab tells you how long it takes to load each file referenced by your web page. If you find that your page is slow to load, this tab can help you find the bottleneck.

Debugging with the Console

If your web page is behaving strangely — for example, the page is blank or missing elements — you should first check your HTML code to make sure it’s correct. (Common HTML errors are not finishing a tag with a greater than sign (>), not including a closing tag, and missing a closing quotation mark for an attribute value.) If your HTML checks out, then there’s a good chance that your JavaScript code is wonky. How do you know? A trip to the Console window is your first step.

The Console is an interactive browser window that shows warnings and errors, displays the output of `console.log()` statements, and enables you to execute expressions and statements without having to run your entire script. The Console is one of the handiest web browser debugging tools, so you need to know your way around it.

Displaying the console in various browsers

To display the Console, open your web browser's development tools and then click the Console tab. You can also use the following keyboard shortcuts:

- » **Chrome for Windows:** Press `Ctrl+Shift+J`.
- » **Chrome for Mac:** Press `Option+⌘+J`.
- » **Firefox for Windows:** Press `Ctrl+Shift+K`.
- » **Firefox for Mac:** Press `Option+⌘+K`.
- » **Microsoft Edge:** Press `F12` and then `Ctrl+2`.
- » **Safari:** Press `Option+⌘+C`.

Logging data to the Console

You can use the `console.log()` method of the special `Console` object to print text and expression values in the Console:

```
console.log(output)
```

- » *output*: The expression you want to print in the Console, formatted as a string

The *output* expression can be a text string, a variable, an object property, a function result, or any combination of these, as long as the expression result is a string.



TIP

You can also use the handy `console.table()` method to output the values of arrays or objects in an easy-to-read tabular format:

```
console.table(output)
```

- » *output*: The array or object (as a variable or as a literal) you want to view in the Console

For debugging purposes, you most often use the Console to keep an eye on the values of variables, object properties, and expressions. That is, when your code sets or changes the value of something, you insert a `console.log()` (or `console.table()`) statement that outputs the new value. When the script execution is complete, you can open the Console and then check out the logged value or values.

Executing code in the Console

One of the great features of the Console is that it's interactive, which means not only can you see messages generated by the browser or by your `console.log()` statements, but you can also type code directly into the Console. That is, you can use the Console to execute expressions and statements. There are many uses for this feature:

- » You can try some experimental expressions or statements to see their effect on the script.
- » When the script is paused, you can output the current value of a variable or property.
- » When the script is paused, you can change the value of a variable or property. For example, if you see that a variable with a value of zero is about to be used as a divisor, you could change that variable to a nonzero value to avoid crashing the script.
- » When the script is paused, you can run a function or method to see if it operates as expected under the current conditions.

Each browser's Console tab includes a text box (usually marked by a greater-than prompt) that you can use to enter your expressions or statements.



TIP

You can execute multiple statements in the Console by separating each statement with a semicolon. For example, you can test a `for . . .` loop by entering a statement similar to the following:

```
for (var i=1; i < 10; i++){console.log(i**2); console.log(i**3);}
```



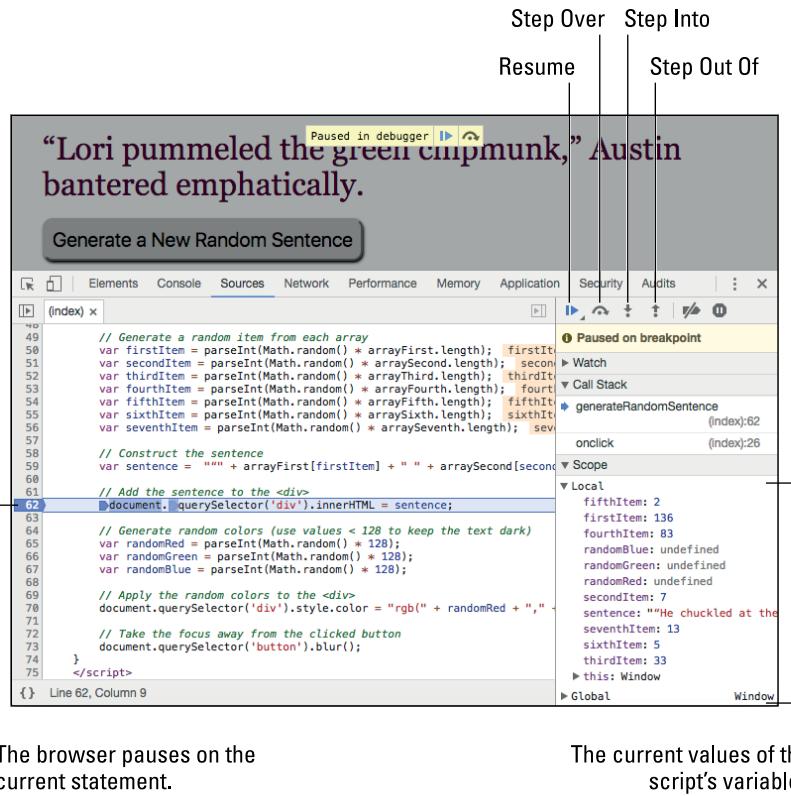
TIP

If you want to repeat an earlier code execution in the Console, or if you want to run some code that's very similar to code you ran earlier, you can recall statements and expressions that you used in the current browser session. Press the Up Arrow key to scroll back through your previously executed code; press the Down Arrow key to scroll forward through your code.

Pausing Your Code

Pausing your code midstream lets you see certain elements such as the current values of variables and properties. It also lets you execute program code one statement at a time so you can monitor the flow of the script.

When you pause your code, JavaScript enters *break mode*, which means the browser displays its debugging tool and highlights the current statement (the one that JavaScript will execute next). Figure 9-4 shows a script in break mode in Chrome's debugger (the Sources tab).



Entering break mode

JavaScript gives you two ways to enter break mode:

- » By setting breakpoints
- » By using a debugger statement

Setting a breakpoint

If you know approximately where an error or logic flaw is occurring, you can enter break mode at a specific statement in the script by setting up a *breakpoint*. Here are the steps to follow:

- 1. Display your web browser's developer tools and switch to the debugging tool.**
- 2. Open the file that contains the JavaScript code you want to debug.**
How you do this depends on the browser: In Chrome and Firefox, press Ctrl+P (Windows) or ⌘+P (Mac).
- 3. Locate the statement where you want to enter break mode.**
JavaScript will run every line of code up to, but not including, this statement.
- 4. Click the line number to the left of the statement to set the breakpoint (see Figure 9-5).**

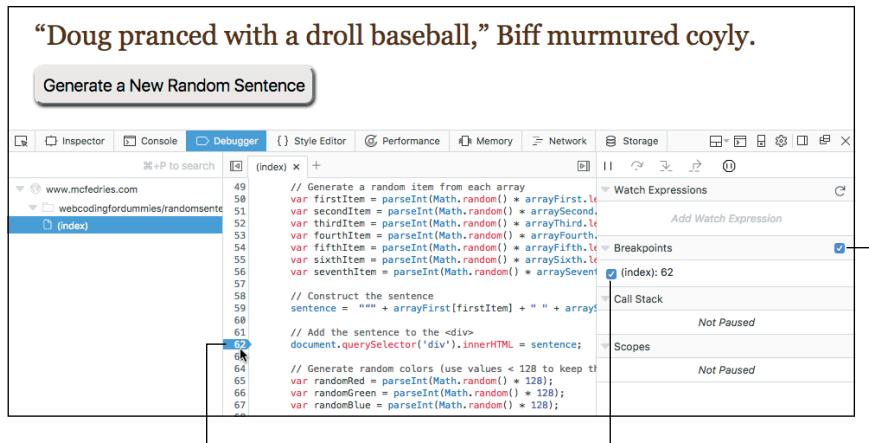


FIGURE 9-5:
In the browser's debugging tool, click a line number to set a breakpoint on that statement.

To remove a breakpoint, most browsers give you three choices:

- » To disable a breakpoint temporarily, deselect the breakpoint's checkbox in the Breakpoints list.
- » To disable all your breakpoints temporarily, deselect the Breakpoints checkbox.
- » To remove a breakpoint completely, click the statement's line number.

Entering break mode using a debugger statement

When developing your web pages, you'll often test the robustness of a script by sending it various test values or by trying it out under different conditions. In many cases, you'll want to enter break mode to make sure things look okay. You could set breakpoints at specific statements, but you lose them if you close the file. For something a little more permanent, you can include a debugger statement in a script. JavaScript automatically enters break mode whenever it encounters a debugger statement.

Here's a bit of code that includes a debugger statement:

```
// Add the sentence to the <div>
document.querySelector('div').innerHTML = sentence;

// Generate random colors (use values < 128 to keep the text
// dark)
var randomRed = parseInt(Math.random() * 128);
var randomGreen = parseInt(Math.random() * 128);
var randomBlue = parseInt(Math.random() * 128);
debugger;
```

Exiting break mode

To exit break mode, you can use either of the following methods in the browser's debugging tool:

- » Click the Resume button.
- » Press the browser's Resume keyboard shortcut:
 - **Chrome:** Press Ctrl+Shift+Enter (Windows), or ⌘+Shift+Enter (Mac), or F8.
 - **Firefox:** Press Ctrl+Shift+Enter (Windows), or ⌘+Shift+Enter (Mac), or F8.

Stepping through Your Code

One of the most common (and most useful) debugging techniques is to step through the code one statement at a time. This lets you get a feel for the program flow to make sure that things such as loops and function calls are executing properly. You can use three techniques:

- » Stepping into some code
- » Stepping over some code
- » Stepping out of some code

Stepping into some code

In break mode, stepping into some code means two things:

- » You execute the code one line at a time.
- » If the next statement to run is a function call, stepping into it takes you into the function and pauses at the function's first statement. You can then continue to step through the function until you execute the last statement, at which point the browser returns you to the statement after the function call.

To step into your code, set a breakpoint and then after your code is in break mode, do one of the following to step through a single statement:

- » Click the Step Into button.
- » Press the browser's Step Into keyboard shortcut:
 - **Chrome:** Press `Ctrl+;` or `F11` (Windows) or `⌘+;` or `F11` (Mac).
 - **Firefox:** Press `F11` (Windows) or `⌘+;` or `F11` (Mac).

Keep stepping through until the script ends or until you're ready to resume normal execution.

Stepping over some code

Some statements call other functions. If you're not interested in stepping through a called function, you can step over it. This means that JavaScript executes the function normally and then resumes break mode at the next statement *after* the function call.

To step over a function, first either step through your code until you come to the function call you want to step over, or set a breakpoint on the function call and refresh the web page. Once you're in break mode, you can step over the function using any of the following techniques:

- » Click the Step Over button.

- » Press the browser's Step Over keyboard shortcut:
- **Chrome:** Press `Ctrl+Shift+F10` (Windows) or `⌘+Shift+F10` (Mac).
 - **Firefox:** Press `F10` (Windows) or `⌘+F10` (Mac).

Stepping out of some code

I'm always accidentally stepping into functions I'd rather step over. If the function is short, I just step through it until I'm back in the original code. If the function is long, however, I don't want to waste time stepping through every statement. Instead, I invoke the Step Out feature using any of these methods:

- » Click the Step Out button.
- » Press the browser's Step Out keyboard shortcut:
- **Chrome:** Press `Ctrl+Shift+F11` (Windows) or `⌘+Shift+F11` (Mac).
 - **Firefox:** Press `Shift+F11` (Windows) or `⌘+Shift+F11` (Mac).

JavaScript executes the rest of the function and then reenters break mode at the first line after the function call.

Monitoring Script Values

Many runtime and logic errors are the result of (or, in some cases, can result in) variables or properties assuming unexpected values. If your script uses or changes these elements in several places, you'll need to enter break mode and monitor the values of these elements to see where things go awry. The browser developer tools offer three main ways to keep an eye on your script values:

- » View the current value of a single variable.
- » View the current values of all the variables in both the local and global scopes.
- » View the value of a custom expression or object property.

Viewing a single variable value

If you just want to eyeball the current value of a variable, the developer tools in both Chrome and Firefox make this straightforward:

- 1. Enter break mode in the code that contains the variable you want to check.**
- 2. If the script hasn't yet set the value of the variable, step through the code until you're past the statement that supplies the variable with a value.**
If you're interested in how the variable's value changes during the script, step through the script until you're past any statement that changes the value.
- 3. Hover the mouse over the variable name.**

The browser pops up a tooltip that displays the variable's current value.

Figure 9-6 shows an example.

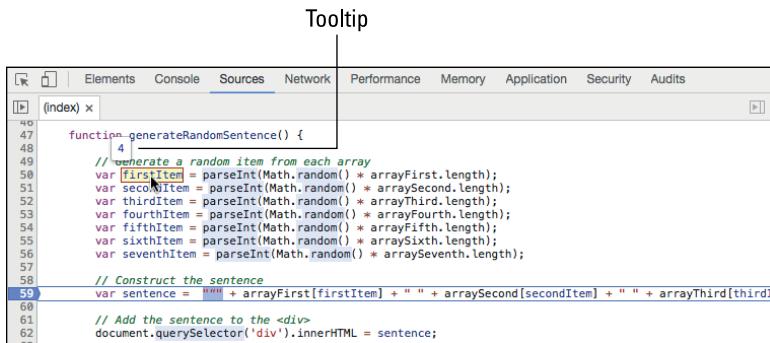


FIGURE 9-6:
In break mode, hover the mouse pointer over a variable name to see the variable's current value.

Viewing all variable values

Most of the values you'll want to monitor will be variables, which come in two flavors (or scopes):

- » **Local scope:** These are variables declared in the current function and are available only to that function.
- » **Global scope:** These are variables declared outside of any function, which makes them available to any script or function on the page.

For a more detailed look at variable scope, see Book 3, Chapter 5.

When you're in break mode, the debugging tool in both Chrome and Firefox displays a pane on the right that includes a section that shows the current values of all your declared variables:

- » **Chrome:** The section is named Scope and it includes two lists: Local (for local variables) and Global (for global variables). I pointed out Chrome's Scope section back in Figure 9-4.

» **Firefox:** The section is named Scopes and it includes two lists: one named after the current function that includes the function's local variables, and one named Window: Global that includes the script's global variables. Figure 9-7 shows an example.

FIGURE 9-7:
In break mode,
Firefox's Scopes
section shows the
current values
of the local and
global variables.

Local variables of the generateRandomSentence function

```

47 | function generateRandomSentence() {
48 |
49 | // Generate a random item from each array
50 | var firstItem = parseInt(Math.random() * arrayFirst.length);
51 | var secondItem = parseInt(Math.random() * arraySecond.length);
52 | var thirdItem = parseInt(Math.random() * arrayThird.length);
53 | var fourthItem = parseInt(Math.random() * arrayFourth.length);
54 | var fifthItem = parseInt(Math.random() * arrayFifth.length);
55 | var sixthItem = parseInt(Math.random() * arraySixth.length);
56 | var seventhItem = parseInt(Math.random() * arraySeventh.length);
57 |
58 | // Construct the sentence
59 | sentence = "" + arrayFirst[firstItem] + " " + arraySecond[secondItem];
60 |
61 | // Add the sentence to the <div>
62 | document.querySelector('div').innerHTML = sentence;
63 |
64 | // Generate random colors (use values < 128 to keep the colors
65 | var randomRed = parseInt(Math.random() * 128);
66 | var randomGreen = parseInt(Math.random() * 128);
67 | var randomBlue = parseInt(Math.random() * 128);

```

Scopes

- generateRandomSentence
 - <this>: Window
 - arguments: Arguments
 - fifthItem: 14
 - firstItem: 78
 - fourthItem: 23
 - randomBlue: undefined
 - randomGreen: undefined
 - randomRed: undefined
 - secondItem: 24
 - seventhItem: 17
 - sixthItem: 0
 - thirdItem: 36
- Window: Global

In Figure 9-7, notice that some of the local variables show the value undefined. Those variables are undefined because the script hasn't yet reached the point where the variables are assigned a value.

Adding a watch expression

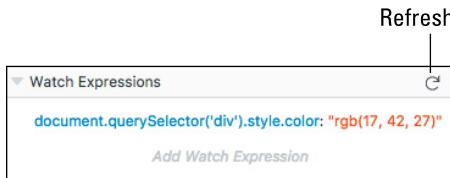
Besides monitoring variable values, JavaScript also lets you monitor the results of any expression or the current value of an object property. To do this, you need to set up a *watch expression* that defines what you want to monitor. These watch expressions appear in a special section of the browser's debugging tools. Here's how to add a watch expression in Chrome and Firefox:

» **Chrome:** In break mode, open the Watch section in the right pane, then click Add Expression (+). Type your expression in the text box that appears, and then press Enter or Return.

» **Firefox:** In break mode, open the Watch Expressions section in the right pane, then click Add Watch Expression (+). Type your expression in the text box that appears, and then press Enter or Return.

The browser adds the expression and then displays the current value of the expression to the right. Figure 9-8 shows an example in Firefox.

FIGURE 9-8:
In Firefox, click
Add Watch
Expression to
define a watch
expression for
your code.



You can use the following techniques to work with your watch expressions:

- » **Edit a watch expression.** Double-click the expression, edit it, and then press Enter or Return.
- » **Update the values of your watch expressions.** Click the Refresh button (located in the upper-right corner of Figure 9-8).
- » **Delete a watch expression.** Hover the mouse over the watch expression you want to remove, then click the Delete icon that appears to the right of the expression.

More Debugging Strategies

Debugging your scripts can be a frustrating job, even during the best of times. Here are a few tips to keep in mind when tracking down programming problems:

- » **Indent your code for readability.** JavaScript code is immeasurably more readable when you indent the code within each statement block. Readable code is that much easier to trace and decipher, so your debugging efforts have one less hurdle to negotiate. How far you indent is a matter of personal style, but two or four spaces is typical:

```
function myFunction() {  
    Each statement in this function  
    block is indented four spaces.  
}
```

If you nest one block inside another, indent the nested block by another four spaces:

```
function myFunction() {  
    Each statement in this function  
block is indented four spaces.  
    for (var counter = 1; counter < 5; counter++) {  
        Each statement in this nested for()  
block is indented another four spaces.  
    }  
}
```

- » **Break down complex tasks.** Don't try to solve all your problems at once. If you have a large script or function that isn't working right, test it in small chunks to try to narrow down the problem.
- » **Break up long statements.** One of the most complicated aspects of script debugging is making sense out of long statements (especially expressions). The Console window can help (you can use it to print parts of the statement), but it's usually best to keep your statements as short as possible. Once you get things working properly, you can often recombine statements for more efficient code.
- » **Comment out problem statements.** If a particular statement is giving you problems, you can temporarily deactivate it by placing two slashes (\\) at the beginning of the line. This tells JavaScript to treat the line as a comment. If you have a number of statements you want to skip, place /* at the beginning of the first statement and */ at the end of the last statement.
- » **Use comments to document your scripts.** Speaking of comments, it's a programming truism that you can never add enough explanatory comments to your code. The more comments you add, the easier your scripts will be to debug.

Top Ten Most Common JavaScript Errors

When you encounter a script problem, the first thing you should do is examine your code for the most common errors. To help you do that, here's a list of the ten most common errors made by both beginning and experienced programmers:

- » **JavaScript keywords as variable names:** JavaScript has many reserved words and keywords that are built into the language, so it's common to accidentally use one of these words as a variable or function name.

Double-check your names to make sure you're not using any reserved words, or the names of any objects, properties, or methods.

- » **Misspelled variables and other names:** Check your variable and function names to make sure you spell them consistently throughout the script. Also, check the spelling of the objects, properties, and methods you use.
- » **Misused uppercase and lowercase letters:** JavaScript is a *case-sensitive* language, which means that it treats each letter differently depending on whether it's uppercase or lowercase. For example, consider the following two statements:

```
var firstName = "Millicent";
var message = "Welcome " + firstname;
```

The first statement declares a variable named `firstName`, but the second statement uses `firstname`. This code would generate the error `firstname` is not defined (or something similar, depending on the browser) because JavaScript thinks that `firstname` is a different (and uninitialized) variable.

- » **Mismatched quotation marks:** In any statement where you began a string literal with a quotation mark (" or '), always check to make sure that you included the corresponding closing quotation mark at the end of the string. Also, check to see if you used one or more instances of the same quotation mark within the string. If so, edit the string to use the proper escape sequence (\\" or \'), instead:

```
// This is illegal
var myString1 = "There are no "bad" programs.';

// This is legal
var myString2 = "There are no \"bad\" programs.;"
```

- » **Mismatched parentheses:** Look for statements that contain a left parenthesis — (— and make sure there's a corresponding right parenthesis —). This also applies to square brackets — [and].

For complex expressions that include three or more sets of parentheses, a quick match-up check is to count the number of left parenthesis in the expression, and then count the number of right parentheses. If these numbers don't match, then you know you have a mismatch somewhere in the expression.



TIP

- » **Missed parentheses after function names:** Speaking of parentheses, if your script calls a function or method that doesn't take any arguments, check that you included the parentheses — () — after the name of the function or method:

```
function tryThis() {  
    alert("Parentheses travel in pairs!");  
}  
  
// This won't work  
tryThis;  
  
// This will  
tryThis();
```

- » **Improper use of braces:** JavaScript uses braces to mark the start ({} and end {}) of statement blocks associated with functions, tests involving `if()` and `switch()`, and loops, including `for()`, `while()`, and `do...while()`. It's very easy to miss one or both braces in a block, and it's even easier to get the braces mixed up when nesting one test or loop inside another. Double-check your braces to make sure each block has both an opening and a closing brace.



TIP

```
keyword {  
    statements  
}
```

(Here, *keyword* means the statement — such as `function` or `if()` — that defines the block.) If you prefer this style, use it all through your script so that you know exactly where to look for each brace.

An easy way to ensure that you never forget a closing brace is to enter it immediately after entering the opening brace. That is, you type `{`, press Enter twice, and then type `}`.

Also, use indentation consistently for the statements within the block. This makes it much easier to see the braces, particularly when you have one block nested within another.

- » **Using = or == instead of ===:** The identity operator (`==`) is one of the least intuitive JavaScript features, because the assignment operator (`=`) feels so much more natural. The equality operator (`==`) can cause problems because it often converts the data types before making the comparison. Therefore,

check all your comparison expressions to make sure you always use === instead of = or ==.

- » **Conflicts between local and global variables:** A global variable is available throughout the entire page, even within functions. So, within a function, make sure that you don't declare and use a variable that has the same name as a global variable.
- » **The use of an page element before it's loaded:** JavaScript runs through a page's HTML one line at a time and checks the syntax of each JavaScript statement as it comes to it. If your code refers to an element (such as a form field) that JavaScript hasn't come to yet, it will generate an error. Therefore, if your code deals with an element, always place the script after the element in the HTML file.

Top Ten Most Common JavaScript Error Messages

To help you decipher the error messages that JavaScript throws your way, here's a list of the ten most common errors and what they mean:

- » **Syntax error:** This load-time error means that JavaScript has detected improper syntax in a statement. The error message almost always tells you the exact line and character where the error occurs (see Figure 9-1).
- » **Expected (or Missing (:** These messages mean that you forgot to include a left parenthesis:

```
function changeBackgroundColor newColor) {
```

If you forget a right parenthesis, instead, you'll see Expected) or Missing):

```
function changeBackgroundColor (newColor{
```

- » **Expected { or Missing { before function body:** These errors tell you that your code is missing the opening brace for a function:

```
function changeBackgroundColor (newColor)  
    statements  
}
```

If you're missing the closing brace, instead, you'll see the errors `Expected }` or `Missing } after function body`.

- » `Unexpected end of input or Missing }` in compound statement: These messages indicate that you forgot the closing brace in an `if()` block or other compound statement:

```
if (currentHour < 12) {  
    console.log("Good morning!");  
} else {  
    console.log("Good day!");
```

If you forget the opening brace, instead, you'll get a `Syntax error` message that points, confusingly, to the block's closing brace.

- » `Missing ; or Missing ; after for-loop initializer|condition`: These errors mean that a `for()` loop definition is missing a semicolon (`;`), either because you forgot the semicolon or because you used some other character (such as a comma):

```
for (var counter = 1; counter < 5, counter++) {
```

- » `Unexpected identifier or Missing ; before statement`: These errors tell you that the previous statement didn't end properly for some reason, or that you've begun a new statement with an invalid value. In JavaScript, statements are supposed to end with a semicolon (`;`), but this is optional. So if JavaScript thinks you haven't finished a statement properly, it assumes it's because a semicolon is missing. For example, this can happen if you forget to include the opening `/*` to begin a multiple-line comment:

```
Start the comment (oops!)  
Close the comment */
```

- » `X is not defined`: This message most often refers to a variable named `X` that has not been declared or initialized, and that you're trying to use in an expression. If that's the case, declare and initialize the variable. Another possible cause is a string literal that isn't enclosed in quotation marks. Finally, also check to see if you misspelled the variable name:

```
var grossProfit = 100000;  
var profitSharing = grossPrifit * profitSharingPercent;
```

- » *X* is not an object or *X* has no properties: These messages mean that your code refers to an object that doesn't exist, or to a property that doesn't belong to the specified object. Check to see if you misspelled the object or property or, for the second case, that you're using the wrong object:

```
document.alert("Nope!")
```

- » Untermminated string constant or Untermminated string literal: Both of these messages mean that you began a string literal with a quotation mark, but forgot to include the closing quotation mark:

```
var greeting = "Welcome to my Web site!
```

- » A script on this page is causing [browser name] to run slowly. Do you want to abort the script? or Lengthy JavaScript still running. Continue?: These errors tell you that your code has probably fallen into an infinite loop. You don't get any specific information about what's causing the problem, so you'll need to scour your code carefully for the possible cause.

4

Coding the Front End, Part 3: jQuery

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- » Selecting page elements with jQuery
- » Adding, populating, and removing page elements
- » Reading and setting HTML attributes
- » Manipulating CSS properties and classes

Chapter 1

Developing Pages Faster with jQuery

jQuery is an amazing tool that's made JavaScript accessible to developers and designers of all levels of experience.

— SCOTT KOSMAN

A n old programming adage tells us that you shouldn't reinvent the wheel — unless you really want to learn how to make a wheel. That is, there's nothing wrong with coding something that someone else has already made, because the experience can help give you a deeper understanding of that aspect of programming. That said, most web development projects don't offer the luxury of limitless hacking time. Quite the opposite, in fact: You almost always have a large amount of code to write and what seems like an impossibly short amount of time in which to write it.

So if someone else has already built a programming wheel, it's a wise coder who takes advantage of it. In this chapter, you explore one of the most powerful and popular web development wheels: jQuery. You discover what jQuery is and how it can make your web development life much easier and far more efficient. You then take a satisfyingly deep dive into jQuery's powerful and accessible tools for

selecting and manipulating page elements, reading and setting tag attributes, and messing with CSS classes and properties, all with very little code.

Getting Started with jQuery

In programming parlance, a *library* is a set of pre-fab code that you can add to your project and then use as part of your own code — for example, by calling the functions provided by the library. jQuery is a JavaScript library, which means it's a set of JavaScript functions that give you access to sophisticated and powerful techniques that would otherwise require hours of programming on your part. jQuery's slogan is "Write less, do more," and that's exactly what it delivers.

Surely having access to such power must cost a fortune, right? Nope. jQuery is and always will be completely free. It's an open-source project maintained by the jQuery Foundation, and it's by far the most popular JavaScript library out there. How popular is it? Some estimates show jQuery in use on over 70 percent of all websites. That's popular!

Okay, but jQuery must be massive, right? Nope. The current version is only about 260KB, and you can get a compressed version that weighs in at a mere 86KB!

Cool, but this thing sounds complicated. jQuery must be hard to learn, right? Again, nope. The syntax is designed to be straightforward and to not require a steep (or even a moderate) learning curve. And if you know how to wield CSS selectors (which I describe in Book 2, Chapter 2), then you're practically a jQuery master already since it takes advantage of those same selectors.

How to include jQuery in your web page

You might think that given jQuery's power and sophistication that it must require some time-consuming, multi-step procedure to install and configure. Fortunately, that's not the case. jQuery is nothing but a JavaScript (.js) file, so you can add it to your page by using a `<script>` tag with a reference to the jQuery external script file.

How do you get this file? You have two ways to go about it:

- » **Download the file.** In this case, surf to jquery.com/download and click the link for the "compressed, production" version. The file you get will have a name like `jquery-3.x.y.min.js`, where `x` and `y` denote the current version.

Copy the downloaded file to your web app folder and then set up your <script> tag to reference the file:

```
<script src="jquery-3.x.y.min.js"></script>
```

- » (Remember to replace *x* and *y* with the actual version numbers of your downloaded file.) If you put the file in a subfolder, be sure to include the folder path:

```
<script src="/js/jquery-3.x.y.min.js"></script>
```

- » **Link to a remote version of the file.** Several *content delivery networks* (CDNs, for short) store the jQuery file and let you link to it. Since these CDNs have multiple servers based around the world, they can deliver the file really fast. Here's the tag to use for Google's CDN:

```
<script src="https://ajax.googleapis.com/ajax/libs/ jquery/3.x.y/jquery.min.js"></script>
```

Here's the version to use from the jQuery site:

```
<script src="http://code.jquery.com/ajax/jquery-3.x.y.min.js"></script>
```

Again, in both cases, be sure to replace *x* and *y* with the actual version numbers of the latest version of jQuery (see <https://code.jquery.com>).

Which route should you take? The CDN path is better for most people because the remote servers almost always deliver the file faster than your own web server will.



WARNING

jQuery version 3 supports all the major web browsers, so it's safe to use in your code. Or, I should say, it's safe to use in your code if you don't need or want to support Internet Explorer 8 and earlier. Support for versions 6 through 8 of Internet Explorer was dropped way back in jQuery 2 (which was released in 2013). Internet Explorer 8 currently has between 0.25 and 1 percent of browser market share, so most web developers have moved on. If you need to support it, however, use jQuery 1.12.4:

```
<script src="https://ajax.googleapis.com/ajax/libs/ jquery/1.12.4/jquery.min.js"></script>
```

or:

```
<script src="http://code.jquery.com/ajax/jquery-1.12.4.min.js"></script>
```

Understanding the \$ function

When you first start learning about jQuery, one of the weirdest things to get your head around is that everything you do in jQuery begins with a dollar sign (\$). Here are some examples:

```
$(document).ready();
$('header').html('<h1>Hello World!</h1>');
$('.warning').css('color', 'red');
$('#mainArticle').append('<section></section>');
```

That \$ symbol you see at the beginning of each statement is actually the name of a function! Technically, it's an alias for the main jQuery function, which is named `jQuery`. That is, the previous four statements could also be written like so:

```
jQuery(document).ready();
jQuery('header').html('<h1>Hello World!</h1>');
jQuery('.warning').css('color', 'red');
jQuery('#mainArticle').append('<section></section>');
```

However, almost no one uses the `jQuery` function name, preferring the shorter and easier-to-type \$ moniker.

Where to put jQuery code

The *Document Object Model* (DOM) looks at a page as a kind of tree where the `document` object is the “trunk” and the page elements — `body`, `header`, `main`, `div`, `p`, and so on — are branches or sub-branches. The HTML “family” elements that I discuss in Book 2, Chapter 2 — that is, the parent, child, ancestor, and descendant elements — define the structure of the DOM.

jQuery is, at heart, a DOM-manipulation library, meaning that all your jQuery code will read or change some aspect of the DOM. However, that means you can't use any jQuery code until your page is fully ready — that is, until the web browser has loaded the `document` object.

Therefore, when deciding where to put your jQuery code, you have two considerations:

» **Your jQuery code resides in a function that you don't need to run right away.** For example, you might have a function that will be called only in response to a button click or some other event. In this case, it's best to put your jQuery code in an external JavaScript file and then make sure your `<script>` tag comes after the jQuery `<script>` tag. Here's an example:

```
<script src="https://ajax.googleapis.com/ajax/libs/
    jquery/3.1.2/jquery.min.js"></script>
<script src="/js/my-code.js"></script>
```

» **Your jQuery code needs to be executed immediately after the document object is loaded.** For example, you might have some code that adds tags or text to the page. In this case, you have to put your jQuery code in a place where the browser will read it only after the document object is loaded. With vanilla JavaScript code, this means adding the `<script>` tag at the end of the body element (that is, just before the `</body>` tag). That works with jQuery code, too, but jQuery gives you a better way:

```
$(document).ready(function() {
    Your jQuery code goes here
});
```

This code listens for the document object to fire the `ready` event, which only happens after the document object is fully loaded. (See Book 4, Chapter 2 to get your head around jQuery events.) The code then defines an anonymous (that is, unnamed) function that's called automatically in response to the `ready` event, which means that the function code executes only after the page is loaded. You can put this code anywhere in the page, as long as it's in a `<script>` tag that comes after the `<script>` that loads jQuery. Here's an example:

```
<script src="https://ajax.googleapis.com/ajax/libs/
    jquery/3.1.2/jquery.min.js"></script>
<script>
    $(document).ready(function() {
        Your jQuery code goes here
    });
</script>
```

Selecting Elements with jQuery

jQuery is a DOM-manipulation library, so that means almost all your jQuery-related statements begin with an expression that selects the DOM

element or elements you want to mess with. Here's the basic syntax to use for this expression:

```
$(selector)
```

- » *selector*: This is a CSS-style selector that specifies the page element or elements. The selector is sent to jQuery's \$ function as an argument.

I talk about the basic CSS selectors in Book 2, Chapter 2, and one of the great advantages of jQuery is that it uses the same selectors; so if you know your CSS selectors, you're well on your way with jQuery.

Using the basic selectors

Most of your jQuery work will involve the five basic selectors that I outline in Book 2, Chapter 2:

- » **The tag selector:** `$('tagName')`: Selects all the elements in the page that use the specified HTML tag name. This example selects all the `<p>` tags:

```
$( 'p' )
```

- » **The class selector:** `$('.class-name')`: Selects all the elements in the page that use the specified class attribute. This example selects all the elements that use the `caption` class:

```
$( '.caption' )
```

- » **The id selector:** `$('#id-name')`: Selects the page element that uses the specified id attribute. This example selects the tag with the `subtitle` id:

```
$( '#subtitle' )
```

- » **The descendant selector:** `$('ancestor descendant')`. Selects all the elements in the page that are the descendants of a specified ancestor element. The following example selects all the `<a>` tags that are contained within an `<aside>` tag:

```
$( 'aside a' )
```

- » **The child selector:** `$('parent > child')`: Selects all the elements in the page that are the direct children of a specified parent element. Here's an example that selects all the `<a>` tags that are direct children of an `<aside>` tag:

```
$( 'aside > a' )
```



TIP

jQuery also lets you make multiple selections in a single expression by separating the selectors with commas. For example, the following selects all the page elements that use the `caption` class, plus the element that has the `id subtitle`:

```
$('.caption, #subtitle')
```

Working with jQuery sets

When you supply jQuery with a selector, what jQuery sends back is a set of page elements that match the selector. With that set in hand, jQuery offers straightforward techniques for doing a large number of tasks:

- » Adding and removing elements
- » Inserting HTML tags and text into an element
- » Reading and setting CSS properties
- » Adding and removing classes
- » Reading, setting, and removing HTML attributes

I cover all these tasks and more in this chapter, but first you also need to know about three other useful techniques that are available with jQuery sets: looping, chaining, and filtering.



TIP

To get the number of elements in a jQuery set, use the `length` property:

```
$(selector).length
```

Automatic looping through jQuery sets

In Book 3, Chapter 6, I talk about the document object's `querySelectorAll()` method, which returns an arraylike set of elements. Once you have that set, you work with its elements by looping through the set. Here's an example:

```
var captions = document.querySelectorAll('.caption');
for (var i = 0; i < captions.length; i++) {
    captions[i].style.fontSize = '.75rem';
}
```

This code selects all the elements with the class `caption`, then loops through the elements, setting the `font-size` property for each element to `.75rem`.

This basic technique — returning a set of elements and then looping through the set to manipulate the elements in some way — is such a common web development task that jQuery decided to automate it for you. That is, when you apply a jQuery method to a set, jQuery automatically applies that method to every element in the set. No need to loop! Here's the jQuery equivalent of the previous code:

```
$('.caption').css('font-size', '.75rem');
```

Chaining jQuery methods

jQuery lets you operate on a set by offering various methods that you can run on the set. For example, the `append` method lets you add an element to each item in the set, and the `css` method lets you apply a CSS property and value to each item in the set.

What if you want to run both methods on the same set? No problem:

```
$('.menuitem a').append('<span>(Click to expand)</span>');
$('.menuitem a').css('color', 'tomato');
```

However, you don't need to use multiple statements here because jQuery supports method *chaining*, where you place each method in a single statement, like so:

```
$('.menuitem a').append('<span>(Click to expand)</span>').
    css('color', 'tomato');
```

Filtering jQuery sets

jQuery offers a number of ways that you can *filter* the selected elements. You won't use filters all that often, but they can be very handy when you need them. Here's quick look at the more useful filters:

» **The even filter:** `$('selector:even')`: Returns every second element in the set, beginning with the first element (that is, it returns elements with the set indexes 0, 2, 4, and so on). Here's an example that selects the even-numbered `<p>` tags:

```
$( 'p:even' )
```

» **The odd filter:** `$('selector:odd')`: Selects every second element in the set, beginning with the second element (that is, it returns elements with the set indexes 1, 3, 5, and so on). Here's an example that selects odd-numbered elements that use the `caption` class:

```
$( '.caption:odd' )
```

» **The first filter:** `$('selector:first')`: Selects the first element in the set. Here's an example that selects the first `<p>` tag from the set of `<p>` tags that are children of a `<section>` tag:

```
$( 'section > p:first' )
```

» **The last filter:** `$('selector:last')`: Selects the last element in the set. Here's an example that selects the last `<a>` tag from the set of `<a>` tags that are descendants of elements that use the class `social`:

```
$( '.social a:last' )
```

» **The not() filter:** `$('selector1:not(selector2)')`: Selects all the elements that match `selector1`, except for those that also match `selector2`. Here's an example that selects all the `<h2>` tags, except for those `<h2>` tags that have the class `subtitle`:

```
$( 'h2:not(.subtitle)' )
```

Manipulating Page Elements with jQuery

Now it's time to experience the true power and ease of the jQuery way of doing things. jQuery's mission is to make it easier and faster for you to work with page elements, and that includes inserting elements into the DOM, adding HTML tags and text to an element, and removing elements from the DOM. The next few sections provide the not-even-close-to-gritty details.

Adding an element

One of the most common web development chores is to add elements to a web page on-the-fly. For example, if your code asks the server for some data, you almost certainly won't want to just dump the raw data onto the page. Instead, it's better to use code to add HTML tags and then populate those tags with the server data.

When you add an element, you always specify the parent element to which it will be added, then you decide whether you want the new element added to the end or to the beginning of the parent.

To use jQuery to add an element to the end of a parent element's DOM hierarchy, use the `append()` method, and to add an element to the beginning of a parent element's DOM hierarchy, use the `prepend()` method:

```
$('parent').append(content);  
$('parent').prepend(content);
```

- » *parent*: A selector that specifies the parent element to which the child element will be added.
- » *content*: The content you want to add. This can be any of the following:
 - A string containing the HTML tags for the type of the element you want to add. For example:

```
$('article').append('<section></section>');
```

- A string containing text. For example:

```
$('.caption').prepend('Figure: ');
```

- A jQuery selector. (Note that jQuery moves the returned element or elements into the parent container.) For example:

```
$('header').append($('h1'));
```

- An array containing any of the previous. For example:

```
$('#section1').prepend([$('h2'), '<p></p>']);
```

- A comma-separated list of any of the previous. For example:

```
var domArray = ['<header></header>', '<main></main>'];  
$('body').append(domArray, '<footer></footer>');
```

Here's a longer example that adds header, nav, main, and footer elements to the <body> tag, and then appends tags and/or text to each of these elements:

```
var domArray = ['<header></header>', '<nav></nav>',
    '<main></main>', '<footer></footer>'];
($('body').append(domArray);
($('header').append('<h1>This is the header.</h1>');
($('nav').append('Nav links will go here.'));
($('main').append('<h2>This is the main part of the page.</h2>');
($('footer').append('This is the footer.'));
```

Figure 1-1 shows the results.

FIGURE 1-1:
A complete web page structure, created using nothing but jQuery.

This is the header.

Nav links will go here.

This is the main part of the page.

This is the footer.

Replacing an element's HTML

You can use jQuery's `append()` and `prepend()` methods to insert HTML tags into one or more elements, as I describe in the previous section. However, it's often the case that you want to completely overwrite an element's HTML tags and text, and you do that using jQuery's `html()` method:

```
$(selector).html(content);
```

- » *selector*: The element (or elements) you want to work with
- » *content*: The HTML tags and text that you want to use to replace the element's existing content

Here's an example:

```
$(‘body’).append(‘<header></header>’);
$(‘header’).append(‘<h2>This is the header.</h2>’);

// Replace the header content
$(‘header’).html(‘<h1>No, <em>this</em> is the header!</h1>’);
```

This code adds a `<header>` tag to the body element, then sets the header's tags and text using `append()`. In the final statement, the header's tags and text are replaced using the `html()` method. Figure 1-2 shows that, indeed, the replacement tags and text are what the user sees.

FIGURE 1-2:
The `html()` method completely replaces any existing tags and text with new content.

No, **this** is the header!

Replacing an element's text

If you want to replace an element's text content — that is, just plain text without any HTML tags — use jQuery's `text()` method:

```
$(selector).text(content);
```

- » `selector`: The element (or elements) you want to work with
- » `content`: The text that you want to replace the element's existing content

If you include tags in `content`, jQuery doesn't ignore them. Instead, it encodes them by changing `<` to `<` and `>` to `>`. This is very handy if you want to display the angle brackets on your page, as shown in the following example:

HTML:

```
<h1>Placeholder Title</h1>
```

jQuery:

```
($('h1').text('Advanced Uses of the <div> Tag'));
```

As you can see in Figure 1-3, jQuery encodes the angle brackets so they are displayed in the page.

FIGURE 1-3:
The `text()` method completely replaces any existing text with new content.

Advanced Uses of the `<div>` Tag

Removing an element

If you no longer require one or more elements on your page, you can use jQuery's `remove()` method to delete them from the DOM:

```
$(selector1).remove(selector2);
```

- » `selector1`: The element (or elements) you want to remove
- » `selector2`: The optional subset of `selector1` elements that you want to remove

For example, the following statement removes all the `h3` elements from the page:

```
$('h3').remove();
```

By contrast, the following statement only removes those `h3` elements that have the class `temp`:

```
($('h3').remove('.temp');
```

Modifying CSS with jQuery

Although you specify your CSS rules in a static stylesheet (`.css`) file, that doesn't mean the rules themselves have to be static. With jQuery on the job, you can modify an element's CSS in a number of ways. You can:

- » Read the current value of a CSS property.
- » Change the value of a CSS property.
- » Add or remove a class.
- » Toggle a class on or off.

Why would you want to make these changes to your CSS? You already know that a big part of a well-designed web page is a strong CSS component that uses typography, colors, and spacing to create a page that's easily readable, sensibly navigable, and pleasing to the eye. But all of that applies to the initial page the user sees. In the sorts of dynamic web apps that you learn how to build in this book, your page will change in response to data obtained from the server or the user clicking a button or pressing a key. This dynamic behavior needs to be matched with dynamic changes to the page, including changes to the CSS to highlight or reflect what's happening.

Working with CSS properties

jQuery makes it straightforward to read or modify CSS properties by offering a single method to use for most of your CSS chores: the `css()` method. The `.css()` method replaces the vanilla JavaScript `style` property that I discuss in Book 3, Chapter 6 and brings with it a significant advantage: You can use the CSS property names as they are. That's right: no need to convert, say, the `background-color` property to `backgroundColor`. Nice!

Reading a CSS property value

If you want to read the current value of a CSS property for an element, use the following syntax for the `css()` method:

```
$(selector).css(property);
```

- » `selector`: The element you want to work with. If `selector` returns a set of elements, jQuery uses only the first element in the set.
- » `property`: The name of the CSS property you want to read.

Here's an example:

CSS:

```
h1 {  
    font-family: Verdana, serif;  
    font-size: 2.5rem;  
}
```

HTML:

```
<h1>Welcome to the css() Method!</h1>  
<div></div>
```

jQuery:

```
// Get the font-size value for the h1 element  
var h1FontSize = $('h1').css('font-size');  
  
// Display the size in the div  
$('div').html('The <code>h1</code> element is using a  
<code>font-size</code> value of ' + h1FontSize);
```

In the CSS, you see that the `h1` element has a `font-size` value of `2.5rem`, which, assuming the default font size is `16px`, corresponds to `40px`. The jQuery code uses the `css()` method to return the `font-size` value of the `h1` element, which it then displays in the empty `div` element, as shown in Figure 1-4. Notice that the property value returned by the `css()` method includes the unit of measurement (`px`, in this case).

FIGURE 1-4:
The `css()` method returns the current value of the specified property.

Welcome to the `css()` Method!

The `h1` element is using a `font-size` value of `40px`

Setting a CSS property value

To set a CSS property value on an element or a set of elements, use the following syntax for the `css()` method:

```
$(selector).css(property, value);
```

- » `selector`: The element or elements you want to work with.
- » `property`: The name of the CSS property you want to set.
- » `value`: The value you want to assign to `property`. The value can either be a string that includes the unit of measurement, if any (such as '`50vw`') or a number. If you use a number for `value`, jQuery automatically adds the `px` measurement unit.

Here's an example:

HTML:

```
<h1>Welcome to the css() Method!</h1>
<div></div>
```

jQuery:

```
// Set the font-size value for the h1 element
$('h1').css('font-size', '3rem');

// Display the new size in the div
$('div').html('The <code>h1</code> element is now using a
<code>font-size</code> value of ' + $('h1').css('font-size'));
```

The jQuery code uses the `css()` method to set the `font-size` value of the `h1` element to `3rem`, and then displays the new value in the empty `div` element, as shown in Figure 1-5.

FIGURE 1-5:
The `css()` method can also set the value of a property.

Welcome to the `css()` Method!

The `h1` element is using a `font-size` value of `48px`



TIP

Setting multiple CSS property values

You can save a bit of wear-and-tear on your typing fingers by setting multiple CSS properties on a single element or set. For example, the long-winded way to change the text color, background color, and font size on an element would be to use three separate statements:

```
$('#my-div').css('color', 'lemonchiffon');
$('#my-div').css('background-color', 'maroon');
$('#my-div').css('font-size', '2rem');
```

Instead, you can convert multiple property-value pairs into a single *object literal* that uses the following syntax:

```
{
    property1: value1,
    property2: value2,
    etc.
    propertyn: valuen
}
```

Here's an example:

```
{
    'color': 'lemonchiffon',
    'background-color': 'maroon',
    'font-size': '2rem'
}
```

You can use this object literal as the `css()` method argument in a single jQuery statement:

```
$('#my-div').css({  
    'color': 'lemonchiffon',  
    'background-color': 'maroon',  
    'font-size': '2rem'  
});
```

Working with width and height: A better method

Have a look at the following code and see if you can figure out what it does:

```
var currWidth = $('#my-div').css('width');  
var newWidth = currWidth + 100;  
$('#my-div').css('width', newWidth);
```

What the code is trying to do is take the current width of an element, add 100 pixels to that value, and then apply that new width value to the element. However, if you run this code, the width of the element doesn't budge one pixel. Why not? The problem is that `css('width')` doesn't return a number. Instead, it returns a string that combines the element width and the `px` measurement unit. So if the element is 250 pixels wide, the `css()` method returns the string `250px` for the element's width value. Adding 100 to this value gives the nonsense string `250px100`, so trying to set the element's `width` property with this value fails.

You could work around this problem by converting the string returned by `css('width')` to a floating-point value by using JavaScript's `parseFloat` function:

```
var currWidth = parseFloat($('#my-div').css('width'));  
var newWidth = currWidth + 100;  
$('#my-div').css('width', newWidth);
```

That works fine, but it's not only a pain to have remember to add the `parseFloat` function each time you need a number instead of a string, but it also makes your code a teensy bit harder to decipher.

Fortunately, the jQuery programmers, no doubt having bumped up against this same problem a few thousand times in their coding careers, implemented a solution: the `width()` method. `width()` returns just the numeric portion of the `width` property, in pixels. You can also use `width()` to set the element's width to a pixel value. Here's the syntax:

```
$(selector).width(value);
```

» `selector`: The element you want to work with

- » **value**: An optional numeric value used to set the width of the element in pixels

Here's the example code rewritten with the `width()` method:

```
var currWidth = $('#my-div').width();
var newWidth = currWidth + 100;
$('#my-div').width(newWidth);
```

jQuery also offers a `height()` method that performs a similar function:

```
$(selector).height(value);
```

- » **selector**: The element you want to work with
- » **value**: An optional numeric value used to set the height of the element in pixels

Manipulating classes

Rather than fiddling with individual CSS properties, you might prefer to work with entire classes. jQuery offers several methods that enable you to do just that.

Adding a class

If you have a class rule defined in your CSS, you can apply that rule to an element by adding the `class` attribute to the element's tag and setting the value of the `class` attribute equal to the name of your class rule.

To add the `class` attribute using code, or, if the `class` attribute already exists, to add another class name to its value, jQuery offers the `addClass()` method:

```
$(selector).addClass(class);
```

- » **selector**: The element you want to work with.
- » **class**: A string with the name of the class you want to add to the element. To add two or more classes, separate each class name with a space.

Here's an example, and Figure 1–6 shows the result.

CSS:

```
.my-class {  
    display: flex;  
    justify-content: center;  
    align-items: center;  
    border: 6px dotted black;  
    font-family: Verdana, serif;  
    font-size: 2rem;  
    background-color: lightgray;  
}
```

HTML:

```
<div id="my-div">  
Hello World!  
</div>
```

jQuery:

```
$('#my-div').addClass('my-class');
```

FIGURE 1-6:
This code uses
the `addClass()`
method to add
the class named
`my-class` to the
`<div>` tag.



REMEMBER

If the `class` attribute doesn't exist in the element, the `addClass()` method inserts it into the tag. So in the previous example, after the code executes, the `<div>` tag now looks like this:

```
<div id="my-div" class="my-class">
```

Removing a class

To remove a class from an element's `class` attribute, jQuery offers the `removeClass()` method:

```
$(selector).removeClass(class);
```

- » **selector**: The element you want to work with.
- » **class**: A string specifying the name of the class you want to remove from the element. To remove two or more classes, separate each class name with a space.

Here's an example:

```
$( '#my-div' ).removeClass('my-class');
```

Toggling a class

One very common web development scenario is switching a web page element between two different states. For example, you might want to change an element's styles depending on whether a check box is selected or deselected, or you might want to alternate between showing and hiding an element's text when the user clicks the element's heading.

One way to handle this would be to use `addClass()` to add a particular class when the element is in one state (for example, the user clicks the element's header for the first time) and then use `removeClass()` to remove that class when the element is in the other state (for example, the user clicks the element's header for a second time).

That would work, but it would mean that your code would somehow have to check the element's current state, something like this pseudo-code:

```
if (the element has the class applied) {  
    remove the class  
} else {  
    add the class  
}
```

That's a lot of extra work, but fortunately it isn't work you have to worry about because jQuery has got your back on this one. The `toggleClass()` method does the testing for you. That is, it checks the element for the specified class; if the class is there, jQuery removes it; if the class isn't there, jQuery adds it. Sweet! Here's the syntax:

```
$(selector).toggleClass(class);
```

- » **selector**: The element you want to work with.

- » *class*: A string specifying the name of the class you want to toggle for the element. To toggle two or more classes, separate each class name with a space.

Here's an example:

```
$('#my-div').toggleClass('my-class');
```

Tweaking HTML Attributes with jQuery

In the previous section, I went on and on about jQuery's `addClass()`, `removeClass()`, and `toggleClass()` methods, one of the characteristics of which is that these methods add, modify, or remove the element's `class` attribute. So you won't be even a tad surprised that jQuery offers a similar set of techniques for manipulating any HTML attribute. These techniques mostly center around the `attr()` method, and the next few sections tell all.

Reading an attribute value

If you want to read the current value of an attribute for an element, use the following syntax for the `attr()` method:

```
$(selector).attr(attribute);
```

- » *selector*: The element you want to work with. If *selector* returns a set of elements, jQuery uses only the first element in the set.
- » *attribute*: The name of the attribute you want to read.

Here's an example that reads the `href` attribute of the first `a` element that's a child of the `footer` element:

```
var firstLink = $('footer > a').attr('href');
```

Setting an attribute value

To set an attribute value on an element, use the following syntax for the `attr()` method:

```
$(selector).attr(attribute, value);
```

- » *selector*: The element you want to work with
- » *attribute*: The name of the attribute you want to set
- » *value*: The string value you want to assign to *attribute*

Here's an example that sets the `title` attribute for the `footer` element's first child element:

```
($('footer > a').attr('title', 'Like us on Facebook!');
```

Removing an attribute

To remove an attribute from an element, jQuery offers the `removeAttr()` method:

```
$(selector).removeAttr(attribute);
```

- » *selector*: The element you want to work with.
- » *attribute*: A string specifying the name of the attribute you want to remove from the element. To remove two or more attributes, separate each class name with a space.

Here's an example:

```
($('footer > a').removeAttr('title');
```

IN THIS CHAPTER

- » Figuring out events
- » Handling mouse clicks, key presses, and more
- » Showing, hiding, and fading elements
- » Moving elements around the page
- » Animating CSS properties

Chapter 2

Livening Up Your Page with Events and Animation

Today's web animation can be built with the same tools we've always used to design and build the web: CSS and JavaScript. That is a huge amount of power and a vast arena in which to be creative.

— VAL HEAD

H TML, CSS, JavaScript, and jQuery are among the web development world's most powerful tools, enabling you to create pages and entire sites that look great and work flawlessly (well, as close to flawlessly as the complexity of the web allows). But there's a problem with most of the web pages built using these tools: The pages just kind of sit there. Once the page loads, its content and its structure are fixed, immutable. You can't click anything, you can't change anything, nothing moves or jiggles, spins or flips, fades in or fades out. Sure, the page doesn't distract, but neither does it delight, and that's a no-no in the modern web. Fortunately, you've come to the right place because this chapter shows you how to liven up even the most moribund page. Here you delve into two techniques for injecting some dynamism into dead pages: events and animation. These powerful

tools not only give your page a dose of adrenaline, but they offer you endless possibilities for exploring and expressing your creativity.

Building Reactive Pages with Events

When you buy a car, no matter how much you paid for it or how technologically advanced it is, the car just sits there unless you do something. (If you're reading this in a future where all the cars are autonomous, my apologies.) That might be fine if it's a good-looking car, but it's much more likely you'll want the car to do something, anything. Here's a short list of actions you can take to achieve that goal:

- » Start the car.
- » Put the transmission into gear.
- » Press the accelerator.
- » Turn on the radio.

The common denominator for all these actions is that they set up a situation to which the car must respond in some way: turning on, engaging the gears, moving, playing sounds. Looked at it from this angle, the car is a machine that responds to external stimuli, or, in a word, to events.

Somewhat surprisingly, a web page is also a machine that responds to external stimuli. I'll describe what I mean.

What's an event?

In web development, an *event* is an action that occurs when a user interacts with a web page. Here are some examples:

- » Loading the page
- » Clicking a button
- » Pressing a key
- » Scrolling the page

How can your web page possibly know when any of these actions occur? The secret is that JavaScript was built with events in mind. As the computer science professors would say, JavaScript is an *event-driven* language.

So why don't web pages respond to events automatically? Why do they just sit there? Because web pages are *static* by default, meaning that they ignore the events that are firing all around them. Your job as a web developer is to change that behavior by making your web pages "listen" for particular events to occur. You do that by setting up special chunks of code called *event handlers* that say, in effect, "Be a dear and watch out for event X to occur, will you? When it does, be so kind as to execute the code that I've placed here for you. Thanks so much." An event handler consists of two parts:

- » **Event listener:** An instruction to the web browser to watch out for ("listen" for) a particular event occurring on a particular element
- » **Callback function:** The code that the web browser executes when it detects that the event has occurred

I said earlier that events are baked into JavaScript, but in this book I'm not going to talk about vanilla JavaScript event handling. That's because jQuery offers straightforward event-handling methods that are easier to use and more flexible than those offered by pure JavaScript, so it makes sense to learn about events the jQuery way.

Understanding the event types

There are dozens of possible events your web page can respond to, but lucky for you only a small subset of these events is needed in most day-to-day web development. I break these down into the following five categories:

- » **Document:** Events that fire in relation to the loading of the document object. The only event you need to worry about here is `ready`, which fires when the document object has completed loading.
- » **Mouse:** Events that fire when the user does something with the mouse (or a similar device, such as a trackpad or touchscreen). The most important events in this category are `click` (the user clicks the mouse), `dblclick` (the user double-clicks the mouse), and `mouseover` (the user moves the mouse pointer over an element).
- » **Keyboard:** Events that fire when the user interacts with the keyboard. The main event in this category is `keypress`, which is fired when the user presses a key.
- » **Form:** Events associated with web page forms. The important ones are `focus` (an element gains the focus, for example, when the user tabs to a form control), `blur` (an element loses the focus), `change` (the user changes the value of a form control), and `submit` (the user submits the form). See Book 6, Chapters 2 and 3 to learn about forms and form events.

» **Browser window:** Events that fire when the user interacts with the browser window. The two main events here are `scroll`, which fires when the user scrolls the window vertically or horizontally, and `resize`, which fires when the user changes the window width or height.

Setting up an event handler

You configure your code to listen for and react to an event by setting up an *event handler* using jQuery's `on()` method. Here's the syntax:

```
$(selector).on(event, function() {
    This code runs when the event fires
});
```

- » **selector:** A jQuery selector that specifies the web page element or set to be monitored for the event. The event is said to be *bound* to the element or set.
- » **event:** A string specifying the name of the event you want the browser to listen for. For the main events I mention in the previous section, use one of the following, enclosed in quotation marks: `ready`, `click`, `dblclick`, `mouseover`, `keypress`, `focus`, `blur`, `change`, `submit`, `scroll`, or `resize`.
- » **function():** The callback function that jQuery executes when the event occurs.

Here's an example:

HTML:

```
<div id="my-div"></div>
<button id="my-button">Click to add some text, above</button>
```

jQuery:

```
$('#my-button').on('click', function() {
    $('#my-div').html('<h1>Hello Click World!</h1>');
});
```

The HTML sets up an empty `div` element and a `button` element. The jQuery code attaches a `click` event listener to the button, and the callback function adds the HTML string `<h1>Hello Click World!</h1>` to the `div`. Figure 2-1 shows the resulting page after the button has been clicked.

FIGURE 2-1:
The click event callback function adds some HTML and text to the div element.



Using jQuery's shortcut event handlers

jQuery also offers some shortcut methods for setting up event handlers. Here's the syntax:

```
$(selector).event(function() {
    This code runs when the event fires
});
```

- » **selector:** A jQuery selector that specifies the web page element to be monitored for the event.
- » **event:** The name of event you want to handle. This defines a jQuery method as the event listener.
- » **function():** The callback function that jQuery executes when the event occurs.

For example, the ready event fires when the document object has finished loading, so here's some code that handles that event:

```
$(document).ready(function() {
    $('body').prepend('<h1>Hello Event World!</h1>');
});
```

As another example, here's a rewrite of the earlier code I used to demonstrate the on() method:

HTML:

```
<div id="my-div"></div>
<button id="my-button">Click to add some text, above</button>
```

jQuery:

```
$('#my-button').click(function() {
    $('#my-div').html('<h1>Hello Click World!</h1>');
});
```

As a third example, the following code uses the `dblclick()` method to swap a `div` element's text and background colors when the `div` is double-clicked:

CSS:

```
div {  
    color: lemonchiffon;  
    background-color: darkgreen;  
}
```

HTML:

```
<div id="my-div">  
    Double-click to switch the text and background colors.  
</div>
```

jQuery:

```
$('#my-div').dblclick(function() {  
    if($('#my-div').css('color') === 'rgb(255, 250, 205') {  
        $('#my-div').css('color', 'darkgreen');  
        $('#my-div').css('background-color', 'lemonchiffon');  
    } else {  
        $('#my-div').css('color', 'lemonchiffon');  
        $('#my-div').css('background-color', 'darkgreen');  
    }  
});
```

In the `dblclick` callback function, an `if()` statement checks to see if the current `color` value of the `div` element equals `rgb(255, 250, 205)`, which corresponds to the `lemonchiffon` color keyword. If so, the text and background colors are swapped.



TIP

When the user clicks a button or other web page element, the browser sets the focus on that element, which almost always means that, post-click, the element ends up with an unsightly “Look ma, I’ve got the focus” border around it. To remove this border, trigger the `blur` event by running the `blur()` method on the clicked element:

```
$('#my-button').on('click', function() {  
    $('#my-div').html('<h1>Hello Click World!</h1>');  
    $('#my-button').blur();  
});
```



REMEMBER

For many events, you can use your code to trigger that event by running the corresponding jQuery shortcut event method without any arguments.

Getting data about the event

When an event fires, jQuery creates an Event object, the properties of which contain info about the event, including the following:

- » **target**: The web page element to which the event occurred. For example, if you set up a `click` handler for a `div` element, that `div` is the target of the click.
- » **which**: A numeric code that specifies the key that was pressed during a `keypress` event.
- » **pageX**: The distance (in pixels) that the mouse pointer was from the left edge of the browser's content area when the event fired.
- » **pageY**: The distance (in pixels) that the mouse pointer was from the top edge of the browser's content area when the event fired.
- » **metaKey**: A Boolean value that equals `true` if the user had the Windows key () or the Mac Command key () held down when the event fired.
- » **shiftKey**: A Boolean value that equals `true` if the user had the Shift key held down when the event fired.

To access these properties, you insert a name for the `Event` object as an argument in your event handler's callback function:

```
$(selector).on(event, function(e) {  
    This code runs when the event fires  
});
```

- » **e**: A name for the `Event` object that jQuery generates when the event fires. You can use whatever name you want, but most coders use `e` (although `evt` and `event` are also common).

For example, when handling the `keypress` event, you need access to the `which` property to find out the code for the key the user pressed. Here's an example page that can help you determine which code value to look for:

HTML:

```
<div>  
    Type a key:  
</div>
```

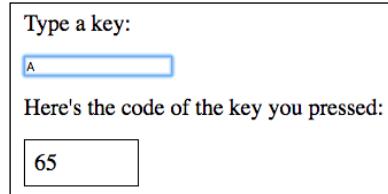
```
<input id="key-input" type="text">
<div>
    Here's the code of the key you pressed:
</div>
<div id="key-output">
</div>
```

jQuery:

```
$('#key-input').keypress(function(e) {
    $('#key-output').text(e.which);
});
```

The HTML sets up an `<input>` tag to accept a keystroke, and a `<div>` tag with `id="key-output"` to use for the output. The jQuery code adds a `keypress` event listener to the `input` element, and when the event fires, the callback function writes `e.which` to the output `div`. Figure 2-2 shows the page in action.

FIGURE 2-2:
Type a key in the input box, and the `keypress` event callback function uses `e.which` to write the numeric code of the pressed key to the `div` element.



Preventing the default event action



TIP

Some events come with default actions that they perform when the event fires. For example, a link's `click` event opens the target URL, whereas a form's `submit` event sends the form data to a script on the server. Most of the time these default actions are exactly what you want, but that's not always the case. For example, you might want to intercept a link click to perform some custom action, such as displaying a menu. Similarly, rather than letting the browser submit a form, you might prefer to massage the form data and then send the data via your script.

For these and many similar situations, you can tell the web browser not to perform an event's default action by running the `Event` object's `preventDefault()` method:

```
event.preventDefault();
```

- » *event*: A reference to the Event object that jQuery creates when an event fires

For example, take a peek at the following code:

HTML:

```
<a href="http://wiley.com/">Wiley</a>
<a href="http://wordspy.com/">Word Spy</a>
<a href="http://webcodingplayground.io/">Web Coding
    Playground</a>
<div id="output">
    Link URL:
<div>
```

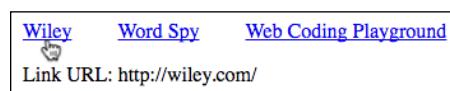
jQuery:

```
$( 'a' ).click(function(e) {
    e.preventDefault();
    strURL = e.target.href
    $('#output').text('Link URL: ' + strURL);
});
```

The HTML defines three links (styled as inline blocks, which I haven't shown here) and a `div` element. The jQuery sets up a `click` event listener for all the `a` elements, and the callback function does three things:

- » It uses the `e.preventDefault()` method to tell the browser not to navigate to the link address.
- » It uses `e.target.href` to get the URL of the link.
- » It displays that URL in the `div` element. Figure 2-3 shows an example.

FIGURE 2-3:
You can use
`e.preventDefault()` to
stop the browser
from navigating
to the link URL.



Getting your head around event delegation



TECHNICAL STUFF

One of the brow-furrowing problems you run into when using jQuery is trying to get an event handler to work on an element that you create with code. To see what I mean, take a look at an example:

HTML:

```
<button id="add-div-button">  
    Click to add the div  
</button>
```

jQuery:

```
// Build the div element as a string and then prepend it  
$('#add-div-button').click(function() {  
    var strDiv = '<div id="my-div">';  
    strDiv += 'Double-click to switch the text and background  
colors.';  
    strDiv += '</div>'  
    $('body').prepend(strDiv);  
});  
  
// Set up the div with a double-click event handler  
$('#my-div').on('dblclick', function() {  
    if($('#my-div').css('color') === 'rgb(255, 250, 205') {  
        $('#my-div').css('color', 'darkgreen');  
        $('#my-div').css('background-color', 'lemonchiffon');  
    } else {  
        $('#my-div').css('color', 'lemonchiffon');  
        $('#my-div').css('background-color', 'darkgreen');  
    }  
});
```

When you click the button, the first jQuery event handler builds a `div` element as a string and then uses `prepend` to add it to the `body` element. That `div` element uses the `id` value `my-div`. However, the second jQuery event handler is for a `dblclick` event on that same `my-div` element. Theoretically, the `dblclick` handler switches the element's text and background colors, but if you try this example, you can double-click the `div` until your finger falls off and nothing will happen.

Why doesn't the event handler handle anything? Because when the browser was loading the page and came upon the code for the `dblclick` event handler, the target — that is, the `div` with the `id` value `my-div` — didn't yet exist, so the browser ignored that event handler.

To fix this problem, you use a jQuery technique called *event delegation*, which means you do two things:

- » You bind the event handler not to the element itself, but to an ancestor element higher up in the web page hierarchy. This needs to be an element that exists when the web browser parses the event handler.
- » Add an extra parameter to the `on()` method that specifies which element your click handler actually applies to.

Here's the new syntax for the `on()` method:

```
$(ancestor).on(event, descendant, function() {
    This code runs when the event fires
});
```

- » *ancestor*: A selector that specifies the ancestor element that is delegated to be monitored for the event
- » *event*: A string specifying the name of event you want the browser to listen for
- » *descendant*: A selector that specifies the descendant element of *ancestor* that's the actual target of the event
- » `function()`: The callback function that jQuery executes when the event occurs

This version of the `on()` method *delegates* the event handler to the *ancestor* element. When the event fires, the *ancestor* element looks through its descendants until it finds the element or set given by *descendant*, and it then runs the handler with that element or set as the event target.

To fix the previous example, you could use the `document` object as the *ancestor* argument, and add `#my-div` as the *descendant* argument:

```
$(document).on('dblclick', '#my-div', function() {
```



WARNING

When choosing which ancestor to use as the delegate, the best practice is to use the closest ancestor that exists when the browser processes the event handler. For example, if in our example we were appending the `div` to, say, an existing `article` element, it would be better to use that `article` element as the delegate than the `document` object. Why is it better, you ask? Because the further away the ancestor, the more descendants the ancestor has to run through before it finds the event target, which can be a real drag on performance.

Turning off an event handler

Most of the time you'll want to leave an event handler on the job full-time so it's always available for your page visitors. However, sometimes you only want an event handler available part-time. For example, if clicking a button loads some HTML and text that you want to leave on the page, then it's best to remove both the button and its event handler to avoid confusing the user.

To remove an event handler, run jQuery's `off()` method:

```
$(selector).off(event);
```

- » `selector`: A jQuery selector that specifies the web page element or set from which you want the event removed
- » `event`: A string specifying the name of the event you want to remove

Here's an example that removes the `click` event from the element with the `id` value `my-button`:

```
$('#my-button').off('click');
```

Building Lively Pages with Animation

When you attend a speech or talk, nothing will put you to sleep faster — or, if you remain awake, make you want to head for the exit quicker — than listening to someone speak in a flat, affectless, monotone. The best orators use intonation, gestures, and the dramatic pause for effect to keep listeners not only in, but on the edge of, their seats.

Web pages, too, can appear flat and lifeless. Even if you've applied lots of color and top-notch typography, that's like dressing up a deadly dull speaker in a flattering dress or sharp suit: The deadly dullness remains. Web page liveliness comes not only from an attractive appearance, but also from the judicious use of animation, the digital equivalent of voice modulation and hand gestures.

That might sound like a lot of extra effort to put in for a bit of eye candy, but interface animations aren't just for show: When used properly they help the reader navigate and use your site, keep the reader engaged, and provide delight. But what about the work involved? Forget about it: jQuery offers a few ready-made tools that enable you to add sophisticated animation effects with just a few lines of code.

Hiding and showing elements

One of the most common web page effects is hiding something and then showing it when the user clicks a heading, a button, or some other page element. These effects are used for drop-down menus, navigation bars, image captions, question-and-answer sections (where clicking the question shows and hides the answer), and many other scenarios.

To hide an element, use jQuery's `hide()` method:

```
$(selector).hide();
```

- » `selector`: A jQuery selector that specifies the web page element or set you want to hide

For example, the following statement hides the web page's header element:

```
$( 'header' ).hide();
```

To show a hidden element, use jQuery's `show()` method:

```
$(selector).show();
```

- » `selector`: A jQuery selector that specifies the hidden web page element or set you want to show

For example, the following statement shows the web page's header element:

```
$( 'header' ).show();
```

Finally, you can toggle an element between shown and hidden by using jQuery's `toggle()` method:

```
$(selector).toggle();
```

- » `selector`: A jQuery selector that specifies the hidden web page element or set you want to toggle between shown and hidden

For example, the following statement toggles the web page's header element:

```
$( 'header' ).toggle();
```

Fading elements out and in

The `hide()`, `show()`, and `toggle()` methods that I cover in the previous section change the display of the element immediately. If the suddenness of these effects seems a bit harsh to you, then you might prefer the jQuery animations that fade an element out or in.

To fade an element out, use jQuery's `fadeOut()` method:

```
$(selector).fadeOut();
```

» `selector`: A jQuery selector that specifies the web page element or set you want to fade out

For example, the following statement fades out the web page's `aside` element:

```
($('aside').fadeOut();
```

To fade an element in, use jQuery's `fadeIn()` method:

```
$(selector).fadeIn();
```

» `selector`: A jQuery selector that specifies the web page element or set you want to fade in

For example, the following statement fades in the web page's `aside` element:

```
($('aside').fadeIn();
```

And, yes, you can toggle the fading by running jQuery's `fadeToggle()` method:

```
$(selector).fadeToggle();
```

» `selector`: A jQuery selector that specifies the web page element or set you want to toggle between fading in and fading out

For example, the following statement toggles fading for the web page's `aside` element:

```
($('aside').fadeToggle();
```

Sliding elements

As an alternative to the fade animations that I cover in the previous section, you can also make an element show or hide itself gradually by sliding into or out of its position on the page.

To hide an element by sliding it up from its bottom edge until it disappears, use jQuery's `slideUp()` method:

```
$(selector).slideUp();
```

» `selector`: A jQuery selector that specifies the web page element or set you want to slide up

For example, the following statement slides up the web page's `nav` element:

```
($('nav').slideUp();
```

To show an element by sliding it down from its top edge, use jQuery's `slideDown()` method:

```
$(selector).slideDown();
```

» `selector`: A jQuery selector that specifies the web page element or set you want to slide down

For example, the following statement slides down the web page's `nav` element:

```
($('nav').slideDown();
```

I know, you're way ahead of me: You can toggle the slide effect by running jQuery's `slideToggle()` method:

```
$(selector).slideToggle();
```

» `selector`: A jQuery selector that specifies the web page element or set you want to toggle between sliding up and sliding down

For example, the following statement toggles sliding for the web page's `nav` element:

```
($('nav').slideToggle();
```

Controlling the animation duration and pace

When you use any of jQuery's animation methods — `hide()`, `show()`, `toggle()`, `fadeOut()`, `fadeIn()`, `fadeToggle()`, `slideUp()`, `slideDown()`, or `slideToggle()` — without parameters, jQuery runs the animation using its default settings:

- » **Duration:** The animation take 400 milliseconds to complete.
- » **Pace:** The animation starts slow, speeds up in the middle, and then slows down at the end. The pace is also called the animation's *easing* function and the default easing function is named `swing`.

You have quite a bit of control over the duration, and a bit of control over the pace, by using jQuery's animations with the addition of two parameters that set the duration and the easing function:

```
$(selector).animation(duration, easing);
```

- » **selector:** A jQuery selector that specifies the web page element or set you want to work with.
- » **animation:** The name of the animation method you want to run.
- » **duration:** The length of the animation, in milliseconds. You can also use the keywords `slow` (equivalent to 600ms) or `fast` (equivalent to 200ms).
- » **easing:** A string that specifies the easing function you want to use for the animation. The default is `swing`, but you can also specify `linear` to have the animation run at a constant pace.

For example, the following statement toggles the `nav` element between hidden and shown, where the animation takes one second and uses the `linear` easing function.

```
$( 'nav' ).toggle(1000, 'linear');
```



WARNING

Resist the temptation to extend the duration of an animation beyond a second or two. Your web visitors are busy people, and no one wants to sit through a ten-second fade or slide animation. As a general rule, your animations should be quick: around half a second in most cases.

Example: Creating a web page accordion

A common web design pattern is the *accordion*, a menu or list of items, each of which contains extra content that is hidden by default. When you click an item in the accordion, that item's hidden content is displayed. Click the item again, and the content returns to being hidden. An accordion is useful when you have a long series or list of items, and to display everything at once would be overwhelming for the reader. Instead, you can display just the headings, menu commands, or similar top-level items, and you can hide the rest of the content associated with each item, thus making the list or menu easier to read and navigate.

Take a look at an example. First, here's some CSS and HTML code to mull over:

CSS:

```
.sentence {  
    display: none;  
}
```

HTML:

```
<header>  
    <h1>Some Food Words to Chew On</h1>  
</header>  
<main>  
    <p>  
        Click a word or its definition to see that term's sample  
        sentence.  
    </p>  
    <section id="alamode" class="word">  
        <b>à la mode</b> (al·uh·MODE, adjective). Describes a  
        dish that's served with ice cream.  
        <p class="sentence">  
            Give her a big spoon and a piece of apple pie <b>à  
            la mode</b> the size of her head, and Moira had her own little  
            slice of heaven.  
        </p>  
    </section>  
    <section id="appetizer" class="word">  
        <b>appetizer</b> (AP·uh·tye·zur, noun). Food or drink  
        that's served before the main meal and is meant to stimulate  
        the appetite.  
        <p class="sentence">  
            A slow eater, Karen was only halfway through her  
            salad <b>appetizer</b> when the waiter showed up with the main  
            course.  
        </p>
```

```
</p>
</section>
<section id="comestible" class="word">
    <b>comestible</b> (kuh·MES·tuh·bul, noun). An item that
    can be eaten as food.
    <p class="sentence">
        After picking up bread, meat, cheese, and a few
        other <b>comestibles</b>, Deirdre was ready for the weekend-
        long Three Stooges festival.
    </p>
</section>
<section id="cuisine" class="word">
    <b>cuisine</b> (kwi·ZEEN, noun). A style of cooking as
    well as the food cooked in that style.
    <p class="sentence">
        His local restaurant was supposed to specialize in
        French <b>cuisine</b>, so Sean wondered why they didn't serve
        french fries.
    </p>
</section>
<section id="epicure" class="word">
    <b>epicure</b> (EP·uh·kyoor, noun). A person with
    sophisticated tastes, especially when it comes to food and
    wine.
    <p class="sentence">
        Being able to tell beef stroganoff from beef
        Wellington and a Bordeaux from a Beaujolais convinced Dominic
        that he was quite the <b>epicure</b>.
    </p>
</section>
<section id="ingest" class="word">
    <b>ingest</b> (in·JEST, verb). To take food into the
    body.
    <p class="sentence">
        Not at all hungry, but also unwilling to displease
        his wife, Mr. Tortellini <b>ingested</b> her spaghetti with
        grim determination.
    </p>
</section>
<section id="nosh" class="word">
    <b>nosh</b> (nawsh, verb). To eat a light meal or a
    snack.
```

```
<p class="sentence">  
    Wanda would guiltily <b>nosh</b> on a pepperoni  
    stick before going in to her vegetarian cooking class.  
</p>  
</section>  
</main>
```

The HTML consists mostly of a series of `<section>` tags, each of which contains a word, its pronunciation, its definition, and a `<p>` tag that contains a sample sentence that uses the word. Each of these `<p>` tags is given the class named `sentence`, and in the CSS code, you can see that the `sentence` class is hidden by default by styling it with the declaration `display: none`. Figure 2-4 shows the initial state of the page.

FIGURE 2-4:
When you first load the page, you see only each word and its pronunciation and definition. The sample sentences are hidden by default with the `display: none` declaration.

Some Food Words to Chew On

Click a word or its definition to see that term's sample sentence.

à la mode (al-uh-MODE, adjective). Describes a dish that's served with ice cream.

appetizer (AP-uh-tye-zur, noun). Food or drink that's served before the main meal and is meant to stimulate the appetite.

comestible (kuh-MES-tuh-bul, noun). An item that can be eaten as food.

cuisine (kwí-ZEEN, noun). A style of cooking as well as the food cooked in that style.

epicure (EP-uh-kyoor, noun). A person with sophisticated tastes, especially when it comes to food and wine.

ingest (in-JEST, verb). To take food into the body.

nosh (nawsh, verb). To eat a light meal or a snack.

The goal here is to display a word's sample sentence when the reader clicks the word (or its pronunciation or definition). One way to do this would be to set up a `click` event handler on each word and then have that handler's callback function use a method such as `slideToggle()` or `fadeToggle()` to show and hide the sample sentence. That would do the job, but it requires a lot of work. Sure, it's not bad with the seven items in my list, but what if there were 70 items, or 700?

Instead, I'm going to take advantage of three timesaving features of my HTML code:

- » Each `<section>` tag uses the class named `word`, so I can set up a single `click` event handler that is bound to that class name.
- » Each `<section>` tag also uses a unique `id` value that is based on its word. I can use that `id` value to know which term was clicked.
- » Each `<p>` tag is a direct child of its parent `<section>` tag, which lets me target the `<p>` tag using the child selector.

Given all this, the jQuery code required to show and hide the sample sentences is remarkably compact:

```
$('.word').click(function(e) {  
    var wordID = e.target.id;  
    $('#' + wordID + ' > p').slideToggle('slow');  
});
```

Three things are going on here:

- » The `click` event method is bound to the class named `word`, so it fires any time the reader clicks a `<section>` tag's content.
- » To figure out which `<section>` tag was clicked, the code gets the value of `e.target.id`, which returns the `id` value of the clicked section element. That `id` value is stored in the `wordID` variable.
- » To build the jQuery selector for the sample sentence, the code appends `#` to `wordID`, and then adds the child selector for the `p` element: `> p`. With the section element's sample sentence selected, the code runs the `slideToggle()` animation to slide the sample sentence in and out of view.

Figure 2-5 shows the page with one of the sample sentences displayed.

Some Food Words to Chew On

Click a word or its definition to see that term's sample sentence.

à la mode (al-uh-MODE, adjective). Describes a dish that's served with ice cream.

appetizer (AP-uh-tye-zur, noun). Food or drink that's served before the main meal and is meant to stimulate the appetite.

comestible (kuh-MES-tuh-bul, noun). An item that can be eaten as food.
*After picking up bread, meat, cheese, and a few other **comestibles**, Deirdre was ready for the weekend-long Three Stooges festival.*

cuisine (kwi-ZEEN, noun). A style of cooking as well as the food cooked in that style.

epicure (EP-uh-kyoor, noun). A person with sophisticated tastes, especially when it comes to food and wine.

ingest (in-JEST, verb). To take food into the body.

nosh (nawsh, verb). To eat a light meal or a snack.

FIGURE 2-5:
Click any word (or its pronunciation or definition) and our four-line jQuery code slides the sample sentence in or out.

Animating CSS properties

One of the most interesting and exciting jQuery methods is `animate()`, which enables you to apply an animation to any CSS property that accepts a numeric value: `font-size`, `padding`, `border-width`, `opacity`, and many more. Here's the syntax to use:

```
$(selector).animate(properties, duration, easing);
```

- » *selector*: A jQuery selector that specifies the web page element or set you want to work with.
- » *properties*: An object literal that specifies the CSS property-value pairs that you want to animate.
- » *duration*: An optional length of the animation, in milliseconds. You can also use the keywords `slow` (equivalent to 600ms) or `fast` (equivalent to 200ms). The default is 400ms.
- » *easing*: An optional string that specifies the easing function you want to use for the animation. The default is `swing`, but you can also specify `linear` to have the animation run at a constant pace.

The *properties* parameter requires a bit more elaboration. It requires an object literal, which is a collection of property-value pairs, separated by commas and surrounded by braces. Here's the general form:

```
{
    property1: value1,
    property2: value2,
    etc.
    propertyN: valueN
}
```

Each *property* is a CSS property name, which needs to be enclosed in quotation marks if it contains a hyphen (-). Each *value* is a number, followed by a measurement unit, if needed. (Some CSS properties, such as `opacity` and `line-spacing`, take unitless numeric values.) If the value has a measurement unit, surround the number and unit with quotation marks. For example, here's the object literal to use if you want your animation to change the left position to 425px, the font size to `1rem`, and the opacity to 1:

```
{
    left: '425px',
    'font-size': '1rem',
    opacity: 1
}
```

You then insert the object literal into the `animate()` method as the *properties* parameter:

```
$('aside').animate(
{
```

```
        left: '425px',
        'font-size': '1rem',
        opacity: 1
    },
    1500,
    'linear'
);
```

This example animates the page's `aside` element with a duration of 1.5 seconds and linear easing. Notice that I arranged the `animate()` arguments vertically for easier reading.



REMEMBER

For an animation to actually animate something, the property values you specify in the `animate()` method's object literal must be different than the values the element already has. For the example just described, the initial CSS rule for the `aside` element might look like this:

```
aside {
    position: absolute;
    left: -20rem;
    font-size: .1rem;
    opacity: 0;
}
```

Given this initial rule, you can see that the animation does three things:

- » Moves the element from its initial position offscreen to 425px from the left edge of the content area
- » Increases the font size from `.1rem` to `1rem`
- » Increases the opacity from 0 (transparent) to 1 (fully visible)

Running code when an animation ends

Most of the time you'll want your jQuery animations to run their course without further ado. However, there might be times when some further ado is exactly what you want. For example, at the completion of an animation, you might want to adjust the text on a button (for example, from "Hide the nav bar" to "Show the nav bar") or you might want to run another animation (a technique known as *animation chaining*).

You can perform these and similar post-animation tasks by adding a callback function to the animation method. First, here's the syntax to use for one of jQuery's built-in animation effects:

```
$(selector).animation(function() {
    Code to run when the animation is done
});
```

- » **selector:** A jQuery selector that specifies the web page element or set you want to work with.
- » **animation:** The name of the animation method you want to run.
- » **function():** The callback function. jQuery executes the code inside this function after the animation ends.

Here's an example:

HTML:

```
<nav>
  <a href="#">Home</a>
  <a href="#">What's New</a>
  <a href="#">What's Old</a>
  <a href="#">What's What</a>
</nav>
<main>
  <button id="slide-nav">Hide the nav bar</button>
</main>
```

jQuery:

```
$('#slide-nav').click(function() {
  $('nav').slideToggle(function() {

    // Get the current button text
    var btnText = $('#slide-nav').text();

    // Check the first four letters of the button text
    // and then change the button text accordingly
    if (btnText.substr(0, 4) === 'Hide') {
      $('#slide-nav').text('Show the nav bar');
    } else {
      $('#slide-nav').text('Hide the nav bar');
    }
});
```

```
    });
});
```

The HTML defines a button element that, when clicked, hides and shows the nav element. The jQuery code sets up a click event handler for the button, and that handler's callback function runs the `slideToggle()` animation on the nav element. The `slideToggle()` animation also includes a callback function that gets the button text, checks to see if the first four characters are Hide, and then changes the button text according to the result.



REMEMBER

```
$(selector).animation(duration, easing, function() {
    Code to run when the animation is done
});
```

For the `animate()` method, you can also include a callback function by using the following syntax:

```
$(selector).animate(properties, duration, easing, function() {
    Code to run when the animation is done
});
```

Here's an example that runs a second `animate()` method after the first one is complete:

```
$('#animate-aside').click(function() {
    $('aside').animate(
        {
            left: '425px'
        },
        500,
        'linear',
        function() {
            $('aside > p').animate(
                {
                    opacity: 1
                },
                2000
            ); // End of the second animate() method
        } // End of the first animate() method's callback
    function()
        ); // End of the first animate() method
    }); // End of the click() method
```

IN THIS CHAPTER

- » Introducing jQuery UI
- » Creating a custom version of jQuery UI
- » Including the jQuery UI code in your page
- » Trying out a few jQuery UI widgets
- » Playing around with jQuery UI interactions and effects

Chapter 3

Getting to Know jQuery UI

Because jQuery UI runs on top of jQuery, the syntax used to initialize, configure, and manipulate the different components is in the same comfortable, easy-to-use, and short-hand style that we've all come to know and love through using jQuery. Therefore, getting used to it is incredibly easy.

— DAN WELLMAN

In Chapters 1 and 2 of this minibook, I go through the basics of jQuery and showed how easy jQuery makes it to select elements, manipulate tags, CSS properties, and HTML attributes, and build interactive and fun pages with events and animations. jQuery's ease and power make it an indispensable tool in the modern web developer's workshop, but as powerful as it is, jQuery can't do everything. In particular, jQuery doesn't offer much — okay, anything — in the way of tools to help ease the chore of building user interface components such as menus, dialog boxes, and tabs. Sure, jQuery gives you the technology to build these things, but the coding is still often time-consuming and laborious.

But it doesn't have to be. That's because the jQuery Foundation — the same group that brings you jQuery — is also behind a sister project called jQuery UI (jQuery User Interface), which offers an impressive set of pre-fab user interface components. In this chapter, you explore what jQuery UI has to offer and investigate a number of the most useful and powerful jQuery UI components.

What's the Deal with jQuery UI?

Have you ever seen one of those homemade Little Free Libraries that people put up on their properties and allow anyone to take (and, ideally, add) books? The jQuery library is a bit like that because it allows third-party developers to create extensions to jQuery called *plug-ins*. These are small bits of code that piggyback on jQuery's syntax, making them intuitive to learn and use. For example, if a plug-in extended jQuery with a method named `doohickey()`, you'd run the plug-in on an element, like so:

```
$(element).doohickey();
```

There are hundreds of available plug-ins (check out <http://plugins.jquery.com> to see the complete list). However, one plug-in in particular is the most popular: jQuery UI, which offers a set of components related to building a web page user interface. jQuery UI itself breaks down its components into ten categories, but for purposes in this chapter, there are three main categories that you explore:

- » **Widgets:** Ready-to-use user interface components such as menus, dialog boxes, tabs, and sliders
- » **Effects:** Animations that go well beyond built-in jQuery effects, such as `hide()` and `fadeIn()`
- » **Interactions:** Mouse-centric tools that enable you to configure web page elements to be resizable, draggable, sortable, and more

jQuery UI has a Download Builder tool that enables you to select just the components you want, a ThemeRoller tool that lets you customize the look of the components you download, and a consistent set of class names that you can access via CSS rules or your jQuery code.

Getting Started with jQuery UI

Getting up and running with jQuery UI involves the following steps:

1. **Surf to the jQuery UI's Download Builder page, at <https://jqueryui.com/download>.**

Figure 3-1 shows the top part of the Download Builder page.

The screenshot shows the 'Download Builder' page. At the top, there are links for quick downloads: Stable (Themes) (1.12.1 for jQuery 1.7+), Legacy (Themes) (1.11.4 for jQuery 1.6+), Legacy (Themes) (1.10.4 for jQuery 1.6+), and Legacy (Themes) (1.9.2 for jQuery 1.6+). Below that is a link to 'All jQuery UI Downloads'. The 'Version' section has a radio button selected for '1.12.1 (Stable, for jQuery 1.7+)'. There are also unselected options for '1.11.4 (Legacy, for jQuery 1.6+)', '1.10.4 (Legacy, for jQuery 1.6+)', and '1.9.2 (Legacy, for jQuery 1.6+)'. The 'Components' section has a 'Toggle All' checkbox checked. The 'Core' section has a 'Toggle All' checkbox checked. The 'Widget' section has a 'Widget' checkbox checked. The 'Position' section has a 'Position' checkbox checked. The ':data Selector' section has a ':data Selector' checkbox checked. The ':disableSelection' section has a ':disableSelection' checkbox checked. The ':focusable Selector' section has a ':focusable Selector' checkbox checked. The 'Form Reset Mixin' section has a 'Form Reset Mixin' checkbox checked.

FIGURE 3-1:
Use the jQuery UI Download Builder page to create your custom jQuery UI download.

2. **Leave the Version option with the most recent version selected.**
3. **Use the check boxes to choose which jQuery UI components you want to use.**

If you don't yet know which components you want to use, leave them all selected for now. The resulting file will be quite big (over 250KB), but you can always come back and select just the components you want to use when you're more familiar with what jQuery UI has to offer.
4. **Near the bottom of the page, use the Theme list to select a CSS theme for your components.**

If you want to roll your own theme, click Design a Custom Theme to open the ThemeRoller, shown in Figure 3-2. Use the ThemeRoller widget on the left to customize your fonts, colors, and more. Then click Download Theme to return to the Download Builder with Custom Theme now showing in the Theme list.

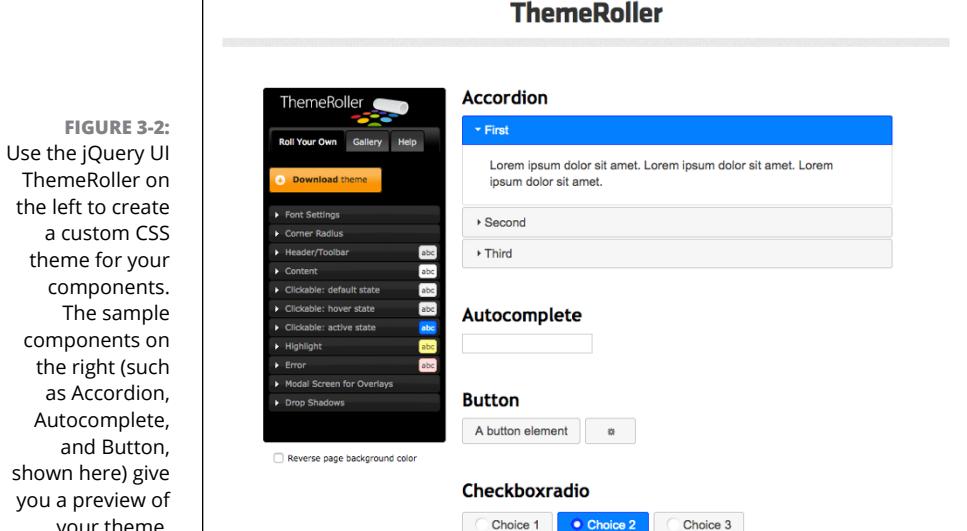


FIGURE 3-2:
Use the jQuery UI ThemeRoller on the left to create a custom CSS theme for your components. The sample components on the right (such as Accordion, Autocomplete, and Button, shown here) give you a preview of your theme.

5. Click Download.

jQuery UI gathers your files into a ZIP archive and downloads the file to your computer.

6. Double-click the downloaded file to unzip it.

7. Copy the jQuery UI CSS file to the folder where you keep your web page CSS files.

At a minimum, you need to copy the jquery-ui.css file and the images subfolder. You might also want to copy the minified version of the CSS — jquery-ui.min.css — to use with your production code.

8. Copy the jQuery UI JavaScript file to the folder where you keep your web page JavaScript files.

You need to copy the jquery-ui.js file. You might also want to copy the minified version — jquery-ui.min.js — to use with your production code.

9. Incorporate the jQuery UI code into your web page.

For the CSS file, set up a <link> tag (adjusting the path to the file as needed for your own folder structure):

```
<link rel="stylesheet" href="/css/jquery-ui.css">
```

For the JavaScript file, set up a `<script>` tag and place it after the `<script>` tag you use for jQuery (again, be sure to adjust the path to the file as needed):

```
<script src="https://ajax.googleapis.com/ajax/libs/
jquery/3.3.1/jquery.min.js"></script>
<script src="/js/jquery-ui.js">
```

Working with the jQuery UI Widgets

A *jQuery UI widget* is a ready-to-use web page user interface component. jQuery UI offers 15 or so of these widgets, most of which are related to forms, so I won't cover them in this chapter. (See Book 6, Chapter 2 to get the details on forms and form controls.) However, that still leaves you with a fistful of remarkably useful widgets — tabs, menus, dialog boxes, and accordions — that you can put to good use right away to make your web pages stand out from the herd.

Dividing content into tabs

In a web browser, the tabs that run across the window just above the content area each contain a web page, and you switch between the pages by clicking the tabs.

You can offer that same convenience in your web pages by implementing jQuery UI's tabs widget, which displays a series of two or more tabs, each of which is loaded with content. The user switches between the content by clicking the tabs. When you have a lot of content to display, but not a lot of room to display it, tabs are your best choice.

A good example of the tabs widget in action is on jQuery UI's ThemeRoller page (<http://jqueryui.com/themeroller>), where the ThemeRoller tool offers three tabs: Roll Your Own, Gallery, and Help, as pointed out in Figure 3-3.



FIGURE 3-3:
jQuery UI's
ThemeRoller tool
makes good use
of jQuery UI's
tabs widget.

To create tabs on your page, you need to set up your HTML using the following steps:

- 1. Add a block-level element to use as the parent for the entire tab structure, and include an `id` value.**

You can use a semantic element such as `<article>` or `<aside>`, if it fits your content, or a generic `<div>` container:

```
<div id="my-tabs">
</div>
```

- 2. The tabs themselves are enclosed in a list (which can be unordered or ordered), where the text for each list item is the text that appears on each tab.**

```
<div id="my-tabs">
  <ul>
    <li>This</li>
    <li>That</li>
    <li>The Other</li>
  </ul>
</div>
```

- 3. For each tab, add a block-level element to hold the tab's content, and include a unique `id` value.**

Again, you can use a semantic element such as `<section>` or `<p>`, if that works for you, or a generic `<div>`:

```
<div id="my-tabs">
  <ul>
    <li>This</li>
    <li>That</li>
    <li>The Other</li>
  </ul>
  <div id="my-tab-1">
    This is the first tab's content.
  </div>
  <div id="my-tab-2">
    This is the second tab's content.
  </div>
  <div id="my-tab-3">
    Yep, this is the third tab's content.
  </div>
</div>
```

- 4.** Return to your list of items and convert each item's text into a link that points to the `id` value of the tab's content block.

Be sure to precede each `id` with a hash symbol (#). Here's the final HTML code:

```
<div id="my-tabs">
  <ul>
    <li><a href="#my-tab-1">This</a></li>
    <li><a href="#my-tab-2">That</a></li>
    <li><a href="#my-tab-3">The Other</a></li>
  </ul>
  <div id="my-tab-1">
    This is the first tab's content.
  </div>
  <div id="my-tab-2">
    This is the second tab's content.
  </div>
  <div id="my-tab-3">
    Yep, this is the third tab's content.
  </div>
</div>
```

With your HTML set up, you turn it into tabs by applying jQuery UI's `tabs()` method to the parent container:

```
$( '#my-tabs' ).tabs();
```

Figure 3-4 shows the result.

FIGURE 3-4:
Some tabs
created using
jQuery UI's
tabs widget.



TIP

You can style the tabs widget by overriding the rules that come with jQuery UI's CSS. There are four main classes you can use to style the tabs widget:

» `ui-tabs`: The parent container. For example, I styled the tabs widget shown in Figure 3-4 to have a width of 300px as follows:

```
.ui-tabs {
  width: 300px;
}
```

- » ui-tabs-nav: The list container (the `` or `` element).
- » ui-tabs-tab: Each `` item in the list (that is, each tab).
- » ui-tabs-panel: The content container for each tab.

Creating a navigation menu

If your page navigation includes quite a few links — especially if those links can be divided into categories — you can tidy things up and make your navigation easier and more comprehensible for page visitors by converting your links into a drop-down menu with submenus.

Creating a menu normally requires quite a bit of coding, but jQuery UI's menu widget simplifies things considerably. Here are the steps to follow to build a menu widget for your page:

- 1. Create a parent element to hold the menu widget structure, and include an id value.**

You can use any block-level element, but most developers use an unordered list (``):

```
<ul id="my-menu">
</ul>
```

- 2. For each menu item, add a list item element (``), where the item text is your menu item text surrounded by a block-level element, such as `<div>`.**

To add a menu separator (a horizontal line across the menu), use a dash as the menu item text:

```
<ul id="my-menu">
  <li>
    <div>Menu Item #1</div>
  </li>
  <li>
    <div>Menu Item #2</div>
  </li>
  <li>
    <div>-</div>
  </li>
  <li>
    <div>Menu Item #3</div>
  </li>
</ul>
```

3. To create a submenu within an existing menu item, insert a new unordered list between the menu item's `` and `` tags, after the menu item text element.

Note that the submenu's `` tag doesn't need an `id` value. Here's the final HTML code:

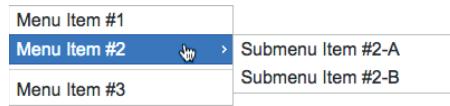
```
<ul id="my-menu">
  <li>
    <div>Menu Item #1</div>
  </li>
  <li>
    <div>Menu Item #2</div>
    <ul>
      <li>
        <div>Submenu Item #2-A</div>
      </li>
      <li>
        <div>Submenu Item #2-B</div>
      </li>
    </ul>
  </li>
  <li>
    <div>--</div>
  </li>
  <li>
    <div>Menu Item #3</div>
  </li>
</ul>
```

Now you turn your HTML tags into a menu by applying jQuery UI's `menu()` method to the parent container:

```
$( '#my-menu' ).menu();
```

Figure 3-5 shows the finished menu.

FIGURE 3-5:
A drop-down menu with a submenu, created using jQuery UI's menu widget.





TIP

You can style the menu widget by overriding the rules that come with jQuery UI's CSS. There are three main classes you can use to style the menu widget:

- » `ui-menu`: The parent container (the `` element). For example, I styled the menu widget shown in Figure 3-5 to have a width of `200px`, as follows:

```
.ui-menu {  
    width: 200px;  
}
```

- » `ui-menu-item`: Each `` item in the list (that is, each menu item).
- » `ui-menu-wrapper`: The content container for each menu item (the `<div>` elements in my example).

Displaying a message in a dialog

In Book 3, Chapter 6, I talk about JavaScript's `alert()` method, which you can use to display a message to the user. As long as you don't overdo it, displaying messages is a handy trick to have up your web development sleeve. The problem, however, is that JavaScript's `alert()` boxes are plain to a fault and aren't customizable. If you're going to subject your page visitors to the occasional message, then why not make the message at least look nice?

You can get a better-looking message by foregoing JavaScript's `alert()` method in favor of jQuery UI's dialog widget. The dialog widget creates a floating window that offers a title bar, a content area for the message, and a button that closes the window.

To set up the dialog widget, create a `<div>` element that uses the following format:

```
<div id="dialog-id" title="dialog-title">  
    Dialog message  
</div>
```

- » `dialog-id`: A unique `id` value for the dialog widget
- » `dialog-title`: The text you want to appear in the dialog widget's title bar
- » `Dialog message`: The message you want to display in the dialog widget's content area

Once that's done, you turn your HTML into a dialog widget by applying jQuery UI's `dialog()` method to the `<div>`:

```
$('#dialog-id').dialog({  
    autoOpen: false  
});
```

Notice that I've included the object literal `{autoOpen: false}`, which tells jQuery UI not to display the dialog automatically when you first run the `dialog()` method. To open the dialog (say, in response to a button click), run the `dialog()` method with the string `open` as the parameter:

```
$('#dialog-id').dialog('open');
```

Here's an example, and Figure 3-6 shows the dialog that appears when the button is clicked:

HTML:

```
<div id="my-dialog" title="Hello Dialog World!">  
    Welcome to my dialog widget!  
</div>  
  
<button id="my-button">  
    Display the dialog  
</button>
```

jQuery:

```
// Initialize the dialog widget  
$('#my-dialog').dialog({  
    autoOpen: false}  
);  
  
// Display the dialog when the button is clicked  
$('#my-button').click(function() {  
    $('#my-dialog').dialog('open');  
});
```



FIGURE 3-6:
The jQuery UI dialog widget that appears when you click the button.



TIP

You can style the dialog widget by overriding the rules that come with jQuery UI's CSS. There are four main classes you can use to style the menu widget:

- » ui-dialog: The parent container (the `<div>` element)
- » ui-dialog-titlebar: The dialog widget's title bar
- » ui-dialog-title: The dialog widget's title text
- » ui-dialog-container: The dialog widget's content area

Hiding and showing content with an accordion

An *accordion* is a series of headings, each with an associated chunk of content, where only one heading/content combo is shown at a time. Accordions are a great way to display multiple items without overwhelming the reader with all the content at once.

I talk about how to use jQuery to build a simple accordion in Book 4, Chapter 2, but jQuery UI offers a more sophisticated accordion widget. To create an accordion, you first need to set up some HTML tags as follows:

- 1. Add a block-level element to use as the parent for the entire accordion structure, and include an `id` value.**

You can use a semantic element such as `<main>` or `<article>`, if it fits your content, or a generic `<div>` container:

```
<div id="my-accordion">
</div>
```

- 2. Add a header.**

You can use any element you want, but a heading tag makes sense semantically:

```
<div id="my-accordion">
  <h6>Header A</h6>
</div>
```

- 3. Add the content that goes with the header from Step 2.**

Again, you can use a semantic element such as `<section>` or `<p>`, if that works for you, or any element you want, such as a `<div>`:

```
<div id="my-accordion">
    <h6>Header A</h6>
    <div>This is the content panel for Header A</div>
</div>
```

4. **Repeat Steps 2 and 3 for each header/content pair you want to include in your accordion.**

Here's the final HTML code for my example:

```
<div id="my-accordion">
    <h6>Header A</h6>
    <div>This is the content panel for Header A</div>
    <h6>Header B</h6>
    <div>This is the content panel for Header B</div>
    <h6>Header C</h6>
    <div>This is the content panel for Header C</div>
</div>
```

With your HTML ready to go, you turn that code into an accordion by applying jQuery UI's `accordion()` method to the parent container:

```
$('#my-accordion').accordion();
```

Figure 3-7 shows the result.

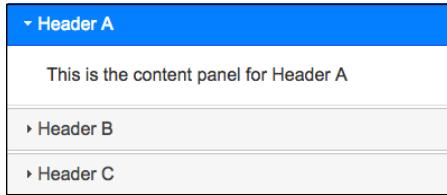


FIGURE 3-7:
An accordion created using
jQuery UI's
accordion widget.



TIP

Note that with jQuery UI's accordion, one content panel is always visible. If you'd prefer that the accordion allow all the content panels to be hidden, initialize the `accordion()` method with an object literal that sets the `collapsible` property to `true`:

```
$('#my-accordion').accordion({
    collapsible: true
});
```



TIP

You can style the accordion widget by overriding the rules that come with jQuery UI's CSS. There are three main classes you can use to style the accordion widget:

- » ui-accordion: The parent container. For example, I styled the accordion widget shown in Figure 3-7 to have a width of 400px, as follows:

```
.ui-accordion {  
    width: 400px;  
}
```

- » ui-accordion-header: The accordion headers.
- » ui-accordion-content: The accordion content panels.

Introducing jQuery UI Effects

As I go on and on about in Book 4, Chapter 2, jQuery offers half a dozen animation effects: `hide()`, `show()`, `fadeOut()`, `fadeIn()`, `slideUp()`, and `slideDown()`, as well as their toggle versions: `toggle()`, `fadeToggle()`, and `slideToggle()`. That's a decent palette to work with, but apparently it wasn't good enough for the jQuery UI team, who've stuffed no less than 14 extra animations into the Effects category.



WARNING

Do you need all those effects? No, you don't. As with all things related to animation, too little is always better than too much, so let moderation be your watchword. That said, there are some fun and interesting effects in the jQuery UI library, so perhaps there's one (or, at most, two) that is just right for your project.

Applying an effect

Before I describe the available animations, let's see how you apply them to an element. The most straightforward way is to use jQuery UI's `effect()` method. Here's the syntax:

```
$(selector).effect(effect, options, duration, function() {  
    Code to run when the effect is done  
});
```

- » *selector*: A jQuery selector that specifies the web page element you want to work with.
- » *effect*: A string that specifies the name of the jQuery UI effect you want to apply to the element.
- » *options*: An object literal that includes one or more property-value pairs that specify the effect options you want to use. These options vary with the effect, but the most common property is *easing*, which sets the easing function. jQuery UI offers more than 30 easings; see <https://api.jqueryui.com/easings> for the complete list and to try out each one.
- » *duration*: The length of the effect, in milliseconds. You can also use the keywords *slow* (equivalent to 600ms) or *fast* (equivalent to 200ms). The default duration is 400ms.
- » *function()*: A callback function that jQuery UI executes after the effect ends.

For example, the following statement applies jQuery UI's bounce effect with a *slow* duration to the element that has an *id* value of *my-div*:

```
$('#my-div').effect('bounce', 'slow');
```

The *effect()* method works best with effects that perform some action on an element, while leaving that element in place (such as bouncing the element). If you want to hide or show an element, then you're better off working with jQuery UI's extensions to jQuery's *hide()*, *show()*, and *toggle()* methods. These use the same syntax as the *effect()* method:

```
$(selector).hide(effect, options, duration, function() {  
    Code to run when the effect is done  
});
```

```
$(selector).show(effect, options, duration, function() {  
    Code to run when the effect is done  
});
```

```
$(selector).toggle(effect, options, duration, function() {  
    Code to run when the effect is done  
});
```

Checking out the effects

Here's a quick look at the available effects offered by jQuery UI:

- » blind: Hides or shows an element as though the element was a window blind that you pull up or down. As an option, you can set the direction property to up, down, left, right, vertical, or horizontal.

```
$('#my-div').toggle('blind',{direction: 'left'});
```

- » bounce: Bounces an element up and down. As options, you can use the distance property to set the maximum bounce height (in pixels), and the times property to set the number of bounces.

```
$('#my-div').effect('bounce',  
{  
    distance: 200,  
    times: 10  
},  
1500  
);
```

- » clip: Hides or shows an element by shrinking the element vertically from the top and bottom. Set the direction property to horizontal to clip the element horizontally.

```
$('#my-div').toggle('clip');
```

- » drop: Hides or shows an element by fading the element out or in while simultaneously sliding the element left or right. As an option, you can set the direction property to up, down, left, or right.

```
$('#my-div').toggle('drop',{direction: 'up'});
```

- » explode: Hides an element by exploding it into pieces that fly off in all directions; shows an element by restoring the exploded pieces to their original configuration. You can set the pieces property to the number of pieces to explode; the value should be a square, such as 16 or 25 (the default is 9).

```
$('#my-div').toggle('explode',{pieces: 16});
```

- » fade: Hides or shows an element by fading the element out or in.

```
$('#my-div').toggle('fade', 'slow');
```

- » **fold:** Hides an element by first shrinking it vertically to a 15-pixel height (the first “fold”), and then shrinking it horizontally until it disappears (the second “fold”); shows an element by reversing the folding procedure. For options, you can use the `size` property to set the height, in pixels, after the first fold (the default is 15); you can set the `horizFirst` property to `true` to make the first fold horizontal rather than vertical.

```
$('#my-div').toggle('fold',{size: 50});
```

- » **highlight:** Highlights the background of an element. Use the `color` property to specify the highlight color as an RGB triplet (the default is `#ffff99`).

```
$('#my-div').effect('highlight',{color: 'ffd700'});
```

- » **puff:** Hides or shows an element by scaling the element larger or smaller while simultaneously fading the element out or in. Add the `percent` property to set the maximum scale percentage (the default is 150).

```
$('#my-div').toggle('puff',{percent: 200});
```

- » **pulsate:** Pulsates an element by quickly oscillating its opacity between 0 and 1. Use the `times` property to set the number of oscillations (the default is 5).

```
$('#my-div').effect('pulsate',{times: 10});
```

- » **scale:** Grows or shrinks an element. For options, you can set the `direction` property to `horizontal`, `vertical`, or both (the default); you can use the `origin` property to set the vanishing point as an array of the form `['h' , 'v']`, where `h` is `top`, `middle`, or `bottom`, and `v` is `left`, `center`, or `right` (the default is `['middle' , 'center']`); you can use the `percent` property to set the scale factor; and you can set the `scale` property to `box`, `content`, or both (the default).

```
$('#my-div').effect('scale',{percent: 25, origin: ['top','left']});
```

- » **shake:** Shakes an element horizontally or vertically. As options, you can set the `direction` property to either `left` (the default) or `right` for a horizontal shake, or to `up` or `down` for a vertical shake; you can use the `distance` property to set the shake displacement, in pixels (the default is 20); and you can set the `times` property to set the number of shakes (the default is 3).

```
$('#my-div').effect('shake',
{
    distance: 10,
    times: 10
},
1000
);
```

» **size**: Changes the dimensions of an element to a specified width and height. You set the new dimensions by adding the `to` property as an option and setting it to an object literal that specifies the width and height, in pixels. You can also use the `origin` property to set the resize fixed point as an array of the form `['h' , 'v']`, where `h` is top, middle, or bottom, and `v` is left, center, or right (the default is `['top' , 'left']`); and you can set the `scale` property to box, content, or both (the default).

```
$('#my-div').effect('size',{to: {width: 200, height: 100}});
```

» **slide**: Hides or shows an element by sliding it out of or into the viewport. For options, you can use the `direction` property to set the direction of the slide to left (the default), right, up, or down; you can use the `distance` property to set the length of the slide, in pixels (the default is the width of the element if `direction` is left or right, or the height of the element if `direction` is up or down).

```
$('#my-div').toggle('slide',{direction: 'up'});
```

Taking a Look at jQuery UI Interactions

To round out this look at the main jQuery UI components, I spend the rest of this chapter looking at the jQuery UI interactions category. An *interaction* is a widget that enables page visitors to use a mouse (or trackpad or touchscreen) to control, modify, or in some other way mess with a web page element. For example, on my Web Design Playground site (see webdesignplayground.io), I use one of the jQuery UI interactions to enable coders to use a mouse to resize the width and height of the editors and other windows.

Applying an interaction

Before I describe the available interactions, take a look at the general syntax you use to apply one to an element:

```
$(selector).interaction(options|events);
```

» **selector**: A jQuery selector that specifies the web page element you want to work with.

- » *interaction*: A string that specifies the name of the jQuery UI interaction you want to apply to the element.
- » *options|events*: An object literal that includes one or more property-value pairs that specify the interaction options you want to use, and one or more interaction events you want to handle. Both the available options and the available events vary depending on the interaction.

For example, the following statement applies jQuery UI's resizable widget with two options that specify the element's minimum width and minimum height, as well as a handler for the widget's resize event, which fires when the element gets resized:

```
$( '#my-div' ).resizable(  
  {  
    minWidth: 40,  
    minHeight: 50,  
    resize: function(event, ui) {  
      console.log(ui.size.width);  
    }  
  }  
);
```

In the event handler, the `event` argument refers to the event itself, whereas the `ui` argument refers to user interface object that the page visitor is interacting with. Most of the interaction widgets offer both `start` and `stop` events, which fire when the interaction begins and ends, respectively.

Trying out the interactions

Here's a quick look at the available interactions offered by jQuery UI:

- » *draggable*: Enables the user to move an element using a mouse. You can constrain the dragging to a particular direction by setting the `axis` property to either `x` (horizontal dragging only) or `y` (vertical dragging only). You can also set the transparency of the element while it's being dragged by setting the `opacity` property to a number between `0` (invisible) and `1` (fully visible). To run code while the element is dragged, create a handler for the `drag` event.

```
$( '#my-div' ).draggable(  
  {  
    axis: 'x',  
    opacity: .5,
```

```
        drag: function(event, ui) {
            console.log(ui.position.left);
        }
    );
});
```

- » **droppable:** Sets up an element as the target of a drag-and-drop operation. That is, if you apply the draggable widget to element A and the droppable widget to element B, the user can drag element A and drop it on element B. You can specify how much of the draggable element must overlap the droppable element before it is considered “dropped” by using the tolerance property set to one of the following: fit (complete overlap is required; this is the default); intersect (50 percent overlap required); pointer (the mouse pointer must be inside the droppable); or touch (any overlap will do). To run code when the element is dropped, create a handler for the drop event.

```
$( '#my-div' ).droppable(
{
    tolerance: 'intersect',
    drop: function(event, ui) {
        console.log('Dropped it!');
    }
});
```

- » **resizable:** Enables the user to resize an element using a mouse. You can specify which directions the user can resize the element by adding the handles property, which is a comma-separated string consisting of one or more of the following directions: n, e, s, w, ne, se, sw, nw, and all. You can set limits on the element’s dimensions (in pixels) by using the maxHeight, minHeight, maxWidth, and minWidth properties. To run code while the element is resized, create a handler for the resize event.

```
$( '#my-div' ).resizable(
{
    handles: 'e, se, s',
    minWidth: 50,
    minHeight: 25,
    resize: function(event, ui) {
        console.log(ui.size.width + ' ' + ui.size.height);
    }
});
```

- » **selectable:** Enables the user to select elements using a mouse. The user can either “lasso” the elements by using the mouse to drag a box around them, or the user can hold down either Ctrl (Windows) or ⌘ (Mac) and then click each element. You can specify how much of the lasso must overlap an element before it is considered “selected” by using the tolerance property set to either of the following: fit (complete overlap is required; this is the default), or touch (any overlap will do). To run code after each element is selected, create a handler for the selecting event.

```
$( '#my-div' ).selectable(  
    {  
        tolerance: 'touch',  
        selecting: function(event, ui) {  
            console.log(ui.selecting.innerText);  
        }  
    }  
);
```

- » **sortable:** Enables the user to change the order of elements using a mouse. You can constrain the sort movement to a particular direction by setting the axis property to either x (horizontal sorting only) or y (vertical sorting only). You can also set the transparency of the element while it's being sorted by setting the opacity property to a number between 0 (invisible) and 1 (fully visible). To run code while an element is being sorted, create a handler for the sort event.

```
$( '#my-div' ).sortable(  
    {  
        axis: 'y',  
        opacity: .5,  
        sort: function(event, ui) {  
            console.log(ui.item[0].innerText);  
        }  
    }  
);
```




Coding the Back End: PHP and MySQL

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- » Controlling PHP code
- » Figuring out functions and objects
- » Debugging PHP

Chapter 1

Learning PHP Coding Basics

In the end, what I think set PHP apart in the early days, and still does today, is that it always tries to find the shortest path to solving the Web problem . . . When you need something up and working by Friday so you don't have to spend all weekend leafing through 800-page manuals, PHP starts to look pretty good.

— RASMUS LERDORF, CREATOR OF PHP

You code the front end of a web project using tools such as HTML and CSS (see Book 2), JavaScript (see Book 3), and jQuery (see Book 4). You can build really awesome web pages using just those front-end tools, but if you want to build pages that are dynamic and applike, then you need to bring in the back end and use it to harness the power of the web server. For web projects, the back end most often means storing data in a MySQL database and accessing that data using the PHP programming language. I cover all that in Chapters 2 and 3 of this minibook. For now, you need some background in PHP coding. In this chapter, you explore PHP from a web developer's perspective, and by the time you're done you'll know everything you need to know about PHP variables, expressions, arrays, loops, functions, and objects. In short, you'll be ready to join the web coding big leagues by bringing together the front end and the back end to create truly spectacular and useful web pages and apps.

Understanding How PHP Scripts Work

PHP is a *server-side* programming language, which means that PHP code executes only on the web server, not in the web browser. Most web servers today come with a piece of software called a *PHP processor*, and it's the job of the PHP processor to run any PHP code that's sent its way. That PHP code can come in two different packages:

- » **A pure PHP file:** This is a file on the web server, usually one with a filename that uses the .php extension. When I call this a "pure" PHP file, I mean that the file contains nothing but PHP code. Such files are rarely loaded directly into the web browser. Instead, pure PHP files are usually called by JavaScript or jQuery code, most often either to process form input or to ask for data from a MySQL database.
- » **As part of an HTML file:** This is a regular HTML file, but with one or more chunks of PHP code embedded in the file. On most web servers, this file requires the .php extension to enable the server to execute the PHP statements.

Whatever the package, the PHP code is processed as follows:

1. A web browser requests the PHP or HTML file.
2. When the web server sees that the file contains PHP code, it passes that code along to the PHP processor.
3. The PHP processor parses and executes the PHP code.
4. If the PHP code contains any statements that output text and/or HTML tags, the PHP processor returns that output to the web server.
5. The web server sends the output from Step 4 to the web browser.



REMEMBER

It's important to understand that in the end no PHP code is ever sent to the web browser. All the browser gets is the output of the PHP code. Yes, it's possible to run PHP scripts that don't output anything, but in web development the main job of most of your PHP code will be to return some data to the browser.

Learning the Basic Syntax of PHP Scripts

You tell the web server that you want to run some PHP code by surrounding that code with the PHP tags:

```
<?php  
    Your PHP statements go here  
?>
```

For example, PHP's basic output mechanism is the echo *output* command, where *output* is a string containing text and/or HTML tags:

```
<?php  
    echo "<h1>Hello PHP World!</h1>";  
?>
```



REMEMBER

Notice that the echo statement ends with a semicolon. All PHP statements require a semicolon at the end.

If you place just the above code in a .php file and load that file into a web browser, you see the output shown in Figure 1-1.



FIGURE 1-1:
The output of
PHP's echo
command.

Alternatively, you can embed the PHP code in an HTML file, as shown in the following example:

```
<!DOCTYPE html>  
<html lang="en">  
    <head>  
        <meta charset="UTF-8">  
        <title>Book 5, Chapter 1, Example 2</title>  
    </head>  
    <body>  
        <p>  
            Here's the output of the PHP script:  
        </p>  
        <?php  
            echo "<h1>Hello PHP World!</h1>";  
        ?>  
    </body>  
</html>
```

Figure 1-2 shows the result.

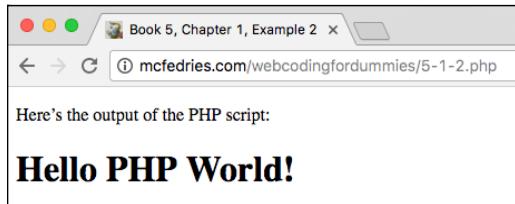


FIGURE 1-2:
You can also embed PHP output within an HTML file.

Declaring PHP Variables

As with JavaScript (see Book 3, Chapter 2), PHP uses variables for storing data to use in expressions and functions, and PHP supports the standard literal data types: integers (such as 5 or -17), floating-point numbers (such as 2.4 or 3.14159), strings (such as "Hello" or 'World'), and Booleans (TRUE or FALSE).

PHP variable names must begin with a dollar sign (\$), followed by a letter or underscore, then any combination of letters, numbers, or underscores. Note that PHP variable names are case-sensitive, so \$str isn't the same variable as \$STR.

You don't need any special keyword (such as JavaScript's var) to declare a variable. Instead, you declare a variable in PHP by assigning the variable a value:

```
$str = "Hello World!";
$interest_rate = 0.03;
$app_loaded = FALSE;
```

Building PHP Expressions

When you build a PHP expression — that is, a collection of symbols, words, and numbers that performs a calculation and produces a result — you can use mostly the same operators as in JavaScript (see Book 3, Chapter 3):

- » **Arithmetic:** Addition (+), Subtraction (-), Multiplication (*), Division (/), Modulus (%), and Exponentiation (**).
- » **Incrementing and decrementing:** Post-increment (\$var++), Pre-increment (++\$var), Post-decrement (\$var--), and Pre-decrement (--\$var).

» **Comparison:** Equal (=), Not Equal (!=), Greater Than (>), Less Than (<), Greater Than or Equal (>=), Less Than or Equal (<=), Identity (==), and Non-Identity (!==). In PHP you can also use <> as the Not Equal operator.

» **Logical:** And (&&), Or (||), and Not (!). In PHP you can also use and as the And operator and or as the Or operator.

Where PHP differs from JavaScript is with the string concatenation operator, which in PHP is the dot (.) symbol rather than JavaScript's plus (+) symbol. Here's an example, and Figure 1-3 shows the result.

```
<?php  
    $str1 = "<h2>Concatenate ";  
    $str2 = "Me!</h2>";  
    echo $str1 . $str2;  
?>
```

FIGURE 1-3:
In PHP, you
use the dot (.)
operator to
concatenate
two strings.



Outputting Text and Tags

Your back-end PHP scripts pass data to your web app's front end (HTML and JavaScript) not by using some complex communications link, but simply by outputting the data. I talk about this in more detail in Book 5, Chapter 3, but for now let's look at the mechanisms PHP offers for outputting data.

PHP's simplest output tool is the `print` command:

```
print output;
```

» *output*: A string — which could be a string literal, string variable, string property value, or the string result of a function — that you want to output. You can include HTML tags in the output string.

```
<?php  
    print "<h1>Hello World!</h1>";  
?>
```

To output more than one item, you need to use PHP's echo command:

```
echo output;
```

» *output*: One or more strings — which could be string literals, string variables, string property values, or the string results of a function — that you want to output. If you include two or more output items, separate each one with a comma. You can include HTML tags in any of the output strings.

```
<?php  
    $str1 = "<h2>Concatenate ";  
    $str2 = "Me!</h2>";  
    echo $str1, $str2;  
?>
```

Adding line breaks

If you use PHP to generate quite a lot of HTML and text for your page, you need to be a bit careful how you structure the output. To see what I mean, first check out the following PHP code:

```
<?php  
    $str1 = "<div>What does PHP stand for?</div>";  
    $str2 = "<div>It's a <i>recursive acronym</i></div>";  
    $str3 = "<div>PHP: Hypertext Preprocessor</div>";  
    echo $str1, $str2, $str3;  
?>
```

This code declares three strings — all *div* elements with text — and uses *echo* to output them. Figure 1-4 shows two browser windows. In the upper window, you can see that the output from the preceding code looks fine. However, the lower window shows the source code for the page and, as you can see, all the output text and tags appear on a single line.

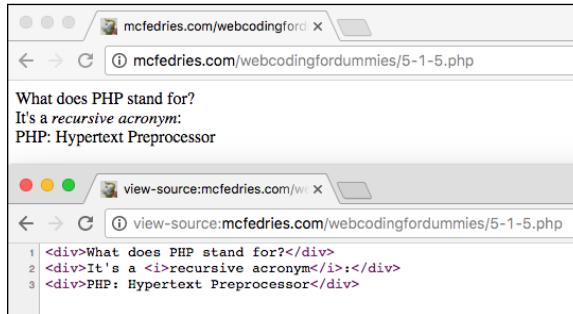
FIGURE 1-4:
When you output tags and text using PHP, the strings run together in a single line in the web page source code.



To make the source code text easier to read, you should add line breaks to your PHP output strings. You insert a line break using the *newline* character \n (which doesn't appear on the web page). Here's the revised code (with \n added to the end of the \$str1 and \$str2 variables), and Figure 1-5 shows that the source code now appears on multiple lines:

```
<?php
    $str1 = "<div>What does PHP stand for?</div>\n";
    $str2 = "<div>It's a <i>recursive acronym</i>:</div>\n";
    $str3 = "<div>PHP: Hypertext Preprocessor</div>";
    echo $str1, $str2, $str3;
?>
```

FIGURE 1-5:
With newlines added to the output strings, the web page source code now appears on separate lines, making it much easier to read.



WARNING

The \n newline code only works in a string that uses double quotation marks. If you use single quotation marks, PHP outputs the characters \n instead of creating a newline. For example:

```
echo 'Ready\nSet\nGo!';
```

The output of this statement is

```
Ready\nSet\nGo!
```

Mixing and escaping quotation marks

You can enclose PHP string literals in either double quotation marks or single quotation marks, but not both:

```
$order = "Double espresso";           // This is legal
$book = 'A Singular Man';            // So's this
$weather = 'Mixed precipitation';    // This is not legal
```

However, mixing quotation mark types is sometimes necessary. Consider this:

```
$tag = "<a href=\"https://wordspy.com\">";
```

That statement will cough up an error because PHP thinks the string ends after the second double quotation mark, so it doesn't know what to do with the rest of the statement. To solve this problem, swap the outer double quotation marks for singles:

```
$tag = '';
```

That works fine. However, what if you want to add some line breaks, as I describe in the previous section:

```
$tag = '<a href="https://wordspy.com/">\nWord Spy\n</a>';
```

Nice try, but newlines (\n) only work when they're enclosed by double quotation marks. The statement above will not include any line breaks and will show the link text as \nWord Spy\n. Sigh.

All is not lost, however, because you can convince the PHP processor to treat a quotation mark as a string literal (instead of a string delimiter), by preceding the quotation mark with a backslash (\). This is known in the trade as *escaping* the quotation mark. For example, you can fix the previous example by enclosing the entire string in double quotation marks (to get the newlines to work) and escaping the double quotation marks used for the <a> tag's href value:

```
$tag = "<a href=\"https://wordspy.com/\">\nWord Spy\n</a>";
```

Outputting variables in strings

One very useful feature of PHP strings is that you can insert a variable name into a string and the PHP processor will handily replace the variable name with its current value. Here's an example:

```
<?php
    $title = "Inflatable Dartboard Landing Page";
    $tag = "<title>$title</title>";
    echo $tag;
?>
```

The output of this code is

```
<title>Inflatable Dartboard Landing Page</title>
```

Some folks call this *interpolating* the variable, but we'll have none of that here.

Alas, variable value substitution only works with strings enclosed by double quotation marks. If you use single quotation marks, PHP outputs the variable name instead of its value. For example, this

```
<?php  
    $title = "Inflatable Dartboard Landing Page";  
    $tag = '<title>$title</title>';  
    echo $tag;  
?>
```

outputs this:

```
<title>$title</title>
```

Outputting long strings

If you have a long string to output, one way to do it would be to break up the string into multiple variables, add newlines at the end of each, if needed, and output each variable.

That works, but PHP offers a shortcut method where you output everything as a single string, but span the string across multiple lines. For example, I can take the final code from the “Adding line breaks” section and achieve the same result by rewriting it as follows:

```
<?php  
$str1 = "<div>What does PHP stand for?</div>  
<div>It's a <i>recursive acronym</i>:</div>  
<div>PHP: Hypertext Preprocessor</div>";  
echo $str1;  
?>
```

The implied newlines at the end of the second and third lines are written to the page, so the page source code will look exactly the same as it does in Figure 1-5.

Outputting really long strings

For a super-long string, you can use PHP's *here document* (or *heredoc*) syntax:

```
<<<terminator
Super-long string goes here
terminator;
```

» *terminator*: This is a label that marks the beginning and end of the string. The label at the end must appear on a line by itself (except for the closing semicolon), with no whitespace before or after the label.

This syntax also supports variable names, so if you include a variable in the string, PHP will substitute the current value of that variable when it outputs the string.

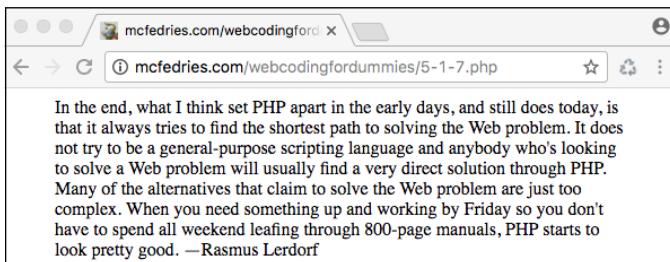
Here's an example:

```
<?php
$author = "Rasmus Lerdorf";
$str = <<<END_OF_STRING
<blockquote>
In the end, what I think set PHP apart in the early
days, and still does today, is that it always tries
to find the shortest path to solving the Web
problem. It does not try to be a general-purpose
scripting language and anybody who's looking to
solve a Web problem will usually find a very direct
solution through PHP. Many of the alternatives that
claim to solve the Web problem are just too complex.
When you need something up and working by Friday so
you don't have to spend all weekend leafing through
800-page manuals, PHP starts to look pretty good.
&mdash;$author
</blockquote>
END_OF_STRING;
echo $str;
?>
```

Notice that I declared a variable named `$author`, and then I included that variable name in the string (it's on the second-last line of the string). PHP treats a heredoc string as though it was enclosed by double quotation marks, so it substitutes the variable value in the output. Figure 1-6 shows the result.

FIGURE 1-6:

The really long string output to the web browser. Note that the value of the \$author variable — Rasmus Lerdorf — appears instead of the variable name.



Working with PHP Arrays

Let's take a quick look at arrays in PHP. I'm going to skip lightly over arrays here because I already talk about them in detail in Book 3, Chapter 7.

Declaring arrays

PHP gives you a bunch of ways to declare and populate arrays. Probably the most straightforward method is to assign values to explicit index numbers:

```
$array_name[index] = value;
```

- » `$array_name`: The name of the array variable
- » `index`: The optional array index number you want to work with
- » `value`: The value you want to assign to the array index number

For example, the following statements assign string values to the first three elements (that is, the elements at array indexes 0, 1, and 2) of an array named `$team_nicknames`:

```
$team_nicknames[0] = 'Banana Slugs';
$team_nicknames[1] = 'Fighting Okra';
$team_nicknames[2] = 'Golden Flashes';
```

Notice in the syntax that I said the `index` parameter was optional. If you leave it out, PHP assigns the index numbers automatically. So, as long as the variable

`$team_nicknames` doesn't already contain any elements, the following code is equivalent to the preceding code:

```
$team_nicknames[] = 'Banana Slugs';
$team_nicknames[] = 'Fighting Okra';
$team_nicknames[] = 'Golden Flashes';
```

To add multiple array values in a single statement, you can use PHP's array keyword:

```
$array_name = array(value1, value1, etc.);
```

» `$array_name`: The name of the array variable

» `value1, value2, etc.`: The values you want to assign to the array

Here's an example:

```
<?php
    $team_nicknames = array('Banana Slugs', 'Fighting Okra',
    'Golden Flashes');
    echo $team_nicknames[0];
?>
```

The output of this code is

```
Banana Slugs
```

Giving associative arrays a look

Most PHP arrays use numeric index values, but in web development work it's often handy to work with string index values, which are called *keys*. An array that uses keys instead of a numeric index is called an *associative array*, because you're associating each key with a value to create an array of key/value pairs.

Here's an example:

```
<?php
    $team_nicknames['Santa Cruz'] = 'Banana Slugs';
    $team_nicknames['Delta State'] = 'Fighting Okra';
    $team_nicknames['Kent State'] = 'Golden Flashes';
    echo $team_nicknames['Delta State'];
?>
```

The output of this code is

```
Fighting Okra
```

To create an associative array using the `array` keyword, you assign each key/value pair using the `=>` operator, as in this example:

```
<?php
    $team_nicknames = array('Santa Cruz' => 'Banana Slugs',
    'Delta State' => 'Fighting Okra', 'Kent State' => 'Golden
    Flashes');
    echo $team_nicknames['Kent State'];
?>
```

The output of this code is

```
Golden Flashes
```

Outputting array values

You can use the `echo` or `print` keyword to output individual array values. However, what if you want to see all the values stored in an array? Rather than, say, looping through the array, PHP offers the `print_r()` function, which outputs the current value of a variable:

```
print_r($variable);
```

» `$variable`: The name of the variable you want to output

If you use an array as the `print_r()` parameter, PHP outputs the contents of the array as key/value pairs. For example, the following code

```
<pre>
<?php
    $team_nicknames = array('Banana Slugs', 'Fighting Okra',
    'Golden Flashes');
    print_r($team_nicknames);
?>
</pre>
```

outputs the following:

```
Array
(
    [0] => Banana Slugs
    [1] => Fighting Okra
    [2] => Golden Flashes
)
```



TIP

Sorting arrays

If you need your array values sorted alphanumerically, PHP offers a handful of functions that will get the job done. The function you use depends on the type of sort you want (ascending or descending) and whether your array uses numeric indexes or string keys (that is, an associative array).

For numeric indexes, you can use the `sort()` function to sort the values in ascending order (0 to 9, then A to Z, then a to z), or the `rsort()` function to sort the values in descending order (z to a, then Z to A, then 9 to 0):

```
sort($array);
rsort($array);
```

» `$array`: The name of the array you want to sort

Here's an example:

```
<pre>
<?php
    $oxymorons = array('Pretty ugly', 'Jumbo shrimp', 'Act
    naturally', 'Original copy');
    sort($oxymorons);
    print_r($oxymorons);
?>
</pre>
```

Here's the output:

```
Array
(
    [0] => Act naturally
    [1] => Jumbo shrimp
    [2] => Original copy
    [3] => Pretty ugly
)
```

For associative arrays, you can use the `asort()` function to sort the values in ascending order (0 to 9, then A to Z, then a to z), or the `arsort()` function to sort the values in descending order (z to a, then Z to A, then 9 to 0):

```
asort($array);
arsort($array);
```

» `$array`: The name of the associative array you want to sort

Here's an example:

```
<pre>
<?php
    $team_nicknames = array('Santa Cruz' => 'Banana Slugs',
    'Delta State' => 'Fighting Okra', 'Kent State' => 'Golden
    Flashes');
    arsort($team_nicknames);
    print_r($team_nicknames);
?>
</pre>
```

Here's the output:

```
Array
(
    [Kent State] => Golden Flashes
    [Delta State] => Fighting Okra
    [Santa Cruz] => Banana Slugs
)
```

Looping through array values

PHP offers a special loop called `foreach()` that you can use to loop through an array's values. Here's the syntax:

```
foreach($array as $key => $value) {  
    Loop statements go here  
}
```

- » `$array`: The name of the array you want to loop through
- » `$key`: An optional variable name that PHP uses to store the key of the current array item
- » `$value`: A variable name that PHP uses to store the value of the current array item

Here's an example:

```
<?php  
$team_nicknames = array('Santa Cruz' => 'Banana Slugs',  
'Delta State' => 'Fighting Okra', 'Kent State' => 'Golden  
Flashes');  
foreach($team_nicknames as $school => $nickname) {  
    echo "The team nickname for $school is $nickname.<br>"  
}  
?>
```

Here's the output:

```
The team nickname for Santa Cruz is Banana Slugs.  
The team nickname for Delta State is Fighting Okra.  
The team nickname for Kent State is Golden Flashes.
```

Creating multidimensional arrays

A *multidimensional array* is one where two or more values are stored within each array element. In a one-dimensional array, the *value* is usually a string, number, or Boolean. Now imagine, instead, that *value* is an array literal. For a two-dimensional array, the general syntax for assigning an array to an array element looks like this:

```
arrayName[index] = Array(value1, value2);
```

As an example, say you want to store an array of background and foreground colors. Here's how you might declare and populate such an array:

```
<?php  
    $colorArray[0] = Array('white', 'black');  
    $colorArray[1] = Array('aliceblue', 'midnightblue');  
    $colorArray[2] = Array('honeydew', 'darkgreen');  
    echo $colorArray[1][1];  
?>
```

Here's the output:

```
midnightblue
```

Alternatively, you can declare and populate an associative array:

```
<?php  
    $colorArray['scheme1'] = Array('foreground' => 'white',  
        'background' => 'black');  
    $colorArray['scheme2'] = Array('foreground' => 'aliceblue',  
        'background' => 'midnightblue');  
    $colorArray['scheme3'] = Array('foreground' => 'honeydew',  
        'background' => 'darkgreen');  
    echo $colorArray['scheme2']['foreground'];  
?>
```

Here's the output:

```
aliceblue
```

Controlling the Flow of Your PHP Code

I go through a detailed discussion of controlling code with decisions and loops in Book 3, Chapter 4. That chapter focuses on JavaScript code, but the structures for making decisions and looping are identical in both JavaScript and PHP. Therefore, I just quickly summarize the available statements here, and refer you to Book 3, Chapter 4 to fill in the details.

Making decisions with if()

You make simple true/false decisions in PHP using the `if()` statement:

```
if (expression) {  
    statements-if-true  
}
```

- » *expression*: A comparison or logical expression that returns true or false.
- » *statements-if-true*: The statement or statements to run if *expression* returns true. If *expression* returns false, PHP skips over the statements.

Here's an example:

```
if ($original_amount !== 0) {  
    $percent_increase = 100 * (($new_amount - $original_amount) /  
    $original_amount);  
}
```

To run one group of statements if the condition returns true and a different group if the result is false, use an `if()...else` statement:

```
if (expression) {  
    statements-if-true  
} else {  
    statements-if-false  
}
```

- » *expression*: A comparison or logical expression that returns true or false
- » *statements-if-true*: The block of statements you want PHP to run if *expression* returns true
- » *statements-if-false*: The block of statements you want executed if *expression* returns false

Here's an example:

```
<?php  
if ($currentHour < 12) {  
    $greeting = "Good morning!";  
} else {
```

```
        $greeting = "Good day!";
    }
    echo $greeting;
?>
```

There is a third syntax for the `if()...else` statement that lets you string together as many logical tests as you need:

```
if (expression1) {
    statements-if-expression1-true
} elseif (expression2) {
    statements-if-expression2-true
}
etc.
else {
    statements-if-false
}
```



REMEMBER

This syntax represents a rare instance where PHP and JavaScript control structures are different (however slightly): You use the keywords `else if` in JavaScript, but the single keyword `elseif` in PHP.

The following code shows a script that uses a nested `if()` statement.

```
<?php
if ($currentHour < 12) {
    $greeting = "Good morning!";
} elseif ($currentHour < 18) {
    $greeting = "Good afternoon!";
} else {
    $greeting = "Good evening!";
}
echo $greeting;
?>
```

Making decisions with `switch()`

For situations where you need to make a whole bunch of tests (say, four or more), PHP offers the `switch()` statement. Here's the syntax:

```
switch(expression) {
    case case1:
        case1 statements
        break;
```

```
    case case2:  
        case2 statements  
        break;  
    etc.  
    default:  
        default statements  
}
```

The *expression* is evaluated at the beginning of the structure. It must return a value (numeric, string, or Boolean). *case1*, *case2*, and so on are possible values for *expression*. PHP examines each case value to see whether one matches the result of *expression* and, if it does, executes the block associated with that case; the *break* statement tells PHP to stop processing the rest of the *switch()* statement.

Here's an example:

```
switch($season) {  
    case 'winter':  
        $footwear = 'snowshoes';  
        break;  
    case 'spring':  
        $footwear = 'galoshes';  
        break;  
    case 'summer':  
        $footwear = 'flip-flops';  
        break;  
    case 'fall':  
        $footwear = 'hiking boots';  
        break;  
}
```

Looping with while()

PHP's *while()* loop uses the following syntax:

```
while (expression) {  
    statements  
}
```

Here, *expression* is a comparison or logical expression that determines how many times the loop gets executed, and *statements* represents a block of statements to execute each time through the loop.

Here's an example:

```
<?php
    $counter = 1;
    while ($counter <= 12) {
        // Generate a random number between 1 and 100
        $randoms[$counter - 1] = rand(1, 100);
        $counter++;
    }
    print_r($randoms);
?>
```

Looping with for()

The structure of a PHP `for()` loop looks like this:

```
for ($counter = start; expression; $counter++) {
    statements
}
```

- » `$counter`: A numeric variable used as a loop counter
- » `start`: The initial value of `$counter`
- » `expression`: A comparison or logical expression that determines the number of times through the loop
- » `$counter++`: The increment operator applied to the `$counter` variable
- » `statements`: The statements to execute each time through the loop

Here's an example:

```
<?php
    for ($counter = 0; $counter < 12; $counter++) {
        // Generate a random number between 1 and 100
        $randoms[$counter] = rand(1, 100);
    }
    print_r($randoms);
?>
```

Looping with do...while()

PHP's do...while() loop uses the following syntax:

```
do {  
    statements  
}  
while (expression);
```

Here, *statements* represents a block of statements to execute each time through the loop, and *expression* is a comparison or logical expression that determines how many times PHP runs through the loop.

Here's an example:

```
<?php  
    $counter = 0;  
    do {  
        // Generate a random number between 1 and 100  
        $randoms[$counter] = rand(1, 100);  
        $counter++;  
    }  
    while ($counter < 12);  
    print_r($randoms);  
?>
```

Working with PHP Functions

I talk about functions until I'm blue in the face in Book 3, Chapter 5. PHP and JavaScript handle functions in the same way, so here I just give you a quick overview from the PHP side of things.

The basic structure of a function looks like this:

```
function function_name(arguments) {  
    statements  
}
```

Here's a summary of the various parts of a function:

- » **function**: Identifies the block of code that follows it as a function
- » **function_name**: A unique name for the function
- » **arguments**: One or more optional values that are passed to the function and that act as variables within the function
- » **statements**: The code that performs the function's tasks or calculations

Here's an example:

```
function display_header() {  
    echo "<header>\n";  
    echo "<img src=\"images/notw.png\" alt=\"News of the Word  
logo\">\n";  
    echo "<h1>News of the Word</h1>\n";  
    echo "<h3>Language news you won't find anywhere else (for  
good reason!)</h3>\n";  
    echo "</header>";  
}
```

To call the function, include in your script a statement consisting of the function name, followed by parentheses:

```
display_header();
```

Passing values to functions

An **argument** is a value that is “sent” — or *passed*, in programming terms — to the function. The argument acts just like a variable, and it automatically stores whatever value is sent. Here's an example:

```
display_header('notw.png');  
  
function display_header($img_file) {  
    echo "<header>\n";  
    echo "<img src=\"images/$img_file\" alt=\"News of the Word  
logo\">\n";  
    echo "<h1>News of the Word</h1>\n";  
    echo "<h3>Language news you won't find anywhere else (for  
good reason!)</h3>\n";  
    echo "</header>";  
}
```

Returning a value from a function

If your function calculates a result, you can send that result back to the statement that called the function by using a `return` statement:

```
return result;
```

As an example, I'll construct a function that calculates and then returns the tip on a restaurant bill:

```
$preTipTotal = 100.00;  
$tipPercentage = 0.15;  
  
function calculate_tip($preTip, $tipPercent) {  
    $tipResult = $preTip * $tipPercent;  
    return $tipResult;  
}  
$tipCost = calculate_tip($preTipTotal, $tipPercentage);  
$totalBill = $preTipTotal + $tipCost;  
echo "Your total bill is \$totalBill";
```

Working with PHP Objects

I discuss objects from a JavaScript point of view in Book 3, Chapter 6, so here I just recall that an *object* is a programmable element that has two key characteristics:

- » You can make changes to the object's *properties*.
- » You can make the object perform a task by activating a *method* associated with the object.

I use objects extensively in Book 5, Chapter 3 when I talk about using PHP to access a MySQL database, so the next few sections provide some necessary background.

Rolling your own objects

Let's take a quick look at creating custom objects in PHP. In the object-oriented world, a *class* acts as a sort of object "template." A cookie cutter provides a good analogy. The cookie cutter isn't a cookie, but, when you use it, the cookie cutter creates an actual cookie that has a predefined shape. A class is the same way. It's not an object, but using it (or *instancing* it, to use the vernacular) creates an

object that uses the class characteristics. These characteristics are governed by the *members* of the class, which are its properties and methods.

Creating a custom class

You define a custom class by using the `class` keyword:

```
class Name {  
    Class properties and methods go here  
}
```

» *Name*: The name you want to assign to your class. Class names traditionally begin with an uppercase letter.

Here's an example:

```
class Invoice {  
}
```

I'll use this class to create customer invoice objects.

Adding properties to the class

The next step is to define the class properties, which are PHP variables preceded by the keyword `public`, which makes them available to code outside the class. Let's add a few properties to the `Invoice` class:

```
class Invoice {  
    public $customer_id;  
    public $subtotal;  
    public $tax_rate;  
}
```

A bit later I show you how to create an object from a class. In most cases you want to initialize some or all of the properties when you create the object, and to do that you must add a special `__construct()` function to the class definition. Here's the general syntax:

```
public function __construct($Arg1, $Arg2, ...) {  
    $this->prop1 = $Arg1;  
    $this->prop2 = $Arg2;  
    etc.  
}
```

- » `$Arg1`, `$Arg2`, etc.: The initial values of the object properties.
- » `$this->`: Refers to the object in which the code is running; the `->` character pair is called the *object operator* and you use it to access an object's properties and methods.
- » `prop1`, `prop2`, etc.: References to the class properties, minus the `$`.

To extend the example:

```
class Invoice {  
    public $customer_id;  
    public $subtotal;  
    public $tax_rate;  
  
    public function __construct($Customer_ID, $Subtotal,  
    $Tax_Rate) {  
        $this->customer_id = $Customer_ID;  
        $this->subtotal = $Subtotal;  
        $this->tax_rate = $Tax_Rate;  
    }  
}
```

Adding methods to the class

The last step in creating your custom class is to add one or more functions that will be used as the class methods. Here's the general syntax:

```
public function method() {  
    Method code goes here  
}
```

- » `method`: The name of the method

To complete our example class, add a method that calculates the invoice total and rounds it to two decimal places:

```
class Invoice {  
    public $customer_id;  
    public $subtotal;  
    public $tax_rate;  
  
    public function __construct($Customer_ID, $Subtotal,  
    $Tax_Rate) {
```

```
$this->customer_id = $Customer_ID;  
$this->subtotal = $Subtotal;  
$this->tax_rate = $Tax_Rate;  
}  
  
public function calculate_total() {  
    $total = $this->subtotal * (1 + $this->tax_rate);  
    return round($total, 2);  
}  
}
```

Creating an object

Given a class — whether it's a built-in PHP class or a class that you've created yourself — you can create an object from the class, which is known as an *instance* of the class. Here's the general format to use:

```
$object = new Class(value1, value2, ...);
```

- » *object*: The variable name of the object
- » *Class*: The name of the class on which to base the object
- » *value1, value2, etc.*: The optional initial values you want to assign to the object's properties

Here's a statement that creates an instance of the `Invoice` class from the previous section:

```
$inv = new Invoice('BONAP', 59.85, .07);
```

Working with object properties

You refer to an object property by using the object operator (`->`):

```
object->property
```

- » *object*: The object that has the property
- » *property*: The name of the property you want to work with

Here's an example that creates an object instance and then references the object's `customer_id` property:

```
$inv = new Invoice('BONAP', 59.85, .07);
$current_customer = $inv->customer_id;
```

To change the value of a property, use the following generic syntax:

```
object->property = value;
```

- » *object*: The object that has the property
- » *property*: The name of the property you want to change
- » *value*: A literal value (such as a string or number) or an expression that returns the value to which you want to set the property

Here's an example:

```
$inv->subtotal = 99.95;
```

Working with object methods

To run a method, you use the following syntax:

```
object->method(arg1, arg2, ...)
```

- » *object*: The object that has the method you want to work with
- » *method*: The name of the method you want to execute
- » *arg1, arg2, etc.*: The arguments required by the method, if any

Here's an example:

```
$inv = new Invoice('BONAP', 59.85, .07);
$invoice_total = $inv->calculate_total();
```

Debugging PHP

JavaScript code runs inside the browser, so debugging that code is straightforward because, in a sense, the code runs right before your eyes. This lets you set up breakpoints, watches, and the other debugging tools that I talk about in Book 3, Chapter 9. PHP code, however, runs on the server, which means that by the time it gets to you (that is, to the browser), the code is done and all you see is the output. That makes PHP code harder to debug, but, thankfully, not impossible to debug. The next few sections take you through a few PHP debugging techniques.

Configuring `php.ini` for debugging

Your first step in setting up PHP for debugging is the `php.ini` file, which is the PHP configuration file. In the XAMPP web development environment that I discuss in Book 1, Chapter 2, here are the default locations of `php.ini`:

- » **Windows:** C:\xampp\php\php.ini
- » **Mac:** /Applications/XAMPP/xamppfiles/etc/php.ini

If you can't locate the file, make sure your Apache web server is running, open the XAMPP Dashboard (<http://localhost/dashboard>), and click PHPInfo. Look for the Loaded Configuration File setting, as shown in Figure 1-7.

FIGURE 1-7:
Examine the Loaded Configuration File setting to determine the location of `php.ini`.



Open `php.ini` in your favorite text editor, then modify the following settings (`php.ini` is a long document, so you should search for each setting to save time):

- » `display_errors`: Determines whether PHP outputs its error messages to the web browser. In a production environment, you want `display_errors` set to Off because you don't want site visitors seeing ugly PHP error messages. However, in a development environment, you definitely want `display_errors` set to On so you can see where your code went wrong:

```
display_errors=On
```

» `error_reporting`: Specifies which types of errors PHP flags. The constant `E_ALL` flags all errors, and the constant `E_STRICT` flags code that doesn't meet recommended PHP standards. You don't need `E_STRICT` in a production environment, but it's useful in a development environment:

```
error_reporting=E_ALL | E_STRICT
```

With `display_errors` set to `On`, you'll now see error messages in the browser window. For example, take a look at the following statement:

```
display_header('notw.png');
```

Can you spot the error? Yep: the `display_header` function call is missing its closing parenthesis. Figure 1-8 shows how PHP flags this error. Notice that the message includes not only the error, but also the location of the file and, crucially, the line number of the statement that generated the error.

FIGURE 1-8:
A typical PHP error message,
showing the
error, file path
and name, and
line number.



Accessing the PHP error log

Setting `display_errors` to `On` is very useful in your development environment, but the PHP default is to set `display_errors` to `Off` in a production environment. This prevents your visitors from seeing error messages, and it also boosts security because you don't want those visitors seeing sensitive information such as the location of your PHP script.

So what happens when PHP generates an error with `display_errors` set to `Off`? It depends on the error, but in most cases you either see a blank web page, or a server error message such as `500 - Internal server error`. Neither is particularly helpful, but all is not lost because PHP still records the error message to the PHP error log.

That's nice, but where is this error log stored on the server? That depends on the server, but you can find out by running the following script:

```
<?php  
    phpinfo();  
?>
```

This displays the PHP configuration data, which includes an `error_log` setting that tells you where the PHP error log is stored.

In some cases, you see just the name of a file — usually `error_log` — and that means the server generates the error log in the same directory as the PHP file that caused the error. So, if you store all your PHP scripts in a `php` subdirectory, your error log will appear in that subdirectory.



REMEMBER

Error messages appear in the error log with the oldest messages at the top, so to see the most recent error, you need to scroll to the bottom of the file.

Debugging with echo statements

You can't set up watch expressions on PHP code, but you can do the next best thing by strategically adding echo (or print) statements that output the current value of whatever variable or function result you want to watch.

For example, here's a loop that generates a dozen random numbers between 1 and 100. To watch the random values as they're generated, I included an echo statement within the loop:

```
<?php
    for ($i = 0; $i < 12; $i++) {
        $randoms[$i] = rand(1, 100);
        echo $randoms[$i] . '<br>';
    }
?>
```

Alternatively, you could wait until the loop completes and then run `print r($random)` to output the entire array.

Another good use of echo statements for debugging is when your PHP code fails, but you don't get an error message. Now you have no idea where the problem lies, so what's a web developer to do? You can gradually narrow down where the error occurs by adding an echo statement to your code that outputs a message like Made it this far!. If you see that message, then you move the echo statement a little farther down the code, repeating this procedure until you don't see the message, meaning the code failed before getting to the echo statement.

Alternatively, you can sprinkle several echo statements throughout your code. You can either give each one a different output message, or you can take advantage of one of PHP's so-called *magic constants*: `__LINE__`. This constant tells you the current line of the code that's being executed, so you could add the following echo statement throughout your code:

```
echo 'Made it to line #' . __LINE__;
```

Debugging with var_dump() statements

PHP features such as echo and `print_r` make it easy to see values associated with variables and arrays, but sometimes your debugging efforts require a bit more information. For example, you might want to know the data type of a variable. You can get both the data type and the current value of a variable or expression by using PHP's `var_dump()` function:

```
var_dump(expression(s));
```

» `expression(s)`: One or more variable names or expressions

Here's an update to the random number generator that dumps the value of the `$randoms` array after the loop:

```
<?php
    for ($i = 0; $i < 12; $i++) {
        $randoms[$i] = rand(1, 100);
    }
    var_dump($randoms);
?>
```

Here's an example of the output:

```
array(12) { [0]=> int(44) [1]=> int(92) [2]=> int(61) [3]=>
    int(61) [4]=> int(12) [5]=> int(60) [6]=> int(14) [7]=>
    int(46) [8]=> int(73) [9]=> int(29) [10]=> int(8) [11]=>
    int(71) }
```

IN THIS CHAPTER

- » Learning about MySQL and what it can do
- » Building MySQL databases and tables
- » Getting your head around SQL
- » Selecting data with queries
- » Modifying data with queries

Chapter 2

Building and Querying MySQL Databases

MySQL is a fast and powerful, yet easy-to-use, database system that offers just about anything a website would need in order to find and serve up data to browsers.

— ROBIN NIXON

One of the central themes of this book is that today's web is all about dynamic content. Sure, if you have (or your client has) just one or two web pages to show the world, then the standard front-end web development tools — HTML, CSS, and JavaScript — are more than enough to get the job done. However, it's much more likely that a modern website will consist of dozens, perhaps even hundreds of pages, with new content getting added regularly. Believe me, as the developer and/or administrator of such a site, you don't want to hand-code all those pages as static HTML and CSS. Life's too short! Fortunately, you don't have to hand-assemble all those pages if you get the back end of the web development world doing the hard work for you. The key is the database software that stores your site info on the server, and that's what this chapter is all about. Here you discover the MySQL database program and learn all that it can do to help you build and maintain dynamic, robust, and fast websites of any size.

What Is MySQL?

In simplest terms, a *database* is a collection of information with some sort of underlying structure and organization. MySQL (pronounced “my ess-kew-ell,” or sometimes “my sequel”) is a *database management system* (DBMS) that runs on the server. This means that MySQL will not only store the data you want to use as the source for some (or perhaps even all) of the data you want to display on your web page, but it will also supply you with the means to manage this data (by sorting, searching, extracting, and so on).

The official description of MySQL is that it’s a *relational database management system* (RDBMS). The “relational” part means that you can set up relations between various parts of a database. For example, most businesses assign some sort of account number for each of their customers. So a database of customer information would include a column for this account number (as well as the name, address, credit limit, and so on). Similarly, you could also include the account number column in a collection of accounts receivable invoices (along with the invoice date, amount, and so on). This lets you relate each invoice to the appropriate customer information. (So, for example, you could easily look up phone numbers and call those deadbeat customers whose invoices are more than 90 days past due!)

MySQL is a massive piece of software that can do incredibly complicated things. Fortunately, as web developers we only need to use a small subset of MySQL’s features, and we don’t have to get into anything mind-blowingly complex. To get started on developing dynamic web pages, in fact, you only need to know about two pieces of the MySQL puzzle: tables and queries.

Tables: Containers for your data

In MySQL databases, you store your information in an object called a *table*. Tables are essentially a grid, where each vertical segment represents a *column* (a specific category of information) and each horizontal segment represents a *row* (a single record in the table).

Figure 2-1 shows a table of customer data. Notice how the table includes separate columns for each logical grouping of the data (company name, contact name, and so on).



The screenshot shows the MySQL Workbench interface with the 'customers' table selected. The table has columns: customer_id, company_name, contact_name, contact_title, address, city, region, postal_code, and country. The data includes entries for various companies like ALFKI, ANATR, ANTON, AROUT, BERGS, BLAUS, BLONP, BOLID, BONAP, and BOTTM, with details such as address, city, and country.

| customer_id | company_name | contact_name | contact_title | address | city | region | postal_code | country |
|-------------|---------------------------------------|--------------------|----------------------|-------------------------------|--------------|---------|---------------|---------------|
| ALFKI | Alfreds Futterkiste | Maria Anders | Sales Representative | Obere Str. 57 | Berlin | | 12209 | Germany |
| ANATR | Ana Trujillo Emparedados y helados | Ana Trujillo | Owner | Avda. de la Constitución 2222 | Mexico D.F. | | 05021 | Mexico |
| ANTON | Antonio Moreno Taquería, Antonio More | Owner | Mataderos 2312 | Mexico D.F. | | 05023 | Mexico | (5) 555-3932 |
| AROUT | Around the Horn | Thomas Hardy | Sales Representative | 120 Hanover Sq. | London | | WA1 1DP | UK |
| BERGS | Berglunds Snabbköp | Christina Berglund | Order Administrator | Berguvsvogen 8 | Luleå | Sweden | 0921-12 34 65 | 0921-12 34 67 |
| BLAUS | Blauer See Delikatessen | Hanna Moos | Sales Representative | Forsterstr. 57 | Mannheim | | 68306 | Germany |
| BLONP | Blondel père et fils | Frédérique Côteaux | Marketing Manager | 24, place Kléber | Strasbourg | | 67000 | France |
| BOLID | Bolido Comidas preparadas | Martin Sommer | Owner | C/ Araquil, 67 | Madrid | | 28023 | Spain |
| BONAP | Bon appétit | Laurence Lebihan | Owner | 12, rue des Bouchers | Marseille | | 13008 | France |
| BOTTM | Bottom-Dollar Markets | Elizabeth Lincoln | Accounting Manager | 23 Tsawassen Blvd. | Tsawassen BC | T2F 8M4 | | Canada |

FIGURE 2-1:
In MySQL databases, tables store the raw data.



REMEMBER

In web development, you use MySQL tables to store the data that will appear in your pages. To get that data from the server to the web page requires five steps:

1. On the web page, some JavaScript code launches a PHP script on the server.
2. That PHP script asks a MySQL database for the data required by the web page.
3. The PHP script configures the data into a format that JavaScript can understand.
4. PHP sends the data back to the web page.
5. The JavaScript code accepts the data and displays it on the page.

I go through these steps in glorious detail in Book 5, Chapter 3 and in Book 6, Chapter 1.

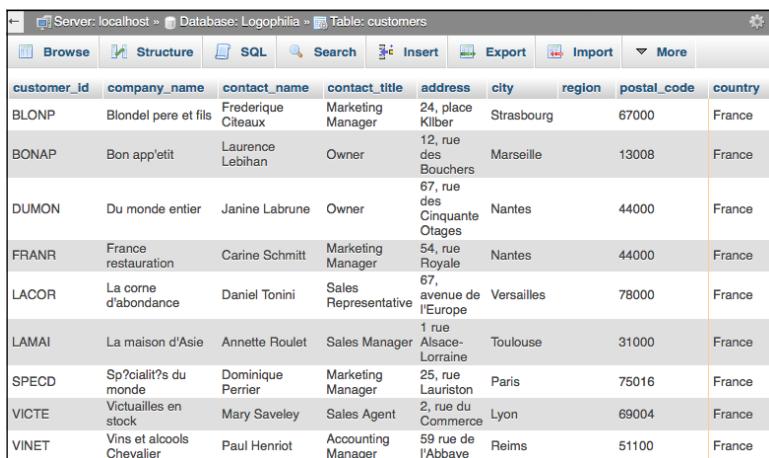
Queries: Asking questions of your data

By far the most common concern expressed by new database users (and many old-timers, as well) is how to extract the information they need from all that data. What if, for example, you have a database of accounts receivable invoices and your boss wants a web page that tells her how many invoices are more than 150 days past due? You can't hand-code such a page because, for a large database, your page would be out of date before you were done. The better way would be to ask MySQL to do the work for you by creating another type of database object: a *query*. Queries are, literally, questions you ask of your data. In this case, you could ask MySQL to display a list of all invoices more than 150 days past due.

Queries let you extract from one or more tables a subset of the data. For example, in a table of customer names and addresses, what if I wanted to see a list of firms

that are located in France? No problem. I'd just set up a query that asks, in effect, "Which rows have 'France' in the country column?" The answer to this question is shown in Figure 2-2.

FIGURE 2-2:
You use MySQL queries to extract a subset of the data from one or more tables.



The screenshot shows the MySQL Workbench interface with the 'customers' table selected. The table has the following structure and data:

| customer_id | company_name | contact_name | contact_title | address | city | region | postal_code | country |
|-------------|---------------------------|--------------------|----------------------|------------------------------|------------|--------|-------------|---------|
| BLONP | Blondel pere et fils | Frederique Citeaux | Marketing Manager | 24, place Kilber | Strasbourg | | 67000 | France |
| BONAP | Bon app'etit | Laurence Lebihan | Owner | 12, rue des Bouchers | Marseille | | 13008 | France |
| DUMON | Du monde entier | Janine Labrune | Owner | 67, rue des Cinquante Otages | Nantes | | 44000 | France |
| FRANR | France restauration | Carine Schmitt | Marketing Manager | 54, rue Royale | Nantes | | 44000 | France |
| LACOR | La corne d'abondance | Daniel Tonini | Sales Representative | 67, avenue de l'Europe | Versailles | | 78000 | France |
| LAMAI | La maison d'Asie | Annette Roulet | Sales Manager | 1 rue Alsace-Lorraine | Toulouse | | 31000 | France |
| SPEC0D | Spécialités du monde | Dominique Perrier | Marketing Manager | 25, rue Lauriston | Paris | | 75016 | France |
| VICTE | Victuailles en stock | Mary Saveley | Sales Agent | 2, rue du Commerce | Lyon | | 69004 | France |
| VINET | Vins et alcools Chevalier | Paul Henriot | Accounting Manager | 59 rue de l'Abbaye | Reims | | 51100 | France |

The actual querying process is performed using a technology called Structured Query Language (or SQL, pronounced "ess-kew-ell"). In the five-step procedure I mention in the previous section, the SQL portion takes place in Step 2.

Introducing phpMyAdmin

To work with MySQL — whether it's creating a database, importing or exporting data, adding a table, inserting and editing data, or testing SQL statements to use in your PHP code — almost all web hosts offer a web application called phpMyAdmin. (It's an odd name, I know: It means, more or less, "PHP-based MySQL Administration.")

In the XAMPP web development environment that I discuss in Book 1, Chapter 2, you have two ways to get phpMyAdmin on the job (make sure you have the Apache web server running):

- » **Dashboard:** From the XAMPP Dashboard page (<http://localhost/dashboard>), click the phpMyAdmin link in the header.
- » **Direct:** Use a web browser to surf to <http://localhost/phpmyadmin>.

Figure 2-3 shows the default phpMyAdmin page.

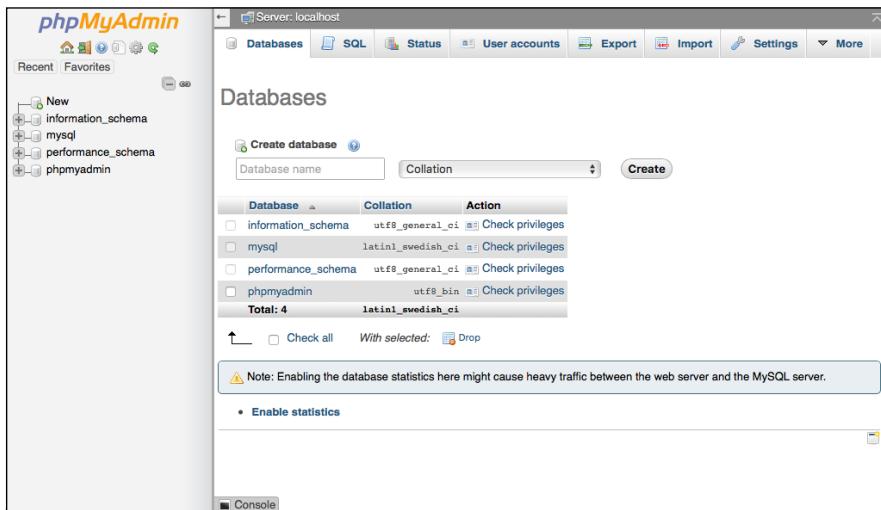


FIGURE 2-3:
From the XAMPP Dashboard, click phpMyAdmin to open the phpMyAdmin web app.

The navigation pane on the left shows the default databases that come with phpMyAdmin (don't mess with these!), while the tabs across the top — Databases, SQL, and so on — take you to different parts of the application.

Importing data into MySQL

Before I talk about building a database from scratch, let me first go through the procedure for getting some existing data into MySQL. phpMyAdmin supports several import formats, but you'll most likely want to use a comma-separated values (.csv) file, where the column data in each row is separated by commas. Another possibility is a SQL (.sql) file, which is a backup file for a MySQL database.

1. **In phpMyAdmin, click the Import tab.**
If you don't see the Import tab, click More, then click Import.
2. **In the File to Import section, click Browse (Windows) or Choose File (Mac).**
Your operating system's file chooser dialog appears.
3. **Click the file that contains the data you want to import and then click Open (Windows) or Choose (Mac).**
4. **In the Format section, make sure the list shows the correct format for the file you chose.**
If you're importing a CSV file, the list should have CSV selected; if you're importing a SQL backup file, the list should have SQL selected.
5. **If you're importing a CSV file, use the Format-Specific Options section to tell phpMyAdmin the structure of the file.**

In particular, if the first line of your CSV file contains the column names of your data, then you need to select the check box labeled The First Line of the File Contains the Table Column Names.

6. Click Go.

phpMyAdmin imports the data.

If you imported a CSV file, you should see the message Import has been successfully finished and in the navigation pane you should see a new database named CSV_DB, as shown in Figure 2-4.

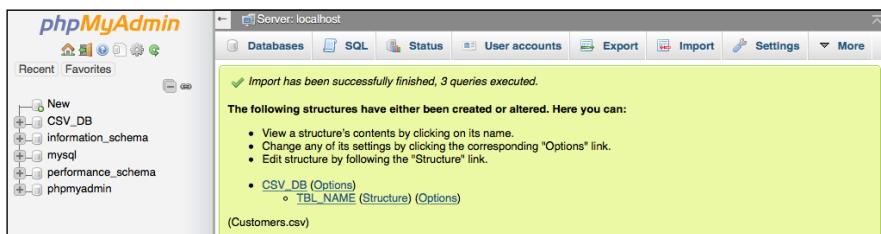


FIGURE 2-4:
Importing a CSV
file creates the
CSV_DB database.

Here are the steps to follow to rename the database and the table that contains the imported data:

1. In the navigation pane, click CSV_DB.

phpMyAdmin opens the database. Notice that you now see a table named TBL_NAME. That's the table that contains the imported CSV data. I show you how to rename it beginning with Step 6.

2. Click the Operations tab.

If you don't see the Operations tab, click More, then click Operations.

3. In the Rename Database To section, type the new database name in the text box provided.

4. Click Go.

phpMyAdmin asks you to confirm.

5. Click OK.

phpMyAdmin changes the database name.

6. In the navigation pane, click TBL_NAME.

7. Click the Operations tab.

If you don't see the Operations tab, click More, then click Operations.

8. In the Table Options section, use the Rename Table To text box to type the new table.
9. Click Go.

phpMyAdmin changes the table name.

Backing up MySQL data

As you work with phpMyAdmin, you should run periodic backups to make sure your data is safe. Here are the steps to follow:

1. In phpMyAdmin, click the Export tab.
If you don't see the Export tab, click More, then click Export.
2. In the Format section, use the list to select SQL (although this is the default format).
3. Click Go.

phpMyAdmin exports the data, which your web browser then downloads to your computer.

Creating a MySQL Database and Its Tables

If you don't import your data, then you need to create your own MySQL databases and populate them with the tables that will hold the actual data.

Creating a MySQL database

The first question you need to ask yourself is: Do I need just a single database or do I need multiple databases? As a web developer, you'll almost always need multiple databases. Here's why:

- » You need a separate database for each website you build.
- » You need a separate database for each web app you build.
- » You need a separate database for each client you have.

If you're just building a single website or app, and you have no clients, then one database is fine, but know that MySQL is ready and willing to accommodate almost any number of databases you care to throw at it.

Here are the steps to follow to create a database using phpMyAdmin:

1. In the navigation pane, click **New** that appears at the top of the navigation tree.
2. In the **Create Database** section, use the **Database Name** text box to type the name you want to use.
3. In the **Collation** list, select **utf8_general_ci**.

Collation refers to how MySQL compares characters (for example, when sorting data). In this case, you're telling MySQL to use a standard, case-insensitive (for example, a equals A) collation on the UTF-8 character set.

4. Click **Create**.

phpMyAdmin creates the database for you.

Designing your table

You need to plan your table design before you create it. By asking yourself a few questions in advance, you can save yourself the trouble of redesigning your table later. For simple tables, you need to ask yourself three basic questions:

- » Does the table belong in the current database?
- » What type of data should I store in each table?
- » What columns should I use to store the data?

The next few sections examine these questions in more detail.

Does the table belong in the current database?

Each database you create should be set up for a specific purpose: a website, a web app, a client, and so on. Once you know the purpose of the database, you can then decide if the table you want to create fits in with the database theme.

For example, if the purpose of the database is to store a client's data, it would be inappropriate to include a table that stores your personal blog posts. Similarly, it wouldn't make sense to include a table of a web app's user accounts in a database that belongs to an entirely different website.

What type of data should I store in each table?

The most important step in creating a table is determining the information you want it to contain. In theory, MySQL tables can be quite large: up to 4,096 columns

and many millions (even billions) of rows. In practice, however, you should strive to keep your tables as small as possible. This saves memory and makes managing the data easier. Ideally, you should aim to set up all your tables with only essential information.

Suppose you want to store user information in a database. You have to decide whether you want all your users in a single table, or whether it would be better to create separate tables for each type of user. For example, a table of customers would include detailed information such as each person's first and last names, postal address, phone number, payment preference, and more. By contrast, a table of people who have opted-in to receive your newsletters might store each person's email address, the newsletters she wants to receive, the subscription type (full or digest), and more. There's not a lot of overlap between these two types of customers, so it probably makes sense to create two separate tables.

When you've decided on the tables you want to use, you then need to think about how much data you want to store in each table. In your customers table, for example, would you also want to include information on each person's site customizations, account creation date, date of last visit, and product preferences? This might all be crucial information for you, but you need to remember that the more data you store, the longer it will take to query and sort the data.

What columns should I use to store the data?

Now you're almost ready for action. The last thing you need to figure out is the specific columns to include in the database. For the most part, the columns are determined by the data itself. For example, a database of business contacts would certainly include columns for name, address, and phone number. But should you split the name into two columns — one for the first name and one for the last name? If you think you'll need to sort the table by last name, then, yes, you probably should. What about the address? You'll probably need individual columns for the city, state, and ZIP code.

Here are two general rules to follow when deciding how many columns to include in your tables:

- » Ask yourself whether you really need the data for a particular column (or if you might need it in the near future). For example, if you think your table of contact names might someday be used to create form letters, a column to record titles (Ms., Mr., Dr., and so on) would come in handy. When in doubt, err on the side of too many columns rather than too few.
- » Always split your data into the smallest columns that make sense. Splitting first and last names is common practice, but creating a separate column for, say, the phone number area code would probably be overkill.



REMEMBER

Don't sweat the design process too much. It's easy to make changes down the road (by adding or deleting columns), so you're never stuck with a bad design.

Deciding which column to use for a primary key

When you create a table, you need to decide which column to use as the *primary key*. The primary key is a column that uses a unique number or character sequence to identify each row in the table. Keys are used constantly in the real world. Your Social Security number is a key that identifies you in government records. Most machines and appliances have unique serial numbers. This book (like most books) has a 13-digit ISBN — International Standard Book Number (which you can see on the back cover).

Why are primary keys necessary? Well, for one thing, MySQL creates an *index* for the primary key column. You can perform searches on indexed data much more quickly than on regular data; therefore, many MySQL operations perform faster if a primary key is present. Keys also make it easy to find rows in a table because the key entries are unique (things such as last names and addresses can have multiple spellings, which makes them hard to find). Finally, once a table has a primary key, MySQL adds its data editing tools, which enable you to modify, copy, and delete table data.

You can configure the table so that MySQL sets and maintains the primary key for you, or you can do it yourself. Which one do you choose? Here are some guidelines:

- » If your data contains a number or character sequence that uniquely defines each row, you can set the key yourself. For example, invoices usually have unique numbers that are perfect for a primary key. Other columns that can serve as primary keys are employee IDs, customer account numbers, and purchase order numbers.
- » If your data has no such unique identifier, let MySQL create a key for you. This means that MySQL will set up an AUTO_INCREMENT column that will automatically assign a unique number to each row (the first row will be 1, the second 2, and so on).

Relating tables

MySQL is a *relational* database system, which means that you can establish relationships between multiple tables. As an example, suppose you have a database that contains (at least) two tables:

- » **orders:** This table holds data on orders placed by your customers, including the customer name, the date of the order, and so on. It also includes an order_id column as the primary key, as shown in Figure 2-5.

| | <input type="checkbox"/> | Edit | Copy | Delete | order_id | customer_id | employee_id |
|--|--------------------------|------|------|--------|----------|-------------|-------------|
| | <input type="checkbox"/> | Edit | Copy | Delete | 10248 | WILMK | 5 |
| | <input type="checkbox"/> | Edit | Copy | Delete | 10249 | TRADH | 6 |
| | <input type="checkbox"/> | Edit | Copy | Delete | 10250 | HANAR | 4 |
| | <input type="checkbox"/> | Edit | Copy | Delete | 10251 | VICTE | 3 |

FIGURE 2-5:
The orders table includes a column named order_id.

» **order_details:** This table holds data on the specific products that comprise each order: the product name, the unit price, the quantity ordered. It also includes an order_id field, as shown in Figure 2-6.

| | <input type="checkbox"/> | Edit | Copy | Delete | order_details_id | order_id | product_id | unit_price | quantity | discount |
|--|--------------------------|------|------|--------|------------------|----------|------------|------------|----------|----------|
| | <input type="checkbox"/> | Edit | Copy | Delete | 1 | 10248 | 11 | \$14.00 | 12 | 0.00 |
| | <input type="checkbox"/> | Edit | Copy | Delete | 2 | 10248 | 42 | \$9.80 | 10 | 0.00 |
| | <input type="checkbox"/> | Edit | Copy | Delete | 3 | 10248 | 72 | \$34.80 | 5 | 0.00 |
| | <input type="checkbox"/> | Edit | Copy | Delete | 4 | 10249 | 14 | \$18.60 | 9 | 0.00 |
| | <input type="checkbox"/> | Edit | Copy | Delete | 5 | 10249 | 51 | \$42.40 | 40 | 0.00 |
| | <input type="checkbox"/> | Edit | Copy | Delete | 6 | 10250 | 41 | \$7.70 | 10 | 0.00 |

FIGURE 2-6:
The order_details table also includes a column named order_id.

Why not lump both tables into a single table? Well, that would mean that, for each product ordered, you'd have to include the name of the customer, the order date, and so on. If the customer purchased ten different products, this information would be repeated ten times. To avoid such waste, the data is kept in separate tables, and the two tables are *related* on the common column called order_id.

For example, notice in Figure 2-5 that the first row in the orders table has an order_id value of 10248. Now check out Figure 2-6, where you see that the first three rows of the order_details table also have an order_id value of 10248. This means that when you join these tables on the related order_id field, MySQL combines the data, as shown in Figure 2-7. For example, notice that the first three rows still have an order_id value of 10248, but they now also include the customer_id column from the orders table.

Creating a MySQL table

Here are the steps to follow to create a table in a MySQL database:

1. In the navigation pane, click the database in which you want to add the table.

FIGURE 2-7:
The order_details and orders tables joined on the common column named order_id.

| order_details_id | order_id | product_id | unit_price | quantity | discount | customer_id |
|------------------|----------|------------|------------|----------|----------|-------------|
| 1 | 10248 | 11 | \$14.00 | 12 | 0.00 | WILMK |
| 2 | 10248 | 42 | \$9.80 | 10 | 0.00 | WILMK |
| 3 | 10248 | 72 | \$34.80 | 5 | 0.00 | WILMK |
| 4 | 10249 | 14 | \$18.60 | 9 | 0.00 | TRADH |
| 5 | 10249 | 51 | \$42.40 | 40 | 0.00 | TRADH |
| 6 | 10250 | 41 | \$7.70 | 10 | 0.00 | HANAR |
| 7 | 10250 | 51 | \$42.40 | 35 | 0.15 | HANAR |

- 2. In the Structure tab, use the Create Table section to type a name for the table, select the number of columns you want, and then click Go.**

If you're not sure how many columns you need, just make your best guess for now. You can always add more later on.

- 3. Type a name for the column.**

- 4. In the Type list, select the data type you want to use for the data.**

There's a very long list of data types to wade through, but only a few make sense in most web projects:

- **INT:** Stores an integer value between -2,147,483,648 and 2,147,483,648. For really small integer values, consider using either TINYINT (-128 to 127 or 0 to 255) or SMALLINT (-32,768 to 32,767 or 0 to 65,535).
- **VARCHAR:** Stores a variable-length string between 0 and 65,535 characters long. If you need to store super-long chunks of text, consider MEDIUMTEXT (up to 16,777,215 characters) instead.
- **DATE:** Stores a date and time value.

- 5. If you selected VARCHAR in Step 4, you can use the Length/Values field to enter a maximum size for the column.**

- 6. Use the Default list to specify a default value that MySQL will enter automatically into the column when you create a new row.**

If you want the current date and time in a DATE column, select CURRENT_TIMESTAMP. Otherwise, select As Defined, then enter a value in the text box that appears.

- 7. In the Collation list, select utf8_general_ci.**

- 8. To allow MySQL to enter no value into the column, select the Null check box.**

If you leave Null deselected, then be sure you always specify a value for the column.

- 9. If you want MySQL to index the column, use the Index list to select the type of index you want.**

In most cases you should choose the all-purpose INDEX type; if the column values are all different, select the UNIQUE type; for a text-heavy field, select the FULLTEXT type.

Don't index every column. Instead, you only need to index those columns that you'll be using for sorting and querying.

10. Repeat Steps 3 through 9 until you've defined all your columns.

11. Click Save.

Adding data to a table

Ideally, most of your table data will get inserted automatically, either by importing data or by having your page users fill in an HTML form (see Book 6, Chapters 2 and 3). If you do need to enter table data by hand, here's how it's done:

- 1. In the navigation pane, click the table in which you want the data added.**
- 2. Click the Insert tab.**

phpMyAdmin displays empty text boxes for each column in the table. If you see two sets of text boxes, scroll down to the bottom of the Insert tab and change Continue Insertion with 2 Rows to Continue Insertion with 1 Row.

- 3. Use the Value fields to add a value for each column.**
If a column accepts null values (that is, if the column's Null check box is selected), then it's okay to leave that column's Value field blank.
- 4. If you want to add multiple rows, use the two lists near the bottom of the page to select Insert as New Row and then Insert Another New Row.**
- 5. Click Go to insert the data.**

Creating a primary key

When you import a table, MySQL doesn't automatically create a primary key, so you need to follow these steps to create the primary key yourself:

- 1. In the navigation pane, click the table you want to work with.**
- 2. Click the Structure tab.**
- 3. Click the check box that appears to the left of the column you want to use as the primary key.**

Make sure you select a column that contains only unique values.

4. Click Primary.

MySQL configures the column as the table's primary key.

What happens if none of your table's fields contain unique items? In that case, you need to create a column to use as the primary key. Here's how:

- 1. In the navigation pane, click the table you want to work with.**
- 2. Click the Structure tab.**
- 3. Leave the Add 1 Columns as is, but select At Beginning of Table in the list, then click Go.**
- 4. Type a name for the primary key field.**

If you're not sure what name to use, something like `table_id` would work, where `table` is the name of the table.

- 5. Select the A_I (AUTO_INCREMENT) check box.**
- MySQL displays the Add Index dialog.
- 6. Leave the default settings as they are, and then click Go.**
- 7. Click Save.**

MySQL adds the field and automatically populates it with unique integer values.

Querying MySQL Data

It's all well and good having a bunch of data hunkered down in a MySQL database, but as a web developer, your real concern is getting that data from the server to the web page. That complete journey is the subject of both Book 5, Chapter 3 and Book 6, Chapter 1, but I'm going to tackle the first leg of the trip here and show you how to specify the data that will eventually get sent to the page. The technique I'm going to show you is called *querying* the data, and the tool of choice is Structured Query Language, or SQL.

What is SQL?

SQL is a collection of commands that interrogate or modify — *query*, in the SQL vernacular — MySQL data in some way. SQL is huge, but as a web developer you really only need to know about four query types:

- » **SELECT:** Returns a subset of a table's data
- » **INSERT:** Adds a new row to a table
- » **UPDATE:** Modifies a table's existing data
- » **DELETE:** Removes one or more rows from a table

In the case of the SELECT, UPDATE, and DELETE query types, you target the specific rows you want to work with by specifying *criteria*, which are extra parameters that define one or more conditions the rows must meet. For example, you might want to run a SELECT query that returns only those customers where the country column is equal to France. Similarly, you might want to run a DELETE query only on those items in the products table where the discontinued column has the value TRUE.

Creating a SELECT query

The most common type of query is the SELECT query that returns rows from one or more tables based on the columns you choose and the criteria you apply to those columns. It's called a *SELECT* query not only because you use it to select certain rows, but also because it's based on the SQL language's *SELECT* statement. *SELECT* is the SQL "verb" that you'll see and work with most often, and it's used to create a subset based on the table, columns, criteria, and other clauses specified in the statement. Here's a simplified syntax for the *SELECT* verb:

```
SELECT select_columns
      FROM table_name
      WHERE criteria
      ORDER BY sort_columns [DESC]
```

- » **SELECT *select_columns*:** Specifies the names of the columns you want in your subset. If you want all the columns, use * instead.
- » **FROM *table_name*:** The name of table that contains the data.
- » **WHERE *criteria*:** Filters the data to give you only those rows that match the specified *criteria*.
- » **ORDER BY *sort_columns*:** Sorts the results in ascending order based on the data in the columns specified by *sort_columns* (separated by commas, if you have more than one). Use the optional DESC keyword to sort the rows in descending order.

The most basic SELECT query is one that returns all the rows from a table. For example, the following SELECT statement returns all the rows from the customers table:

```
SELECT *
  FROM customers
```

In the following example, only the company_name, city, and country columns are returned in the results:

```
SELECT company_name, city, country
  FROM customers
```

Here's another example that sorts the rows based on the values in the company_name column:

```
SELECT *
  FROM customers
 ORDER BY company_name
```

Understanding query criteria

The heart of any query is its criteria. They are a set of expressions that determine the rows that are included in the query results. All query expressions have the same general structure. They contain one or more *operands* — which can be literal values (such as 123 or "USA" or 2018-08-23), *identifiers* (names of MySQL objects, such as tables), or functions — separated by one or more *operators* — the symbols that combine the operands in some way, such as the plus sign (+) and the greater than sign (>).

Most criteria expressions are logical formulas that, when applied to each row in the table, return TRUE or FALSE. The subset contains only those rows for which the expression returns TRUE.

Comparison operators

You use comparison operators to compare field values to a literal, a function result, or to a value in another field. Table 2-1 lists MySQL's comparison operators.

TABLE 2-1**Comparison Operators for Criteria Expressions**

| Operator | General Form | Matches Rows Where ... |
|----------|-----------------|---|
| = | = <i>Value</i> | The column value is equal to <i>Value</i> . |
| <> | <> <i>Value</i> | The column value is not equal to <i>Value</i> . |
| > | > <i>Value</i> | The column value is greater than <i>Value</i> . |
| >= | >= <i>Value</i> | The column value is greater than or equal to <i>Value</i> . |
| < | < <i>Value</i> | The column value is less than <i>Value</i> . |
| <= | <= <i>Value</i> | The column value is less than or equal to <i>Value</i> . |

For example, suppose you have a `products` table with a `units_in_stock` column. If you want a `SELECT` query to return just those products that are out of stock, you'd use the following SQL statement:

```
SELECT *
  FROM products
 WHERE units_in_stock = 0
```

The LIKE operator

If you need to allow for multiple spellings in a text column, or if you're not sure how to spell a word you want to use, the *wildcard characters* can help. There are two wildcards: the underscore (_) substitutes for a single character, and the percent sign (%) substitutes for a group of characters. You use them in combination with the `LIKE` operator, as shown in Table 2-3.

TABLE 2-3**The LIKE Operator for Criteria Expressions**

| Example | Matches Rows Where ... |
|------------------|--|
| LIKE 'Re_d' | The column value is Reid, Read, reed, and so on. |
| LIKE 'M_' | The column value is MA, MD, ME, and so on. |
| LIKE 'R%' | The column value begins with R. |
| LIKE '%office%' | The column value contains the word office. |
| LIKE '2017-12-%' | The column value is any date in December 2017. |

The BETWEEN...AND operator

If you need to select rows where a column value lies between two other values, use the BETWEEN...AND operator. For example, suppose you want to see all the rows in the `order_details` table where the `quantity` value is between (and includes) 50 and 100. Here's a SELECT statement that does the job:

```
SELECT *
  FROM order_details
 WHERE quantity BETWEEN 50 AND 100
```

You can use this operator for numbers, dates, and even text.

The IN operator

You use the IN operator to match rows where the specified column value is one of a set of values. For example, suppose you want to return a subset of the `customers` table that contains only those rows where the `region` column equals NY, CA, TX, IN, or ME. Here's the SELECT statement to use:

```
SELECT *
  FROM customers
 WHERE region IN('NY', 'CA', 'TX', 'IN', 'ME')
```

The IS NULL operator

What do you do if you want to select rows where a certain column is empty? For example, a table of invoices might have a `date_paid` column where, if this column is empty, it means the invoice hasn't been paid yet. For these challenges, MySQL provides the IS NULL operator. Applying this operator to a column selects only those rows whereby the column is empty. Here's an example:

```
SELECT *
  FROM invoices
 WHERE date_paid IS NULL
```

To select rows when a particular column is *not* empty, use the IS NOT NULL operator.

Compound criteria and the logical operators

For many criteria, a single expression just doesn't do the job. For more sophisticated needs, you can set up *compound criteria* where you enter either multiple expressions for the same column or multiple expressions for different columns. You use the logical operators to combine or modify expressions. Table 2-4 summarizes MySQL's logical operators.

TABLE 2-4**Logical Operators for Criteria Expressions**

| Operator | General Form | Matches Rows When ... |
|----------|------------------------|--|
| AND | <i>Expr1 And Expr2</i> | Both <i>Expr1</i> and <i>Expr2</i> are TRUE. |
| OR | <i>Expr1 Or Expr2</i> | At least one of <i>Expr1</i> and <i>Expr2</i> is TRUE. |
| NOT | <i>Not Expr</i> | <i>Expr</i> is not TRUE. |
| XOR | <i>Expr1 Xor Expr2</i> | Only one of <i>Expr1</i> and <i>Expr2</i> is TRUE (XOR is short for <i>exclusive or</i>). |

The AND and OR operators let you create compound criteria using a single expression. For example, suppose you want to match all the rows in your products table where the units_in_stock column is either 0 or greater than or equal to 100. The following SELECT statement does the job:

```
SELECT *
  FROM products
 WHERE units_in_stock = 0 OR units_in_stock >= 100
```

The NOT operator looks for rows that *don't* match a particular logical expression. In a table of customer data, for example, if you want to find all non-North American customers, you filter out the customers using the country column, like so:

```
SELECT *
  FROM customers
 WHERE NOT country = 'USA' AND
       NOT country = 'Canada' AND
       NOT country = 'Mexico'
```

Querying multiple tables

Although most of your MySQL queries will use just a single table, some of the most useful and powerful queries involve two (or more) tables. The type of multiple-table query you'll see and use most often is called an *inner join* because it joins two tables based on a common column.

To create an inner join on two tables, use the following version of the FROM clause:

```
FROM table1
  INNER JOIN table2
    ON table1.column = table2.column
```

Here, `table1` and `table2` are the names of the two tables you want to join, and `table1.column` and `table2.column` are the common columns in each table. Note that the column names don't have to be the same.

For example, suppose you have two tables: `orders` and `order_details`, and they each have a column named `order_id` that stores a value that is unique for each order. The following `SELECT` statement sets up an inner join on these tables:

```
SELECT *
  FROM orders
INNER JOIN order_details
    ON orders.order_id = order_details.order_id
```

If you only want certain columns from both tables in the results, specify the column names after the `SELECT` command using the `table.column` syntax, as in this example:

```
SELECT orders.order_id, orders.customer_id,
       order_details.quantity
  FROM orders
INNER JOIN order_details
    ON orders.order_id = order_details.order_id
```

INNER JOINS? OUTER JOINS? WHAT'S THE DIFFERENCE?



TECHNICAL
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Besides inner joins, MySQL also supports a variation on the multiple-table query theme called an *outer join*. To understand the difference between these two join types, let's run through some examples using the sample data in the following table.

The `novelties` table has two columns: `name` and `supplier`, and the `suppliers` table has a single column: `supplier`. Here are three things to note about these tables:

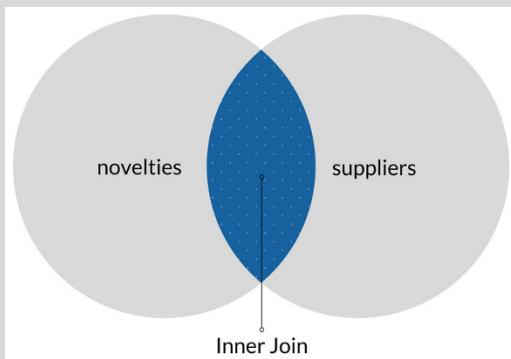
- The two tables have the `supplier` column in common.
- The `novelties` table includes several rows that use `Internal` as the `supplier` value, but `Internal` is not listed in the `suppliers` table.
- The `suppliers` table includes one row — `Nov-L-T Industries` — that is not used anywhere in the `novelties` table.

The novelties Table

| name | supplier |
|---------------------------|-------------------|
| Inflatable Dartboard | Facepalm LLC |
| Banana Peel Welcome Mat | Facepalm LLC |
| Non-Reflective Mirror | Facepalm LLC |
| Fireproof Firewood | Internal |
| Donut Holes | Internal |
| No-String Guitar | Internal |
| Helium Paperweight | RUSerious, Ltd. |
| Sandpaper Bathroom Tissue | RUSerious, Ltd. |
| All-Stick Frying Pan | Silly Stuff, Inc. |
| Water-Resistant Sponge | Silly Stuff, Inc. |

The suppliers Table

An inner join only returns the overlapping data between two tables. To visualize this, consider the following Venn diagram.



Here's a SELECT statement that runs an inner join on the novelties and suppliers tables:

```
SELECT novelties.name, suppliers.supplier  
FROM novelties
```

(continued)

(continued)

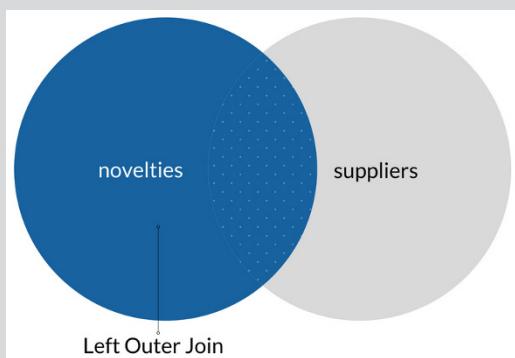
```
INNER JOIN suppliers  
ON novelties.supplier = suppliers.supplier
```

Here are the results:

| novelties.name | suppliers.supplier |
|---------------------------|--------------------|
| Inflatable Dartboard | Facepalm LLC |
| Banana Peel Welcome Mat | Facepalm LLC |
| Non-Reflective Mirror | Facepalm LLC |
| Helium Paperweight | RUSerious, Ltd. |
| Sandpaper Bathroom Tissue | RUSerious, Ltd. |
| All-Stick Frying Pan | Silly Stuff, Inc. |
| Water-Resistant Sponge | Silly Stuff, Inc. |

Notice that from the `novelties` table we don't see any of the rows that had `Internal` as the `supplier` value because that value doesn't appear in the `suppliers` table. Similarly, we don't see the `Nov-L-T Industries` supplier because that value doesn't appear in the `novelties` table.

However, suppose we want all the `novelties` to appear in the results. That's called a *left outer join*, and to see why, take a look at the following Venn diagram. This join includes all the `novelties` rows, plus the overlapping data from the `suppliers` table.



Here's a `SELECT` statement that runs a left outer join on the `novelties` and `suppliers` tables:

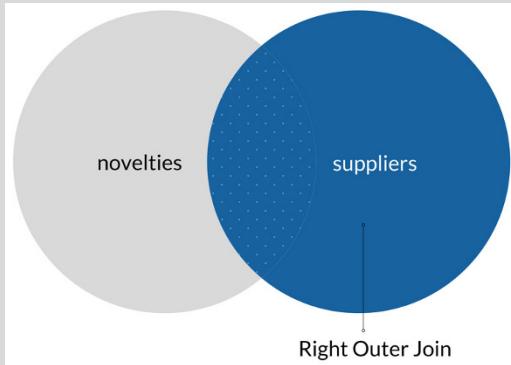
```
SELECT novelties.name, suppliers.supplier
  FROM novelties
  LEFT OUTER JOIN suppliers
    ON novelties.supplier = suppliers.supplier
```

Here are the results:

| name | supplier |
|---------------------------|-------------------|
| Inflatable Dartboard | Facepalm LLC |
| Banana Peel Welcome Mat | Facepalm LLC |
| Non-Reflective Mirror | Facepalm LLC |
| Fireproof Firewood | NULL |
| Donut Holes | NULL |
| No-String Guitar | NULL |
| Helium Paperweight | RUSerious, Ltd. |
| Sandpaper Bathroom Tissue | RUSerious, Ltd. |
| All-Stick Frying Pan | Silly Stuff, Inc. |
| Water-Resistant Sponge | Silly Stuff, Inc. |

Notice that for those novelties that don't have a corresponding supplier value in the suppliers table, MySQL returns NULL.

Finally, you might want all the suppliers to appear in the results. That's called a *right outer join*, and you can see why by taking a peek at the following Venn diagram. This join includes all the suppliers rows, plus the overlapping data from the novelties table.



(continued)

(continued)

Here's a SELECT statement that runs a right outer join on the `novelties` and `suppliers` tables:

```
SELECT novelties.name, suppliers.supplier
    FROM novelties
    RIGHT OUTER JOIN suppliers
        ON novelties.supplier = suppliers.supplier
```

Here are the results:

| name | supplier |
|---------------------------|--------------------|
| Inflatable Dartboard | Facepalm LLC |
| Banana Peel Welcome Mat | Facepalm LLC |
| Non-Reflective Mirror | Facepalm LLC |
| NULL | Nov-L-T Industries |
| Helium Paperweight | RUSerious, Ltd. |
| Sandpaper Bathroom Tissue | RUSerious, Ltd. |
| All-Stick Frying Pan | Silly Stuff, Inc. |
| Water-Resistant Sponge | Silly Stuff, Inc. |

Notice that for those suppliers that don't have a corresponding `supplier` value in the `novelties` table, MySQL returns NULL.

Adding table data with an INSERT query

An INSERT query adds a new row to an existing table. In MySQL, you build an INSERT query using the `INSERT` verb:

```
INSERT
    INTO table (columns)
    VALUES (values)
```

- » *table*: The name of the table into which you want the row appended.
- » *columns*: A comma-separated list of column names from *table*. The values you specify will be added to these columns.

- » *values*: A comma-separated list of values that you want to add. The order of these values must correspond with the order of the column names in the *columns* parameter.

For example, suppose we have a table named `categories` that includes three fields: `category_id`, `category_name`, and `description`. First, assume that `category_id` is the table's primary key and its value is generated automatically by an `AUTO_INCREMENT` function, which means you can ignore it when building your `INSERT` query. Therefore, you can use the following SQL statement to add a new row:

```
INSERT  
    INTO categories (category_name, description)  
        VALUES ('Breads', 'Multi-grain, rye, and other  
deliciousness')
```

Modifying table data with an UPDATE query

An `UPDATE` query modifies the values in one or more columns and optionally restricts the scope of the updating to those rows that satisfy some criteria. In MySQL, you build an `UPDATE` query by using the `UPDATE` verb to construct a statement with the following syntax:

```
UPDATE table  
    SET column1=value1, column2=value2, ...  
    WHERE criteria
```

- » *table*: The table that contains the data you want to update
- » *column1=value1, column2=value2, etc.*: The new values you want to assign to the specified columns
- » *criteria*: The criteria that define which rows will be updated

For example, suppose you have `products` table and want to increase the values in the `unit_price` column by 5 percent for the Beverages category (`category_id = 1`). This is the same as multiplying the current `unit_price` values by 1.05, so the `UPDATE` statement looks like this:

```
UPDATE products  
    SET unit_price = unit_price*1.05  
    WHERE CategoryID = 1
```

Removing table data with a DELETE query

A DELETE query removes rows from a table and optionally restricts the scope of the deletion to those rows that satisfy some criteria. If you don't include criteria, MySQL deletes every row in the specified table.

In MySQL, you build a delete query by using the DELETE verb to construct a statement with the following syntax:

```
DELETE  
    FROM table  
    WHERE criteria
```

- » *table*: The table that contains the rows you want to delete
- » *criteria*: The criteria that defines which rows will be deleted

For example, if you want to delete those rows in the `products` table where the `supplier_id` value is 1, you use the following SQL statement:

```
DELETE  
    FROM products  
    WHERE supplier_id = 1
```

IN THIS CHAPTER

- » PHP and MySQL: Understanding web development's most enduring marriage
- » Connecting to a MySQL database with PHP
- » Using PHP to access MySQL data with a SELECT query
- » Processing the SELECT query results
- » Using PHP to run INSERT, UPDATE, and DELETE queries

Chapter 3

Using PHP to Access MySQL Data

PHP and MySQL work together to provide powerful, flexible components that can keep up with the expanding database driven development needs of virtually any organization, large or small.

— ISAAC DUNLAP

Run a Google search on the text PHP MySQL "Match made in heaven" and you get more than a few results. I'm not surprised one bit because it seems as though these two technologies were meant to be together; a case of love at first byte, as it were. What's the secret of their success as a couple? First, it helps that they're both free (not the usual prerequisite for marriage success, I know), which ensures that they're both widely available and widely supported. Second, both PHP and MySQL reward a little bit of learning effort up front with a lot of flexibility and power right off the bat. Although both are complex, sophisticated pieces of technology, you need to learn only a few basics to take your web development skills to a whole new level. I cover the first two parts of those basics in Chapters 1 and 2 of this minibook. In this chapter, I bring everything together

by showing you how to combine PHP and MySQL to create the foundation you need to build truly dynamic and powerful web applications.

Understanding the Role of PHP and MySQL in Your Web App

Before getting to the trees of actual PHP code, I want to take a moment to look out over the forest of the server back end, so you’re comfortable and familiar with the process. Specifically, I want to look at how PHP and MySQL team up to deliver the back-end portion of a web app. Rather than getting bogged down in an abstract discussion of what happens when a user requests a page that requires some data from the server, I’ll use a concrete example. The following steps take you through the back-end process that happens when the web app I built to display this book’s sample code gets a request for a specific example:

1. **A reader (perhaps even you!) requests the web page of a specific book sample page. Here’s a for instance:**

```
http://mcfedries.com/webcodingfordummies/example.php?book=4&chapter=1&example=2
```

The PHP script file is `example.php` and the request data — known to the cognoscenti as a *query string* — is everything after the question mark (?): `book=4&chapter=1&example=2`. This string is requesting the second example from Book 4, Chapter 1.

2. **The web server retrieves `example.php` and sends it to the PHP processor.**
3. **The PHP script parses the query string to determine which sample the user is requesting.**

For the query string shown in Step 1, the script would extract the book number as 4, the chapter number as 1, and the example number as 2.

4. **The script connects to the database that stores the code samples.**
5. **The script uses the query string data to create and run a `SELECT` query that returns the sample code.**

The `SELECT` statement looks something like this:

```
SELECT *
  FROM code_samples
 WHERE book_num=4 AND chapter_num=1 AND example_num=2
```

6. The script massages the SELECT results into a format readable by the browser.

This format is usually just HTML, but another popular format is JSON (JavaScript Object Notation), which you learn about in Book 6, Chapter 1.

7. The web server sends the formatted data to the web browser, which displays the code sample.

The rest of this chapter expands on Steps 3 through 6.

Using PHP to Access MySQL Data

When used as the back end of a web app, PHP's main job is to interact with MySQL to retrieve the data requested by the app and then format that data so that it's usable by the app for display in the browser. To do all that, PHP runs through five steps:

1. Get the request parameters from the URL query string.
2. Connect to the MySQL database.
3. Create and run a SELECT query to extract the requested data.
4. Get the data ready to be sent to the browser.
5. Output the data for the web browser.

I talk about INSERT, UPDATE, and DELETE queries later in this chapter, but the next few sections take you through the details of this five-step procedure from the point of view of a SELECT query.



WARNING

In the sections that follow, I don't discuss security techniques for blocking malicious hacking attempts. That's a crucial topic, however, so I devote a big chunk of Book 7, Chapter 1 to the all-important details, which you should read before deploying any dynamic web apps.

Parsing the query string

Many PHP scripts don't require any information from the web app to get the data that the app needs. For example, if the script's job is to return every record from a table, or to return a predetermined subset of a table, then your app just needs to call the script.

However, it's more common for a web app to decide on-the-fly (say, based on user input or some other event) what data it requires, and in such cases it needs to let the server know what to send. To get your web app to request data from the web server, you send a query string to the server. You can send a query string using two different methods:

- » **GET:** Specifies the data by adding the query string to the URL of the request. This is the method I talk about in this chapter.
- » **POST:** Specifies the data by adding it to the HTTP header of the request. This method is associated with HTML forms and some AJAX requests, which I cover in Book 6.

In the GET case, the query string is a series of name-value pairs that use the following general form:

```
name1=value1&name2=value2&...
```

Here's an example:

```
book=4&chapter=1&example=2
```

In the case of a GET request, you build the request by taking the URL of the PHP script that will handle the request, adding a question mark (?) to designate the boundary between the script address and the query string, and then adding the query string itself. Here's an example:

```
http://mcfedries.com/webcodingfordummies/example.php?book=4&chapter=1&example=2
```

Now your PHP script has something to work with, and you access the query string data by using PHP's `$_GET` variable, which is an associative array created from the query string's name-value pairs. Specifically, the array's keys are the query string's names, and the array's values are the corresponding query string values. For example, the preceding URL creates the following `$_GET` array:

```
$_GET['book'] => 4  
$_GET['chapter'] => 1  
$_GET['example'] => 2
```

Note, however, that it's good programming practice to not assume that the `$_GET` array is populated successfully every time. You should check each element of the array by using PHP's `isset()` function, which returns `true` if a variable exists and has a value other than `null`. Here's some PHP code that checks that each element of the preceding `$_GET` array exists and isn't `null`:

```
if (isset($_GET['book'])) {
    $book_num = $_GET['book'];
} else {
    echo 'The "book" parameter is missing!<br>';
    echo 'We are done here, sorry.';
    exit(0);
}
if (isset($_GET['chapter'])) {
    $chapter_num = $_GET['chapter'];
} else {
    echo 'The "chapter" parameter is missing!<br>';
    echo 'Sorry it didn\'t work out.';
    exit(0);
}
if (isset($_GET['example'])) {
    $example_num = $_GET['example'];
} else {
    echo 'The "example" parameter is missing!<br>';
    echo 'You had <em>one</em> job!';
    exit(0);
}
```

This code checks each element of the `$_GET` array:

- » If the element exists and isn't null, the code assigns the array value to a variable.
- » If the element either doesn't exist or is null, the code outputs a message specifying the missing parameter and then stops the code by running the `exit(0)` function (the 0 just means that you're terminating the script in the standard way).

Connecting to the MySQL database

You give PHP access to MySQL through an object called `MySQLi` (short for *MySQL Improved*). There are actually several ways to bring PHP and MySQL together, but `MySQLi` is both modern and straightforward, so it's the one I cover in this book.

You connect to a MySQL database by creating an instance of the `MySQLi` object. Here's the general format to use:

```
$var = new MySQLi(hostname, username, password, database);
```

- » *\$var*: The variable that stores the new MySQLi object.
- » *hostname*: The name of the server that's running MySQL. If the server is on the same computer as your script (which is usually the case), then you can use `localhost` as the *hostname*.
- » *username*: The account name of a user who has access to the MySQL database.
- » *password*: The password associated with the *username* account.
- » *database*: The name of the MySQL database.

Here's a script that sets up the connection parameters using four variables, and then creates the new MySQLi object:

```
<?php
    $host = 'localhost';
    $user = 'logophil_reader';
    $password = 'webcodingfordummies';
    $database = 'logophil_webcodingfordummies';

    $mysqli = new MySQLi($host, $user, $password, $database);
?>
```

However, you shouldn't connect to a database without also checking that the connection was successful. Fortunately, the MySQLi object makes this easy by setting two properties when an error occurs:

- » `connect_errno`: The error number
- » `connect_error`: The error message

These properties are `null` by default, so your code can use an `if()` test to check if either `connect_error` or `connect_errno` has been set:

```
if($mysqli->connect_error) {
    echo 'Connection Failed!
        Error #' . $mysqli->connect_errno
        . ': ' . $mysqli->connect_error;
    exit(0);
}
```

If an error occurs, the code displays a message like the one shown in Figure 3-1 and then runs `exit(0)` to stop execution of the script.

FIGURE 3-1:
An example of
an error number
and message
generated by the
MySQLi object.

```
Connection Failed! Error #1045: Access denied for user 'logophil_reader'@'localhost' (using password: YES)
```

Before moving on to querying the database, there are two quick housekeeping chores you need to add to your code. First, tell your MySQLi object to use the UTF-8 character set:

```
$mysqli->set_charset('utf8');
```

Second, use the MySQLi object's `close()` method to close the database connection by adding the following statement at the end of your script (that is, just before the `>` closing tag):

```
$mysqli->close();
```

Creating and running the SELECT query

To run a SELECT query on the database, you need to create a string variable to hold the SELECT statement and then use that string to run the MySQLi object's `query()` method. Here's an example:

```
$sql = 'SELECT category_name, description
        FROM categories';
$result = $mysqli->query($sql);

// Check for a query error
if (!$result) {
    echo 'Query Failed!
          Error: ' . $mysqli->error;
    exit(0);
}
```

The result of the query is stored in the `$result` variable. You might think that this variable now holds all the data, but that's not the case. Instead, `$result` is an object that contains information about the data, not the data itself. You make use of that information in the next section, but for now notice that you can use the `result` object to check for an error in the query. That is, if `$result` is `null`, the query failed, so display the error message (using the MySQLi object's `error` property) and exit the script.



TIP

If you want to know how many rows the SELECT query returned, you can reference the result object's num_rows property:

```
$result->num_rows
```

Storing the query results in an array

The object returned by the query() method is really just a pointer to the actual data, but you can use the object to retrieve the SELECT query's rows. There are various ways to do this, but I'll go the associative array route, which uses the result object's fetch_all(MYSQLI_ASSOC) method to return all the rows as an associative array. (If you prefer to work with a numeric array, replace the MYSQLI_ASSOC constant with MYSQLI_NUM):

```
$array = $mysqli_result->fetch_all(MYSQLI_ASSOC);
```

- » `$array`: The name of the associative array you want to use to hold the query rows
- » `$mysqli_result`: The result object returned by MySQLi's query() method

Note that this is a two-dimensional array, which makes sense because table data is two-dimensional (that is, it consists of one or more rows and one or more columns).

I'll make this more concrete by extending the example:

```
$sql = 'SELECT category_name, description
        FROM categories';
$result = $mysqli->query($sql);

// Check for a query error
if (!$result) {
    echo 'Query Failed!
          Error: ' . $mysqli->error;
    exit(0);
}

// Get the query rows as an associative array
$rows = $result->fetch_all(MYSQLI_ASSOC);

// Get the total number of rows
$total_rows = count($rows);

echo "Returned $total_rows categories:<br>";
```

Here, `fetch_all()` stores the query result as an array named `$rows`. The code then uses `count()` to get the total number of rows in the array.

Looping through the query results

By storing the query results in an array, you make it easy to process the data by looping through the array using a `foreach()` loop:

```
// Get the query rows as an associative array
$rows = $result->fetch_all(MYSQLI_ASSOC);

// Loop through the rows
foreach($rows as $row) {
    echo $row['category_name'] . ': ' .
        $row['description'] . '<br>';
}
```

Here's what's happening in the `foreach()` loop:

- » Each item in the `$rows` array is referenced using the `$row` variable.
- » Each `$row` item is itself an associative array, where the key-value pairs are the column names and their values.
- » Because the keys of the `$row` array are the column names, the code can refer to the values using the `$row['column']` syntax.

Incorporating query string values in the query

I talk earlier in this chapter about how you can use `$_GET` to parse a URL's query string, so now I show you an example that uses a query string value in a `SELECT` query. First, here's the code:

```
<body>
<?php
    // Parse the query string
    if (isset($_GET['category'])) {
        $category_num = $_GET['category'];
    } else {
```

```

        echo 'The "category" parameter is missing!<br>';
        echo 'We are done here, sorry.';
        exit(0);
    }

    // Store the database connection parameters
    $host = 'localhost';
    $user = 'logophil_reader';
    $password = 'webcodingfordummies';
    $database = 'logophil_webcodingfordummies';

    // Create a new MySQLi object with the
    // database connection parameters
    $mysqli = new MySQLi($host, $user, $password, $database);

    // Create and run a SELECT query
    // This is an INNER JOIN of the products and
    // categories tables, based on the category_id
    // value that was in the query string
    $sql = "SELECT products.product_name,
                products.unit_price,
                products.units_in_stock,
                categories.category_name
        FROM products
        INNER JOIN categories
        ON products.category_id = categories.category_id
        WHERE products.category_id = $category_num";
    $result = $mysqli->query($sql);

    // Get the query rows as an associative array
    $rows = $result->fetch_all(MYSQLI_ASSOC);

    // Get the category name
    $category = $rows[0]['category_name'];

    echo "<h2>$category</h2>";
    echo '<table>';
    echo '<tr>';
    echo '<th>Product</th>';
    echo '<th>Price</th>';
    echo '<th>In Stock</th>';
    echo '</tr>';

    // Loop through the rows
    foreach($rows as $row) {

```

```

        echo '<tr>';
        echo '<td>' . $row['product_name'] . '</td>
              <td>' . $row['unit_price'] . '</td>
              <td>' . $row['units_in_stock'] . '</td>';
        echo '</tr>';
    }
echo '</table>>';

// That's it for now
$mysqli->close();
?>
</body>

```

First, note that to keep the code shorter, I removed the error checking code. There's quite a bit going on here, so I'll go through it piece by piece:

- » The script resides within an HTML file, and you'd load the file using a URL that looks something like this:

```

http://mcfedries.com/webcodingfordummies/5-3-4.
php?category=1

```

- » The first part of the script uses `$_GET['category']` to get the category number from the query string, and that value is stored in the `$category_num` variable.
- » The script then builds a SQL SELECT statement, which is an inner join on the products and categories tables. The WHERE clause restricts the results to just those products that have the category value from the query string:

```

WHERE products.category_id = $category_num

```

- » The `query()` method runs the SELECT query and stores the result in the `$result` object.
- » The `fetch_all(MYSQLI_ASSOC)` method stores the returned row in an associative array named `$rows`.
- » Each element in the `$rows` array includes the category name in the `category_name` column, so the script arbitrarily uses `$rows[0]['category_name']` to get the category name and store it in the `$category` variable.
- » The script then outputs an `<h2>` heading for the category name, as well as some HTML table tags.
- » A `foreach()` loop runs through the query rows. During each pass, the code outputs an HTML table row (`<tr>`) and a table cell (`<td>`) for each value.

» Finally, the code outputs the closing `</table>` tag and closes the MySQLi connection.

Figure 3–2 shows the result.

| Beverages | | |
|---------------------------|----------|----------|
| Product | Price | In Stock |
| Chai | \$18.00 | 39 |
| Chang | \$19.00 | 17 |
| Guaran Fantastica | \$4.50 | 20 |
| Sasquatch Ale | \$14.00 | 111 |
| Steeleye Stout | \$18.00 | 20 |
| Cots de Blaye | \$263.50 | 17 |
| Chartreuse verte | \$18.00 | 69 |
| Ipoh Coffee | \$46.00 | 17 |
| Laughing Lumberjack Lager | \$14.00 | 52 |
| Outback Lager | \$15.00 | 15 |
| Rhonbrenn Klosterbier | \$7.75 | 125 |
| Lakkalikiri | \$18.00 | 57 |

FIGURE 3-2:
The output of the script, which lays out the query data in an HTML table.

Creating and Running Insert, Update, and Delete Queries

Performing INSERT, UPDATE, and DELETE queries in PHP is much simpler than performing SELECT queries because once your code has checked whether the query completed successfully, you're done. Here's an example that runs an INSERT query:

```
<?php

    // Store the database connection parameters
    $host = 'localhost';
    $user = 'logophil_reader';
    $password = 'webcodingfordummies';
    $database = 'logophil_webcodingfordummies';

    // Create a new MySQLi object with the
    // database connection parameters
    $mysqli = new MySQLi($host, $user, $password, $database);

    // Check for a connection error
    if($mysqli->connect_error) {
        echo 'Connection Failed!
```

```
        Error #' . $mysqli->connect_errno  
        . ': ' . $mysqli->connect_error;  
    exit(0);  
}  
  
// Create and run an INSERT query  
$sql = "INSERT  
        INTO categories (category_name, description)  
        VALUES ('Breads', 'Multi-grain, rye, and other  
deliciousness');
```

```
        $result = $mysqli->query($sql);  
  
// Check for a query error  
if (!$result) {  
    echo 'Query Failed!  
        Error: ' . $mysqli->error;  
    exit(0);  
}  
?>
```

When given an `INSERT`, `UPDATE`, or `DELETE` statement, `MySQLi`'s `query()` method returns `true` if the query executed successfully, or `false` if the query failed.

Separating Your MySQL Login Credentials

When you're building a web app or some other medium-to-large web project that requires a back end, you'll soon notice that your PHP scripts that access the project's MySQL data begin to multiply in a rabbitlike fashion. Before you know it, you've got 10 or 20 such scripts lying around. What do these scripts all have in common? They all include the same code for connecting to the project's MySQL database. It's not a big deal to just copy and paste that code into each new script, but it can be a huge deal if one day you have to change your login credentials. For example, for security reasons you might decide to change the password. That means you now have to wade through every single one of your scripts and make that change. Annoying!

A better way to go is to make use of PHP's `require` statement, which enables you to insert the contents of a specified PHP file into the current PHP file:

```
require php_file;
```

» `php_file`: The path and filename of the PHP file you want to insert

So what you do is take your MySQL database credentials code and paste it into a separate PHP file:

```
<?php  
    $host = 'localhost';  
    $user = 'logophil_reader';  
    $password = 'webcodingfordummies';  
    $database = 'logophil_webcodingfordummies';  
?>
```

Say this file is named `credentials.php`. If it resides in the same directory as your scripts, then you'd replace the credentials code in your PHP scripts with the following statement:

```
require 'credentials.php';
```

If the credentials file resides in a subdirectory, then you need to include the full path to the file:

```
require '/includes/credentials.php';
```

Note that if PHP can't find or load this file for some reason, the script will halt with an error.



Coding Dynamic Web Pages

Contents at a Glance

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- » Loading server data into a page element
- » Sending data to and receiving data from the server
- » Getting to know JSON
- » Using JSON to work with complex data from the server

Chapter 1

Melding PHP and JavaScript with Ajax and JSON

Basically, what “Ajax” means is “JavaScript now works.” And that in turn means that web-based applications can now be made to work much more like desktop ones.

— PAUL GRAHAM

When coding web pages, it feels like there's a great divide between the browser front end and the server back end. When you're working on the front end, you can use HTML tags, CSS properties, and JavaScript code to build, style, and animate your pages. When you're working on the back end, you can use MySQL and PHP code to define, access, and manipulate data. That all works, but front-end code without back-end data produces a lifeless page, whereas back-end data without front-end code produces useless information. To create a truly dynamic web page, you need to cross this divide. You need to give your web page a mechanism to interact with the server to ask for and receive

server data, and you need to give the server a mechanism to return that data in a format the page can understand and manipulate.

In this chapter, you investigate two such mechanisms: Ajax for sending data back and forth between the web page and the server, and JSON for putting that data into a format that's easily read by your web page code.

What Is Ajax?

Back in the early days of the web, the only way to see new data in a web page was to reload the entire page from the server. It didn't matter if just a single word or a single color had been changed, you still needed to grab everything from the server and refresh the entire page. This was back in the days when broadband Internet access wasn't as widespread as it is now (at least in some places), so that page reload could take quite a long time, depending on the size of your Internet tubes.

The sheer inefficiency of this process led some very smart people to wonder if there was a better way. Would it be possible, they asked, to somehow get the web browser to set up a communications channel with the web server that would enable the browser to request new data from the server without requiring a complete page reload?

Thankfully for modern web developers such as you and I, the answer to that question was a resounding “Yes!” The result was a new technology with the decidedly unlovely name of *Asynchronous JavaScript and XML*, which nowadays we shorten, with gratitude in our hearts, to Ajax.



TECHNICAL STUFF

Ajax is a mind-bogglingly complicated technology under the hood, but we won't be opening that hood even a tiny bit. Instead, I only go so far as to say that what Ajax does is insert a layer — called the *Ajax engine* — between the web page and the web server. With that idea in mind, let me give you a quickie explanation of what the Ajax name means:

- » *Asynchronous*: The web page doesn't have to wait for the server to resend the entire page when the page changes. Instead, requests are handled by the Ajax engine, which uses an object called XMLHttpRequest (XHR, for short) to ask the server for the data while also keeping the page displayed so the user can still interact with it.
- » *JavaScript*: The language used by the Ajax engine and also the language used to send requests to the server and to handle the response. A pure JavaScript approach is quite complicated, however, so in this book I use jQuery to greatly simplify the interaction.

- » **XML:** The eXtensible Markup Language, which is the data format that the Ajax engine uses to send data to the server and to receive data from the server. Fortunately, you don't have to worry about this because jQuery makes it easy to send the data, and JSON (discussed later) makes it easy to process the received data.

Making Ajax Calls with jQuery

In Book 4, I talk a lot about how jQuery makes many everyday JavaScript coding tasks easier and faster. That's certainly the case with Ajax, because the jQuery programmers put a lot of effort into making Ajax calls as painless as possible. As I hope to show in this section, I believe they succeeded admirably.

To begin, understand that jQuery's Ajax support isn't limited to a single technique; far from it. There are actually quite a few Ajax-related features in the jQuery library, but for this book I'm going to focus on just the four easiest ones:

- » `.load()`: Enables you to load the data returned by the server into a specified web page element
- » `.get()`: Sends a GET request to the server, which is suitable for sending a relatively small amount of data
- » `.post()`: Sends a POST request to the server, which is suitable for sending a relatively large amount of data
- » `.getJSON()`: Sends a GET request to the server, and accepts data from the server in the JSON format

The rest of this section covers `.load()`, `.get()`, and `.post()` in more detail. I tackle `.getJSON()` a bit later when I talk about JSON stuff.

Learning more about GET and POST requests



REMEMBER

When you're working with Ajax calls to the server, one of the decisions you have to make is what request method to use: GET or POST. How on Earth are you supposed to do that? Fortunately, it really only comes down to one thing: the length of the data. GET requests are meant to be used when the data you send to the server is relatively short. The actual limit depends on the web server, but the most common ceiling is 2,048 characters. Anything longer than that and the server might

cough up a 414 Request URI Too Long error. If you're sending long data (such as a blog entry), use a POST request.

Some folks will tell you that POST is more secure than GET, but is that true? From an Ajax perspective, no, there's not much difference. Normal GET requests operate by adding a query string to the end of the URL, which is easily seen by the user. In an Ajax GET call, the page URL doesn't change, but the URL used for the Ajax request does change to include the query string. This URL is easily seen by opening the browser's web development tools. In Chrome, for example, select the Network tab, as shown in Figure 1-1. If that query string contains sensitive data, a savvy user can find it without too much trouble.

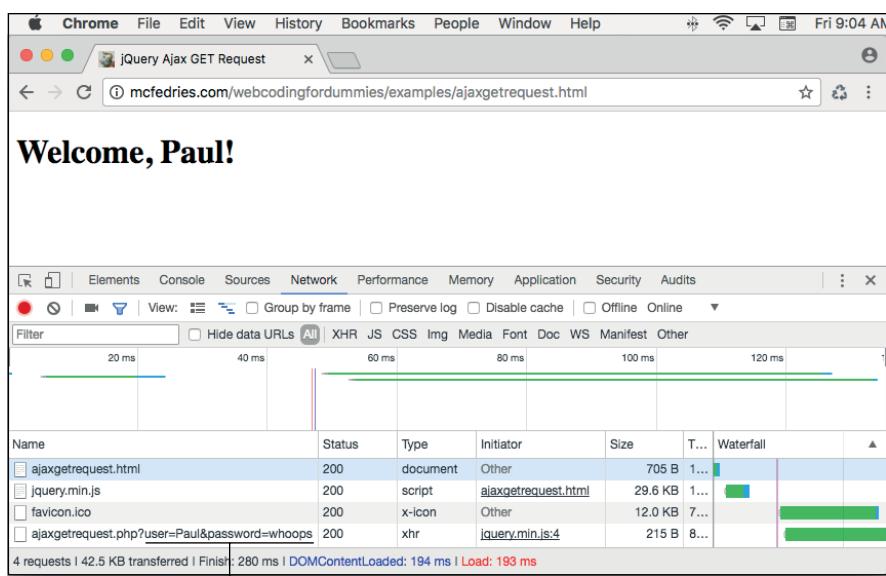


FIGURE 1-1:
The Ajax GET
request query
string is easily
visible in the
browser's
development
tools.

Alas, POST request data is also readily seen by a sophisticated user. In Chrome's dev tools, for example, click the Network tab, click the Ajax request (it's the one that shows `xhr`, short for the `XMLHttpRequest` object used by Ajax) in the Type column, click the Headers tab, then scroll down to the Form Data section, as shown in Figure 1-2.



TIP

If you only ever send relatively small amounts of data to the server, you can certainly stick with using just GET requests. However, some developers use both, even when sending small amounts of data, as a way of making their code more readable:

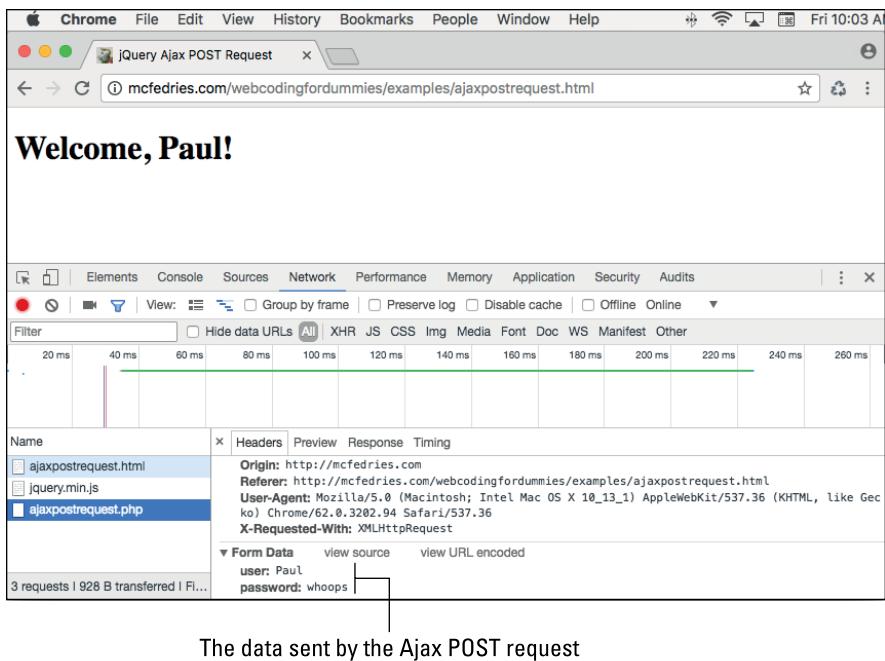


FIGURE 1-2:
The Ajax POST
request data
is only slightly
harder to find
in the browser's
development
tools.

- » Use a GET request when you want to retrieve data from the server without modifying the server data in any way.
- » Use a POST request when you want to modify — that is, add, update, or delete — server data.

Handling POST requests in PHP

I cover handling GET requests in PHP code in Book 5, Chapter 3. Handling POST requests is very similar, so here I just take a quick look at how you handle them in PHP.

POST requests can be sent in two ways. The first method is as a query string consisting of a series of name-value pairs that use the following general form:

```
name1=value1&name2=value2&...
```

Here's an example:

```
book=4&chapter=1&example=2
```

The second method sends the POST data as an object literal consisting of a series of key-value pairs with the following syntax:

```
{key1: value1, key2: value2, ...}
```

Here's an example:

```
{book: 4, chapter: 1, example: 2}
```

Either way, you access the data by using PHP's `$_POST` variable, which is an associative array created from either the query string's name-value pairs or the object's key-value pairs. The preceding examples create the following `$_POST` array:

```
$_POST['book'] => 4  
$_POST['chapter'] => 1  
$_POST['example'] => 2
```

As with the `$_GET` array, your code should check that each of the expected elements of the `$_POST` array exist by using PHP's `isset()` function, which returns `true` if a variable exists and has a value other than `null`. Here's an example:

```
if (isset($_POST['book'])) {  
    $book_num = $_POST['book'];  
} else {  
    echo 'The "book" parameter is missing!<br>';  
    echo 'We are done here, sorry.';  
    exit(0);  
}
```

Using `.load()` to update an element with server data

One of the most common and most useful Ajax techniques is to update just a single element on the page with data from the server. All the other elements on the page stay the same, so the user's experience isn't disrupted by a jarring and annoying page reload.

jQuery makes this technique very straightforward by offering the `.load()` method. How you use this method depends on what you want to load, whether you want to send data to the server, and whether you want to run some code when the load is done. The next few sections take you through the possibilities.

Loading an HTML file

The most common use of `.load()` is to populate a page element with the contents of an HTML file. Here's the general syntax to use:

```
$(element).load(HTMLFile);
```

- » *element*: A jQuery selector that specifies the element into which the HTML will be loaded.
- » *HTMLFile*: The name of the file that contains the HTML code you want loaded into *element*. If the file resides in a directory that's different than the current file's directory, you need to include the path info, as well.

For example, here's an `<h1>` tag that represents the entire contents of a file named `helloajaxworld.html`:

```
<h1>Hello Ajax World!</h1>
```

Now consider the following HTML code:

```
<script>
    $(document).ready(function() {
        $('#target').load('helloajaxworld.html');
    });
</script>
<body>
    <div id="target">
    </div>
</body>
```

The `<body>` tag includes a `div` element that uses an `id` value of `target`. When the page is loaded (that is, when the `document` object's `ready` event fires), the script runs the following statement:

```
$('#target').load('helloajaxworld.html');
```

This statement tells the browser to use an Ajax call to grab the contents of `helloajaxworld.html` from the server and then insert that content into the element that uses the `id` value of `target` (that is, the page's `<div>` tag). Figure 1-3 shows the result.

FIGURE 1-3:
Using jQuery's .load() method to load the contents of an HTML file into a page element.



WARNING

There's a built-in browser security restriction called the *same-origin policy*, which only allows a script to access data from another file if both files have the same origin, meaning the following must be the same for both:

- » **Protocol:** This usually means both files must use http or both must use https. If one file uses http and the other uses https, the Ajax call will fail.
- » **Host name:** The two files can't be on different subdomains. If one file uses mydomain.com and the other uses www.mydomain.com, the Ajax call will fail.
- » **Port number:** The two files must use the same port number. The standard HTTP port is 80, but if you call the script with, say, port 88 (that is, http://mydomain.com:88/), the Ajax call will fail.

Therefore, make sure that the HTML file you request has the same origin as the file that contains the .load() statement.



TIP

Loading a common header and footer

Why not just put the HTML file's content into the page by hand? You should definitely do that if you'll only be using that content once. However, it's very common in web development to have content that is repeated over multiple pages. For example, a particular web project might use the same header and the same footer on every page. Adding the header and footer code by hand is easy as pie if the project consists of just one or two pages. But what if it contains a dozen pages, or two dozen? Yep, you can copy and paste the code no problem, but if you have to change anything in the header or footer, then have fun updating a couple of dozen files.

Forget all that. Instead, put your header code in a separate file (called, say, header.html), your footer code in another file (called, you guessed it, footer.html), and then store them in a separate directory (called, say, includes). Then use .load() to insert that content. That is, all your pages would include code similar to the following:

```
<script>
$(document).ready(function() {
    $('header').load('includes/header.html');
    $('footer').load('includes/footer.html');
});
```

```
</script>
<body>
    <header></header>
    The rest of the page stuff goes here
    <footer></footer>
</body>
```

Loading output from a PHP script

If you have a PHP script that uses `echo` or `print` to output HTML tags and text, you can use `.load()` to insert that output into a page element. The general syntax is nearly identical to the one for loading an HTML file:

```
$(element).load(PHPfile);
```

- » `element`: A jQuery selector that specifies the element into which the PHP output will be loaded.
- » `PHPfile`: The name of the file that contains the PHP code. If the PHP file sits in a directory other than the current file's directory, include the path info.

For example, here's a PHP file named `get-server-time.php`:

```
<?php
    $current_time = date('H:m:s');
    echo "The time on the server is $current_time.";
?>
```

The script gets the current time on the server and then outputs a message displaying the time. Now consider the following HTML code:

```
<script>
    $(document).ready(function() {
        $('#target').load('get-server-time.php');
    });
</script>
<body>
    <h2 id="target">
    </h2>
</body>
```

When the page is ready, the `.load()` method calls `get-server-time.php` and loads the output into the `<h2>` tag, as shown in Figure 1-4.

FIGURE 1-4:
Using jQuery's .load() method to load the output of a PHP script into a page element.



WARNING

The same-origin policy that I mention earlier for HTML files is also in effect for PHP files. That is, the PHP script you request must have the same origin as the file that contains the .load() statement.

Loading a page fragment

Most of the time you'll use .load() to insert the entire contents of an HTML file or PHP output into a page element. However, jQuery also offers a mechanism to insert just a fragment of the page or output. Here's the syntax:

```
$(element).load(file fragment);
```

- » *element*: A jQuery selector that specifies the element into which the HTML tags and text will be loaded
- » *file*: The name of the file (plus its directory path, if needed) that contains either the HTML code or PHP output you want loaded into *element*
- » *fragment*: A jQuery selector that specifies the portion of *file* that gets loaded into *element*

For example, suppose you want to set up a summary page that lists the titles and first paragraphs from a collection of longer posts. Here's the partial code from one of those posts:

```
<header>
    <h1>It's Official: Teen Instant Messages Nothing But
        Gibberish</h1>
</header>
<main>
    <article>
        <section class="first-paragraph">
            In a scathing report released today, communications
            experts have declared that the instant messages teenagers
            exchange with each other are in reality nothing but gibberish.
            U.S. Chatmaster General Todd Dood, with technical help from
            the National Security Agency, examined thousands of instant
            messages.
```

```
</section>
The rest of the post's sections go here
</article>
</main>
```

Notice two things in this code:

- » The title of the post is inside an `<h1>` tag.
- » The first paragraph of the post is assigned the class `first-paragraph`.

Given these two tidbits, and assuming this page is located in `posts/post1.html`, you can use a couple of `.load()` statements to add the title and first paragraph to the summary page (see Figure 1-5 for the results):

```
<script>
$(document).ready(function() {
    $('#title1').load('posts/post1.html h1');
    $('#intro1').load('posts/post1.html .first-paragraph');
});
</script>
<body>
    <header id="title1">
    </header>
    <article id="intro1">
    </article>
    <div>
        <a href="posts/post1.html">Read the rest of the
        post...</a>
    </div>
</body>
```

FIGURE 1-5:
Using jQuery's `.load()` method
to load the
title and first
paragraph from
another page.

It's Official: Teen Instant Messages Nothing But Gibberish

In a scathing report released today, communications experts have declared that the instant messages teenagers exchange with each other are in reality nothing but gibberish. U.S. Chatmaster General Todd Dood, with technical help from the National Security Agency, examined thousands of instant messages.

[Read the rest of the post...](#)

Sending data to the server

If you want to load the output from a PHP script, sometimes you might want to pass along to the script some parameters that specify or limit the data sent

back by the script. For example, you might ask for the data from a particular user account, the customers from a specified region, or the ten most recent blog posts.

Here's the variation of the `.load()` syntax that enables you to send data to the server:

```
$(element).load(PHPfile, data);
```

» `element`: A jQuery selector that specifies the element into which the PHP output will be loaded.

» `PHPfile`: The name of the PHP file (plus its directory path, if needed) that creates the PHP output you want loaded into `element`.

» `data`: The data to send to the server. This can be string or object literal:

- **String:** A query string that specifies a set of name-value pairs using the following format:

```
'name1=value1&name2=value2, ...'
```

jQuery sends the query string as a GET request.

- **Object:** An object literal that specifies a set of key-value pairs using the following format:

```
{key1: value1, key2: value2, ...}
```

jQuery sends the object as a POST request.

For example, suppose you have a PHP file named `get-category.php` that uses `$_POST` to look for a category number in an object literal and then returns data about that category. Here's how you'd load the PHP script's output into a page element with `id` value of `category-output`:

```
$('#category-output').load('get-category.php', {category: 1});
```

Running a function after the load

Most of the time you'll be content just to load some text and tags into an element and then be done with it. Sometimes, however, it's useful to run some code post-load. You can do that by adding a callback function to the `.load()` method:

```
$(element).load(file, data, function() {
    Code to run after the load finishes goes here
});
```

For example, you might want to search the loaded data for a particular value. Similarly, you might want to adjust the data's CSS based on some criteria.

As an example of the latter, suppose you have a `<nav>` tag and you use `.load()` to populate the element with your site's main navigation links. In most cases, you'd put that code in an external JavaScript file and then include the file in each page so that all your pages load the same navigation links. That's fine, but it's useful for site visitors if you mark up each of the main navigation links in some way when a visitor is viewing one of those pages. For example, if you have a "What's New" page, your `What's New` link should appear different from the other navigation links when someone is viewing that page.

You can do that by adding a callback function that examines the filename of the current page. If it matches the filename of a navigation link, it applies a class to that link. Here's some code that does this:

CSS:

```
.current-nav-link {  
    background-color: black;  
    color: white;  
}
```

HTML (`nav.html`):

```
<a href="/index.html" id="home">Home</a>  
<a href="/whatsnew.html" id="whatsnew">What's New</a>  
<a href="/pages/whatsold.html" id="whatsold">What's Old</a>  
<a href="/whatswhat.html" id="whatswhat">What's What</a>
```

jQuery:

```
$( 'nav' ).load('nav.html', function() {  
    var current_page = window.location.pathname.split('/').  
        pop();  
    switch (current_page) {  
        case 'whatsnew.html':  
            $('#whatsnew').addClass('current-nav-link');  
            break;  
  
        case 'whatsold.html':  
            $('#whatsold').addClass('current-nav-link');  
            break;  
    }  
});
```

```

        case 'whatswhat.html':
            $('#whatswhat').addClass('current-nav-link');
            break;

        default:
            $('#home').addClass('current-nav-link');
    }
});

```

The CSS defines a class named `current-nav-link` that switches the background to black and the text color to white. The HTML shows `nav.html`, the file that holds the navigation links. The jQuery code uses `.load()` to load `nav.html` into the `<nav>` tag (not shown in the code), and then a callback function does two things:

- » It determines the filename of the current page by taking the URL's path (given by `window.location.pathname`), splitting it into an array with the backslash (/) as the separator, and then running the `pop()` method to get the last item in the array (that is, the filename).
- » It uses a `switch()` statement to check whether the current filename is equal to the filename used by one of the main navigation links. If so, then the code uses jQuery's `addClass()` method to add the `current-nav-link` class to the link element.

Figure 1-6 shows an example of this code at work.

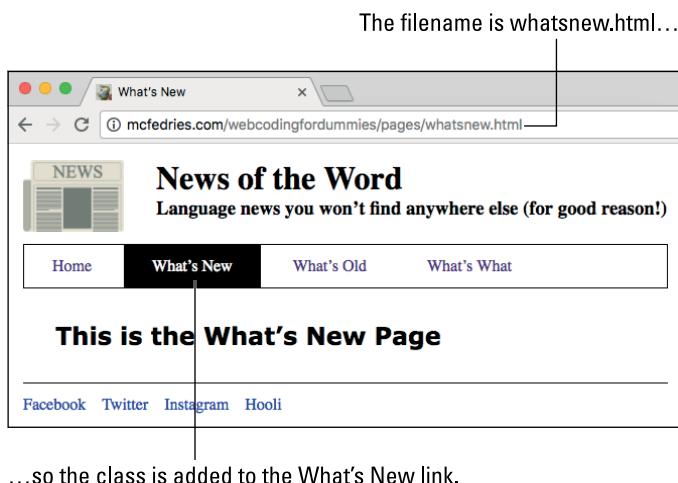


FIGURE 1-6:
The `.load()` callback function determines the current page's filename. If that filename is the same as the filename of a navigation link, the code adds a class to that link.

Using `.get()` or `.post()` to communicate with the server

If you want to communicate with the server via Ajax without that communication being tied to a specific page element, use the `.get()` or `.post()` functions, which send GET and POST requests, respectively. These functions use the same general syntax:

```
$.get(script, data-to-send, function(returned-data) {
    Code to run if the operation is successful
});
$.post(script, data-to-send, function(returned-data) {
    Code to run if the operation is successful
});
```

- » `script`: The name of the PHP file (plus its directory path, if needed) that you want to run.
- » `data-to-send`: Specifies the data to send to the server. This can be string or object literal:
 - **String**: A query string that specifies a set of name-value pairs using the following format:

```
'name1=value1&name2=value2, ...'
```
 - **Object**: An object literal that specifies a set of key-value pairs using the following format:

```
{key1: value1, key2: value2, ...}
```
- » `function(returned-data)`: A function that jQuery runs if the GET or POST operation was success. The data returned by the server is stored in the `returned-data` parameter.

Note, first, that the syntax is slightly unusual in that you don't specify an element after the `$()` method.

These are extremely versatile functions that you can use in a number of different ways:

- » **Run a script**: If all you want to do is execute a server script, run either method with just the `script` parameter. For example:

```
$.get('php/update-rss-feeds.php');
```

- » **Run a script with data:** If you want to run a server script and also supply that script with some data, run either method with both the *script* and *data-to-send* parameters. For example:

```
$.get('php/update-rss-feeds.php', 'feedID=2');
```

- » **Retrieve data:** If you want to run a server script and process the data that the script sends back, run either method with the *script* parameter and the *function(returned-data)* callback function. For example:

```
$.post('total-inventory.php', function(data) {
    console.log('Total inventory: ' + data);
});
```

- » **Send and retrieve data:** If you want to run a server script, supply that script with some data, and process the data that the script sends back, run either method with all the parameters. For example:

```
$.post('total-inventory.php', 'category=1', function(data) {
    console.log('Total Beverage inventory: ' + data);
});
```

For example, suppose you want to know the total value of the inventory (that is, the units in stock multiplied by the price of each unit) for a particular category. Here's a partial PHP script named `total-inventory.php` that does the job:

```
// Parse the query string
$category_num = $_POST['category'];

// Create and run a SELECT query
$sql = "SELECT unit_price, units_in_stock
        FROM products
        WHERE category_id = $category_num";
$result = $mysqli->query($sql);

// Get the query rows as an associative array
$rows = $result->fetch_all(MYSQLI_ASSOC);
$inventory_total = 0;

// Loop through the rows
foreach($rows as $row) {
    $inventory_total += $row['unit_price'] * $row['units_in_
    stock'];
}
echo $inventory_total;
```

This script (which has many parts not shown, such as the MySQL connection statements), takes a category value via POST and runs a SELECT query that returns the unit_price and units_in_stock for that category. The code then loops through the returned rows, adding to the inventory_total variable each time by multiplying unit_price and units_in_stock. The script finishes by echoing the final value of inventory_total.

Now consider the front-end code:

CSS:

```
div {  
    color: green;  
    font-size: 1.25rem;  
}  
.warning {  
    color: red;  
    font-weight: bold;  
}
```

HTML:

```
<h1>Inventory Report</h1>  
<div></div>
```

JavaScript/jQuery:

```
$(document).ready(function() {  
    $.post('total-inventory.php', 'category=1', function(data) {  
        var msg = 'The total inventory is $' + data;  
        if (data >= 10000) {  
            msg = 'WARNING! Total inventory is $' + data;  
            $('div').addClass('warning');  
        }  
        $('div').html(msg);  
    });  
});
```

The jQuery .post() function calls total-inventory.php and sends category=1 as the data. The callback function stores the PHP output (that is, the \$inventory_total value) in the data parameter, sets up a default message, and checks to see if data is over 10000. If it is, the code changes the message and adds the warning class to the div element. Finally, the code displays the message in the div. Figure 1-7 shows an example result.

FIGURE 1-7:
A warning message displayed by the `.post()` callback function.

Inventory Report

WARNING! Total inventory is \$12480.25

Introducing JSON

As I show over and over in this chapter, when the PHP script is ready to send data back to the front end, it uses one or more `echo` (or `print`) statements to output the data. That process works fine if all your web page needs from the server is some relatively simple output, such as HTML tags, text, or a single value (such as a number or string).

However, with a web app, it's common to require more sophisticated data, usually some subset of a table or a join of two or more tables. You can't send pure MySQL data back to the web browser because there are no front-end tools that can work with data in that format. Instead, what you need to do is convert the server data into a special format called *JavaScript Object Notation*, or **JSON** (pronounced like the name Jason), for short.

Learning the JSON syntax

I talk about JavaScript object literals in several places in this book, and if you know about object literals, then JSON objects will look very familiar. Here's the general syntax:

```
{  
    "property1": value1,  
    "property2": value2,  
    ...  
    "propertyN": valueN  
}
```

JSON data looks like an object, but it's really just text that consists of one or more property-value pairs with the following characteristics:

- » Each property name is surrounded by double quotation marks ("").
- » Each value can be one of the following:
 - A number
 - A string (in which case the value must be surrounded by double quotation marks)

- A Boolean (true or false)
- null (that is, no value)
- A JavaScript array literal (comma-separated values surrounded by square brackets — [and])
- A JavaScript object literal (comma-separated *property: value* pairs surrounded by braces — { and })
 - » The property-value pairs are separated by commas.
 - » The block of property-value pairs is surrounded by braces ({ and }).

Here's an example:

```
{  
    "account": 853,  
    "name": "Alfreds Futterkiste",  
    "supplier": false,  
    "recentOrders": [28394,29539,30014],  
    "contact": {  
        "name": "Maria Anders",  
        "phone": "030-0074321",  
        "email": "m.anders@futterkiste.com"  
    }  
}
```

Declaring and using JSON variables

In the next section, I talk about how useful JSON is for getting complex data — especially database records — from the server to your web page. However, you can also use JSON data in your non-Ajax code. You begin by declaring a JSON variable:

```
var customer = {  
    "account": 853,  
    "name": "Alfreds Futterkiste",  
    "supplier": false,  
    "recentOrders": [28394,29539,30014],  
    "contact": {  
        "name": "Maria Anders",  
        "phone": "030-0074321",  
        "email": "anders@futterkiste.com"  
    }  
}
```

You can then refer to any property in the JSON data by using the `variable.property` syntax. Here are some examples:

```
customer.account      // Returns 853
customer.name         // Returns "Alfreds Futterkiste"
customer.recentOrders[1] // Returns 29539
customer.contact.email // Returns "anders@futterkiste.com"
```



The JSON syntax can be a bit tricky, so it's a good idea to check that your data is valid before using it in your code. The easiest way to do that is to use the JSONLint (<https://jsonlint.com>) validation tool. Copy your JSON code, paste it into the JSONLint text area, then click Validate JSON.

Returning Ajax Data as JSON Text

The real power of JSON becomes clear during Ajax calls when you want to return a complex set of data to the web page. This usually means an array of database records. Sure, you can use your PHP code to loop through the array and output the data along with some HTML tags and text. However, most web apps don't want to merely display the data; they want to process the data in some way, and that means handling the data using a callback function. That still leaves the rather large problem of getting the server data to the web page, but that's where JSON comes in. Because JSON data is just text, it's easy to transfer that data between the server and the web page.

Converting server data to the JSON format

You might be shaking in your boots imagining the complexity of the code required to convert an array of database records into the JSON format. Shake no more, because, amazingly, it takes but a single line of PHP code to do the job! That's because PHP comes with a handy and powerful function called `json_encode()` that can take any value and automagically turn it into a JSON object. Here's the syntax:

```
json_encode(value, options)
```

» `value`: The value you want to convert to JSON. For most of your Ajax calls, this will be an array of MySQL table rows returned by the `fetch_all()` method.

» *options*: An optional series of constants, separated by the OR operator (|). These constants determine how the function encodes special characters such as quotation marks. Here are four you'll use most often:

- `JSON_HEX_TAG`: Encodes less than (<) and greater than (>) as \u003C and \u003E, respectively
- `JSON_HEX_AMP`: Encodes ampersands (&) as \u0026
- `JSON_HEX_APOS`: Encodes single quotation marks ('') as \u0027
- `JSON_HEX_QUOT`: Encodes double quotation marks ("") as \u0022

The usual procedure is to store the output of `json_encode()` in a variable, then `echo` or `print` that variable. Here's an example (where it's assumed that the variable `$rows` contains an array of MySQL rows):

```
$JSON_data = json_encode($rows, JSON_HEX_APOS | JSON_HEX_QUOT);
echo $JSON_data;
```

Here's a longer example that assumes you've already used PHP to connect to a MySQL database, and the resulting `MySQLi` object is stored in the `$mysqli` variable:

```
// Create and run a SELECT query
$sql = "SELECT company_name, contact_name, contact_title,
        contact_email
        FROM suppliers";
$result = $mysqli->query($sql);

// Get the query rows as an associative array
$rows = $result->fetch_all(MYSQLI_ASSOC);

// Convert the array to JSON, then output it
$JSON_data = json_encode($rows, JSON_HEX_APOS | JSON_HEX_QUOT);
echo $JSON_data;
```

Here's a partial listing of what gets stored in `$JSON_data`:

```
[{
    "company_name": "Exotic Liquids",
    "contact_name": "Charlotte Cooper",
    "contact_title": "Purchasing Manager",
    "contact_email": "charlottec@exoticliquids.com"
}, {
    "company_name": "New Orleans Cajun Delights",
    "contact_name": "Shelley Burke",
```

```
        "contact_title": "Order Administrator",
        "contact_email": "sburke@neworleanscajundelights.com"
    },
    {
        "company_name": "Grandma Kelly\u0027s Homestead",
        "contact_name": "Regina Murphy",
        "contact_title": "Sales Representative",
        "contact_email": "regina.murphy@grandmakellyshomestead.com"
    },
    etc.
]
```

Notice that this is an array of JSON strings, each of which represents a row from the data returned by the MySQL SELECT query. Note, too, that I've formatted this with newlines and spaces to make it easier to read. That actual data stored in the variable contains no whitespace.

Handling JSON data returned by the server

By far the easiest way to process JSON data returned by a PHP script is to use jQuery's `.getJSON()` function to initiate the Ajax call. Here's the syntax:

```
$.getJSON(script, data-to-send, function(JSON-array) {
    Code to run if the operation is successful
});
```

- » *script*: The name of the PHP file (plus its directory path, if needed) that you want to run.
- » *data-to-send*: The data to send to the server, which can be a string or an object literal.
- » *function(JSON-array)*: A function that jQuery runs if the operation was successful. The data returned by the server is stored in the *JSON-array* parameter.

Because the PHP script returns an array of JSON strings, the `.getJSON()` callback function will usually use a `.each()` loop to run through the array:

```
$.each(JSON-array, function(index, JSON-string) {
    Code to handle each JSON string goes here
});
```

- » *JSON-array*: The JSON array returned by the server
- » *index*: The current index value of the array
- » *JSON-string*: The current array item, which is a JSON string

Here's some code that processes the PHP output from the previous section:

HTML:

```
<h1>Supplier Contacts</h1>
<main></main>
```

JavaScript/jQuery:

```
$.getJSON( 'php/get-supplier-contacts.php', function(data) {
    $.each(data, function(index, contact) {
        $('main').append('<section id="contact' + index +
        '">');
        $('#contact' + index).append('<div>Company: ' + contact.
        company_name + '</div>');
        $('#contact' + index).append('<div>Contact: ' + contact.
        contact_name + '</div>');
        $('#contact' + index).append('<div>Title: ' + contact.
        contact_title + '</div>');
        $('#contact' + index).append('<div>Email: ' + contact.
        contact_email + '</div>');
    });
});
```

The code uses `.each()` to loop through the array of supplier contacts:

- » A new `<section>` with an `id` set to "contact"+`index` is appended to `main`.
- » A `<div>` tag for each of the four pieces of contact data (`company_name`, `contact_name`, `contact_title`, and `contact_email`) is appended to the new `<section>` tag.

Figure 1-8 shows part of the resulting page.

Supplier Contacts

FIGURE 1-8:
The callback loops through the JSON array, appending each object to the `<main>` tag.

```
Company: Exotic Liquids  
Contact: Charlotte Cooper  
Title: Purchasing Manager  
Email: charlottec@exoticliquids.com
```

```
Company: New Orleans Cajun Delights  
Contact: Shelley Burke  
Title: Order Administrator  
Email: sburke@neworleanscajundelights.com
```

```
Company: Grandma Kelly's Homestead  
Contact: Regina Murphy  
Title: Sales Representative  
Email: regina.murphy@grandmakellyshomestead.com
```

The `.getJSON()` function sends the data to the server using a GET request. What if you want to use a POST request, instead? Alas, jQuery doesn't offer a function such as `.postJSON()`. Instead, you use the `.post()` function, but when you get the JSON data back from the server, you turn it into a JavaScript object by using the `JSON.parse()` function:

```
JSON.parse(data)
```

» `data`: The JSON data returned by the server

Here's an example:

```
$.post('php/get-supplier-contacts.php', function(data) {  
  
    // Convert the JSON text to a JavaScript object  
    var obj = JSON.parse(data);  
  
    $.each(obj, function(index, contact) {  
        $('#main').append('<section id="contact' + index +  
        '">');  
        $('#contact' + index).append('<div>Company: ' + contact.  
        company_name + '</div>');  
        $('#contact' + index).append('<div>Contact: ' + contact.  
        contact_name + '</div>');  
        $('#contact' + index).append('<div>Title: ' + contact.  
        contact_title + '</div>');  
        $('#contact' + index).append('<div>Email: ' + contact.  
        contact_email + '</div>');  
    });  
});
```

IN THIS CHAPTER

- » Understanding web form basics
- » Coding text boxes, checkboxes, and radio buttons
- » Programming lists, labels, and buttons
- » Monitoring and triggering form events
- » Getting the form data to the server

Chapter 2

Building and Processing Web Forms

From humble beginnings, forms in HTML5 are now tremendously flexible and powerful, providing natively much of the functionality that we as developers have been adding in with JavaScript over the years.

— PETER GASSTON

A dynamic web page is one that interacts with the user and responds in some way to that interaction. However, when I use the word “interaction” here, I don’t mean (or I don’t just mean) users scrolling through your content and clicking a link here and there. A dynamic web page solicits feedback from the user and then responds to that feedback in an appropriate way (whatever “appropriate” might mean in that context). Sure, you can pester your page visitors for info by tossing them a confirm or prompt box or two, but these are mere toys in the land of web interactivity. The real tools for soliciting feedback and then acting on it — that is, for making your pages truly dynamic — are web forms.

In this chapter, you explore all that web forms have to offer. After mastering the basics, you investigate the amazing new features offered by HTML5 web forms, unearth the power of form events, and learn how to dress up your form data and send it off to the web server. It’s a veritable forms smorgasbord, so belly up!

What Is a Web Form?

Most modern programs toss a dialog box in your face if they need to extract some information from you. For example, selecting a program's Print command most likely results in some kind of Print dialog box showing up. The purpose of this dialog box is to ask for info such as the number of copies you want, the pages you want to print, the printer you want to use, and so on.

A form is essentially the web page equivalent of a dialog box. It's a page section populated with text boxes, lists, checkboxes, command buttons, and other controls to get information from the user. For example, Figure 2-1 shows a form from my website. This is a form that people can use to send me a message. The form includes a text box for the person's name, another for her email address, a larger text area for the message, and a command button to send the data to my server.

The form is titled "Contact Me" in a large, bold font at the top. Below the title is a sub-instruction: "FILL IN THE FORM FIELDS AND CLICK SEND". There are three input fields: "Name" with placeholder text "Your name (optional)", "Email" with placeholder text "Email address (optional)", and a larger "Message" text area. A blue "Send" button is located below the message area. At the bottom of the form is a small note: "†Your email address is safe with me. I promise never to sell it, rent it, trade it, or give it away."

FIGURE 2-1:
A typical
web form.

Contact forms are very common, but there are lots of other uses for forms:

- » If you put out a newsletter, you can use a form to sign up subscribers.
- » If your website includes pages with restricted access, you can use a form to get a person's username and password for verification.
- » If you have information in a database, you can use a form to have people specify what information they want to access.
- » If your site has a search feature, you can use a form to get the search text and offer options for filtering and sorting the search results.

Understanding How Web Forms Work

A web form is a little data-gathering machine. What kinds of data can it gather? You name it:

- » Text, from a single word up to a long post
- » Numbers, dates, and times
- » Which item is (or items are) selected in a list
- » Whether a checkbox is selected
- » Which one of a group of radio buttons is selected

What happens to that data after you've gathered it? There are two roads the data can travel: Server Street and Local Lane.

The Server Street route means that your web server gets in on the action. Here are the basic steps that occur:

1. The user clicks a button to submit the form.
2. Your JavaScript/jQuery code gathers and readies the form data for sending.
3. The code uses an Ajax call to send the form data to a PHP script on the server.
4. The PHP script extracts the form data.
5. PHP uses some or all of the form data to build and execute a MySQL query.
6. PHP outputs either the requested data or some kind of code that indicates the result of the operation.
7. Your JavaScript/jQuery code processes the data returned by the server and updates the web page accordingly.

The Local Lane route doesn't get the web server involved at all:

1. The user changes the form data in some way.
2. Your JavaScript/jQuery code detects the changed data.
3. The event handler for the changed form field updates the web page based on the changed data.

In this chapter, I show you how to build a form and then how to handle form events, which will enable you to stroll down Local Lane as much as you want. I also cover submitting data at the end of the chapter, which gives you everything you need to know for getting to Server Street.

Building an HTML5 Web Form

You build web forms with your bare hands using special HTML tags. The latest version of HTML — HTML5 — includes many new form goodies, most of which now have great browser support, so I show you both the oldie-but-goodie and the latest-and-greatest in the form world over the next few sections.

Setting up the form

To get your form started, you wrap everything inside the `<form>` tag:

```
<form>
</form>
```

In this book, you create forms that either update the page locally or submit data to the server via Ajax. All that front-end interaction is controlled by JavaScript and jQuery code, so you don't need any special attributes in the `<form>` tag.

However, I'd be remiss if I didn't mention the version of the `<form>` tag you need to use if you want your form data submitted directly to a script on the server:

```
<form action="script" method="method">
```

- » `script`: The URL of the server script you want to use to process the form data.
- » `method`: The method you want to use to send the data: get or post. (I talk about the difference between these two methods in Book 6, Chapter 1.)

Here's an example:

```
<form
action="http://mcfedries.com/webcodingfordummies/php/get-
    supplier-contacts.php"
method="post">
```



WARNING

If you're just using the form to add local interaction to the web page and you won't be submitting any form data to the server, then technically you don't need the `<form>` tag at all. However, you should use one anyway most of the time because including the `<form>` tag enables the user to submit the form by pressing Enter or Return, and it also gets you a submit button (such as Go) in mobile browsers.

Adding a form button

Most forms include a button that the user clicks when he's completed the form and wants to initiate the form's underlying action. This is known as *submitting* the form, and that term has traditionally meant sending the form data to a server-side script for processing. These days, however, and certainly in this book, "submitting" the form can also mean:

- » Updating something on the web page without sending anything to the server. For example, clicking a button might set the page's background color.
- » Running a function that gathers the form data and uses an Ajax call to send the data to the server and process what the server sends back. For example, if the form asks for the person's username and password, clicking the form button would launch the login process.

The old style of submitting a form is to use an `<input>` where the type attribute is set to `submit`:

```
<input type="submit" value="buttonText">
```

- » `buttonText`: The text that appears on the button face

For example:

```
<input type="submit" value="Submit Me!">
```

This style is rarely used in modern web development because it's a bit tricky to style such a button. For that reason, most web developers use the `<button>` tag, instead:

```
<button type="submit">buttonText</button>
```

- » `buttonText`: The text that appears on the button face

For example:

```
<button type="submit">Ship It</button>
```



TIP

For better-looking buttons, use CSS to style the following:

- » **Rounded corners:** To control the roundness of the button corners, use the border-radius property set to either a measurement (in, say, pixels) or a percentage. For example:

```
button {  
    border-radius: 15px;  
}
```

- » **Drop shadow:** To add a drop shadow to a button, apply the box-shadow *x y blur color* property, where *x* is the horizontal offset of the shadow, *y* is the vertical offset of the shadow, *blur* is amount the shadow is blurred, and *color* is the shadow color. For example:

```
button {  
    box-shadow: 3px 3px 5px gray;  
}
```

Working with text fields

Text-based fields are the most commonly used form elements, and most of them use the `<input>` tag:

```
<input type="textType" name="textName" value="textValue" placeholder="textPrompt">
```

- » *textType*: The kind of text field you want to use in your form.
- » *textName*: The name you assign to the field. If you'll be submitting the form data via Ajax, you must include a name value for each field.
- » *textValue*: The initial value of the field, if any.
- » *textPrompt*: Text that appears temporarily in the field when the page first loads and is used to prompt the user about the required input. The placeholder text disappears as soon as the user starts typing in the field.

Here's a list of the available text-based types you can use for the `type` attribute:

- » **text:** Displays a text box into which the user types a line of text. Add the `size` attribute to specify the width of the field, in characters (the default is 20). Here's an example:

```
<input type="text" name="company" size="50">
```

- » **number:** Displays a text box into which the user types a numeric value. Most browsers add a spin box that enables the user to increment or decrement the number by clicking the up or down arrow, respectively. Check out this example:

```
<input type="number" name="points" value="100">
```

I should also mention the `range` type, which displays a slider control that enables the user to click and drag to choose a numeric value between a specified minimum and maximum:

```
<input type="range" name="transparency" min="0" max="100"  
      value="100">
```

- » **email:** Displays a text box into which the user types an email address. Add the `multiple` attribute to allow the user to type two or more addresses, separated by commas. Add the `size` attribute to specify the width of the field, in characters. An example for you:

```
<input type="email" name="user-email" placeholder="you@  
yourdomain.com">
```

- » **url:** Displays a text box into which the user types a URL. Add the `size` attribute to specify the width of the field, in characters. Here's a for instance:

```
<input type="url" name="homepage" placeholder="e.g.,  
http://domain.com/">
```

- » **tel:** Displays a text box into which the user types a telephone number. Use the `size` attribute to specify the width of the field, in characters. Here's an example:

```
<input type="tel" name="mobile" placeholder="(xxx)xxx-  
xxxx">
```

- » **time:** Displays a text box into which the user types a time, usually hours and minutes. For example:

```
<input type="time" name="start-time">
```

- » **password**: Displays a text box into which the user types a password. The typed characters appear as dots (•). Add the autocomplete attribute to specify whether the user's browser or password management software can automatically enter the password. Set the attribute to current-password to allow password autocompletion, or to off to disallow autocompletion. Need an example? Done:

```
<input type="password" name="userpassword"  
      autocomplete="current-password">
```

- » **search**: Displays a text box into which the user types a search term. Add the size attribute to specify the width of the field, in characters. Why, yes, I do have an example:

```
<input type="search" name="q" placeholder="Type a search  
term">
```

- » **hidden**: Adds an input field to the form, but doesn't display the field to the user. That sounds weird, I know, but it's a handy way to store a value that you want to include in the submit, but you don't want the user to see or modify. Here's an example:

```
<input id="userSession" name="user-session" type="hidden"  
      value="jwr274">
```



REMEMBER

Some older browsers don't get special text fields such as `email` and `time`, but you can still use them in your pages because those clueless browsers will ignore the `type` attribute and just display a standard text field.

That was a lot of text-related fields, but we're not done yet! There are two others you need to know about:

- » **<textarea>**: This tag displays a text box into which the user can type multiple lines of text. Add the rows attribute to specify how many lines of text are displayed. If you want default text to appear in the text box, add the text between the `<textarea>` and `</textarea>` tags. Here's an example:

```
<textarea name="message" rows="5">  
Default text goes here.  
</textarea>
```

» <label>: Associates a label with a form field. There are two ways to use a label:

Method #1 — Surround the form field with <label> and </label> tags, and insert the label text before or after the field, like so:

```
<label>
Email:
<input type="email" name="user-email" placeholder="you@
yourdomain.com">
</label>
```

Method #2 — Add an id value to the field tag, set the <label> tag's for attribute to the same value, and insert the label text between the <label> and </label> tags, as I've done here:

```
<label for="useremail">Email:</label>
<input id="useremail" type="email" name="user-email"
placeholder="you@yourdomain.com">
```

Figure 2-2 demonstrates each of these text fields.

Text Input Types

Text:

Number:

Email:

URL:

Telephone:

Time:

Password:

Search:

Textarea:

FIGURE 2-2:
The various
text input types
you can use in
your forms.

Referencing text fields by field type

One common form-scripting technique is to run an operation on every field of the same type. For example, you might want to apply a style to all the URL fields. Here's the jQuery selector to use to select all `input` elements of a given type:

```
$(‘input[type=fieldType]’)
```

» `fieldType`: The type attribute value you want to select, such as `text` or `url`

For example, the following selector returns the set of all `input` elements that use the type `url`:

```
$(‘input[type=url]’)
```

Getting a text field value

Your script can get the current value of any text field by using jQuery's `val()` method:

```
$(field).val()
```

» `field`: A selector that specifies the form field you want to work with

Here's an example:

HTML:

```
<label>
  Search the site:
<input id="search-field" name="q" type="search">
</label>
```

jQuery:

```
var searchString = $('#search-field').val();
```

Setting a text field value

To set a text field value, use jQuery's `val()` method, but with a value:

```
$(field).val(value)
```

» *field*: A selector that specifies the form field you want to work with

» *value*: The value you want to assign to the text field

Here's an example:

HTML:

```
<label>
  Type your homepage address:
<input id="homepage-field" name="homepage" type="url">
</label>
```

JavaScript/jQuery:

```
var homepageURL = $('#homepage-field').val();
$('#homepage-field').val(homepageURL.toLowerCase());
```

This code grabs a URL, converts it to all lowercase characters, then returns it to the same `url` field.

Coding checkboxes

You use a checkbox in a web form to toggle a setting on (that is, the checkbox is selected) and off (the checkbox is deselected). You create a checkbox by including in your form the following version of the `<input>` tag:

```
<input type="checkbox" name="checkName" value="checkValue"
      [checked]>
```

» *checkName*: The name you want to assign to the checkbox. If you'll be submitting the form data via Ajax, you must include both a name and a value for the checkbox.

» *checkValue*: The value you want to assign to the checkbox. Note that this is a hidden value sent to the server when the form is submitted; the user never sees it.

» *checked*: When this optional attribute is present, the checkbox is initially selected.

Here's an example:

```
<fieldset>
    <legend>
        What's your phobia? (Please check all that apply):
    </legend>
    <div>
        <label>
            <input type="checkbox" name="phobia"
value="Ants">Myrmecophobia (Fear of ants)
        </label>
    </div>
    <div>
        <label>
            <input type="checkbox" name="phobia"
value="Bald">Peladophobia (Fear of becoming bald)
        </label>
    </div>
    <div>
        <label>
            <input type="checkbox" name="phobia" value="Beards"
checked>Pogonophobia (Fear of beards)
        </label>
    </div>
    <div>
        <label>
            <input type="checkbox" name="phobia"
value="Bed">Clinophobia (Fear of going to bed)
        </label>
    </div>
    <div>
        <label>
            <input type="checkbox" name="phobia" value="Chins"
checked>Geniophobia (Fear of chins)
        </label>
    </div>
    <div>
        <label>
            <input type="checkbox" name="phobia"
value="Flowers">Anthophobia (Fear of flowers)
        </label>
    </div>
    <div>
```

```
<label>
    <input type="checkbox" name="phobia"
value="Flying">Aviatophobia (Fear of flying)
</label>
</div>
<div>
    <label>
        <input type="checkbox" name="phobia"
value="Purple">Porphyrophobia (Fear of purple)
        </label>
    </div>
    <div>
        <label>
            <input type="checkbox" name="phobia" value="Teeth"
checked>Odontophobia (Fear of teeth)
            </label>
        </div>
        <div>
            <label>
                <input type="checkbox" name="phobia"
value="Thinking">Phronemophobia (Fear of thinking)
                </label>
            </div>
            <div>
                <label>
                    <input type="checkbox" name="phobia" value="Vegetabl
es">Lachanophobia (Fear of vegetables)
                    </label>
                </div>
                <div>
                    <label>
                        <input type="checkbox" name="phobia" value="Fear"
checked>Phobophobia (Fear of fear)
                        </label>
                    </div>
                    <div>
                        <label>
                            <input type="checkbox" name="phobia"
value="Everything">Pantophobia (Fear of everything)
                            </label>
                        </div>
                    </div>
                </div>
            </div>
        </div>
    </div>
</fieldset>
```

Some notes about this code:

- » You use the `<fieldset>` tag to group a collection of form fields together.
- » You use the `<legend>` tag to create a caption for the parent `fieldset` element. Figure 2-3 shows how this looks in the browser.
- » Because the `<input>` tags are wrapped in their respective `<label>` tags, it means the user can select or deselect each checkbox by clicking the checkbox itself or by clicking its label.

FIGURE 2-3:
Some checkbox
form fields,
wrapped in a
fieldset group
with a legend
element.

What's your phobia? (Please check all that apply):

- Myrmecophobia (Fear of ants)
- Peladophobia (Fear of becoming bald)
- Pogonophobia (Fear of beards)
- Clinophobia (Fear of going to bed)
- Geniophobia (Fear of chins)
- Anthophobia (Fear of flowers)
- Aviatophobia (Fear of flying)
- Porphyrophobia (Fear of purple)
- Odontophobia (Fear of teeth)
- Phronemophobia (Fear of thinking)
- Lachanophobia (Fear of vegetables)
- Phobophobia (Fear of fear)
- Pantophobia (Fear of everything)



REMEMBER

One strange thing about a checkbox field is that it's only included in the form submission if it's selected. If the checkbox is deselected, it's not sent to the server.

Referencing checkboxes

If your code needs to reference all the checkboxes in a page, use the following jQuery selector:

```
$( 'input[type=checkbox]' )
```

If you just want the checkboxes from a particular form, use a descendent or child selector on the form's `id` value:

```
$( '#formid input[type=checkbox]' )
```

Getting the checkbox state

You have to be a bit careful when discussing the “value” of a checkbox. If it's the `value` attribute you want to work with, then getting this is no different than getting the `value` property of a text field by using jQuery's `val()` method.

However, what you're more likely to be interested in is whether a checkbox is selected or deselected. This is called the **checkbox state**. In that case, you need to examine the `checked` attribute, instead:

```
$(checkbox).prop('checked')
```

» *checkbox*: A selector that specifies the checkbox you want to work with

The `checked` attribute returns `true` if the checkbox is selected, or `false` if the checkbox is deselected.

As an example, consider this code:

```
<label>
  <input id="autosave" type="checkbox" name="autosave">
  Autosave this project?
</label>
```

The following statement stores the checkbox state in a variable named `autosaveState`:

```
var autosaveState = $('#autosave').prop('checked');
```

Setting the checkbox state

To set a checkbox field to either the selected or deselected state, assign a Boolean expression to the `checked` attribute:

```
$(checkbox).prop('checked', Boolean)
```

» *checkbox*: A selector that specifies the checkbox you want to modify.

» *Boolean*: The Boolean value or expression you want to assign to the checkbox. Use `true` to select the checkbox; use `false` to deselect the checkbox.

For example, take a look back at the long list of phobia checkboxes (that is, the code demonstrated in Figure 2-3). Suppose you want to set up that form so that the user can select at most three checkboxes. Here's some code that does the job:

```
'form').click(function(e) {
  // Get the checkbox that was clicked
  var clickedCheckbox = e.target.value;
```

```

// Get the total number of selected checkboxes
var totalSelected = $('input[type=checkbox]:checked').
length;

// Do we now have more than three selected checkboxes?
if (totalSelected > 3) {

    // If so, deselect the checkbox that was just clicked
    $('input[value=' + clickedCheckbox + ']').
    prop('checked', false);
}
});

```

This event handler runs when anything inside the `form` element is clicked. The code first saves the value of the clicked checkbox. Then the code uses jQuery's `:checked` selector to return the set of all `checkbox` elements that have the `checked` attribute, and the `length` property tells you how many are in the set. An `if()` test checks to see if more than three are now selected. If that's true, the code deselects the checkbox that was just clicked.

Working with radio buttons

If you want to offer your users a collection of related options, only one of which can be selected at a time, then radio buttons are the way to go. Form radio buttons congregate in groups of two or more where only one button in the group can be selected at any time. If the user clicks another button in that group, it becomes selected and the previously selected button becomes deselected.

You create a radio button using the following variation of the `<input>` tag:

```

<input type="radio" name="radioGroup" value="radioValue"
[checked]>

```

- » `radioGroup`: The name you want to assign to the group of radio buttons. All the radio buttons that use the same name value belong to that group.
- » `radioValue`: The value you want to assign to the radio button. If this radio button is selected when the form is submitted, then this is the value sent to the server.
- » `checked`: When this optional attribute is present, the radio button is initially selected.

Here's an example, and Figure 2-4 shows what happens:

```
<fieldset>
  <legend>
    Select a delivery method
  </legend>
  <div>
    <input type="radio" id="carrier-pigeon" name="delivery"
    value="pigeon" checked>
    <label for="carrier-pigeon">Carrier pigeon</label>
  </div>
  <div>
    <input type="radio" id="pony-express" name="delivery"
    value="pony">
    <label for="pony-express">Pony express</label>
  </div>
  <div>
    <input type="radio" id="snail-mail" name="delivery"
    value="postal">
    <label for="snail-mail">Snail mail</label>
  </div>
  <div>
    <input type="radio" id="some-punk" name="delivery"
    value="bikemarier">
    <label for="some-punk">Some punk on a bike</label>
  </div>
</fieldset>
```

Select a delivery method

- Carrier pigeon
- Pony express
- Snail mail
- Some punk on a bike

FIGURE 2-4:
Some radio
button form
fields.

Referencing radio buttons

If your code needs to work with all the radio buttons in a page, use this jQuery selector:

```
$(‘input[type=radio]’)
```

If you want the radio buttons from a particular form, use a descendent or child selector on the form's `id` value:

```
$('#formid input[type=radio]')
```

If you require just the radio buttons from a particular group, use the following jQuery selector, where `radioGroup` is the common name of the group:

```
'input[name=radioGroup]')
```

Getting a radio button state

If your code needs to know whether a particular radio button is selected or deselected, you need to determine the radio button *state*. You do that by examining the radio button's `checked` attribute, like so:

```
$(radio).prop('checked')
```

» `radio`: A jQuery selector that specifies the radio button field you want to work with

The `checked` attribute returns `true` if the radio button is selected, or `false` if the button is deselected.

For example, given the radio buttons shown earlier, the following statement stores the state of the radio button with the `id` value of `pony-express`:

```
var ponySelected = $('#pony-express').prop('checked');
```

However, it's more likely that your code will want to know which radio button in a group is selected. You can do that by applying jQuery's `:checked` selector to the group:

```
var deliveryMethod = $('input[name=delivery]:checked');
```



TIP

To get the text of the label associated with a radio button, you can take advantage of a selector called the *sibling* selector, which uses the tilde (~) symbol. The sibling selector returns elements that have the same parent element. In the radio button code I show earlier, the `<input>` and `<label>` tags are siblings, so you can use the following expression to return the selected radio button's label text:

```
$('input[name=delivery]:checked ~ label').text();
```

Setting the radio button state

To set a radio button field to either the selected or deselected state, assign a Boolean expression to the checked attribute:

```
$(radio).prop('checked', Boolean)
```

- » *radio*: A jQuery selector that specifies the radio button you want to change.
- » *Boolean*: The Boolean value or expression you want to assign to the radio button. Use true to select the radio button; use false to deselect the radio button.

For example, if the initial state of the form group had the first radio button selected, you can reset the group by selecting that button. The easiest way to do this is to use jQuery's .first() method, which returns the first item in a set:

```
$('input[name=delivery]').first().prop('checked', true);
```

Adding selection lists

Selection lists are common sights in HTML forms because they enable the web developer to display a relatively large number of choices in a compact control that most users know how to operate. When deciding between a checkbox, radio button group, or a selection list, here are some rough guidelines to follow:

- » If an option or setting has only two values that can be represented by on and off, use a checkbox.
- » If the option or setting has three or four values, use a group of three or four radio buttons.
- » If the option or setting has five or more values, use a selection list.

This section shows you how to create and program selection lists. As you work through this part, it'll help to remember that a selection list is really an amalgam of two types of fields: the list container and the options within that container. The former is a `select` element and the latter is a collection of `option` elements.

To create the list container, you use the `<select>` tag:

```
<select name="selectName" size="selectSize" [multiple]>
```

- » `selectName`: The name you want to assign to the selection list.
- » `selectSize`: The optional number of rows in the selection list box that are visible. If you omit this value, the browser displays the list as a drop-down box.
- » `multiple`: When this optional attribute is present, the user is allowed to select multiple options in the list.

For each item in the list, you add an `<option>` tag between the `<select>` and `</select>` tags:

```
<option value="optionValue" [selected]>
```

- » `optionValue`: The value you want to assign to the list option.
- » `selected`: When this optional attribute is present, the list option is initially selected.

Here are some examples:

```
<form>
    <div>
        <label for="hair-color">Select your hair color:</label><br>
        <select id="hair-color" name="hair-color">
            <option value="black">Black</option>
            <option value="blonde">Blonde</option>
            <option value="brunette" selected>Brunette</option>
            <option value="red">Red</option>
            <option value="neon">Something neon</option>
            <option value="none">None</option>
        </select>
    </div>
    <div>
        <label for="hair-style">Select your hair style:</label><br>
        <select id="hair-style" name="hair-style" size="4">
            <option value="bouffant">Bouffant</option>
            <option value="mohawk">Mohawk</option>
            <option value="page-boy">Page Boy</option>
            <option value="permed">Permed</option>
            <option value="shag">Shag</option>
        </select>
    </div>
</form>
```

```

        <option value="straight" selected>Straight</option>
        <option value="none">Style? What style?</option>
    </select>
</div>
<div>
    <label for="hair-products">Hair products used in the
last year:</label><br>
    <select id="hair-products" name="hair-products" size="5"
multiple>
        <option value="gel">Gel</option>
        <option value="grecian-formula">Grecian Formula
    </option>
        <option value="mousse">Mousse</option>
        <option value="peroxide">Peroxide</option>
        <option value="shoe-black">Shoe black</option>
    </select>
</div>
</form>

```

There are three lists here (see Figure 2-5):

- » hair-color: This list doesn't specify a size, so the browser displays it as a drop-down list.
- » hair-style: This list uses a size value of 4, so there are four options visible in the list.
- » hair-products: This list uses a size value of 5, so there are five options visible in the list. Also, the multiple attribute is set, so you can select multiple options in the list.

Putting On Hairs: Reader Survey

Select your hair color:

Brunette

Select your hair style:

Page Boy
Permed
Shag
Straight

Hair products used in the last year:

Gel
Grecian Formula
Mousse
Peroxide
Shoe black

FIGURE 2-5:
Some examples of selection lists.

Referencing selection lists

If your code needs to work with all the options in a selection list, use this jQuery selector, where *listid* is the id value of the select element:

```
$('#listid > option')
```

To work with a particular option within a list, use jQuery's `nth-child(n)` selector, where *n* specifies the option's position in the list (1 is the first option, 2 is the second option, and so on):

```
$('#listid > option:nth-child(2)')
```



TIP

If you want a reference to the first option in the list, you can use `:first-child` instead of `:nth-child(1)`.

To get the option's text (that is, the text that the user sees in the list), run the `text()` method:

```
$('#listid > option:nth-child(2)').text();
```

Getting the selected list option

If your code needs to know whether a particular option in a selection list is selected or deselected, examine the option's `selected` attribute, like so:

```
$(option).prop('selected')
```

» *option*: A jQuery selector that specifies the option element you want to work with

The `selected` attribute returns `true` if the option is selected, or `false` if the option is deselected.

For example, given the selection lists shown earlier, the following statement stores the state of the first item in the selection list with the id value of `hair-color`:

```
var black = $('#hair-color > option:first-child').  
prop('selected');
```

However, it's more likely that your code will want to know which option in the selection list is selected. You do that by applying jQuery's `:selected` selector to the list's option elements:

```
var hairColor = $('#hair-color > option:selected').text();
```

If the list includes the `multiple` attribute, then `:selected` returns a set that contains all the selected elements.

Changing the selected option

To set a selection list option to either the selected or deselected state, assign a Boolean expression to the `selected` attribute:

```
$(option).prop('selected', Boolean)
```

- » `option`: A jQuery selector that specifies the option element you want to modify.
- » `Boolean`: The Boolean value or expression you want to assign to the option. Use `true` to select the option; use `false` to deselect the option.

For example, if the initial state of a multiple-selection list had no items selected, you might want to reset the list by deselecting all the options. You can do that by returning the set of all the selected options in the list, and then applying the `selected` attribute as `false`:

```
$('#hair-products > option:selected').prop('selected', false);
```

Programming pickers

HTML also offers a number of other `<input>` tag types that fall under a category I call “pickers,” meaning that in each case the field displays a button that, when clicked, opens a control that enables the user to pick a value. Here’s a quick look at the available pickers:

- » `color`: Opens a color picker dialog that enables the user to choose a color. The color picker varies depending on the browser and operating system; Figure 2-6 shows the Microsoft Edge version. Set the `value` attribute in the `#rrggbb` format to specify an initial color (the default is black: `#000000`). Here’s an example:

```
<input type="color" name="bg-color" value="#ff6347">
```

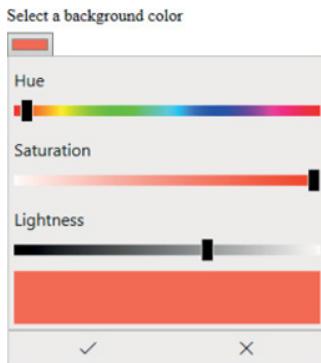


FIGURE 2-6:
The color picker
that appears in
Microsoft Edge.

» **date**: Opens a date picker dialog so that the user can choose a date. Figure 2-7 shows the Chrome version. Set the `value` attribute in the `yyyy-mm-dd` format to specify an initial date. Note that the date the user sees might use a different format (such as `mm/dd/yyyy`, as seen in Figure 2-7), but the value returned by the element is always in the `yyyy-mm-dd` format. Here's an example:

```
<input type="date" name="appt-date" value="2018-08-23">
```

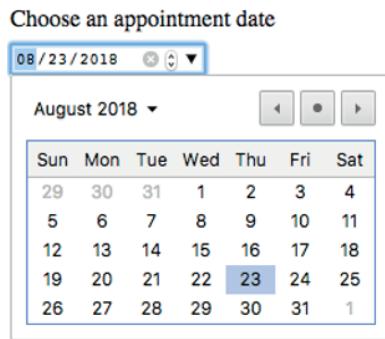


FIGURE 2-7:
The date picker
that appears in
Google Chrome
for Mac.

» **file**: Opens the user's operating system's file picker dialog so that the user can select a file. You can add the `multiple` attribute to enable the user to select more than one file. Here's an example:

```
<input type="file" name="user-photo">
```

- » month: Opens a month picker dialog to enable the user to choose a month and year. Set the value attribute in the yyyy-mm format to specify an initial month and year. The value the user sees might be in a different format (such as August 2018), but the value returned by the element is always in the yyyy-mm format. Here's an example:

```
<input type="month" name="birthday-month" value="2018-08">
```

- » week: Opens a week picker dialog for the user to select a week and year. To specify an initial year and month, set the value attribute in the yyyy-Wnn format, where nn is the two-digit week number. The value shown to the user might be in another format (such as Week 34, 2018), but the value returned by the element is always in the yyyy-Wnn format. Here's an example:

```
<input type="week" name="vacation-week" value="2018-W34">
```

Handling and Triggering Form Events

With all the clicking, typing, tabbing, and dragging that goes on, web forms are veritable event factories. Fortunately, you can let most of these events pass you by, but there are a few that come in handy, both in running code when the event occurs, and in triggering the events yourself.

Most form events are clicks, so you can handle them by setting click event handlers using jQuery's `.click()` method (which I cover in Book 4, Chapter 2). Here's an example:

HTML:

```
<form>
  <div>
    <label for="user">Username:</label>
    <input id="user" type="text" name="username">
  </div>
  <div>
    <label for="pwd">Password:</label>
    <input id="pwd" type="password" name="password">
  </div>
</form>
```

jQuery:

```
$(‘form’).click(function() {  
    console.log(‘Thanks for clicking the form!’);  
});
```

This example listens for clicks on the entire `form` element, but you can also create `click` event handlers for buttons, `input` elements, checkboxes, radio buttons, and more.

Setting the focus

One simple feature that can improve the user experience on your form pages is to set the focus on the first form field when your page loads. This saves the user from having to make that annoying click inside the first field.

To get this done, run jQuery's `focus()` method on the element you want to have the focus at startup:

```
$(field).focus();
```

» `field`: A selector that specifies the form field you want to have the focus

Here's an example that sets the focus on the text field with `id` equal to `user` at startup:

HTML:

```
<form>  
    <div>  
        <label for="user">Username:</label>  
        <input id="user" type="text" name="username">  
    </div>  
    <div>  
        <label for="pwd">Password:</label>  
        <input id="pwd" type="password" name="password">  
    </div>  
</form>
```

jQuery:

```
$(document).ready(function() {  
    $('#user').focus();  
});
```

Monitoring the focus event

Rather than setting the focus, you might want to monitor when a particular field gets the focus (for example, by the user clicking or tabbing into the field). You can do that by setting up a `focus()` event handler on the field:

```
$(field).focus(function() {  
    Focus code goes here  
});
```

» *field*: A selector that specifies the form field you want to monitor for the focus event

Here's an example:

```
$('#user').focus(function() {  
    console.log('The username field has the focus!');  
});
```

Blurring an element

One of the more annoying browser interface quirks is the focus ring that appears around certain elements — especially buttons — when you click them. This focus ring is not only ugly, but also slightly dangerous because it means the user can “click” the button again just by pressing the spacebar. You can work around this by applying jQuery's `blur()` method on the element, which causes it to lose focus:

```
$(field).blur();
```

» *field*: A selector that specifies the form field you no longer want to have the focus

Here's an example that uses a button element's `click` event handler to blur the button (in the handler, the expression `$(this)` refers to the element that was clicked, in this case the button):

HTML:

```
<button id="reset-products" type="button">  
    Reset Products  
</button>
```

jQuery:

```
$('#reset-products').click(function() {
    // Deselect everything
    $('#hair-products > option:selected').prop('selected',
    false);

    // Blur the button
    $(this).blur();
});
```

Monitoring the blur event

Rather than blurring an element, you might want to run some code when a particular element is blurred (for example, by the user clicking or tabbing out of the field). You can do that by setting up a `blur()` event handler:

```
$(field).blur(function() {
    Blur code goes here
});
```

- » `field`: A selector that specifies the form field you want to monitor for the blur event.

Here's an example:

```
$('#user').blur(function() {
    console.log('The username field no longer has the focus!');
});
```

Listening for element changes

One of the most useful form events is the `change` event, which fires when the value or state of a field is modified in some way. When this event fires depends on the element type:

- » For a `textarea` element and the various text-related `input` elements, the `change` event fires when the element loses the focus.
- » For checkboxes, radio buttons, selection lists, and pickers, the `change` event fires as soon as the user clicks the element to modify the selection or value.

You listen for a field's change events by setting up a `change()` event handler:

```
$(field).change(function() {  
    Change code goes here  
});
```

» *field*: A selector that specifies the form field you want to monitor for the change event

Here's an example:

HTML:

```
<div>  
    <label for="bgcolor">Select a background color</label>  
    <input id="bgcolor" type="color" name="bg-color"  
        value="#ffffff">  
</div>
```

jQuery:

```
$('#bgcolor').change(function() {  
    var bgColor = $(this).val();  
    $('body').css('background-color', bgColor);  
});
```

The HTML code sets up a color picker. The jQuery code applies the change event handler to the color picker. When the change event fires on the picker, the code stores the new color value in the `bgColor` variable, then applies that color to the body element's `background-color` property.

Submitting the Form

There's one form event that I didn't cover in the previous section, and it's a biggie: the `submit` event, which fires when the form data is to be sent to the server. Here's the general syntax:

```
$(form).submit(function(e) {  
    Submit code goes here  
});
```

- » *form*: A selector that specifies the form you want to monitor for the submit event.
- » *e*: This argument represents the event object.

You'll rarely, if ever, allow the `submit` event to occur directly. Instead, you'll want to intercept the `submit` so that you can gather the data and then send it to the server yourself using an Ajax call. Handling the `submit` event yourself gives you much more control over both what gets sent to the server and how what gets sent back from the server gets processed.

Triggering the submit event

Here's a list of the various ways that the `submit` event gets triggered:

- » When the user clicks a button or `input` element that resides within a `<form>` tag and has its `type` attribute set to `submit`
- » When the user clicks a `button` element that resides within a `<form>` tag and has no `type` attribute
- » When the user presses Enter or Return while a `form` element has the focus, and either a button or `input` element resides within the `<form>` tag and has its `type` attribute set to `submit`, or a `button` element resides within the `<form>` tag and has no `type` attribute
- » When your code runs jQuery's `.submit()` method:

```
$(form).submit();
```

- *form*: A selector that specifies the form you want to submit

Preventing the default form submission

You control the form submission yourself by sending the data to the server with an Ajax call. The `submit` event doesn't know that, however, and it will try to submit the form data anyway. That's a no-no, so you need to prevent the default form submission by using the event object's `preventDefault()` method:

```
$('form').submit(function(e) {
    e.preventDefault();
});
```

Preparing the data for submission

Before you can submit your form data, you need to convert it to a format that your server's PHP script can work with. The format depends on the Ajax request method you want to use:

- » GET: This format requires a string of *name=value* pairs, separated by ampersands (&). To convert your form data to this format, use jQuery's `serialize()` function:

```
$(form).serialize();
```

- *form*: A selector that specifies the form you want to work with

- » POST: This format requires an array of *key: value* pairs, separated by commas (,). To convert your form data to this format, use jQuery's `serializeArray()` function:

```
$(form).serializeArray();
```

- *form*: A selector that specifies the form you want to work with

For example:

```
var formData = $('form').serialize();
```

Most commonly, your code stores the result of the `serialize()` or `serializeArray()` function in a variable, and that variable gets submitted to the server.

Submitting the form data

Now you're almost ready to submit the data. As an example, here's some HTML code for a form and `div` that I'll use to output the form results:

```
<form>
  <div>
    <label for="first">First name:</label>
    <input id="first" type="text" name="first-name">
  </div>
  <div>
    <label for="last">Last name:</label>
    <input id="last" type="text" name="last-name">
  </div>
  <div>
    <label for="nick">Nickname:</label>
    <input id="nick" type="text" name="nickname">
  </div>
```

```

        </div>
        <button type="submit">Submit</button>
    </form>

    <div class="output">
    </div>

```

Now here's the JavaScript/jQuery code that submits the form (using `.get()` in this case) and processes the result (which just echoes back the form data, as shown in Figure 2-8):

```

$( 'form' ).submit(function(e) {
    // Prevent the default form submission
    e.preventDefault();

    // Convert the data to GET format
    var formData = $(this).serialize();

    // Submit the data using an Ajax GET request
    $.get('php/echo-form-fields-get.php', formData,
        function(data) {
            // Show the data returned by the server
            $('.output').html(data);
        });
});

```

| Field | Value |
|------------|---------------|
| first-name | Peter |
| last-name | Viscus |
| nickname | Slippery Pete |

FIGURE 2-8:
An example form submission.



We're missing one very important stop on our road to dynamic web pages: We haven't validated the form data! Form validation is so important, in fact, that I devote an entire chapter to it: Book 6, Chapter 3. Don't miss it!

IN THIS CHAPTER

- » **Validating data in the browser and on the server**
- » **Making a field mandatory**
- » **Setting restrictions on form fields**
- » **Practicing good data hygiene**

Chapter 3

Validating Form Data

Garbage in, garbage out. Or rather more felicitously: The tree of nonsense is watered with error, and from its branches swing the pumpkins of disaster.

— NICK HARKAWAY

In the old computing axiom of *garbage in, garbage out* (GIGO), or if in your genes or heart you're British, *rubbish in, rubbish out* (yes, RIRO), lies a cautionary tale. If the data that goes into a system is inaccurate, incomplete, incompatible, or in some other way invalid, the information that comes out of that system will be outdated, outlandish, outrageous, or just outright wrong. What does this have to do with you as a web developer? Plenty, because it's your job to make sure that the data the user enters into a form is accurate, complete, and compatible with your system. In a word, you have to make sure the data is valid. If that sounds like a lot of work, then I've got some happy news for you: HTML5 has data validation baked in, so you can just piggyback on the hard work of some real nerds. In this chapter, you explore these HTML5 validation techniques. Ah, but your work isn't over yet, friend. You also have to validate the same data once again on the server. Crazy? Like a fox. But there's more good news on the server side of things, because PHP has a few ready-to-run tools that take most of the pain out of validation. In this chapter, you also dive deep into those tools. Sleeves rolled up? Then let's begin.

Validating Form Data in the Browser

Before JavaScript came along, web servers would spend inordinate amounts of processing time checking the data submitted from a form and, all too often, returning the data back to the user to fill in an empty field or fix some invalid entry. Someone eventually realized that machines costing tens of thousands of dollars (which was the cost of the average server machine when the web was in swaddling clothes) ought to have better things to do with their time than chastising users for not entering their email address correctly (or whatever). Wouldn't it make infinitely more sense for the validation of a form's data to first occur within the browser *before* the form was even submitted?

The answer to that is an unqualified "Duh!" And once JavaScript took hold with its browser-based scripting, using it to do form validation on the browser became the new language's most important and useful feature. Alas, data validation is a complex business, so it didn't take long for everyone's JavaScript validation code to run to hundreds or even thousands of lines. Plus there was no standardization, meaning that every web project had to create its own validation code from scratch, pretty much guaranteeing it wouldn't work like any other web project's validation code. Isn't there a better way?

Give me another "Duh!" Perhaps that's why the big brains who were in charge of making HTML5 a reality decided to do something about the situation. Several types of form validation are part of HTML5, which means now you can get the web browser to handle your validation chores.



WARNING

HTML5 validation has huge browser support, so no major worries there. However, there's still a tiny minority of older browsers that will scoff at your browser validation efforts. Not to worry, though: You'll get them on the server side!

Making a form field mandatory

It's common for a form to contain at least one field that the user must fill in. For example, if your form is for a login, then you certainly need both the username and password fields to be mandatory, meaning you want to set up the form so that the submission won't go through unless both fields are filled in.

Here are a few things you can do to encourage users to fill in mandatory fields:

- » Make it clear which fields are mandatory. Many sites place an asterisk before or after a field and include a note such as `Fields marked with *` are required at the top of the form.

- » For a radio button group, always set up your form so that one of the `<input>` tags includes the `checked` attribute. This ensures that one option will always be selected.
- » For a selection list, make sure that one of the `<option>` tags includes the `selected` attribute.

Outside of these techniques, you can make any field mandatory by adding the `required` attribute to the form field tag. Here's an example:

```
<form>
  <div>
    <label for="fave-beatle">Favorite Beatle:</label>
    <input id="fave-beatle" type="text" required>
    <button type="submit">Submit</button>
  </div>
</form>
```

The `<input>` tag has the `required` attribute. If you leave this field blank and try to submit the form, the browser prevents the submission and displays a message telling you to fill in the field. This message is slightly different, depending on the web browser. Figure 3-1 shows the message that Chrome displays.

FIGURE 3-1:
Add the
required
attribute to a
form field to
ensure it gets
filled in.



Restricting the length of a text field

Another useful built-in HTML5 validation technique is setting restrictions on the length of the value entered into a text field. For example, you might want a password value to have a minimum length, and you might want a username to have a maximum length. Easier done than said:

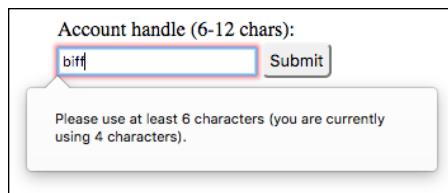
- » To add a minimum length restriction, set the `minlength` attribute to the least number of characters the user must enter.
- » To add a maximum length restriction, set the `maxlength` attribute to the most number of characters the user can enter.

Take a look at an example:

```
<form>
  <div>
    <label for="acct-handle">Account handle (6-12
    chars):</label>
    <input id="acct-handle"
      type="text"
      placeholder="Enter 6-12 characters"
      minlength="6"
      maxlength="12">
    <button type="submit">Submit</button>
  </div>
</form>
```

The `<input>` tag asks for a value no less than 6 and no more than 12 characters long. If the user enters a value shorter or longer and tries to submit the form, the browser prevents the submission and displays a message asking for more or fewer characters. Figure 3-2 shows the version of the message that Firefox displays.

FIGURE 3-2:
Use the
minlength
and/or
maxlength
attributes
to restrict a
field's length.



Setting maximum and minimum values on a numeric field

HTML5 can also validate a numeric field based on a specified minimum or maximum value for the field. Here are the attributes to use:

- » `min`: To add a minimum value restriction, set the `min` attribute to the smallest allowable value the user can enter.
- » `max`: To add a maximum value restriction, set the `max` attribute to the largest allowable value the user can enter.

Here's an example:

```
<form>
  <div>
```

```
<label for="loan-term">Loan term (years):</label>
<input id="loan-term"
       type="number"
       placeholder="3-25"
       min="3"
       max="25">
<button type="submit">Submit</button>
</div>
</form>
```

The number `<input>` tag asks for a value between 3 and 25. If the user enters a value outside of this range and tries to submit the form, the browser prevents the submission and displays a message to reenter a value that's either less than or equal to the maximum (as shown in Figure 3-3) or greater than or equal to the minimum.

FIGURE 3-3:
Use the `min` and/or `max` attributes to accept values within a specified range.

A screenshot of a web browser window. Inside, there is a form with a label "Loan term (years):" followed by an input field containing "30". To the right of the input field is a "Submit" button. Below the form, a red rectangular box contains a yellow exclamation mark icon and the text "Value must be less than or equal to 25." This indicates that the value entered (30) is outside the allowed range of 3 to 25.

Validating email fields

Generic field validation attributes such as `required`, `minlength`, and `max` are very useful, but some form fields need a more targeted validation technique. In a field that accepts an email address, for example, any entered value should look something like `username@domain`. If that sounds like a daunting challenge, you're right, it is. Fortunately, that challenge has already been taken up by some of the best coders on the planet. The result? Built-in HTML5 validation for email addresses. And when I say "built-in," I mean built-in, because once you specify `type="email"` in the `<input>` tag, modern web browsers will automatically validate the field input to make sure it looks like an email address when the form is submitted, as shown in Figure 3-4.

FIGURE 3-4:
Modern browsers automatically validate email fields.

A screenshot of a web browser window. Inside, there is a form with a label "Email:" followed by an input field containing "paul@". To the right of the input field is a "Submit" button. Below the form, a red rectangular box contains a yellow exclamation mark icon and the text "Please enter a part following '@'. 'paul@' is incomplete." This indicates that the email address is incomplete because it lacks a domain part after the '@' symbol.

Making field values conform to a pattern

One of the most powerful and flexible HTML5 validation techniques is *pattern matching*, where you specify a pattern of letters, numbers, and other symbols that the field input must match. You add pattern matching validation to a text, email, url, tel, search, or password field by adding the pattern attribute:

```
pattern="regular_expression"
```

- » *regular_expression*: A type of expression called a *regular expression* that uses special symbols to define the pattern you want to apply to the field

For example, suppose you want to set up a pattern for a ten-digit North American telephone number that includes dashes, such as 555-123-4567 or 888-987-6543. In a regular expression, the symbol \d represents any digit from 0 to 9, so your regular expression would look like this:

```
\d\d\d-\d\d\d-\d\d\d\d
```

Here's the regular expression added to a telephone number field:

```
<input id="user-phone"
       type="tel"
       pattern="\d\d\d-\d\d\d-\d\d\d\d"
       placeholder="e.g., 123-456-7890"
       title="Enter a 10-digit number in the format 123-456-7890">
```



TIP

It's a good idea to add the title attribute and use it to describe the pattern you want to user to enter. Also, you can find all kinds of useful, ready-made patterns at the HTML5 Pattern site: <http://html5pattern.com>.

Table 3-1 summarizes the most useful regular expression symbols to use with the pattern attribute. See “Regular Expressions Reference,” later in this chapter, for a more detailed look at this powerful tool.

From this table, you can see that an alternative way to write the 10-digit telephone regular expression would be the following:

```
[0-9]{3}-[0-9]{3}-[0-9]{4}
```

TABLE 3-1**The Most Useful Regular Expression Symbols**

| Symbol | Matches |
|----------|---|
| \d | Any digit from 0 through 9 |
| \D | Any character that is not a digit from 0 through 9 |
| . | Any character |
| \s | Any whitespace character, such as the space, tab (\t), newline (\n), and carriage return (\r) |
| \S | Any non-whitespace character |
| [] | Whatever characters are listed between the square brackets |
| [c1–c2] | Anything in the range of letters or digits from c1 to c2 |
| [^] | Everything except whatever characters are listed between the square brackets |
| [^c1–c2] | Everything except the characters in the range of letters or digits from c1 to c2 |
| ? | If the character preceding it appears just once or not at all |
| * | If the character preceding it is missing or if it appears one or more times |
| + | If the character preceding it appears one or more times |
| {n} | If the character preceding it appears exactly n times |
| {n,} | If the character preceding it appears at least n times |
| {n,m} | If the character preceding it appears at least n times and no more than m times |
| p1 p2 | Pattern p1 or pattern p2 |

Styling invalid fields

One useful thing you can do as a web developer is make it obvious for the user when a form field contains invalid data. Sure, the browser will display its little tooltip to alert the user when she submits the form, but that tooltip only stays onscreen for a few seconds. It would be better to style the invalid field in some way so the user always knows it needs fixing.

One straightforward way to do that is to take advantage of the CSS :invalid pseudo-selector, which enables you to apply a CSS rule to any invalid field.

For example, here's a rule that adds a red highlight around any `<input>` tag that is invalid:

```
input:invalid {  
    border-color: rgba(255, 0, 0, .5);  
    box-shadow: 0 0 10px 2px rgba(255, 0, 0, .8);  
}
```

The problem, however, is that the web browser checks for invalid fields as soon as it loads the page. So, for example, if you have fields with the `required` attribute that are initially empty when the page loads, the browser will flag those as invalid and apply the `invalid` styling. Your users will be saying, “Gimme a break, I just got here!”

One way to work around this problem is to display an initial message (such as `required`) beside each required field, then replace that message with something positive (such as a check mark) when the field is filled in.

Here's some code that does that:

CSS:

```
input:invalid+span::after {  
    content: '(required)';  
    color: red;  
}  
input:valid+span::after {  
    content: '\2713';  
    color: green;  
}
```

HTML:

```
<form>  
    <div>  
        <label for="user-name">Name:</label>  
        <input id="user-name"  
            type="text"  
            placeholder="Optional"  
            required>  
        <span></span>  
    </div>  
    <div>  
        <label for="user-email">Email:</label>  
        <input id="user-email"
```

```
        type="email"
        placeholder="e.g., you@domain.com"
        required>
    <span></span>
</div>
<button type="submit">Submit</button>
</form>
```

Notice in the HTML that both fields have the `required` attribute and both fields also have an empty `span` element right after them. Those `span` elements are where you'll put your messages, and that's what the CSS code is doing:

- » The first CSS rule looks for any invalid input field, then uses the adjacent sibling select (+) to select the `span` that comes immediately after the field. The `::after` pseudo-element adds the content (`required`) to the `span` and colors it red.
- » The second CSS rule is very similar, except that it looks for any valid input field, then adds a green check mark (given by Unicode character 2713) to the `span`.

Figure 3-5 shows these rules in action, where the Name field is valid and the Email field is invalid.

FIGURE 3-5:
The CSS rules add
a green check
mark to valid
fields, and the red
text (required)
to invalid fields.

The figure shows a simple HTML form with two fields. The first field is labeled "Name:" and contains the value "Paul". To the right of the input field is a small green checkmark icon. The second field is labeled "Email:" and contains the placeholder text "e.g., you@domain.com". To the right of the input field is the red text "(required)". Below the fields is a "Submit" button.

Another approach is to use jQuery to listen for the `invalid` event firing on any input element. The `invalid` event fires when the user tries to submit the form and one or more fields contain invalid data. In your event handler, you could then apply a predefined class to the invalid field. Here's some code that does just that:

CSS:

```
.error {
    border-color: rgba(255, 0, 0, .5);
    box-shadow: 0 0 10px 2px rgba(255, 0, 0, .8);
}
```

```
input:valid {  
    border-color: lightgray;  
    box-shadow: none;  
}
```

HTML:

```
<form>  
    <div>  
        <label for="user-name">Name:</label>  
        <input id="user-name"  
            type="text"  
            placeholder="Your name"  
            required>  
    </div>  
    <div>  
        <label for="user-email">Email:</label>  
        <input id="user-email"  
            type="email"  
            placeholder="e.g., you@domain.com"  
            required>  
    </div>  
    <button type="submit">Submit</button>  
</form>
```

jQuery:

```
$("input").on("invalid", function() {  
    $(this).addClass('error');  
});
```

The HTML is the same as in the previous example, minus the extra `` tags. The CSS code defines a rule for the `error` class that uses `border-color` and `box-shadow` to add a red-tinged highlight to an element. The `input:valid` selector removes the border and box shadow when the field becomes valid. The jQuery code listens for the `invalid` event on any `input` element. When it fires, the event handler adds the `error` class to the element.

Validating Form Data on the Server

You might have looked at the title of this section and cried, “The server! But we just went through validating form data in the browser! Surely we don’t have to validate on the server, as well!” First of all, calm down. Second, yep, it would be

nice if we lived in a world where validating form data in the web browser was good enough. Alas, that Shangri-La doesn't exist. The problem, you see, is that there are still a few folks surfing with very old web browsers that wouldn't know HTML5 from Maroon 5, and so don't support either `<input>` tag types such as `number`, `email`, and `date`, or browser-based validation. It's also possible that someone might, innocently or maliciously, bypass your form and send data directly to the server (say, by using a URL query string).

Either way, you can't be certain that the data that shows up on the server's doorstep has been validated, so it's up to your server script to ensure the data is legit before processing it. Happily, as you see in the next few sections, PHP is loaded with features that make validating data straightforward and painless.

Checking for required fields

If one or more fields in your form are mandatory, you can check those fields on the server by using PHP's `empty()` function:

```
empty(expression)
```

» *expression*: The literal, variable, expression, or function result that you want to test

The `empty()` function returns `FALSE` if the expression exists and has a non-empty, non-zero value; it returns `TRUE`, otherwise.

I'll go through a complete example that shows one way to handle validation errors on the server. First, here's some HTML:

```
<form>
  <div>
    <label for="user-name">Name</label>
    <input id="user-name"
           type="text"
           name="user-name">
  </div>
  <div>
    <label for="user-email">Email</label>
    <input id="user-email"
           type="email"
           name="user-email">
  </div>
  <button type="submit">Submit</button>
```

```
</form>
<article class="output"></article>
```

The form has two text fields, and there's also an `<article>` tag that you'll use a bit later to output the server results.

On the server, I created a PHP file named `validate-required-fields.php`:

```
<?php
    // Store the default status
    $server_results['status'] = 'success';

    // Check the user-name field
    if(isset($_GET['user-name'])) {
        $user_name = $_GET['user-name'];
        // Is it empty?
        if(empty($user_name)) {
            // If so, update the status and add an error
            message for the field
            $server_results['status'] = 'error';
            $server_results['user-name'] = 'Missing user name';
        }
    }
    // Check the user-email field
    if(isset($_GET['user-email'])) {
        $user_email = $_GET['user-email'];
        // Is it empty?
        if(empty($user_email)) {
            // If so, update the status and add an error
            message for the field
            $server_results['status'] = 'error';
            $server_results['user-email'] = 'Missing email
address';
        }
    }
    // If status is still "success", add the success message
    if($server_results['status'] === 'success') {
        $output = "Success! Thanks for submitting the form,
$user_name";
        $server_results['output'] = $output;
    }
    // Create and then output the JSON data
    $JSON_data = json_encode($server_results, JSON_HEX_APOS |
    JSON_HEX_QUOT);
```

```
echo $JSON_data;  
?>
```

This script uses the `$server_results` associative array to store the data that gets sent back to the browser. At first the array's `status` key is set to `success`. Then the script checks the `user-name` field from the `$_GET` array: If the field is empty, the array's `status` key is set to `error` and an array item is added that sets an error message for the field. The same process is then used for the `user-email` field. If after those checks the array's `status` key is still set to `success` (meaning there were no validation errors), then the array is updated with a success message. Finally, the array is converted to JSON and outputted.

Back on the client, the `form` element's `submit` event handler converts and submits the form data, and then processes the result:

```
$( 'form' ).submit( function(e) {  
  
    // Prevent the default form submission  
    e.preventDefault();  
  
    // Convert the data to a query string  
    var formData = $(this).serialize();  
  
    // Send the data to the server  
    $.getJSON('php/validate-required-fields.php', formData,  
    function(data) {  
  
        // Display the output element  
        $('.output').css('display', 'block');  
  
        // Check the validation status  
        if(data.status === 'success') {  
            // Output the success result  
            $('.output').html(data.output);  
        } else {  
            // Output the validation error(s)  
            $('.output').html('<section>Whoops! There were  
errors:</section>');  
            $.each(data, function(key, error) {  
                if(key !== 'status') {  
                    // Get the label text  
                    var label = $('label[for=' + key +  
']').text();  
                    $('.output').append('<section>Error in ' +  
label + ' field: ' + error + '</section>');  
                }  
            });  
        }  
    });  
});
```

```
        }
    });
}
});
```

Note, in particular, the `.getJSON()` callback function checks the value of `data.status`: If it equals `success`, the script's success message is displayed. Otherwise, the `.each()` loop adds each error message to the output element. Figure 3–6 shows an example.

FIGURE 3-6:
Some example validation error messages returned from the server script.

The screenshot shows a simple form with two fields: 'Name' and 'Email'. Below the form is a red box containing error messages: 'Whoops! There were errors:', 'Error in Name field: Missing user name', and 'Error in Email field: Missing email address'. A green 'Submit' button is located below the fields.

Validating text data

Besides validating that a text field exists, you might also want to perform two other validation checks on a text field:

» **The field contains alphabetic characters only.** To ensure the field contains only lowercase or uppercase letters, use the `ctype_alpha()` function:

```
ctype_alpha(text)
```

- `text`: Your form field's text data

The `ctype_alpha()` function returns `TRUE` if the field contains only letters, `FALSE` otherwise.

» **The field length is greater than some minimum and/or less than some maximum value.** To check the length of the field, use the `strlen()` function:

```
strlen(text)
```

- `text`: Your form field's text data

The `strlen()` function returns the number of characters in the field.

Here's some PHP code that performs these checks on a form field called `user-name`:

```
<?php
    // Store the default status
    $server_results['status'] = 'success';

    // Check the user-name field
    if(isset($_GET['user-name'])) {
        $user_name = $_GET['user-name'];
        // Is it empty?
        if(empty($user_name)) {
            // If so, update the status and add an error
            message for the field
            $server_results['status'] = 'error';
            $server_results['user-name'] = 'Missing user name';
        } else {
            // Does it contain non-alphabetic characters?
            if(!ctype_alpha($user_name)){
                // If so, update the status and add an error
                message for the field
                $server_results['status'] = 'error';
                $server_results['user-name'] = 'User name must
                be text';
            } else {
                // Does the user name contains less than 3 or
                more than 12 characters?
                if(strlen($user_name) < 3 || strlen($user_name)
                > 12) {
                    // If so, update the status and add an error
                    message for the field
                    $server_results['status'] = 'error';
                    $server_results['user-name'] = 'User name
                    must be 3 to 12 characters long';
                }
            }
        }
    }
    // If status is still "success", add the success message
    if($server_results['status'] === 'success') {
        $output = "Success! Thanks for submitting the form,
        $user_name.";
        $server_results['output'] = $output;
    }
}
```

```
// Create and then output the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
echo $JSON_data;
?>
```

Validating a field based on the data type

If you want to ensure the value of a field is a particular data type, PHP offers a powerful function called `filter_var()` that can help:

```
filter_var(var, filter, options)
```

- » *var*: The variable, expression, or function result you want to check.
- » *filter*: An optional constant value that determines the data type you want to check. Here are some useful filters:
 - FILTER_VALIDATE_BOOLEAN: Checks for a Boolean value.
 - FILTER_VALIDATE_EMAIL: Checks for a valid email address.
 - FILTER_VALIDATE_FLOAT: Checks for a floating point value.
 - FILTER_VALIDATE_INT: Checks for an integer value.
 - FILTER_VALIDATE_URL: Checks for a valid URL.
- » *options*: An optional array that sets one or more options for the *filter*. For example, FILTER_VALIDATE_INT accepts the options `min_range` and `max_range`, which set the minimum and maximum allowable integers. Here's the setup for a minimum of 0 and a maximum of 100:

```
array('options' => array('min_range' => 0, 'max_range' =>
100))
```

The `filter_var()` function returns the data if it's valid according to the specified filter; if the data isn't valid, the function returns FALSE (or NULL, if you're using FILTER_VALIDATE_BOOLEAN).

Here's an example script that checks for integer values within an allowable range:

```
<?php
// Store the default status
$server_results['status'] = 'success';
```

```
// Check the user-age field
if(isset($_GET['user-age'])) {
    $user_age = $_GET['user-age'];
    // Is it empty?
    if(empty($user_age)) {
        // Add an error message for the field
        $server_results['status'] = 'error';
        $server_results['user-age'] = 'Missing age value';
    } else {
        // Is the field not an integer?
        if(!filter_var($user_age, FILTER_VALIDATE_INT)){
            // Add an error message for the field
            $server_results['status'] = 'error';
            $server_results['user-age'] = 'Age must be an
integer';
        } else {
            // Is the age not between 14 and 114?
            $options = array('options' => array('min_range'
=> 14, 'max_range' => 114));
            if(!filter_var($user_age, FILTER_VALIDATE_INT,
$options)) {
                // Add an error message for the field
                $server_results['status'] = 'error';
                $server_results['user-age'] = 'Age must be
between 14 and 114';
            }
        }
    }
}
// If status is "success", add the success message
if($server_results['status'] === 'success') {
    $output = "Success! You don't look a day over " .
intval($user_age - 1) . ".";
    $server_results['output'] = $output;
}
// Create and then output the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
echo $JSON_data;
?>
```

The script uses `filter_var($user_age, FILTER_VALIDATE_INT)` twice: first without and then with the `options` parameter. The first instance just checks for an integer value, whereas the second checks for an integer between 14 and 114. The integer check is redundant here, but I added both so you could get a feel for how `filter_var()` works.

Validating against a pattern

If you want to use a regular expression to validate a field value, PHP says “No problem!” by offering you the `preg_match()` function. Here’s the simplified syntax:

```
preg_match(pattern, string)
```

- » *pattern*: The regular expression, which you enter as a string. Note, too, that the regular expression must be surrounded by slashes (/).
- » *string*: The string (such as a form field value) that you want to match against the regular expression.

The `preg_match()` function returns TRUE if *string* matches *pattern*, and FALSE, otherwise.

For example, suppose you want to check an account number to ensure that it uses the pattern AA-12345 — that is, two uppercase letters, a hyphen, then five numbers. Assuming the value is stored in a variable named `$account_number`, here’s a `preg_match()` function that will validate the variable:

```
preg_match('/[A-Z]{2}-[0-9]{5}/', $account_number)
```

Regular Expressions Reference



TECHNICAL
STUFF

You can validate form data using regular expressions either in the web browser by adding a `pattern` attribute to the field, or on the server by using PHP’s `preg_match()` function. To help you get the most out of these powerful techniques, the rest of this chapter takes you through some examples that show you how to use the regular expression symbols. In the examples that follow, remember to surround the regular expression with slashes (/) when you use it in the `preg_match()` function; you don’t need the slashes when you use the regular expression as a `pattern` attribute value.

Here are the symbols you can use in your regular expressions:

- » `\d`: Matches any digit from 0 through 9:

| Regular Expression | String | Match? |
|-----------------------|--------|--------|
| <code>\d\d\d</code> | "123" | Yes |
| <code>\d\d\d\d</code> | "123" | No |

| Regular Expression | String | Match? |
|--------------------|----------------|--------|
| \d\d\d | "12C" | No |
| \d\d\d-\d\d\d- | "123-555-6789" | Yes |

» \D: Matches any character that's not a digit from 0 through 9:

| Regular Expression | String | Match? |
|--------------------|----------|--------|
| /\D\D\D/ | "AB! " | Yes |
| /\D\D\D/ | "A1B" | No |
| /\D-\D\D\D\D/ | "A-BCDE" | Yes |

» \w: Matches any character that's a letter, a digit, or an underscore (_):

| Regular Expression | String | Match? |
|--------------------|--------|--------|
| \w\w\w | "F1" | Yes |
| \w\w\w | "F+1" | No |
| A\w\ | "A" | Yes |
| A\w\ | "A!" | No |

» \W: Matches any character that's not a letter, a digit, or an underscore (_):

| Regular Expression | String | Match? |
|--------------------|--------|--------|
| \W\W\W\W | "<!--" | Yes |
| \W\W\W | "<a>" | No |
| 1\W\ | "10" | No |
| 1\W\ | "1!" | Yes |

» . (dot): Matches any character that's not a newline:

| Regular Expression | String | Match? |
|--------------------|--------|--------|
| | "ABCD" | Yes |
| | "123" | No |
| A.. | "A@B" | Yes |

» \s: Matches any whitespace character, such as the space, tab (\t), newline (\n), and carriage return (\r):

| Regular Expression | String | Match? |
|--------------------|------------|--------|
| \d\d\d\s\d\d\d | "123 4567" | Yes |
| \d\d\d\s\d\d\d | "123-4567" | No |
| \d\d\d\s\d\d\d | "123 4567" | No |

» \S: Matches any non-whitespace character:

| Regular Expression | String | Match? |
|--------------------|------------|--------|
| \d\d\d\S\d\d\d | "123 4567" | No |
| \d\d\d\S\d\d\d | "123-4567" | Yes |
| A\S B | "A+B" | Yes |

» []: Matches whatever characters are listed between the square brackets. The [] symbol also accepts a range of letters and/or digits:

| Regular Expression | String | Match? |
|-----------------------------|-----------------|--------|
| [+-]\d\d\d | "+123" | Yes |
| [+-]\d\d\d | "\$123" | No |
| [2468]-A | "2-A" | Yes |
| [2468]-A | "1-A" | No |
| [(]\d\d\d[)]\d\d\d\d-\d\d\d | "(123)555-6789" | Yes |

| Regular Expression | String | Match? |
|--------------------|--------|--------|
| [A-Z]\d\d\d | "A123" | Yes |
| [A-Z]\d\d\d | "a123" | No |
| [A-Za-z]\d\d\d | "a123" | Yes |
| [0-5]A | "3A" | Yes |
| [0-5]A | "6A" | No |
| [0-59]A | "9A" | Yes |



REMEMBER

Remember that the range [0-59] matches the digits 0 to 5 or 9 and *not* the range 0 to 59.

- » `[^]`: Matches everything but whatever characters are listed between the square brackets. As with the `[]` symbol, you can use letter or digit ranges.

| Regular Expression | String | Match? |
|--------------------|--------|--------|
| [^+-]\d\d\d | "+123" | No |
| [^+-]\d\d\d | "123" | Yes |
| [^2468]-A | "2-A" | No |
| [^2468]-A | "1-A" | Yes |
| [^A-Z]\d\d\d | "A123" | No |
| [^A-Z]\d\d\d | "a123" | Yes |
| [^A-Za-z]\d\d\d | "#123" | Yes |
| [^0-5]A | "3A" | No |
| [^0-5]A | "6A" | Yes |
| [^0-59]A | "9A" | No |

- » `\b`: Matches one or more characters if they appear on a word boundary (that is, at the beginning or the end of a word). If you place `\b` before the characters, it matches if they appear at the beginning of a word; if you place `\b` after the characters, it matches if they appear at the end of a word.

| Regular Expression | String | Match? |
|--------------------|---------|--------|
| \bode | "odeon" | Yes |
| \bode | "code" | No |
| ode\b | "code" | Yes |
| ode\b | "odeon" | No |
| \bode\b | "ode" | Yes |

» \B: Matches one or more characters if they don't appear on a word boundary (the beginning or the end of a word). If you place \B before the characters, it matches if they don't appear at the beginning of a word; if you place \B after the characters, it matches if they don't appear at the end of a word.

| Regular Expression | String | Match? |
|--------------------|---------|--------|
| \Bode/ | "odeon" | No |
| \Bode/ | "code" | Yes |
| /ode\B/ | "code" | No |
| /ode\B/ | "odeon" | Yes |
| \Bode\B/ | "code" | No |
| \Bode\B/ | "coder" | Yes |

» ?: Matches if the character preceding it appears just once or not at all:

| Regular Expression | String | Match? |
|--------------------|----------|--------|
| e-?mail | "email" | Yes |
| e-?mail | "e-mail" | Yes |
| e-?mail | "e-mail" | No |
| e-?mail | "e:mail" | No |

» *: Matches if the character preceding it is missing or if it appears one or more times:

| Regular Expression | String | Match? |
|--------------------|----------|--------|
| e-*mail | "email" | Yes |
| e-*mail | "e-mail" | Yes |
| e-*mail | "e-mail" | Yes |
| e-*mail | "e:mail" | No |

» `+`: Matches if the character preceding it appears one or more times:

| Regular Expression | String | Match? |
|--------------------|-----------|--------|
| e-+mail | "email" | No |
| e-+mail | "e-mail" | Yes |
| e-+mail | "e--mail" | Yes |
| e-+mail | "e:mail" | No |

» `{n}`: Matches if the character preceding it appears exactly n times:

| Regular Expression | String | Match? |
|--------------------|--------------|--------|
| lo{2}p | "loop" | Yes |
| lo{2}p | "lop" | No |
| \d{5} | "12345" | Yes |
| \d{5}-\d{4} | "12345-6789" | Yes |

» `{n,}`: Matches if the character preceding it appears at least n times:

| Regular Expression | String | Match? |
|--------------------|---------|--------|
| lo{2,}p | "loop" | Yes |
| lo{2,}p | "lop" | No |
| lo{2,}p | "looop" | Yes |
| \d{5,} | "12345" | Yes |

| Regular Expression | String | Match? |
|--------------------|----------|--------|
| \d{5,} | "123456" | Yes |
| \d{5,} | "1234" | No |

» $\{n,m\}$: Matches if the character preceding it appears at least n times and no more than m times:

| Regular Expression | String | Match? |
|--------------------|----------|--------|
| lo{1,2}p | "loop" | Yes |
| lo{1,2}p | "lop" | Yes |
| lo{1,2}p | "looop" | No |
| \d{1,5} | "12345" | Yes |
| \d{1,5} | "123456" | No |
| \d{1,5} | "1234" | Yes |

» ^: Matches if the characters that come after it appear at the beginning of the string:

| Regular Expression | String | Match? |
|--------------------|--------------|--------|
| ^Java | "JavaScript" | Yes |
| ^Java | "HotJava" | No |
| ^[^+-]?\d\d\d | "123" | Yes |
| ^[^+-]?\d\d\d | "+123" | No |

» \$: Matches if the characters that come after it appear at the end of the string:

| Regular Expression | String | Match? |
|--------------------|--------------|--------|
| Java\$ | "JavaScript" | No |
| Java\$ | "HotJava" | Yes |

| Regular Expression | String | Match? |
|--------------------|----------|--------|
| \d\d.\d% | "12.3%" | Yes |
| \d\d.\d% | "12.30%" | No |



TIP

If you need to include one of the characters from a regular expression symbol as a literal in your expression, escape the character by preceding it with a backslash (\). For example, suppose you want to see if a string ends with .com. The following regular expression won't work:

```
.com$
```

That's because the dot (.) symbol represents any character except a newline. To force the regular expression to match only a literal dot, escape the dot, like this:

```
\.com$
```

- » | : Place this symbol between two patterns, and the regular expression matches if the string matches one pattern or the other. (Don't confuse this symbol with JavaScript's OR operator: ||.)

| Regular Expression | String | Match? |
|----------------------------|--------------|--------|
| ^(\d{5} \d{5}-\d{4})\$ | "12345" | Yes |
| ^(\d{5} \d{5}-\d{4})\$ | "12345-6789" | Yes |
| ^(\d{5} \d{5}-\d{4})\$ | "123456789" | No |



REMEMBER

The preceding examples use parentheses to group the two patterns together. With regular expressions, you can use parentheses to group items and set precedence, just as you can with JavaScript expressions. A regular expression of the form `^(pattern)$` means that the pattern defines the entire string, not just some of the characters in the string.

Coding Web Apps

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- » Learning about web apps
- » Planning your app's data, workflow, and interface
- » Planning a responsive web app
- » Planning an accessible web app
- » Becoming familiar with web app security issues

Chapter 1

Planning a Web App

*What you can do, or dream you can, begin it,
Boldness has genius, power, and magic in it.*

— JOHANN WOLFGANG VON GOETHE

There are many reasons to get and stay interested in web coding and development. Here are just a few: the challenge of learning something new; the confidence that comes from figuring out hard or complex problems; the satisfactions that inhere from getting code to work; the desire to get a job in web development; the feeling that you're operating right at the leading edge of the modern world. These are all great and motivating reasons to code for the web, but there's another reason to dive deep into CSS and JavaScript and all the rest: as an outlet for your creative side. Sure, anybody who learns a bit of HTML and a few CSS properties can put up pages of information, but as a full-stack web developer who also knows JavaScript, jQuery, MySQL, and PHP, you've got all the tools you need to create bold and beautiful apps for the web. That's where the real creativity lies: having a vision of something cool, interesting, and fun and then using code to realize that vision for other people to see and use. This minibook helps you unleash the right side of your brain and make your creative vision a reality by showing you how to use all your web coding and development skills and know-how to build web apps. First up: the all-important planning process.

What Is a Web App?

If you go to the web home for a company called Alphabet (<https://abc.xyz>), you get a general introduction to the company, plus some information for investors, news releases, links to corporate documents such as the company bylaws, and so on. But Alphabet is also the parent company for some of the web's most iconic spots:

- » **Google** (www.google.com): Search the web.
- » **Gmail** ([https://mail.google.com](http://mail.google.com)): Send and receive email messages.
- » **Google Maps** ([https://maps.google.com](http://maps.google.com)): Locate and get directions to places using maps.
- » **YouTube** (www.youtube.com): Play and upload videos.

What's the difference between the parent Alphabet site and these other sites? Lots, of course, but there are two differences that I think are most important:

- » Each of the other sites is focused on a single task or topic: searching, emailing, maps, or videos.
- » Each of the other sites offers an interface that enables the user to "operate" the site in some way. For example, Google has a simple search form, whereas Gmail looks like an email Inbox and offers commands such as Compose and Reply.



REMEMBER

In other words, the Alphabet home is a basic website that's really just a collection of documents you can navigate, whereas the likes of Google, Gmail, Google Maps, and YouTube are more like the applications you use on your computer. They are, in short, *web apps*, because although they reside on the web and are built using web technologies such as HTML, CSS, JavaScript, MySQL, and PHP, they enable you to perform tasks and create things just like a computer application.

Fortunately, you don't have to have an idea for the next YouTube or Gmail to get started coding web apps. (Although, hey, if you do, I say go for it!) Web apps can be anything you want, as long as they enable you or your users to do something. If that something happens to be fun, creative, interesting, or useful, then congratulations: You've made the world a better place.

Planning Your Web App: The Basics

If you're like me, when you come up with an exciting idea for a web app, the first thing you want to do is open your trusty text editor and start bashing out some code. That's a satisfying way to go, but, believe me, that satisfaction dissipates awfully fast when you're forced to go back and redo a bunch of code or completely restructure your database because, in your haste, you took a wrong turn and ended up at a dead end or too far from your goal.

I plea, then, for just a bit of restraint so that you can spend the first hour or two of your project thinking about what you want to build and laying out the steps required to get there. Think of it like planning a car trip. You know your destination, but it's unlikely you'll want to just get in the car and start driving in the general direction of your goal. You need to plan your route, load up with supplies such as gas, water, and food, gather tools such as a GPS, and so on. To figure out the web-development equivalents of such things, it helps to ask yourself five questions:



REMEMBER

- » What is my app's functionality?
- » What are my app's data requirements?
- » How will my app work?
- » How many pages will my app require?
- » What will my app's pages look like?

The next few sections go through these questions both in a general way and more specifically with the app I'm going to build. It's called FootPower! and it's a simple app for logging and viewing foot-propelled activities such as walking, running, and cycling.

What is my app's functionality?

The first stage in planning any web app is understanding what you want the app to do. You can break this down into two categories:

- » **User functions:** These are the tasks that the user performs when she operates whatever controls your app provides. The standard four tasks are given by the unfortunately named CRUD acronym: creating, reading, updating, and deleting.
- » **App functions:** These are tasks that your app performs outside of the interface controls. Examples are creating user accounts, signing users in and out, handling forgotten passwords, and backing up data.

For FootPower!, here's a list of the user functions I want to implement:

- » Creating new activities, each of which records activity details such as the type of activity, and the activity date, distance, and duration
- » Viewing previous activities, with the capability to filter the activities by date and type
- » Editing an existing activity
- » Deleting an activity

Here are the app functions I want to implement:

- » Creating new users
- » Verifying new users by sending a verification email
- » Signing existing users in and out
- » Maintaining a user's app settings
- » Handling forgotten passwords
- » Deleting a user account

What are my app's data requirements?

Web apps don't necessarily have to use a back end. If your web app is a calculator, for example, then you'd only need to present the front-end interface to the user; no back-end database or Ajax calls are required. (I talk about how to build an app that doesn't require a back end in Book 8.) But if your app requires persistent data — which might be data you supply or data that's created by each user — then you need to store that data in a MySQL database and use Ajax calls to transfer that data between the browser and the server.



REMEMBER

Before you load up phpMyAdmin, however, you need to sit down and figure out what you want to store in your database. Web app data generally falls into three categories:

- » **User data:** If your app has user accounts, then you need to store account data such as the username or email address, password, profile settings, and site preferences.
- » **User-generated data:** If your app enables users to create things, then you need to save that data so that it can be restored to the user the next time he signs in.

» **App data:** If your app presents data to users, then you need to store that data in MySQL. You might also want to store behind-the-app-scenes data such as analytics and visitor statistics.

My FootPower! app's data requirements fall into two segments:

- » The app will have user accounts, so I need a MySQL table to store each account's email address, password, verification status, and a few site preferences.
- » Users will be recording their foot-propelled movements, so I need two tables to store this data:
 - Each user is creating a log of his activities, so I need a table to record the data for each of these logs, basically just a unique log ID, the ID of the user who owns the log, and the date the log was created.
 - Within each user's log will be the activities themselves, which I'll store in a separate table that includes a unique ID for each activity, the user's log ID, and fields for each chunk of activity data: type, date, distance, and duration.

How will my app work?



REMEMBER

Once you know what you want your app to do and what data your app requires, you're ready to tackle how your app works. This is called the app's *workflow* and it covers at a high level what the app does and the order in which it does those things. A simple flowchart is usually the way to go here: Just map out what happens from the time users type in your app URL to the time they leave the page.

Figure 1-1 shows the workflow I envision for my FootPower! app.

How many pages will my app require?

Your app's workflow should tell you fairly specifically how many pages your app needs. Most web apps are focused on a single set of related tasks, so your users will spend most of their time on the page that provides the app's main interface, usually the home page. However, your app will need other pages to handle tasks such as registering users, signing in users, and displaying account options. Record every page you need, which will act as an overall to-do list for the front end.

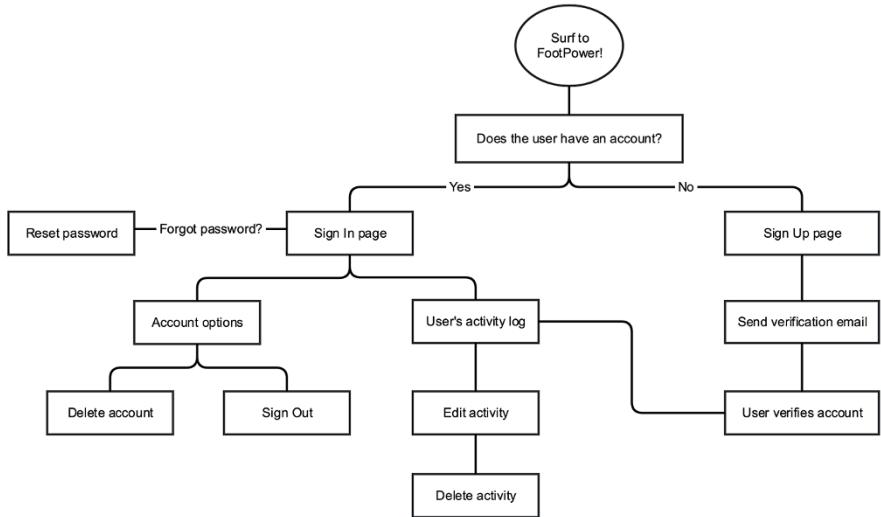


FIGURE 1-1:
The workflow
for my Foot-
Power! app.

Here's my list for the FootPower! app:

- » The home page, which will require two versions:
 - The unregistered or signed-out version of the home page, which will serve as a kind of ad for the app
 - The signed-in version, which will show the user's activity log and enable log-based tasks such as creating, filtering, editing, and deleting activities
- » A page that enables new users to register
- » A page letting new users know that a verification email has been sent
- » A sign-in page
- » A page that enables the user to edit and delete activities
- » A password reset page
- » An account options page
- » An account delete page

What will my app's pages look like?

Before you start laying down your HTML and CSS code, you need to have a decent sense of what you want your app's pages to look like. Sure, all of that might be in your head, but it really pays in the long run to get those images down on paper with a sketch or two. These sketches don't have to be fancy in the least. Just take

a pen, pencil, or your favorite Crayola color and rough out the overall structure. Simple forms (such as those for signing in or resetting a password) don't require much effort, but for more elaborate pages, such as your app's home page, you need to flesh out the design a bit: header, navigation, main content, sidebar, footer, and so on.

Figure 1-2 shows my sketch for the home page that a signed-in user will see.

The sketch depicts a web page layout for a fitness tracking application. At the top left is the 'FootPower!' logo. To its right are 'Your Account' and 'Sign Out' buttons. Below the header is a section titled 'Your Activity Log' with a 'Log an Activity' button. A search bar allows users to filter activities by date ('From 2018-05-01 to 2018-06-01') and type ('Type All'). A table lists activity logs:

| Type | Date | Distance | Duration | Edit |
|-------|------------|----------|----------|--------|
| Run | 2018-05-31 | 8.05 | 00:42:15 | [icon] |
| Walk | 2018-05-24 | 10.00 | 01:05:00 | [icon] |
| Cycle | 2018-05-28 | 20.50 | 00:40:15 | [icon] |
| Run | 2018-05-26 | 10.17 | 00:53:40 | [icon] |
| Run | 2018-05-24 | 12.00 | 01:05:42 | [icon] |
| Walk | 2018-05-23 | 8.00 | 01:28:00 | [icon] |
| Cycle | 2018-05-22 | 40.00 | 01:20:15 | [icon] |

To the right of the activity log is a 'Activity Summary' sidebar containing statistics for all activities, walks, runs, and rides.

FIGURE 1-2:
A sketch of
the signed-in
user's home
page for the
FootPower! app.

Planning Your Web App: Responsiveness

A web app is something like the online equivalent of a desktop program, but that doesn't mean you should build your web app to look good and work properly only on desktop-sized screens. Why not? For the simple reason that your app's visitors will be using a wide range of device sizes, from PCs with gigantic displays several feet wide, all the way down to smartphones with screens just a few inches wide. On the modern web, one size definitely does not fit all, so you need to plan your app so that its *user experience* (UX, to the cognoscenti) — that is, what visitors see and interact with — is positive for everyone.



REMEMBER

To make your web app look good and operate well on any size screen, you need to plan your app with *responsiveness* in mind. A responsive web app is one that changes its layout, styling, and often also its content to ensure that the app works on whatever screen the reader is using.

To see why you need to code responsively from the start of your web app, consider the two main non-responsive layouts you could otherwise use:

- » **Fixed-width:** A layout where the width of the content is set to a fixed size. In this case, if the fixed-width is greater than the width of the screen, most of the time the user has to scroll horizontally to see all the content, as shown in Figure 1-3.

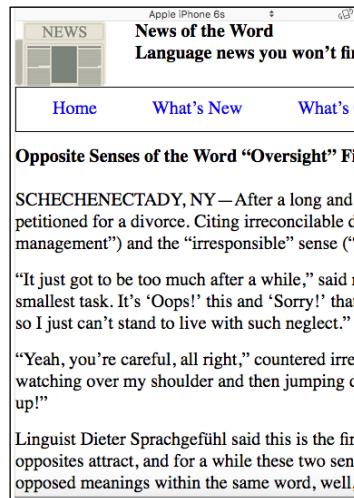


FIGURE 1-3:
When a page has
a fixed width,
users with small
screens have to
scroll horizontally
to see all the
content.

- » **No-width:** A layout where the width of the content has no set width. You might think having no width would enable the text and images to wrap nicely on a small screen, and you'd be right. However, the problem is on larger screens, where your text lines expand to fill the browser width and, as you can see in Figure 1-4, those lines can become ridiculously long, to the point where scanning the lines becomes just about impossible.

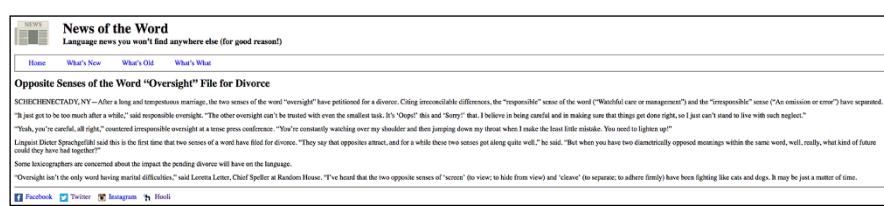


FIGURE 1-4:
When a page has
no maximum
width, the lines
of text become
too long for
comfortable
reading.

To work around these problems and to ensure your web app looks good on any screen size, you need to implement the following responsive techniques:

- » **Set the viewport:** To ensure that your layout works well in smaller screens, use the following `<meta>` tag to tell the browser to set the viewport width to the width of the current device's screen, and to set the viewport's zoom level to 1 (that is, not zoomed in or zoomed out).

```
<meta name="viewport" content="width=device-width,  
initial-scale=1.0">
```

- » **Liquid layout:** A layout in which the overall width is set to a maximum (so that text lines never get too long to read), but the page elements have their widths set in percentages (or a similar relative measure such as `viewport width: vw`). Since even really old web browsers support percentages, this is a good fallback layout to use. For example:

CSS:

```
body {  
    max-width: 800px;  
}  
article {  
    width: 67%;  
}  
aside {  
    width: 33%;  
}
```

HTML:

```
<body>  
    <main>  
        <article>  
        </article>  
        <aside>  
        </aside>  
    </main>  
</body>
```

» **Flexible layout:** A layout that uses flexbox to automatically wrap items when the browser window is too narrow to contain them. You set the container's `flex-wrap` property to `wrap`, as shown in the following example:

CSS:

```
body {  
    max-width: 800px;  
}  
main {  
    display: flex;  
    flex-wrap: wrap;  
}  
article {  
    flex-grow: 2;  
    flex-shrink: 0;  
    flex-basis: 300px;  
}  
aside {  
    flex-grow: 1;  
    flex-shrink: 0;  
    flex-basis: 150px;  
}
```

HTML:

```
<body>  
  <main>  
    <article>  
    </article>  
    <aside>  
    </aside>  
  </main>  
</body>
```

Note, too, that I've set `flex-shrink` to `0` and added `flex-basis` values, which combine to create a minimum width for each element.

» **Adaptive layout:** A layout that changes depending on the current value of certain screen features, such as width. An adaptive layout uses a CSS feature called a *media query*, which is an expression accompanied by a code block consisting of one or more style rules. The expression interrogates some feature of the screen, usually its width. If that expression is true for the current device, then the browser applies the media query's style rules; if the expression is false, the browser ignores the media query's rules. Here's the syntax:

```
@media (expression) {
    Style rules go here
}
```

Here's an example that applies two style rules whenever the current screen width is less than or equal to 767px:

```
@media (max-width: 767px) {
    header {
        height: 48px;
    }
    .site-title {
        font-size: 24px;
    }
}
```

Figures 1-5 through 1-7 demonstrate a more advanced example, where the layout of the page changes, depending on the screen width.

The screenshot shows a website layout with the following structure:

- Header:** The title "HISTORICAL TYPOGRAPHY" is at the top center. Below it is a dark navigation bar with links: HOME, ARTICLES, BLOG, RESEARCH, and ABOUT US.
- Left Sidebar:** This sidebar contains a section titled "More Titles" with a list of book titles:
 - Art of the Printed Book*
 - Books and Printing*
 - The Crystal Goblet*
 - An Essay on Typography*
 - Fine Print on Type*
 - Periods of Typography*
 - Type and Typography*
- Main Article Area:** The central column contains an article titled "The Art of the Book" with the subtitle "A Review of Some Recent European and American Work in Typography, Page Decoration & Binding". The text discusses the evolution of printing styles from Gothic to Renaissance, mentioning figures like Mainz Bible and Psalters. It also notes the influence of classical Rome on later styles.
- Right Sidebar:** This sidebar is titled "Book Info" and provides details about the book "The Art of the Book":
 - Title:** The Art of the Book: A Review of Some Recent European and American Work in Typography, Page Decoration & Binding
 - Authors:** Bernard H. Newdigate, Douglas Cockerell, L. Deubner, & E. A. Taylor
 - Editor:** Charles Holme
 - Publisher:** "The Studio" Ltd., London
 - Publication Date:** 1914

FIGURE 1-5: A typical page with header, navigation, an article, and two sidebars. On a desktop screen, the article is flanked by the sidebars.

The screenshot shows a website for 'HISTORICAL TYPOGRAPHY'. At the top, there's a navigation bar with links for HOME, ARTICLES, BLOG, RESEARCH, and ABOUT US. Below the navigation, there's a sidebar on the left containing links to 'More Titles' (Art of the Printed Book, Books and Printing, The Crystal Goblet, An Essay on Typography, Fine Print on Type), 'Periods of Typography' (Type and Typography), and a main article titled 'The Art of the Book'. The main article's content discusses the transition from Gothic to Roman typefaces in Europe. Below the article is a 'Book Info' section with details like Title, Authors, Editor, Publisher, Publication Date, and a note about the text being in the public domain.

FIGURE 1-6:
On a narrower tablet-sized screen, the right sidebar wraps below the left sidebar and the article.



» **Responsive images:** Renders an image fluidly so that its size adjusts to different screen sizes. Ideally, you want the image to scale no larger than its original size to avoid ugly pixilation and jagged edges, and you want the width and height to maintain the original aspect ratio so that the image doesn't look skewed when its size changes. You can achieve both goals by styling the image with the declarations `max-height: 100%`, which allows the image to scale but to grow no larger than its original size, and `height: auto`, which tells the browser to adjust the height automatically as the width changes. (Alternatively, you can set `width: auto` to get the browser to adjust the width automatically as the height changes). Here's an example:

```
.aside-img {
    max-height: 100%;
    height: auto;
}
```



FIGURE 1-7:
On an even narrower smartphone-sized screen, both sidebars appear below the article.

» **Responsive typography:** Renders font sizes and vertical measures (such as height and margin-top) with the relative units em or rem rather than fixed-size pixels (px); renders horizontal measures (such as width and padding-right) in percentages (%) instead of pixels (px). Using relative measurement units enables the page typography to flow seamlessly as the screen size changes.

Planning Your Web App: Accessibility

When planning a web app, the thoughtful developer remains aware at all times that the people who visit and use the app come with different abilities. When planning a web app, the ethical developer understands that, even though every

person is different, they all have an equal right to use the app. When you give everyone equal access to your web app, you're making your app *accessible*.



REMEMBER

Planning for accessibility means taking the following impairments into account:

- » **Visual:** Includes full or partial blindness, color-blindness, and reduced vision.
- » **Auditory:** Includes full or partial deafness, difficulty hearing, the inability to hear sounds at certain frequencies, and tinnitus.
- » **Motor:** Includes the inability to use a pointing device such as a mouse, restricted movement, lack of fine motor control, excessive trembling or shaking, and slow reflexes or response times.
- » **Cognitive:** Includes learning disabilities, focusing problems, impaired memory, and extreme distractibility.

An accessible design is the right choice ethically, but it's also the right choice practically because a significant percentage (estimates range from 5 to 20 percent) of the people who use your web app will exhibit one or more of the above disabilities in varying degrees. Fortunately, as long as you build your app with equal access in mind from the get-go, adding accessible features takes very little effort on your part.



TIP

Before you get started, it's a good idea to crank up a screen reading application so that you can test out how your web app works when "heard." If you use Windows, start up the Narrator utility; if you're on a Mac, fire up the VoiceOver utility.

Web app accessibility is a massive topic, but for our purposes you can boil it down to implementing the following techniques:

- » **Include alternative text for all images.** For the visually impaired, a screen reader reads aloud the value of every `` tag's `alt` attribute, so important or structural images should include a brief description as the `alt` value:

```

```

You don't need to add an `alt` value for purely decorative images, but you must include the `alt` tag (set to an empty string: `alt=""`) or your HTML code won't validate.

- » **Add an ARIA label to all form fields.** ARIA stands for Accessible Rich Internet Applications, and it's a technology for adding accessibility to web apps. When you add the `aria-label` attribute to an `<input>`, `<select>`, or `<textarea>` tag, the screen reader reads that attribute's text:

```
<input type="radio"
       id="pony-express"
       name="delivery"
       value="pony"
       aria-label="Pony express delivery option">
```

- » **Add a label for all form fields.** Adding the `<label>` tag — either by using the `for` attribute to reference the `id` of the corresponding field, or by surrounding the field with `<label>` and `</label>` tags — enables the user to select the field by also clicking the label. This increases the target area for clicking, which helps users with unsteady hands. Be sure to add a label for every `<input>` tag, as well as each `<select>` and `<textarea>` tag:

```
<label for="user-email">Email address</label>
<input id="user-email" type="email">
```

- » **Use headings hierarchically.** All page headings should use `<h1>` through `<h6>` tags, where that order reflects the hierarchy of the heading structure: `<h1>` is the top-level heading in a section of the page, `<h2>` is the second-level heading in that section, and so on. Don't skip heading levels (say, by jumping from `<h2>` to `<h4>`).

- » **Use semantic HTML5 page tags.** These include `<header>`, `<nav>`, `<main>`, `<article>`, `<section>`, `<aside>`, and `<footer>`. These so-called *landmarks* help assistive technologies make sense of your web app. You should also add ARIA role attributes to these tags, as follows:

```
<header role="banner">
<nav role="navigation">
<main role="main">
<article role="contentinfo">
<section role="contentinfo">
<aside role="complementary">
<aside role="note">
<footer role="contentinfo">
```

Wait: two role possibilities for the `<aside>` tag? Yep: Choose the role value that best fits the content of the sidebar.

» **Add ARIA roles to non-semantic elements.** If your app uses non-semantic elements, such as a jQuery UI or jQuery Mobile widget, you can alert assistive technologies to what the widget does by adding the `role` attribute and setting it equal to the widget's function in the app. Some example role values are `dialog`, `menu`, `menubar`, `progressbar`, `scrollbar`, `slider`, `tab`, `tablist`, `tabpanel`, and `toolbar`. For example, here's how you'd add the various tab-related roles to jQuery UI's Tabs widget:

```
<div id="my-tabs">
  <ul role="tablist">
    <li><a href="#my-tab-1" role="tab">This</a></li>
    <li><a href="#my-tab-2" role="tab">That</a></li>
    <li><a href="#my-tab-3" role="tab">The Other
      </a></li>
    </ul>
    <div id="my-tab-1" role="tabpanel">
      This is the first tab's content.
    </div>
    <div id="my-tab-2" role="tabpanel">
      This is the second tab's content.
    </div>
    <div id="my-tab-3" role="tabpanel">
      Yep, this is the third tab's content.
    </div>
  </div>
```



TIP

See Mozilla Developer Network's Using ARIA page at https://developer.mozilla.org/en-US/docs/Web/Accessibility/ARIA/ARIA_Techniques to see a complete list of ARIA roles.

» **Ensure your app's colors have sufficient contrast.** If text colors too closely match the background color, the text will be hard to decipher, particularly for the visually impaired.



TIP

Once your app is on the web, you can check its accessibility by heading over to the Web Accessibility Evaluation Tool (WAVE) at <http://wave.webaim.org>. Paste your web app's address into the text box and press Enter/Return to see a report.

Planning Your Web App: Security

Like it or not (and I suspect not), we live in a world populated by a small but determined band of miscreants who spend all their time and energy trying to deface, destroy, or exploit web apps just like the one you're about to build. And

make no mistake: If you put an unprotected web app online, it will be found by one (or more) of these rascallions and bad things will ensue.

So you need to take a piece of paper, write the word “SECURITY” in bold letters, and tape it to your cat’s forehead as a constant reminder that building a web app really means building a secure web app. And I don’t mean building your app and then bolting on some security features at the very end — no, you need to bake in the security goodness right from the start.

As important as web app security is, you might be surprised to hear that I can summarize it with just two axioms:



REMEMBER

- » **Never trust data sent to the server.** For example, if you have a form with a text field, an attacker can insert a specially constructed text string that forces MySQL to perform unwanted actions, such as deleting data. Alternatively, it’s possible for an attacker to submit data to the server without using your form at all.
- » **Always control data sent from the server.** When you send data back to the web page, you need to be sure that you’re not sending anything dangerous. For example, if an attacker uses a form’s text field to submit a `<script>` tag with malicious JavaScript code, and you then redisplay the form’s values without checking them, that script will execute. Similarly, if you use the server to store sensitive data such as sign-in passwords and private information, you need to install safeguards so that this data doesn’t fall into the wrong hands.

Understanding the dangers

There are, it often seems, almost as many security exploits as there are low-lifes trying to compromise our apps. However, the most common security dangers fall into four main categories: SQL injection, cross-site scripting, insecure file uploads, and unauthorized access.

SQL injection



WARNING

Probably the most common exploit, *SQL injection* involves inserting some malicious code into an ordinary SQL command, such as a SELECT or DELETE statement. Consider the following sign-in form:

```
<form>
  <label for="username">User name:</label>
  <input id="username" type="text" name="user">
```

```
<label for="password">Password:</label>
<input id="password" type="password" name="pass">
</form>
```

When this form is submitted, a PHP script to sign in the user might look, in part, like this:

```
<?php
    $user = $_POST['user'];
    $pass = $_POST['pass'];
    $sql = "SELECT *
        FROM users
        WHERE username='$user' AND password='$pass'";
?>
```

That works fine as long as the user types a legit username and password, but what happens if some scoundrel types `admin' #` in the user field and nothing at all in the password field? Here's the resulting value of the `$sql` variable:

```
SELECT * FROM users WHERE username='admin' #' AND password=''
```

The key here is the hash symbol (#), which marks the beginning of a comment in an SQL command, meaning that the rest of the line is ignored. (Just so you know, MySQL also uses -- to mark the start of a comment.) That is, the actual SQL command that gets processed is this:

```
SELECT * FROM users WHERE username='admin'
```

Congratulations, some criminal has just signed in as the administrator!

As another example, suppose your web app has a button that, when clicked, deletes an item from the current user's data. Your Ajax call might pass along a `user-id` and an `item-id`, meaning that your PHP script would do something like the following to remove the specified item:

```
<?php
    $user_id = $_POST['user-id'];
    $item_id = $_POST['item-id'];
    $sql = "DELETE
        FROM items
        WHERE userid='$user_id' AND itemid='$item_id'";
?>
```

Looks fine from here, but suppose some fiend passes the following as the user-id value: whatever' OR 1=1 #. Assuming the item-id value is blank, here's the resulting \$sql variable value:

```
DELETE FROM items WHERE userid='whatever' OR 1=1 #' AND
itemid=''
```

Taking the comment symbol (#) into account, the actual command looks like this:

```
DELETE FROM items WHERE userid='whatever' OR 1=1
```

The 1=1 part always returns TRUE, so the result is that the command deletes everything from the items table!

Cross-site scripting (XSS)



WARNING

Cross-site scripting (usually shortened to XSS) is a way of surreptitiously forcing an innocent user to launch an attacker's malicious script. This most often happens when the malefactor uses a phishing email or similar ruse to trick the user into visiting a page that spoofs a form used on a legitimate site.

For example, suppose the form asks the user to enter her credit card number and password. If this was a normal form submission and the user entered either the wrong credit card number or the wrong password, the PHP script on the server might redisplay the form to ask the user to try again:

```
<?php
$cc = $_POST['credit-card'];
$pw = $_POST['password'];

// Code that checks these inputs goes here

// If one or both inputs are invalid:
echo '<input type="text" name="credit-card" value="' .
$cc . '">';
echo '<input type="password" name="password">';
?>
```

Notice, in particular, that this "helpful" script redisplays the credit card value (stored in the \$cc variable) in the text field. Imagine, then, that our attacker's spoofed form actually sends the following text instead of the credit card number:

><script>alert('Ha ha!');</script><a href="

Here's the resulting HTML (which I've tidied up a bit so you can see what's going on):

```
<input type="text" name="credit-card" value="">
<script>
    alert('Ha ha!');
</script>
<a href="">
<input type="password" name="password" value="">
```

What happens here? That's right: The JavaScript code between the `<script>` and `</script>` tags executes and, believe me, in the real world it's unlikely to just display an innocuous alert box.

Insecure file uploads



WARNING

If your web app allows users to upload files — for example, you might want to allow each user to upload a small image to use as a profile avatar — then you open up a new can of security worms because a malicious user can:

- » Upload huge files, which tax the server's resources.
- » Upload a nasty script instead of, say, an image.
- » Overwrite existing server files.

Unauthorized access



WARNING

If your web app requires users to sign in with a username (or email address) and password, then keeping those passwords secure is of paramount importance. Otherwise, an unauthorized interloper could sign in as a legitimate user and either destroy or tamper with that user's data, post messages or other content under that user's name, and even delete the user's account.

Defending your web app

There's an alarming number of potential exploits that a villainous user can use to wreak havoc on your web app. Fortunately, if you implement multiple lines of defense — a strategy sometimes called *defense in depth* — you can inoculate your app against all but the most determined attacks.

Sanitizing incoming data

Defending your web app begins with *sanitizing* any data sent to the server. There are four main ways to sanitize data:

» **Converting:** Encoding an input's characters to harmless equivalents. The most useful PHP function for this is `htmlentities()`, which takes a string input and converts any special characters to either an HTML entity code, if one exists, or to an HTML character code. In particular, `htmlentities()` changes < to <, > to >, " to ", and & to &. For example, `htmlentities('<script>alert("Take that!")</script>')` returns the following (now harmless) string:

```
&lt;script&ampgtalert(&quot;Take that!&quot;)&lt;/script&ampgt
```

» **Filtering:** Removing unwanted characters from an input. Use PHP's `filter_var()` function and specify one or more of the function's sanitizing filters:

```
filter_var(input, filter)
```

- *input*: The input value you want to sanitize.
- *filter*: A constant value that determines the characters you want to remove from *input*. Here are some useful filters:
 - `FILTER_SANITIZE_EMAIL`: Removes all characters except letters, numbers, and the following: !#\$%&'*+=?^_`{|}~@. []
 - `FILTER_SANITIZE_NUMBER_FLOAT`: Removes all characters except numbers, plus (+), and minus (-). To allow decimals, add the `FILTER_FLAG_ALLOW_FRACTION` flag:

```
filter_var($val, FILTER_SANITIZE_NUMBER_FLOAT,  
FILTER_FLAG_ALLOW_FRACTION)
```

- `FILTER_SANITIZE_STRING`: Removes all HTML tags. For example:

```
filter_var('<script>alert("Take that!")</script>',  
FILTER_SANITIZE_STRING)
```

Returns:

```
alert("Take that!");
```

- `FILTER_SANITIZE_URL`: Removes all characters except letters, numbers, and the following: \$-_+!*()'{}|\^\~[]`<>#%;/?:@=&

» **Data type checking:** Testing the data type of an input to ensure that it matches what's expected. PHP calls this *character type checking*, and it offers the following functions:

- `ctype_alnum(input)` — Returns TRUE if *input* contains only letters and/or numbers

- `ctype_alpha(input)` — Returns TRUE if *input* contains only letters
- `ctype_digit(input)` — Returns TRUE if *input* contains only numbers
- `ctype_lower(input)` — Returns TRUE if *input* contains only lowercase letters
- `ctype_upper(input)` — Returns TRUE if *input* contains only uppercase letters

» **Whitelisting:** Allowing only certain values in an input. For example, suppose the input is an account number of the form 12–3456; that is, two numbers, a dash (–), then four numbers. You can't use `ctype_digit()` on this value directly because of the dash, but you can temporarily remove the dash and then check the resulting value:

```
$acct_num = $_POST['account-number'];
$allowed = '-';
$new_input = str_replace($allowed, '', $acct_num);
if(ctype_digit($new_input) === false) {
    exit(0);
}
```



TIP

This code uses the `str_replace()` function to replace dashes with the empty string (which removes them) and then runs `ctype_digit()` on the result. If your input has multiple acceptable characters, you can whitelist them all by setting the `$allowed` variable to an array:

```
$allowed = array(' ', '.', '$');
```

Using prepared statements

As I show earlier in this chapter, the nastiness that is SQL injection works by tricking an innocent SQL statement into running malevolent code. You can (and should) try to prevent that by sanitizing your form inputs, but MySQL also offers a powerful technique that gives you exquisite control over the type of data that gets included in an SQL statement. The technique is called *prepared statements* (or sometimes *parameterized statements* or *parameterized queries*), and it means you no longer send an SQL statement directly to the database server. Instead, the query now proceeds in three separate stages:

1. The preparation stage.

This stage involves running an SQL-like statement through MySQLi's `prepare()` method. Most importantly, you replace each external value (that is, each value received from a web form) with a question mark (?), which acts as a placeholder for the value. The statement you've thus prepared acts as a kind of template that MySQLi will use to run the query.

2. The binding stage.

This stage involves using MySQLi's `bind_param()` method to define each external value as a parameter, and then bind that parameter to the prepared statement. Specifically, MySQLi replaces each `?` placeholder with a parameter. The binding specifies a data type (such as a string or integer) for each parameter.

3. The execution stage.

The final stage runs MySQLi's `execute()` method on the prepared statement. This hands off the actual running of the SQL command to the server, which uses the combination of the prepared statement template and the bound parameters to run the SQL operation.

Because the server knows what data types to expect for the external values, it can't run injected SQL code as actual code. Instead, it treats the injection as text (or whatever data type you specify), and the SQL operation runs in complete safety.

Here's an example:

```
<?php
    // Assume these external values came from a
    // form submission and have been sanitized
    $customer = 'ALFKI';
    $employee = 1;

    // Declare a string for the query template
    // Use ? to add a placeholder for each external value
    $sql = "SELECT *
        FROM orders
        INNER JOIN customers
        ON orders.customer_id = customers.customer_id
        WHERE orders.customer_id = ?
        AND orders.employee_id = ?";

    // Prepare the statement template
    $stmt = $mysqli->prepare($sql);

    // Bind the parameters (one string, one integer)
    $stmt->bind_param("si", $customer, $employee);

    // Execute the prepared statement
    $stmt->execute();

    // Get the results
    $result = $stmt->get_result();
?>
```

To save space, the code declares two variables — \$customer and \$employee — that are assumed to be external values that came from a form and have been sanitized. The code then declares the string \$sql to the SQL text, but with ? placeholders used instead of the actual external values. The code runs the prepare(\$sql) method to create the prepared statement, which is stored in the \$stmt variable. Now the code runs bind_param() to bind the external values:

```
bind_param(types, parameter(s))
```

- » *types*: A string that specifies, in order, the data type of each parameter. The four possible values are s (string), i (integer), d (double; that is, a floating-point value), and b (blob; that is, a binary object, such as an image).
- » *parameter(s)*: The parameters you want to bind, separated by commas.

Finally, the code runs the execute() method to run the prepared statement, and then uses get_result() to get the result of the SQL operation.

Escaping outgoing data

Before you send data back to the web page, you need to ensure that you're not sending back anything that could produce unexpected or even malicious results. That means converting problematic characters such as ampersands (&), less than (<), greater than (>), and double quotation marks ("") to HTML entities or character codes. This is called *escaping* the data.

How you do this depends on how you're returning the data:

- » **If you're returning strings via echo (or print):** Apply the htmlentities() function to each string that might contain data that needs to be escaped:

```
echo htmlentities($user_bio);
```

- » **If you're returning JSON via echo (or print):** Apply the json_encode() function to the data and specify one or more flags (separated by |) that specify which values you want encoded: JSON_HEX_AMP (ampersands), JSON_HEX_APOS (single quotations), JSON_HEX_QUOT (double quotations), or JSON_HEX_TAG (less than and greater than). Here's an example:

```
$JSON_text = json_encode($rows, JSON_HEX_APOS |
    JSON_HEX_QUOT | JSON_HEX_TAG);
echo $JSON_text;
```

Securing file uploads

Here are a few suggestions to beef up security when allowing users to upload files:

- » **Restrict the maximum file upload size.** If you have access to `php.ini`, change the `upload_max_filesize` setting to some relatively small value, depending on what types of uploads you're allowing. For example, if users can upload avatar images, you might set this value to 2MB.
- » **Verify the file type.** Run some checks on the uploaded file to make sure its file type conforms to what your web app is expecting. For example, check the file extension to make sure it matches the type (or types) of file you allow. If you're expecting a binary file such as an image, run PHP's `is_binary()` function on the uploaded file; if this function returns FALSE, then you can reject the upload because it might be a script (which is text).
- » **Use PHP's FTP functions to handle the upload.** If you have access to an FTP server, then PHP's built-in FTP functions are a secure way to handle the file upload:
 - `ftp_connect()`: Sets up a connection to the FTP server
 - `ftp_login()`: Sends your login credentials to the FTP server
 - `ftp_put()`: Transfers a file from the user's PC to the server
 - `ftp_close()`: Disconnects from the FTP server

Securing passwords

If your web app has registered users who must sign in with a password, it's essential that you do everything you can to enable users to create strong passwords and to store those passwords on the server in a secure way.



REMEMBER

Letting users create strong passwords means following these guidelines:

- » Don't place any restrictions on the character types (lowercase letters, uppercase letters, numbers, and symbols) that can be used to build a password.
- » Do require that users form their passwords using at least one character from three or, ideally, all four character types.
- » Don't set a maximum length on the password. Longer passwords are always more secure than shorter ones.
- » Do set a minimum length on the password. Eight characters is probably reasonable.

Here are some suggestions for storing and handling passwords securely:

- » **Don't transfer passwords in a URL query string.** Query strings are visible in the browser window and get added to the server logs, so any passwords are exposed.
- » **Don't store passwords in plain text.** If you do, and your system gets compromised, the attacker will have an easy time wreaking havoc on your user's accounts.
- » **Do store passwords encrypted.** You encrypt each password using a *hash*, which is a function that scrambles the password by performing a mathematical function that's easy to run, but extremely difficult to reverse. PHP makes it easy to hash a password by offering the `password_hash()` function.
- » **Do salt your passwords.** A *salt* is random data added to the password before it gets hashed, which makes it even harder to decrypt. Salting is handled automatically by the `password_hash()` function.
- » **Do allow users to change their passwords.** It's good (though seldom followed) practice to change your password regularly, so you should offer this capability to your users.
- » **Don't send a password over email.** Email is sent as plain text, so it's easy for a malicious user to intercept the password.

I go through a detailed example of registering user accounts, storing passwords securely, handling sign-ins, and offering password change and recovery features in Chapter 4 of this minibook.

IN THIS CHAPTER

- » Getting your directory structure set up
- » Creating the app database and adding the required tables
- » Understanding PHP sessions
- » Creating your app's startup files
- » Making your coding life easier by taking a modular approach

Chapter 2

Laying the Foundation

Every great developer you know got there by solving problems they were unqualified to solve until they actually did it.

— PATRICK MCKENZIE

A well-built web app begins with a solid foundation. Sure, when you've got a great idea for a web app, it's always tempting to work on the visible front end first, even if it's just cobbling together a quick proof-of-concept page. However, party pooper that I am, I'm going to gently suggest that it's a good idea to nail down at least some of the more fundamental work off the top. Not only does that give you some major items to check off your app to-do list, but having a solid foundation under your feet will help you immeasurably when it comes time to code the rest of your app.

This chapter is all about laying down that solid foundation. First I show you how to figure out your app's directory structure. I then talk about constructing the database and tables. From there, I crank up the text editor and talk about some useful PHP techniques such as defining constants, setting up and securing sessions, and including code from one PHP file in another. Finally, I show you how to code the startup files your app needs for both its back end and its front end. Along the way, you see a practical example of every technique as I build out the foundation code for my own FootPower! app.

Setting Up the Directory Structure

Start by opening the “Employees Only” door and heading into the back room of the web app. Your back-end work begins by setting up some directories and subdirectories to store your app’s files. Doing this now offers two benefits:



REMEMBER

- » **Organization:** Even a small app can end up with quite a few files, from PHP scripts to HTML code to external CSS and JavaScript files. If you add your directories on-the-fly as they’re needed, it’s a certainty they’ll end up a bit of a mess, with files scattered hither and thither (as my old grandmother used to say). It’s better to come up with a sensible directory structure now and stick with it throughout the development cycle.
- » **Security:** A smart back-end developer divides her files between those files that users need to view and operate the web app and those files that only do work behind the scenes. The former should be accessible to the public, but it’s best to configure things so that the latter aren’t accessible to anyone but you.

Okay, I hear you saying, “Organization I can get on board with, but what’s all this about security?” Good question. Here’s the answer:



WARNING

When your app is on the web, it’s stored in a directory that the web server makes publicly available to anyone who comes along. This public accessibility means that it’s at least technically possible for someone to gain direct access to the files stored in that directory. That access isn’t a big thing for your HTML, CSS, and JavaScript files, which anyone can easily view. However, it’s a huge deal for your PHP files, which can contain sensitive information such as your database credentials.



REMEMBER

To see how you prevent such unauthorized access, you need to understand that every web app has a top-level directory, which is known as either the *web root* or the *document root*. The web root is the directory that the server makes accessible to the public, which means that anything outside of the web root is inaccessible to remote users (while still being available to your web app).

So your directory structure begins by creating one directory and two subdirectories:

- » The directory is the overall storage location for your app. You can name this whatever you want, but it’s probably best to use the name of the app.
- » One subdirectory will be the web root. I’m going to name my web root `public` to reinforce that only files that should be publicly accessible go in this subdirectory.

- » The other subdirectory will contain the PHP files that you don't want remote users to be able to access. I'm going to name this subdirectory `private` to remind me that this is where I put files that should not have public access.

Setting up the public subdirectory

After you've created the `public` subdirectory, you need to tell the web server that this location is the new web root. If you set up the XAMPP web development environment as I describe in Book 1, Chapter 2, then you change the web root by editing a document named `httpd.conf`, the location of which depends on your operating system:

- » **Windows:** Look for `httpd.conf` in the following folder:

```
c:/xampp/apache/conf
```

- » **Mac:** Look for `httpd.conf` here:

```
/Applications/XAMPP/xamppfiles/etc
```

Open `httpd.conf` in a text editor and then scroll to or search for the line that begins with `DocumentRoot`. For example, here's the Mac version of the line:

```
DocumentRoot: "/Applications/XAMPP/xamppfiles/htdocs"
```

Edit this line to point to your app's web root subdirectory. For example, if you added your main app folder to `htdocs`, add a slash (/), the app folder name, and then `/public`. Here's the web root path that I'm using for my `FootPower!` app:

```
DocumentRoot:  
"/Applications/XAMPP/xamppfiles/htdocs/footpower/public"
```

By default, the web server denies permission to the entire server filesystem, with one exception: the web root. Therefore, you must now tell the server that it's okay for remote users to access the new web root. To do that, first look for the line in `httpd.conf` that begins with `<Directory`, followed by the path to the old web root. For example, here's the Mac version of the line:

```
<Directory "/Applications/XAMPP/xamppfiles/htdocs">
```

Edit this line to point to your app's web root, as in this example:

```
<Directory  
"/Applications/XAMPP/xamppfiles/htdocs/footpower/public">
```

Save the file and restart the web server to put the new configuration into effect.



TIP

To make sure your web root is working properly, create a new PHP file in the public directory, give it the name index.php, and then add an echo statement, something like this:

```
<?php  
    echo "Hello World from the web root!";  
?>
```

Now surf to localhost and make sure you see the correct output, as shown in Figure 2-1.

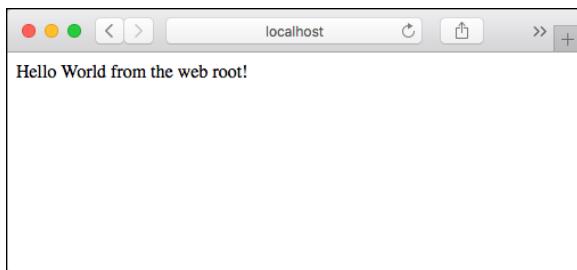


FIGURE 2-1:
The new web
root, ready
for action.



REMEMBER

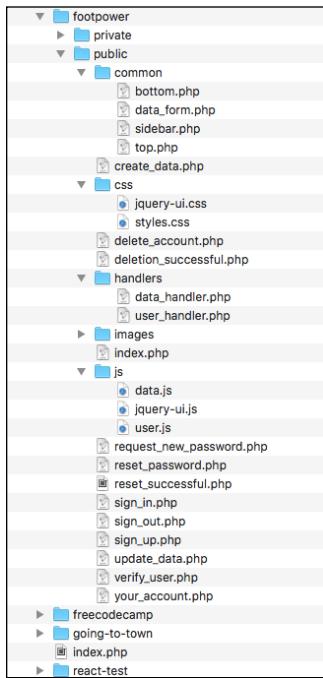
It's unlikely you'll have access to http.conf when you put your web app online. However, your web host will offer some sort of mechanism for specifying a particular directory as the web root, so check the host's Help or Support documentation.

Your final chore for setting up the public directory is to add the subdirectories you'll use to store various file types. Here are my suggestions:

| Subdirectory | What It Stores |
|--------------|---|
| /common | Files that are used in all your web app's pages, including the top part of each page (the opening tags and the head section) and common page elements such as a header, sidebar, and footer |
| /css | Your web app's CSS files |
| /handlers | Files that handle Ajax requests from the front end |
| /images | Image files used in your web app |
| /js | Your web app's JavaScript files |

To give you a kind of road map to where we're going, Figure 2-2 shows the final file structure of my FootPower! app's `public` directory.

FIGURE 2-2:
All the public
files and
directories I
use in the final
version of my
FootPower! app.



Setting up the private subdirectory

Getting the `private` subdirectory configured is much easier because you only have to create the subdirectories you need to organize your app's back-end files. Here are my suggestions:

| Subdirectory | What It Stores |
|-----------------------|--|
| <code>/classes</code> | Files that contain the code for your web app's classes |
| <code>/common</code> | Files that are used in other back-end files |
| <code>/logs</code> | Log files, such as the error log |

Figure 2-3 shows the final file structure of my FootPower! app's `private` directory.

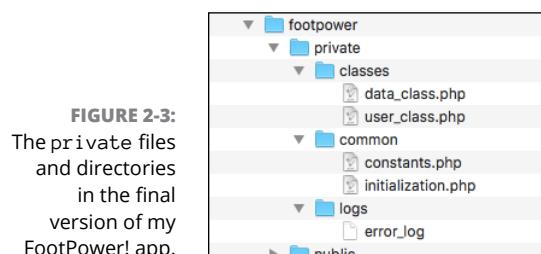


FIGURE 2-3:
The private files and directories in the final version of my FootPower! app.

Creating the Database and Tables

You already know your web app's data requirements, so now it's time to load phpMyAdmin on your development server (<http://localhost/phpMyAdmin>), and then use it to create your MySQL data stores. I go through this in detail in Book 5, Chapter 2, so I only list the general steps here:

- 1. Create a database for your web app using the `utf8_general_ci` collation.**
- 2. If your app needs to support user accounts, create a table to hold the account data.**

At a minimum, this table will have an ID field, a username field, and a password field.

- 3. If your app needs to save user-generated data, create a table to hold the data.**

This table should have an ID field as well as user ID field that, for each user, contains the same ID from the user table you created in Step 2.

- 4. If your app is configured so that the user creates one main item and then many subitems, create a table to hold the subitems.**

To be clear, the table you created in Step 3 holds each user's main item, and this new table holds the subitems. This table should have an ID field, a field that points to the ID of the main item, and a field for each tidbit of data you want to store.

An example might make this clearer, so I'll go through the data structures for my FootPower! app. First, here's the users table:

| Field Name | Type | Other Settings |
|------------|--------------|-----------------------------|
| user_id | INT | PRIMARY KEY, AUTO_INCREMENT |
| username | VARCHAR(150) | UNIQUE, NOT NULL |
| password | VARCHAR(255) | NOT NULL |

| Field Name | Type | Other Settings |
|-------------------|-------------|---------------------------|
| distance_unit | VARCHAR(10) | DEFAULT 'miles' |
| verification_code | VARCHAR(32) | NOT NULL |
| verified | TINYINT | DEFAULT 0 |
| creation_date | TIMESTAMP | DEFAULT CURRENT_TIMESTAMP |

Each registered user gets an activity log in which to record her activities, so next up is the logs table:

| Field Name | Type | Other Settings |
|---------------|-----------|--------------------------------|
| log_id | INT | PRIMARY KEY, AUTO_INCREMENT |
| user_id | INT | NOT NULL |
| creation_date | TIMESTAMP | DEFAULT CURRENT_TIMESTAMP |

Note that both the users and logs tables have a common user_id field. This enables me to link each log to the user who owns it.

For now, go ahead and add one record to this table, where user_id equals 1 and creation_date is today's date (in YYYY-MM-DD format).

Finally, each log records the user's foot-propelled activities, so I'll store this data in the activities table:

| Field Name | Type | Other Settings |
|-------------|---------------|-----------------------------|
| activity_id | INT | PRIMARY KEY, AUTO_INCREMENT |
| log_id | INT | NOT NULL |
| type | VARCHAR(25) | NOT NULL |
| date | DATE | NOT NULL |
| distance | DECIMAL(10,6) | |
| duration | TIME | |

Note that both the logs and activities tables have a common log_id field. This will enable me to link each activity to the log in which it belongs.

Getting Some Back-End Code Ready

The back end of a web app consists of both the MySQL data and the PHP code that manipulates that data and returns information to the app's front end. You can get some of the PHP code written now, and you can add the rest as you build the app.

Defining PHP constants

It's a rare web app that doesn't have one or more variables that are used throughout the back-end code, but where the value of those variables must never change. For example, when you're managing server data, your PHP files are constantly logging into the MySQL database, which requires credentials such as a username and password. That username and password are the same throughout your code, but your code will fail if, somehow, these values get changed.



REMEMBER

A variable that never changes value sounds almost like an oxymoron, so perhaps that's why programmers of yore came up with the idea of the *constant*, a special kind of variable that, once defined with a value, can't be changed. You set up a constant in PHP by using the `define()` function:

```
define(name, value)
```

- » *name*: The name of the constant. By convention, constant names are all uppercase and don't begin with a dollar sign (\$).
- » *value*: The value of the constant. The value must be an integer, floating point number, string, or Boolean.

Here's an example:

```
define("GREETING", "Hello Constant World!")
```

It's good web app practice to gather all your constants and put them in a separate file, which you can then include in any other PHP file that requires one or more of the constants. (I talk about how you include a PHP file in another PHP file later in this chapter.) For example, here's a PHP file that defines the database credentials for my FootPower! app:

```
<?php
    define('HOST', 'localhost');
    define('USER', 'root');
    define('PASSWORD', '');
    define('DATABASE', 'footpower');
?>
```

I've named this file constants.php and added it to the app's private/common/ directory.

Understanding PHP sessions

One of the biggest web app challenges is keeping track of certain bits of information as the user moves from page to page within the app. For example, when someone first surfs to the app's home page, your PHP code might store the current date and time in a variable, with the goal of, say, tracking how long that person spends using the app. A worthy goal, to be sure, but when the user moves on to another page in the app, your saved date and time gets destroyed.

Similarly, suppose the user's first name is stored in the database and you use the first name to personalize each page. Does that mean every time the user accesses a different page in your app, your code must query the database just to get the name?



REMEMBER

The first scenario is ineffective and the second is inefficient, so is there a better way? You bet there is: PHP sessions. In the PHP world, a *session* is the period that a user spends interacting with a web app, no matter how many different app pages she navigates.

You start a session by invoking the `session_start()` function:

```
session_start();
```

Once you've done that, the session remains active until the user closes the browser window. Your web server also specifies a maximum lifetime for a session, usually 1,440 seconds (24 minutes). You can check this by running `echo phpinfo()` and looking for the `session.gc_maxlifetime` value. You can work around this timeout in one of two ways:

- » By adding the `session_start()` function to each page, which refreshes the session.
- » By running PHP's `session_status()` function, which returns the constant `PHP_SESSION_NONE` if the user doesn't have a current session.

How does a session help you keep track of information about a user? By offering an array called `$_SESSION`, which you can populate with whatever values you want to track:

```
$_SESSION['start_time'] = time();
$_SESSION['user_first_name'] = 'Biff';
$_SESSION['logged_in'] = 1;
```

Securing a PHP session

A PHP session is a vital link between your users and your app because it enables you to store data that make each user's experience easier, more efficient, and more seamless. However, because sessions are such a powerful tool, the world's dark-side hackers have come up with a number of ingenious ways to hijack user sessions and thereby gain access to session data.

A full tutorial on protecting your users from would-be session-stealers would require an entire book, but there's a relatively simple technique you can use to thwart all but the most tenacious villains. The technique involves a value called a *token*, which is a random collection of numbers and letters, usually 32 characters long. How does a token serve to keep a session secure? It's a three-step process:

1. When the session begins, generate a new token and store it in the `$_SESSION` array.
2. In each form used by your web app, include a hidden input field (that is, an `<input>` tag where the `type` attribute is set to `hidden`) and set the value of that field to the session's token value.
3. In your PHP script that processes the form data, compare the value of the form's hidden field with the token value stored in the `$_SESSION` array. If they're identical, it means the form submission is secure (that is, the form was submitted by the session user) and you can safely proceed; if they're different, however, it almost certainly means that an attacker was trying to pull a fast one and your code should stop processing the form data.



REMEMBER

There are a bunch of ways to create some random data in PHP, but a good one for our purposes is `openssl_random_pseudo_bytes()`:

```
openssl_random_pseudo_bytes(length)
```

» `length`: An integer that specifies the number of random bytes you want returned

The `openssl_random_pseudo_bytes()` function returns a string of random bytes, but byte values aren't much good to us. We need to convert the binary string to a hexadecimal string, and that's the job of PHP's `bin2hex()` function:

```
bin2hex(str)
```

» `str`: The binary string you want to convert

For example, 16 bytes will convert to 32 hex characters, so you can use something like the following expression to generate a token:

```
bin2hex(openssl_random_pseudo_bytes(16));
```

This creates a value similar to the following:

```
387f90ce4b3d8f9bd7e4b38068c9fce3
```

For your session, you'd store the result in the `$_SESSION` array, like so:

```
$_SESSION['token'] = bin2hex(openssl_random_pseudo_bytes(16));
```

It's also good practice to generate a fresh token after a certain period of time has elapsed, say 15 minutes. To handle this, when the session starts you use the `$_SESSION` array to store the current time plus the expiration time:

```
$_SESSION['token_expires'] = time() + 900;
```

PHP's `time()` function returns the number of seconds since January 1, 1970, so adding 900 sets the expiration time to 15 minutes in the future. Your web app would then use each session refresh to check whether the token has expired:

```
if (time() > $_SESSION['token_expires']){
    $_SESSION['token'] = bin2hex(openssl_random_pseudo_bytes(16));
    $_SESSION['token_expires'] = time() + 900;
}
```

Including code from another PHP file

Most web apps are multi-page affairs, which means your app consists of multiple PHP files, each of which performs a specific task, such as creating data, retrieving data, or logging in a user. Depending on the structure of your app, each of these PHP files will include some or all of the following:

- » Constants used throughout the project
- » Database login credentials
- » Database connection code

- » Classes, functions, and other code used on each page
- » Common interface elements such as the header, app navigation, sidebar, and footer

You don't want to copy and paste all this code into each PHP file because if the code changes, then you have to update every instance of the code. Instead, place each chunk of common code in its own PHP file and save those files in a subdirectory. Earlier in this chapter, I explain that you should create two common subdirectories for such files, one in the `public` directory and one in the `private` directory. To get a common file's code into another PHP file, use PHP's `include_once` statement:

```
include_once file;
```

- » *file*: The path and name of the file with the code you want to include

For example, here's a PHP file that defines some constants that hold the database credentials for my FootPower! app:

```
<?php
    define('HOST', 'localhost');
    define('USER', 'root');
    define('PASSWORD', '');
    define('DATABASE', 'footpower');
?>
```

I've stored this code in a file named `constants.php` in the `private/common/` subdirectory, so I'd use the following statement to include it from the web root folder:

```
include_once '../private/common/constants.php';
```

The double dots (...) stand for "go up one directory," so here they take the script up to the app's filesystem root, and from there the statement adds the path to `constants.php`.

Creating the App Startup Files

All web apps perform a number of chores at the beginning of any task. On the back end, these initialization chores include starting a user session and connecting to the database, and on the front end the startup includes outputting the app's

common HTML (especially the `<head>` section) and including the app's common components, such as a header and footer.

Rather than repeating the code for these startup chores in every file, you should create two files — one for the back end initialization and one for the front end's common code — and then include the files as you begin each web app task. The next two sections provide the details.

Creating the back-end initialization file

When performing any task, a typical web app must first run through a number of back-end chores, including the following:

- » Setting the error reporting level
- » Starting a session for the current user, if one hasn't been started already
- » Creating a token for the session
- » Including common files, such as a file of constants used throughout the app
- » Connecting to the database, if the app uses server data

You should store this file in your web app's `private/common/` directory. For FootPower!, I created an initialization file named `/private/common/initialization.php`:

```
<?php
    // Make sure we see all the errors and warnings
    error_reporting(E_ALL | E_STRICT);

    // Start a session
    session_start();

    // Have we not created a token for this session,
    // or has the token expired?
    if (!isset($_SESSION['token']) || time() >
        $_SESSION['token_expires']){
        $_SESSION['token'] =
            bin2hex(openssl_random_pseudo_bytes(16));
        $_SESSION['token_expires'] = time() + 900;
        $_SESSION['log_id'] = 1;
    }
```

```

// Include the app constants
include_once 'constants.php';

// Connect to the database
$mysqli = new MySQLi(HOST, USER, PASSWORD, DATABASE);

// Check for an error
if($mysqli->connect_error) {
    echo 'Connection Failed!
        Error #' . $mysqli->connect_errno
        . ':' . $mysqli->connect_error;
    exit(0);
}
?>

```

This code cranks up the error reporting to 11 for the purposes of debugging, starts a new session, creates a session token (if needed), includes the constants file (which contains the database credentials), and then connects to the database and creates a MySQLi object. Note, too, that I set `$_SESSION['log_id']` to 1, but this is temporary. In Book 7, Chapter 4, you see that this value gets set to the user's log ID value when the user signs in to the app.



WARNING

You want to use `error_reporting(E_ALL | E_STRICT)` when you're developing your web app because you want the PHP processor to let you know when something's amiss, either as an error (`E_ALL`) or as non-standard PHP code (`E_STRICT`). However, you certainly don't want your app's users to see these errors or warnings, so when you're ready for your web app to go live, edit `initialization.php` to follow this statement:

```
error_reporting(E_ALL | E_STRICT)
```

with these statements:

```

ini_set('display_errors', 0);
ini_set('log_errors', 1);
ini_set('error_log', '../private/logs/error_log');
```

These statements configure PHP to not display errors onscreen, but to log them to a file, the name and path of which is specified in the final statement.

Creating the front-end common files

Each page of your web app has a common structure. For example, the top part of each page includes the following elements:

- » The DOCTYPE and the `<html>` tag
- » The head element, including the `<meta>` tags, page title, CSS `<link>` tags, and JavaScript `<script>` tags
- » An event handler for jQuery's ready event
- » The `<body>` tag
- » Common page elements, such as the `<header>`, `<nav>`, and `<main>` tags

Here's an example, which I'm going to name `public/common/top.php`:

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8">
    <meta name="viewport" content="width=device-width, initial-
scale=1.0">
    <title>FootPower! | <?php echo $page_title ?></title>
    <link href="css/styles.css" rel="stylesheet">
    <script src="https://ajax.googleapis.com/ajax/libs/
jquery/3.2.1/jquery.min.js"></script>
    <script>
        $(document).ready(function() {
            });
    </script>
</head>
<body>
    <header role="banner">
    </header>
    <main role="main">
        <article role="contentinfo">
            <header class="article-header" role="banner">
                <div class="header-title">
                    <h1><?php echo $page_title ?></h1>
                </div>
            </header>
```

In this code, note that the page title is given by the following inline PHP:

```
<?php echo $page_title ?>
```



TIP

The idea here is that each page will set the `$page_title` variable just before including `top.php`, which enables you to define a custom title for each page. For example, the home page might do this:

```
<?php  
    $page_title = 'Home';  
    include_once 'common/top.php';  
?>
```

Note that this same title also gets inserted in the page header element, within the `<h1>` tag.

Most web apps also include a sidebar — defined by an `<aside>` tag — that includes info common to all pages, such as a description of the app, instructions for using the app, the latest app news, or a newsletter sign-up form. For this sidebar, create a separate file called, say, `public\common\sidebar.php` and include your code:

```
<aside role="complementary">  
    Your sidebar text and tags go here  
</aside>
```

Finally, you need a file to handle the common elements that appear at the bottom of each page, including the `</main>` closing tag, a footer, and the `</body>` and `</html>` closing tags. For this code, create a separate file called, say, `public\common\bottom.php` and add your code:

```
</main>  
<footer role="contentinfo">  
    Copyright <?php echo date('Y'); ?> Your Name  
</footer>  
<script src="js/data.js"></script>  
<script src="js/user.js"></script>  
</body>  
</html>
```



TIP

The footer uses the PHP statement `echo date('Y')` to output the current year for the Copyright notice. This file also adds references to the app's two external JavaScript files: `data.js` and `user.js`. Adding these at the bottom of the page (instead of the usual place in the page's head section) ensures that your JavaScript code can work with the elements added to the page on the fly.

Building the app home page

With the initialization files in place, it's time to build the skeleton for the app's home page. At the moment, this page is nothing but PHP:

```
<?php
    include_once '../private/common/initialization.php';
    $page_title = 'Home';
    include_once 'common/top.php';
?>
Main app content goes here
<?php
    include_once 'common/sidebar.php';
    include_once 'common/bottom.php';
?>
```

Save this file as `index.php` in the web root directory.

IN THIS CHAPTER

- » Setting up your app's data class
- » Creating a script to handle the app's Ajax data requests
- » Creating new data items
- » Reading, updating, and deleting data
- » Handling data robustly and securely

Chapter 3

Managing Data

Talk is cheap. Show me the code.

— LINUS TORVALDS

Some web apps are relatively simple and don't require a back-end database. Such apps are all front end, with maybe a bit of data stored in the user's browser. Front-end-only apps are very common and can be amazingly useful, a claim I hope to live up to when I talk about building just such an app in Book 8.

The rest of the web app world is a sophisticated and powerful marriage of both front-end interface and back-end infrastructure, and a big part of that server scaffolding is the data stored in a database such as MySQL. One of hats you must wear as a web developer is writing the code that enables data to pass robustly and securely between the front and back ends, and that code is the main topic of this chapter. First, I show you how to set up the PHP classes and functions. With that done, it's time to explore the unglamorous but necessary world of creating, reading, updating, and deleting data. Along the way, you see a practical example of every technique as I build out the data-handling code for my own FootPower! app.

Handling Data the CRUD Way

Most web apps that deal with back-end data need to implement at least four common tasks:



REMEMBER

- » **Create new data:** Enables the user or the app itself (or both) to add new data items
- » **Read data:** Retrieves some or all of the items in the database and displays them in a web page
- » **Update data:** Enables the user or the app (or, again, both) to edit an existing item and have those changes written back to the database
- » **Delete data:** Enables the user or the app (or, yep, both) to remove an item from the database

As you can deduce from the first letters of each of these tasks, this data model is known affectionately in the web development trade as CRUD. I devote the rest of this chapter to showing you a method for building CRUD into your web app. Before getting to all of that, here's the big picture view of what I'll be up to in the next few pages:

1. Build a class for handling data interactions. That class includes one method for each of the CRUD verbs: create, read, update, and delete.
2. Provide the user with an interface for initiating any of the CRUD actions. For example, you might build a form to enable the user to create a new data item.
3. To start processing a CRUD verb, set up an event handler for each CRUD interface element. If you're using a form, for example, then you might set up a submit event handler for that form.
4. Use each CRUD event handler to send the form data to a single PHP script via Ajax. Importantly, that form data includes the value of a hidden field that specifies the type of task being performed (create, update, and so on).
5. In the PHP script, create a new object from the class of Step 1, check the CRUD type sent by the Ajax call, and then call the corresponding class method. For example, if the event is creating a new data item, the script would call the class method that handles creating new items.

The next couple of sections cover setting up the first part of the data class and building the PHP script that handles the Ajax form submissions.

Starting the web app's data class

In most cases, web app data forms a one-to-many relationship, where one item in a table is related to many items in another table. Some examples:

- » One blog can contain many posts.
- » One shopping cart can contain many products.
- » For my FootPower! app, one activity log can contain many activities.

The idea is to create a class for the “one” side of the relationship, which is often called the *master* table. The master class for your web app’s data needs to do the following three things, at a minimum:

- » Accept a parameter that references the current MySQLi object.
- » Define a method for each of the four CRUD verbs.
- » Define any helper functions required by the CRUD verbs.

With these goals in mind, here’s the skeleton class file:

```
<?php
class Data {

    // Holds the app's current MySQLi object
    private $_mysqli;

    // Use the class constructor to store the passed MySQLi
    // object
    public function __construct($mysqli=NULL) {
        $this->_mysqli = $mysqli;
    }

    // Here comes the CRUD
    public function createData() {

    }
    public function readAllData() {

    }
    public function readDataItem() {

    }
}
```

```
    public function updateData() {  
        }  
    public function deleteData() {  
        }  
    }  
?>
```

The class declares the private property `$_mysqli`, which it uses to store the current instance of the `MySQLi` object (created earlier in the `initialization.php` script). The class then declares functions for each CRUD verb, including two for the read task: one to read all the data and one to read a single data item. Store this file in `private/classes/data_class.php`.

To create an instance of this class, you'd use a statement similar to the following:

```
$log = new Data($mysqli);
```

Creating a data handler script

All the CRUD verbs — create, read, update, and delete — will be initiated via Ajax calls to a single PHP script. The Ajax call needs to specify the CRUD verb required, and the PHP code routes the request to the corresponding method in the Data class.

Here's the PHP script, saved as `public/handlers/data_handler.php`:

```
<?php  
  
    // Initialize the app  
    include_once '../private/common/initialization.php';  
  
    // Include the Data class  
    include_once '../private/classes/data_class.php';  
  
    // Initialize the results  
    $server_results['status'] = 'success';  
    $server_results['message'] = '';  
  
    // Make sure a log ID was passed  
    if (!isset($_POST['log-id'])) {
```

```
$server_results['status'] = 'error';
$server_results['message'] = 'Error: No log ID
specified!';
}
// Make sure a data verb was passed
elseif (!isset($_POST['data-verb'])) {
    $server_results['status'] = 'error';
    $server_results['message'] = 'Error: No data verb
specified!';
}
// Make sure a token value was passed
elseif (!isset($_POST['token'])) {
    $server_results['status'] = 'error';
    $server_results['message'] = 'Error: Invalid action!';
}
// Make sure the token is legit
elseif ($_SESSION['token'] !== $_POST['token']) {
    $server_results['status'] = 'error';
    $server_results['message'] = 'Timeout Error!<p>Please
refresh the page and try again.';
}
// If we get this far, all is well, so go for it
else {

    // Create a new Data object
    $data = new Data($mysqli);

    // Pass the data verb to the appropriate method
    switch ($_POST['data-verb']) {

        // Create a new data item
        case 'create':
            $server_results = json_decode($data-
>createData());
            break;

        // Read all the data items
        case 'read-all-data':
            $server_results = json_decode($data-
>readAllData());
            break;

        // Read one data item
        case 'read-data-item':
```

```

        $server_results = json_decode($data-
>readDataItem());
        break;
    // Update a data item
    case 'update':
        $server_results = json_decode($data-
>updateData());
        break;

    // Delete a new data item
    case 'delete':
        $server_results = json_decode($data-
>deleteData());
        break;

    default:
        $server_results['status'] = 'error';
        $server_results['message'] = 'Error: Unknown
data verb!';
    }
}
// Create and then output the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
echo $JSON_data;
?>

```

After initializing the app by including `initialization.php`, the code also includes the `Data` class file. The code then sets up an array named `$server_results`, which holds the results that the script sends back to the front end:

- » `$server_results['status']` will be either success or error.
- » `$server_results['message']` holds the success or error message to display.

The code next runs through a series of checks: making sure there's a reference to the database item you want to work with (`log-id`, in the preceding example); making sure a CRUD verb was passed; making sure a token value was passed; and comparing that token value with the session token. If the code gets past those tests, a `switch()` statement runs through the possible values for `$_POST['data-verb']` — `create`, `read-all-data`, `read-data-item`, `update`, or `delete` — and calls the corresponding `Data` method.

In the rest of this chapter, I fill in the details for the various `Data` methods and the front-end interfaces that support them.

Creating New Data

If your web app enables users to work with data items, then you won't be able to display anything to the user until she has created an item or three, which means setting up the "create" portion of your CRUD system should be your first order of business. To enable users to create data, you need to do three things:



REMEMBER

1. Build a form to capture the data.
2. Create a submit event handler that uses an Ajax call to send the form data to the server.
3. Validate and sanitize the form data, then insert the new info into the database.

Building the form

In most CRUD-based web apps, the forms used to create and edit items are identical. In such cases, rather than creating two separate forms that merely repeat the same the HTML code, it's best to use a single form. That is, go ahead and create separate pages for the create and edit tasks, but place the form code in a separate file and then include that file in each page. When you load each page, you add JavaScript code that adjusts the form controls accordingly:

- » When the user wants to create a new data item, reset the form controls to blank or default values.
- » When the user wants to edit an existing data item, populate the form controls with the existing data.

I go through the specifics of building HTML forms in Book 6, Chapter 2, so I won't go into the details again here. Instead, I'll just show you the form code I'm using for my FootPower! app (which I've stored as `public/common/data_form.php`):

```
<form id="data-form">
    <div class="form-wrapper">
        <div class="form-row">
            <div class="control-wrapper">
                <label for="activity-type">Activity type</label>
                <select id="activity-type" name="activity-type" size="1" aria-label="Select the type of activity">
                    <option value="Walk">Walk</option>
                    <option value="Run">Run</option>
                    <option value="Cycle">Cycle</option>
                </select>
            </div>
        </div>
    </div>
</form>
```

```

        <div class="control-wrapper">
            <label for="activity-date">Activity date</label>
            <input id="activity-date" type="date"
name="activity-date" aria-label="The date of the activity"
required>
        </div>
    </div>
    <div class="form-row">
        <div class="control-wrapper">
            <label for="activity-distance">Distance</label>
            <input id="activity-distance" type="number"
name="activity-distance" min="0" max="999" step=".01" data-
distance="0" aria-label="The distance of the activity">
            <span><?php echo $_SESSION['distance_unit'] ?>
(<a href="your_account.php">change</a>)</span>
        </div>
        <div class="control-wrapper" id="activity-duration">
            <label for="activity-duration">Duration
(hh:mm:ss)</label>
            <input id="activity-duration-hours"
type="number" name="activity-duration-hours" min="0" max="999"
placeholder="hh" aria-label="The number of hours the activity
required"> :
            <input id="activity-duration-minutes"
type="number" name="activity-duration-minutes"
min="0" max="59" placeholder="mm" aria-label="The number of
minutes the activity required"> :
            <input id="activity-duration-seconds"
type="number" name="activity-duration-seconds"
min="0" max="59" placeholder="ss" aria-label="The number of
seconds the activity required">
        </div>
    </div>
    <div class="form-row">
        <div class="control-wrapper">
            <div>
                <button id="data-save-button" class="btn
data-save-button" type="submit" role="button">Save</button>
            </div>
            <div>
                <button id="data-cancel-button" class="btn
btn-plain data-cancel-button" role="button">Cancel</button>
                <span id="result" class="result-text"></span>
            </div>
        </div>
    
```

```

        <div class="control-wrapper">
            <div>
                <button id="data-delete-button" class="btn data-delete-button" type="button" role="button">Delete this Activity</button>
            </div>
            </div>
        </div>
        <span id="form-error" class="error error-message form-error-message"></span>
        <span id="form-message" class="form-message"></span>
        <input type="hidden" id="log-id" name="log-id" value="<?php echo $_SESSION['log_id']; ?>">
        <input type="hidden" id="activity-id" name="activity-id">
        <input type="hidden" id="data-verb" name="data-verb">
        <input type="hidden" id="token" name="token" value="<?php echo $_SESSION['token']; ?>">
    </form>

```

This form gathers four bits of info from the user: the activity type, the activity date, the distance (which can be expressed in either kilometers or miles; see Book 7, Chapter 4), and the duration (given by separate fields for the hours, minutes, and seconds). Note, too, the four hidden fields:

- » **log-id**: The ID of the log to which the new item will be added, as given by PHP's `$_SESSION['log_id']` variable. As I mention in Book 7, Chapter 2, this is set to 1 now because I assume at this point that the app has only a single user. However, when I add users in Book 7, Chapter 4, the value of the `log-id` field will reflect the log ID value of the currently logged-in user.
- » **activity-id**: During an update task, the ID of the activity the user is currently editing.
- » **data-verb**: The type of CRUD verb the form is for (such as `create` or `update`).
- » **token**: The current session token, as given by PHP's `$_SESSION['token']` variable.

To use this form, I include it in the `create_data.php` file, which is stored in the web root:

```

<?php
    include_once '../private/common/initialization.php';
    $page_title = 'Add an Activity';

```

```

include_once 'common/top.php';
include_once 'common/data_form.php';
include_once 'common/sidebar.php';
include_once 'common/bottom.php';
?>

```

Figure 3-1 shows the resulting form. (To save space, I haven't shown the CSS behind the form, but you can see it online at <https://mcfedries.com/webcodingfordummies>.)

The screenshot shows a web form titled "ADD AN ACTIVITY". It contains the following fields:

- Activity type:** A dropdown menu set to "Walk".
- Activity date:** A text input field containing "2018-01-07".
- Distance:** A text input field containing "0" followed by a link "(change)".
- Duration (hh:mm:ss):** A text input field containing "0 : 0 : 0".
- Buttons:** A green "SAVE" button and a grey "CANCEL" button.

FIGURE 3-1:
The FootPower! form that enables a user to create a new activity.

How does the form get its default values? In the common page startup file — top.php, which I talk about in Book 7, Chapter 2, I added the following code:

```

$(document).ready(function() {

    // Get the current filename and run code for that file
    var currentURL = window.location.pathname;
    var currentFile =
        currentURL.substr(currentURL.lastIndexOf('/') + 1);
    switch (currentFile) {

        // Display the signed-in user's Activity Log
        case 'index.php':
            readActivities();
            break;

        // Set up the Create Data form
        case 'create_data.php':
            initializeCreateDataForm();
            break;

        // Set up the Edit Data form
        case 'update_data.php':
    }
}

```

```
        initializeUpdateDataForm();
        break;
    }
});
```

The code extracts the filename for the current URL, and then uses a `switch()` statement to call a function depending on the result. For the `create_data.php` file, the code calls the `initializeCreateDataForm()` function:

```
function initializeCreateDataForm() {

    // Hide the Delete button
    $('#data-delete-button').hide();

    // Set the data verb to 'create'
    $('#data-verb').val('create');

    // Populate the form
    $('#activity-type').val('Walk');
    var d = new Date();
    var todaysDate = d.getFullYear() + '-' + Number(d.getMonth() + 1).padWithZeros(2, 'left') + '-' + d.getDate().padWithZeros(2, 'left');
    $('#activity-date').val(todaysDate);
    $('#activity-distance').val(0);
    $('#activity-duration-hours').val(0);
    $('#activity-duration-minutes').val(0);
    $('#activity-duration-seconds').val(0);
}
```

This function does three things:

- » Hides the form's Delete button.
- » Sets the value of the form's `data-verb` field to `create`.
- » Resets the form fields. In particular, it sets the date field to today's date and the numeric fields to 0.

To store this code, the code for the other CRUD event handlers, as well as any helper code required for data interactions, I created an external JavaScript file and saved it to `public/js/data.js`.

Sending the form data to the server

To process the form, you need to set up a handler for the form's submit event. Here's the one I'm using for the FootPower! app:

```
$( '#data-form' ).submit( function(e) {  
  
    // Prevent the default submission  
    e.preventDefault();  
  
    // Disable the Save button to prevent double submissions  
    $('#data-save-button').prop('disabled', true);  
  
    // Convert the data to POST format  
    var formData = $(this).serializeArray();  
  
    // Submit the data to the handler  
    $.post('/handlers/data_handler.php', formData,  
    function(data) {  
  
        // Convert the JSON string to a JavaScript object  
        var result = JSON.parse(data);  
  
        if(result.status === 'error') {  
  
            // Display the error  
            $('#form-error').html(result.message).css('display',  
            'inline-block');  
  
            // Enable the Save button  
            $('#data-save-button').prop('disabled', false);  
  
        } else {  
  
            // Display the success message  
            $('#form-message').html(result.message).  
            css('display', 'inline-block');  
  
            // Return to the home page after 3 seconds  
            window.setTimeout("window.location='index.php'",  
            3000);  
        }  
    });  
});
```

This code prevents the default form submission, disables the Save button, converts the form data to the POST format, then uses jQuery's `.post()` method to send the data to the `data_handler.php` script on the server. The callback function runs JavaScript's `JSON.parse()` method on the returned JSON string to convert it into a JavaScript object, and then outputs the result. If the data gets inserted successfully, the user is sent back to the home page.

Adding the data item

When the server script receives the data via the Ajax call, it must validate and sanitize the data; then, assuming everything checks out, run a prepared SQL INSERT statement to add a new record to the table. All this happens in the Data class's `createData()` method. Here's the code from my FootPower! app:

```
public function createData() {  
  
    // Store the default status  
    $server_results['status'] = 'success';  
    $server_results['control'] = 'form';  
  
    // Check the log-id field  
    $log_id = $_POST['log-id'];  
    if(empty($log_id)) {  
        $server_results['status'] = 'error';  
        $server_results['message'] = 'Error: Missing log ID';  
    } else {  
        // Sanitize it to an integer  
        $log_id = filter_var($log_id,  
            FILTER_SANITIZE_NUMBER_FLOAT);  
        if (!$log_id) {  
            $server_results['status'] = 'error';  
            $server_results['message'] = 'Error: Invalid  
            log ID';  
        } else {  
            // Check the activity-type field (required)  
            if(isset($_POST['activity-type'])) {  
                $activity_type = $_POST['activity-type'];  
                if(empty($activity_type)) {  
                    $server_results['status'] = 'error';  
                    $server_results['message'] = 'Error:  
                    Missing activity type';  
                } else {  
                    // Insert the data into the database  
                    $query = "INSERT INTO logs (log_id, activity_type)  
                    VALUES (?, ?)";  
                    $stmt = $this->db->prepare($query);  
                    $stmt->execute([$log_id, $activity_type]);  
                    $server_results['status'] = 'success';  
                    $server_results['message'] = 'Log added successfully';  
                }  
            }  
        }  
    }  
}
```

```

                // Sanitize it by accepting only one of
            three values: 'Walk', 'Run', or 'Cycle'
                if ($activity_type !== 'Walk' AND
$activity_type !== 'Run' AND $activity_type !== 'Cycle') {
                    $server_results['status'] = 'error';
                    $server_results['message'] = 'Error:
Invalid activity type';
                } else {
                    // Check the activity-date field
                    (required)
                        if(isset($_POST['activity-date'])) {
                            $activity_date = $_POST[
                            'activity-date'];
                            if(empty($activity_date)) {
                                $server_results['status'] =
                                'error';
                                $server_results['message'] =
                                'Error: Missing activity date';
                            } else {
                                // Check for a valid date (that
                                is, one that uses the pattern YYYY-MM-DD)
                                if(!preg_match('/^([0-9]{4}-
(0[1-9]|1[0-2])-(0[1-9]|1[0-9]|2[0-9]|3[0-1])$/',
$activity_date)) {
                                    $server_results['status'] =
                                    'error';
                                    $server_results['message'] =
                                    'Error: Invalid activity date';
                                }
                            }
                        }
                    }
                }
            }
        }
    }
}

// Check the activity-distance field
$activity_distance = 0;
if(isset($_POST['activity-distance'])) {
    $activity_distance = $_POST['activity-distance'];

    // Sanitize it to a floating-point value
    $activity_distance = filter_var($activity_distance,
FILTER_SANITIZE_NUMBER_FLOAT, FILTER_FLAG_ALLOW_FRACTION);
}

```

```
    }
    // Check the activity-duration-hours field
    $activity_hours = 0;
    if(isset($_POST['activity-duration-hours'])) {
        $activity_hours = $_POST['activity-duration-hours'];
        $activity_hours = filter_var($activity_hours,
FILTER_SANITIZE_NUMBER_FLOAT);
    }
    // Check the activity-duration-minutes field
    $activity_minutes = 0;
    if(isset($_POST['activity-duration-minutes'])) {
        $activity_minutes = $_POST['activity-duration-minutes'];
        $activity_minutes = filter_var($activity_minutes,
FILTER_SANITIZE_NUMBER_FLOAT);
    }
    // Check the activity-duration-seconds field
    $activity_seconds = 0;
    if(isset($_POST['activity-duration-seconds'])) {
        $activity_seconds = $_POST['activity-duration-seconds'];
        $activity_seconds = filter_var($activity_seconds,
FILTER_SANITIZE_NUMBER_FLOAT);
    }
    $activity_duration = $activity_hours . ':' .
$activity_minutes . ':' . $activity_seconds;

    if($server_results['status'] === 'success') {

        // Create the SQL template
        $sql = "INSERT INTO activities
                (log_id, type, date, distance, duration)
                VALUES (?, ?, ?, ?, ?, ?)";

        // Prepare the statement template
        $stmt = $this->_mysqli->prepare($sql);

        // Bind the parameters
        $stmt->bind_param("issds", $log_id, $activity_type,
$activity_date, $activity_distance, $activity_duration);

        // Execute the prepared statement
        $stmt->execute();

        // Get the results
        $result = $stmt->get_result();
```

```

        if($this->_mysqli->errno === 0) {
            $server_results['message'] = 'Activity saved
successfully! Sending you back to the activity log...';
        } else {
            $server_results['status'] = 'error';
            $server_results['message'] = 'MySQLi error #: ' .
$this->_mysqli->errno . ':' . $this->_mysqli->error;
        }
    }
    // Create and then output the JSON data
    $JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
    return $JSON_data;
}

```

This code runs through each of the form fields, checking for valid values and sanitizing as needed. Along the way, the results are stored in the `$server_results` array, where `$server_results['status']` is either `success` or `error`, and `$server_results['message']` is the message that gets displayed to the user.

Reading and Displaying Data

Once your database has at least one item stored, then it's time to handle the "R" in CRUD: reading the data and displaying it to the user. I handle this in five stages:

- » Getting the home page's HTML ready to receive data
- » Writing the code for the Ajax call that requests the data
- » Updating the Data class file to handle the read task
- » Displaying the returned data
- » Wiring up the controls that filter the data

Getting the home page ready for data

Right now the home page (`index.php`) file is a skeleton with an empty `main` element. Your job now is to fill that `main` element with the app's data, as well as some controls for operating the app. Here an example from my `FootPower!` app:

```
<div class="activity-log-toolbar" role="toolbar">
    <label for="activity-filter-date-from">From </label>
    <input id="activity-filter-date-from" class="activity-filter" type="date" value=<?php echo date('Y-m-d', strtotime('-30 days')) ?>">
    <label for="activity-filter-date-to"> to </label>
    <input id="activity-filter-date-to" class="activity-filter" type="date" value=<?php echo date('Y-m-d') ?>">
    <label for="activity-filter-type">Type</label>
    <select id="activity-filter-type" class="activity-filter">
        <option id="activity-filter-type-all">All</option>
        <option id="activity-filter-type-walk">Walk</option>
        <option id="activity-filter-type-run">Run</option>
        <option id="activity-filter-type-cycle">Cycle</option>
    </select>
    <button id="data-create-button" class="btn" role="button">Add New</button>
</div>

<!-- The Activity Log appears here -->
<section id="activity-log" class="activity-log">
</section>

<!-- This hidden form contains the values we need to read the
     data: log-id, data-verb, and token -->
<form id="data-read-form" class="hidden">
    <input type="hidden" id="log-id" name="log-id" value=<?php
echo $_SESSION['log_id']; ?>">
    <input type="hidden" id="data-verb" name="data-verb"
value="read-all-data">
    <input type="hidden" id="token" name="token" value=<?php
echo $_SESSION['token']; ?>">
</form>

<!-- If there's an error reading the data, the error message
     appears inside this span -->
<span id="read-error" class="error error-message"></span>
```

Here are the components you see in this code:

- » A div element, which is a toolbar that includes the controls for filtering the data by date or by activity type. Note the bits of inline PHP that set the “to” date to the current date and the “From” date to 30 days earlier.
- » An empty section element, which is where the data will appear.

- » A form element that includes three hidden fields: log-id, data-verb (set to read-all-data), and token.
- » A span element that will be used to display an error messages that crop up.

Earlier in this chapter, I show that jQuery's `ready()` method called different functions depending on the file being opened. For `index.php`, that function is `readActivities()`, which initiates the read task and which I discuss shortly. For now, if I comment out that function call, Figure 3-2 shows you what the home page looks like before things go any further.

The screenshot shows the homepage of the FootPower! application. At the top is a logo consisting of a blue foot icon above the word "FOOT" in large blue letters, with "POWER!" in smaller blue letters below it. Below the logo is the text "YOUR ACTIVITY LOG". Underneath that is a search/filter bar with three input fields: "From" (containing "2017-12-08"), "to" (containing "2018-01-07"), and "Type" (containing "All"). To the right of these fields is a dropdown arrow. Next to the dropdown is a green button labeled "ADD NEW".

FIGURE 3-2:
The FootPower!
home page, ready
to receive the
activity log data.

Making an Ajax request for the data

Once you've got your home page HTML set up, you're ready to initiate the read process, which gathers the hidden form data and then makes the Ajax request to the data handler script on the server.

For my FootPower! app, I initiate the Ajax request by calling the `readActivities()` function:

```
function readActivities() {
    // Get the form data and convert it to POST
    formData = $('#data-read-form').serializeArray();

    // Submit the data to the handler
    $.post('/handlers/data_handler.php', formData,
        function(data) {
            Code to handle the data returned from the server will
            go here
    }
}
```

The function grabs the data from the hidden form, converts it to POST format, and then sends it to the server's `data_handler.php` script.

Reading the data

As I discuss earlier, the main job of the `data_handler.php` script is to route the Ajax request depending on the value of the CRUD verb. For the read-all-data value, the handler calls the data class's `readAllData()` method. This method takes the ID of the Data object, validates and sanitizes it, then uses it to create a SELECT statement that grabs the master object's data items.

Here's the code for the FootPower! version of the `readAllData()` method:

```
public function readAllData() {

    // Store the default status
    $server_results['status'] = 'success';

    // Check the log_id field
    $log_id = $_POST['log-id'];
    if(empty($log_id)) {
        $server_results['status'] = 'error';
        $server_results['message'] = 'Error: Missing log ID';
    } else {
        // Sanitize it to an integer
        $log_id = filter_var($log_id, FILTER_SANITIZE_NUMBER_FLOAT);
        if (!$log_id) {
            $server_results['status'] = 'error';
            $server_results['message'] = 'Error: Invalid
log ID';
        }
    }
    if($server_results['status'] === 'success') {

        // Create the SQL template
        $sql = "SELECT * FROM activities
                WHERE log_id=?"
                ORDER BY date DESC";

        // Prepare the statement template
        $stmt = $this->_mysqli->prepare($sql);

        // Bind the parameter
        $stmt->bind_param("i", $log_id);

        // Execute the prepared statement
        $stmt->execute();
    }
}
```

```

    // Get the results
    $result = $stmt->get_result();

    if($this->_mysqli->errno === 0) {
        // Get the query rows as an associative array
        $rows = $result->fetch_all(MYSQLI_ASSOC);

        // Convert the array to JSON, then output it
        $JSON_data = json_encode($rows, JSON_HEX_APOS |
        JSON_HEX_QUOT);
        return $JSON_data;
    } else {
        $server_results['status'] = 'error';
        $server_results['message'] = 'MySQLi error #: ' .
        $this->_mysqli->errno . ':' . $this->_mysqli->error;
    }

}

if($server_results['status'] === 'error') {
    // Create and then output the JSON string
    $JSON_data = json_encode($server_results, JSON_HEX_APOS |
    JSON_HEX_QUOT);
    return $JSON_data;
}
}

```

The code validates and sanitizes the log ID, then sets up a prepared SELECT statement to grab all the records from the `activities` table using the `$log_id` value (sanitized and stored in the `$log_id` variable) as the filter. The results are then returned as a JSON string.

Displaying the data

The server sends back either an error message or the actual data for displaying, so your front-end code needs to allow for both possibilities.

Here's the updated version of the FootPower! app's `readActivities()` function, with the added code shown in bold:

```

function readActivities() {

    // Get the form data and convert it to POST
    formData = $('#data-read-form').serializeArray();
    // Submit the data to the handler

```

```

$.post('/handlers/data_handler.php', formData,
function(data) {

    // Convert the JSON string to a JavaScript object
    var result = JSON.parse(data);

    // If there was an error, result.status will be defined
    if (typeof result.status !== 'undefined') {

        // If so, display the error
        $('#read-error').html(result.message).css('display',
        'inline-block');

    } else {

        // Otherwise, go ahead and display the data
        activityLog = result;
        applyFilters();
    }
});
}

```

The returned data is converted to a JavaScript object with `JSON.parse(data)`, and that object is stored in the `results` variable. To check for an error, the code tests whether `activityLog.status` is `undefined`. If not, the code outputs the error message; otherwise, the code stores the returned data in the `activityLog` variable, which is declared as a global variable, and then calls `applyFilters()` (which I discuss in the next section).

Filtering the data

If your app might end up presenting the user with a ton of data, you should consider implementing controls to enable the user to filter the data to see only a manageable subset of the records. For example, you could set up a couple of `<input type="date">` tags that enable the user to choose a date range. Similarly, you could create a `<select>` list that includes the unique options for a field, and when the user selects one of these options, the data is filtered to show only the records that match the selected value.

My FootPower! app implements each of these filter options:

- » A date field that specifies the earliest activity data displayed
- » A second date field that specifies the latest activity data displayed

» A select list that enables the user to choose a specific activity type: Walk, Run, or Cycle (or All to see every type)

I displayed the HTML for these controls earlier. Here's the JavaScript that handles the change events for these controls:

```
/*
 * Click handler for the Activity Log's Date "From" filter
 */
$('#filter-activity-date-from').change(function() {
    applyFilters();
});

/*
 * Click handler for the Activity Log's Date "To" filter
 */
$('#filter-activity-date-to').change(function() {
    applyFilters();
});

/*
 * Click handler for the Activity Log's Type filter
 */
$('#filter-activity-type').change(function() {
    applyFilters();
});

/*
 * Applies the current Activity Log filters
 */
function applyFilters() {

    // Get the current filter values
    var earliestDateFilter = $('#filter-activity-date-from').val();
    var latestDateFilter = $('#filter-activity-date-to').val();
    var activityTypeFilter = $('#filter-activity-type > option:selected').text();

    // Filter based on the "From" date
    filteredLog = activityLog.filter(function(activity) {
        return activity.date >= earliestDateFilter;
    });
}
```

```

    // Filter based on the "To" date
    filteredLog = filteredLog.filter(function(activity) {
        return activity.date <= latestDateFilter;
    });

    // Filter based on the "Type" value
    if(activityTypeFilter === 'All') {
        displayActivityLog(filteredLog);
    } else {
        filteredLog = filteredLog.filter(function(activity) {
            return activity.type === activityTypeFilter;
        });
        displayActivityLog(filteredLog);
    }
}

```

All three of the event handlers do nothing else but call the `applyFilters()` function. This function first gets the current filter values and then it applies each filter in turn. In each case, the code uses JavaScript's `filter()` method to return a subset of the array. Note, however, that the first time `filter()` runs, it applies the filter on the full `activityLog` array and returns the filtered array as `filteredLog`. The second time `filter()` runs, it applies the filter to the `filteredLog` array, which makes the filter cumulative. For the Type filter, if the value is All, the code just outputs the filtered data by calling `displayActivityLog()` with the filtered array as a parameter. Otherwise, it applies the filter and then displays the data.

Here's the function that performs the actual displaying of the data:

```

function displayActivityLog(log) {
    $('.activity-log').html('<div id="activity-log-header" class="activity activity-log-header">');
    $('#activity-log-header').append('<div class="activity-item">Type</div>');
    $('#activity-log-header').append('<div class="activity-item">Date</div>');
    $('#activity-log-header').append('<div class="activity-item">Distance</div>');
    $('#activity-log-header').append('<div class="activity-item">Duration</div>');
}

```

```

$('.activity-log').append('</div>');
$.each(log, function(index, activity) {
    $('.activity-log').append('<div id="activity' + index +
'" class="activity">');
    switch (activity.type) {
        case 'Walk':
            activityIcon = '';
            break;
        case 'Run':
            activityIcon = '';
            break;
        case 'Cycle':
            activityIcon = '';
            break;
    }
    $('#activity' + index).append('<div class="activity-item">' + activityIcon + activity.type + '</div>');
    $('#activity' + index).append('<div class="activity-item">' + activity.date + '</div>');
    $('#activity' + activity.activity_id).append('<div class="activity-item">' + Number(activity.distance).toFixed(2) + '</div>');
    $('#activity' + index).append('<div class="activity-item">' + activity.duration + '</div>');
    $('#activity' + activity.activity_id).append('<div class="activity-item"><input id="activity-' + activity.activity_id + '" class="data-edit-button" type="image" src="images/pencil.png" alt="Pencil icon; click to edit this activity"></div>');
    $('.activity-log').append('</div>');
});
}

```

This code mostly just appends HTML to the home page's empty `<section>` tag (which I've given the class name `activity-log`). A `switch()` statement checks the activity type to output the corresponding icon image. The CSS, which I don't have room to show, configures the data with a flexbox layout that alternates the data item background to make it easier to read, as you can see in Figure 3-3.

| Your Activity Log | | | | |
|---|------------|--|---|---|
| From <input type="text" value="2017-12-08"/> | | to <input type="text" value="2018-01-07"/> | Type <input type="button" value="All"/> | <input type="button" value="ADD NEW"/> |
| Type | Date | Distance (kilometers) | Duration (hh:mm:ss) | Edit |
|  Run | 2018-01-05 | 4.02 | 00:21:12 |  |
|  Run | 2018-01-04 | 8.05 | 00:42:09 |  |
|  Walk | 2018-01-04 | 10.00 | 02:00:00 |  |
|  Run | 2018-01-01 | 6.09 | 00:32:00 |  |
|  Walk | 2018-01-01 | 7.00 | 01:17:00 |  |
|  Run | 2017-12-31 | 10.00 | 00:52:00 |  |
|  Cycle | 2017-12-29 | 20.00 | 01:18:00 |  |
|  Run | 2017-12-28 | 10.05 | 00:53:10 |  |
|  Run | 2017-12-27 | 8.18 | 00:44:39 |  |
|  Walk | 2017-12-27 | 7.00 | 01:20:00 |  |

FIGURE 3-3:
The FootPower!
home page, now
with fresh data.

Updating and Editing Data

To enable the user to update existing data items, you need to add an Edit button for each item. In most cases, clicking this button presents a form that's identical to the one used to create an item, although with the existing item's data already filled in. Submitting that form should then run an UPDATE query on the server to preserve the user's edits.

To handle this in my FootPower! app, I included an Edit column to the Activity Log, and for each activity I displayed a pencil icon, as shown in Figure 3-3.

Here's the jQuery code I used to add the pencil icons to each activity:

```
$('#activity' + activity.activity_id).append('
<div
    class="activity-item"><input id="activity-' + activity.
    activity_id + '" class="activity-crud-update" type="image"
    src="images/pencil.png" alt="Pencil icon; click to edit this
    activity"></div>');
```

Note, in particular, that for each `<input>` tag, the `id` value is set to `activity-id`, where `id` is the `activity_id` value of the current activity.

Here's the click event handler that runs when the user clicks a pencil icon:

```
$('#activity-log').click(function(e) {
    e.preventDefault();
```

```

// Make sure we're dealing with an edit link
if(e.target.className === 'data-edit-button') {

    //Get the activity's ID
    var activityID = Number(e.target.id.split('-')[1]);

    // Load the Update form and send the activity ID in the
    // query string
    window.location = 'update_data.php?activity-id=' +
    activityID;
}
});

```

Here's what happening in this code:

- » Since you created the edit links in code, you can't use them as jQuery selectors, so you use the closest DOM ancestor, which is the `<section id="activity-log">` tag.
- » The clicked activity's ID value is extracted and stored in the `activityID` variable.
- » The browser is sent to the `update_data.php` file, with the activity ID stored in the URL's query string.

First, here's the code for the `update_data.php` page:

```

<?php
    include_once '../private/common/initialization.php';
    $page_title = 'Edit Activity';
    include_once 'common/top.php';
    include_once 'common/data_form.php';
?>
        <!-- The jQuery UI dialog markup for Delete This
Activity-->
        <div id="confirm-delete" class="activity-delete-
dialog" title="Delete This Activity?" role="dialog">
            <p>Are you sure you want to remove this
activity from your log?
                This action can't be undone!</p>
        </div>

<?php
    include_once 'common/sidebar.php';
    include_once 'common/bottom.php';
?>

```

**REMEMBER**

Note the extra markup for a jQuery UI dialog. I talk about this in the next section.

The document's `ready()` event (shown earlier) looks for this file and runs the `initializeUpdateDataForm()` function:

```
function initializeUpdateDataForm() {

    // Get the activity ID from the URL query string and save it
    // to the form
    var activityID = Number(window.location.search.split('=')[1]);
    $('#activity-id').val(activityID);

    // Get the data for this item
    var formData = [
        {"name": "log-id", "value": $('#log-id').val()},
        {"name": "activity-id", "value": $('#activity-id').val()},
        {"name": "data-verb", "value": "read-data-item"},
        {"name": "token", "value": $('#token').val()}
    ];

    // Submit the data to the handler
    $.post('/handlers/data_handler.php', formData,
    function(data) {

        // Convert the JSON string to a JavaScript object
        // We know that "data" is a single-item array, so just
        take the first item
        var result = JSON.parse(data)[0];

        // If there was an error, result.status will be defined
        if (typeof result.status !== 'undefined') {

            // If so, display the error
            $('#form-error').html(result.message).css('display',
            'inline-block');

        } else {
            // Show the Delete button
            $('#data-delete-button').show();

            // Set the data verb to "update"
            $('#data-verb').val('update');
        }
    });
}
```

```

        // Store the activity values
        // We know that "result" is a single-item array,
        so just take the first item
        activity = result[0];
        var activityType = activity.type;
        var activityDate = activity.date
        var activityDistance = Number(activity.distance).
toFixed(2);
        var activityDuration = activity.duration.split(':');

        // Use the activity values to populate the edit form
        $('#activity-id').val(activityID);
        $('#activity-type').val(activityType);
        $('#activity-date').val(activityDate);
        $('#activity-distance').val(activityDistance);
        $('#activity-duration-hours').
        val(activityDuration[0]);
        $('#activity-duration-minutes').
        val(activityDuration[1]);
        $('#activity-duration-seconds').
        val(activityDuration[2]);
    }
}

```

The first part of this code grabs the activity to be updated from the server. The ID of the activity is extracted from the URL's query string and then stored in the form's hidden `activity-id` field. The form's hidden field values are gathered and then sent via the `.post()` method to the `data_handler.php` script on the server. Note in particular then the `data-verb` value is set to `read-data-item`, which means the server script will call the `Data` class's `readDataItem()` method:

```

public function readDataItem() {

    // Store the default status
    $server_results['status'] = 'success';

    // Check the log-id field
    $log_id = $_POST['log-id'];
    if(empty($log_id)) {
        $server_results['status'] = 'error';
        $server_results['message'] = 'Error: Missing log ID';
    } else {

```

```
// Sanitize it to an integer
$log_id = filter_var($log_id, FILTER_SANITIZE_NUMBER_FLOAT);
if (!$log_id) {
    $server_results['status'] = 'error';
    $server_results['message'] = 'Error: Invalid
log ID';
} else {
    // Check the activity-id field
    $activity_id = $_POST['activity-id'];
    if(empty($activity_id)) {
        $server_results['status'] = 'error';
        $server_results['message'] = 'Error: Missing
activity ID';
    } else {
        // Sanitize it to an integer
        $activity_id = filter_var($activity_id,
FILTER_SANITIZE_NUMBER_FLOAT);
        if (!$activity_id) {
            $server_results['status'] = 'error';
            $server_results['message'] = 'Error: Invalid
activity ID';
        }
    }
}
// Are we good?
if($server_results['status'] === 'success') {

    // Create the SQL template
    $sql = "SELECT * FROM activities
            WHERE log_id=?
            AND activity_id=?
            LIMIT 1";

    // Prepare the statement template
    $stmt = $this->_mysqli->prepare($sql);

    // Bind the parameters
    $stmt->bind_param("ii", $log_id, $activity_id);

    // Execute the prepared statement
    $stmt->execute();
```

```

// Get the results
$result = $stmt->get_result();

if($this->_mysqli->errno === 0) {

    // Get the query row as an associative array
    $row = $result->fetch_all(MYSQLI_ASSOC);

    // Convert the array to JSON, then return it
    $JSON_data = json_encode($row, JSON_HEX_APOS |
    JSON_HEX_QUOT);
    return $JSON_data;
} else {
    $server_results['status'] = 'error';
    $server_results['message'] = 'MySQLi error #: ' .
    $this->_mysqli->errno . ': ' . $this->_mysqli->error;
}
}

if($server_results['status'] === 'error') {
    // Create and then return the JSON string
    $JSON_data = json_encode($server_results,
    JSON_HEX_APOS | JSON_HEX_QUOT);
    return $JSON_data;
}
}
}

```

Back in `initializeUpdateDataForm()`, the returned item is stored in `result` and checked for an error. If there was no error, the form's `data-verb` value is set to update and the hidden Delete button is displayed. Finally, the activity's values are stored in variables, and then those variable values are used to populate the form controls.

Figure 3-4 shows an example of an activity ready to be edited.

FIGURE 3-4:
Clicking an activity's Edit icon displays the form populated with the activity's values.

Clicking Save runs the same event handler that I show earlier. The `data_handler.php` code on the server routes the Ajax request to the `Data` object's `updateData()` method. This method runs the same validation and sanitization code as `createData()`, shown earlier, except that `updateData()` also checks the update verb's `activity_id` value (which holds the ID of the activity being updated) and stores the sanitized version in the `$activity_id` variable:

```
// Check the activity-id field
$activity_id = $_POST['activity-id'];
if(empty($activity_id)) {
    $server_results['status'] = 'error';
    $server_results['activity-type'] = 'Missing activity ID';
} else {
    // Sanitize it to an integer
    $activity_id = filter_var($activity_id, FILTER_SANITIZE_NUMBER_FLOAT);
    if (!$activity_id) {
        $server_results['status'] = 'error';
        $server_results['message'] = 'Invalid activity ID';
    }
}
```

If everything checks out, the code prepares an SQL UPDATE statement to save the activity edit to the database:

```
if($server_results['status'] === 'success') {

    // Create the SQL template
    $sql = "UPDATE activities
            SET type=?, date=?, distance=?, duration=?
            WHERE log_id=? AND activity_id=?";

    // Prepare the statement template
    $stmt = $this->_mysqli->prepare($sql);

    // Bind the parameters
    $stmt->bind_param("ssdsii", $activity_type, $activity_date,
    $activity_distance, $activity_duration, $log_id,
    $activity_id);

    // Execute the prepared statement
    $stmt->execute();
```

```

// Get the results
$result = $stmt->get_result();

if($this->_mysqli->errno === 0) {
    $server_results['message'] = 'Activity updated
successfully!';
} else {
    $server_results['status'] = 'error';
    $server_results['message'] = 'MySQLi error #: ' .
    $this->_mysqli->errno;
}
}

// Create and then return the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
    JSON_HEX_QUOT);
return $JSON_data;

```

Deleting Data

As a final data-handling chore, your web app should provide an interface that enables the user to delete data items from the server. Careful, though: You also need some way to ask the user to confirm the deletion, to avoid accidental (and non-reversible) data loss. The usual way to confirm an action in a web app is to display a so-called *modal* dialog, which prevents the user from doing anything else on the screen until the dialog is dismissed. You could code such a dialog by hand, but why go to that trouble when our friends at jQuery UI have an awesome dialog widget that you can use with just a few lines of code?

Before I get to that, take a look back at Figure 3-4, which includes a Delete This Activity button. Clicking this button displays the confirmation dialog, so let's see how that works. Assuming you've downloaded a version of jQuery UI that contains the dialog widget (see Book 4, Chapter 3), you first add the HTML markup for the dialog:

```

<div id="confirm-delete" title="Delete This Activity?">
    <p>Are you sure you want to remove this activity from your
    log? This action can't be undone.</p>
</div>

```

The `title` attribute of the `div` element becomes the dialog title, and the text within the `div` element becomes the dialog's body text.

To configure the dialog, you add the following code:

```
$("#confirm-delete").dialog({  
    autoOpen: false,  
    closeOnEscape: true,  
    modal: true,  
    width: 400,  
    buttons: [  
        {  
            text: 'Cancel',  
            click: function() {  
                $(this).dialog('close');  
            }  
        },  
        {  
            text: 'Delete',  
            click: function() {  
                $(this).dialog('close');  
                Code to initiate the Ajax call to the server will  
go here  
            }  
        }  
    ]  
});
```

There are five options specified here (see <http://api.jqueryui.com/dialog/> for the complete list):

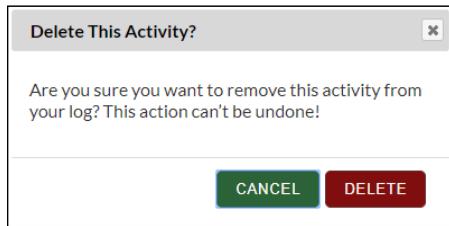
- » **autoOpen**: Determines whether the dialog opens automatically when the page loads. The default is `true`, so use `false` to control when the dialog appears.
- » **closeOnEscape**: When `true`, enables the user to close the dialog by pressing the Esc key.
- » **modal**: Set to `true` to make the dialog modal.
- » **width**: Specifies the width, in pixels, of the dialog.
- » **buttons**: This array specifies the command buttons that appear in the dialog. Use the `text` value to set the button text and the `click` value to specify a callback function that runs when the button is clicked.

To open the modal dialog, set up a click event handler for the button that you want to display the dialog:

```
$('#data-delete-button').click(function(e) {  
  
    // Take the focus off the button  
    $(this).blur();  
  
    // Open the jQuery UI dialog  
    $('#confirm-delete').dialog('open');  
  
    // Prevent the default action  
    e.preventDefault();  
});
```

Figure 3-5 shows the confirmation dialog I'm using for my FootPower! web app.

FIGURE 3-5:
When the user clicks Delete This Activity, this modal confirmation dialog appears.



Clicking the Cancel button just closes the dialog with no further action. Clicking Delete, however, means the user is serious about the deletion, so you need to add some code to this button's click handler:

```
click: function() {  
  
    // Close the dialog  
    $(this).dialog('close');  
  
    // Disable all the buttons  
    $('#data-form button').prop('disabled', true);  
  
    // Set the data verb to "delete"  
    $('#data-verb').val('delete');  
  
    // Get the form data and convert it to a POST-able format  
    // We only need the log ID, activity ID, CRUD verb, and  
    token from the form,
```

```
// so we'll build the array by hand instead of using
serializeArray()
formData = [
    {"name": "log-id", "value": $('#log-id').val()},
    {"name": "activity-id", "value": $('#activity-id').
val()},
    {"name": "data-verb", "value": $('#data-verb').val()},
    {"name": "token", "value": $('#token').val()}
];

// Submit the data to the handler
$.post('/handlers/data_handler.php', formData,
function(data) {

    // Convert the JSON string to a JavaScript object
    var result = JSON.parse(data);

    if(result.status === 'error') {

        // Display the error
        $('#form-error').html(result.message).css('display',
'inline-block');

        // Enable all the buttons
        $('#data-form button').prop('disabled', false);

    } else {

        // Display the success message
        $('#form-message').html(result.message).
css('display', 'inline-block');

        // Return to the home page after 1 second
        window.setTimeout("window.location='index.php'", 1000);
    }
});
}
```

Here's what happening in this code:

- » The form's data-verb value is set to delete.
- » The form's log-id, activity-id, crud-verb, and token values are added to the POST array.

» The POST data is passed along via Ajax to the `data_handler.php` script on the server.

The `data_handler.php` script sees that the `data-verb` value is `delete`, so it routes the Ajax request to the `Data` object's `deleteData()` method. That method validates and sanitizes the `log_id` and `activity_id` values, then uses them to prepare and execute a SQL `DELETE` statement:

```
if($server_results['status'] === 'success') {

    // Create the SQL template
    $sql = "DELETE FROM activities WHERE log_id=? AND
activity_id=?";

    // Prepare the statement template
    $stmt = $this->_mysqli->prepare($sql);

    // Bind the parameters
    $stmt->bind_param("ii", $log_id, $activity_id);

    // Execute the prepared statement
    $stmt->execute();

    // Get the results
    $result = $stmt->get_result();

    if($this->_mysqli->errno === 0) {
        $server_results['message'] = 'Activity deleted
successfully! Sending you back to the activity log...';
    } else {
        $server_results['status'] = 'error';
        $server_results['message'] = 'MySQLi error #: ' .
$this->_mysqli->errno . ':' . $this->_mysqli->error;
    }
}

// Create and then return the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
return $JSON_data;
}
```

IN THIS CHAPTER

- » Setting up your app's user class
- » Creating new user accounts
- » Signing users in and out of the web app
- » Handling forgotten passwords
- » Managing user accounts flexibly and securely

Chapter 4

Managing App Users

The craft of programming begins with empathy, not formatting or languages or tools or algorithms or data structures.

— KENT BECK

If your web app enables users to create data items, then those users will come with the more than reasonable expectation that your web app will preserve that data. The simplest web apps honor that expectation by saving user data locally in the web browser, a topic that I talk about in Book 8, Chapter 1. However, your users might also come with the further expectation that their data should be available to them no matter which device or web browser they happen to be using. This level of expectation is certainly still reasonable, but it's considerably more complex because now you're in the realm of managing user accounts on the server. This means creating user accounts, securely storing passwords, verifying new accounts, managing both sign-ins and sign-outs, updating user credentials, handling forgotten passwords, and more.

Yep, it's a big job, but I have a feeling you're more than up to the task. In this chapter, you explore the fascinating world of user management and delve into all the details required to set up a bulletproof and secure user account system.

Configuring the Home Page

One of the main changes you need to make when you want to add support for user accounts is configuring the web app's home page to show a different set of tags depending on whether the user is signed in or not:

- » If a user is signed in, show the user's data and a Sign Out button.
- » If the visitor doesn't have an account or isn't signed in, show an introductory screen and a Sign Up button that encourages those without an account to create one, and show a Sign In button so that users with accounts can access their data.

Fortunately, you don't need to create two different home pages. Instead, you can use some inline PHP to check whether a user is signed in and display the appropriate HTML tags and text depending on the result.



TIP

To make this sort of thing easier, PHP has an alternative `if()...else` syntax that you can use to add HTML tags to a page based on one or more conditions. Here's the general structure:

```
<?php
    if(condition):
?
    HTML tags to display if condition is TRUE
<?php
    else:
?
    HTML tags to display if condition is FALSE
<?php
    endif;
?
```

The *condition* in your web app will be something that returns `TRUE` if the user is signed in, and `FALSE` otherwise. There are various ways to approach this, but the easiest is to set a session variable when the user signs in. Because a username is required to sign in, it makes sense to use the username as the session variable. For example, assuming your web app has some sort of sign-in form (more on that in a bit) that includes a `username` field, then the following PHP statement would store a sanitized version of the username in a session variable named `username`:

```
$_SESSION['username'] = htmlentities($_POST['username'],
    ENT_QUOTES);
```

You can then use `isset($_SESSION['username'])` as the condition to determine what HTML tags the user sees. Here's a partial modification of the FootPower! `index.php` file:

```
<?php
    include_once '../private/common/initialization.php';
    if(isset($_SESSION['username'])) {
        $page_title = 'Your Activity Log';
    } else {
        $page_title = 'Welcome to FootPower!';
    }
    include_once 'common/top.php';

    if(isset($_SESSION['username'])):
?>
    The rest of the Activity Log code goes here (see Book 7,
Chapter 3)
<?php
    else:
?>
    <section class="footpower-intro" role="contentinfo">
        <p>
            Are you a walker, a runner, or a cyclist? Heck,
            maybe you're all three! Either way, you know the joy and
            satisfaction of propelling yourself across the face of the
            Earth using nothing but the power of your own two feet.
        </p>
        <p>
            Have you walked, ran, or cycled recently? If so,
            we salute you! But why relegate the details of that activity
            to the dim mists of history and memory? Why not save your
            effort for posterity? Just sign up for a free FootPower!
            account and you'll never forget a walk, run, or ride again!
        </p>
        <div>
            
            
            
        </div>
    </section>
</article>
```

```
<?php
    endif;
    include_once 'common/sidebar.php';
    include_once 'common/bottom.php';
?>
```

If the `username` session variable is set, the user is logged in, so display the Activity Log for that user. Otherwise, display an introductory message.

You also need conditional code that determines the buttons the user sees. Here's the modified version of the `FootPower! top.php` file:

```
<body>
    <header class="top-header" role="banner">
        <div class="top-header-logo">
            
        </div>
        <div class="top-header-user">
<?php
    if(isset($_SESSION['username'])):
?>
            <button id="show-user-account-button" class="btn-
plain">Your Account</button>
            <button id="user-sign-out-button" class="btn">Sign
Out</button>
<?php
    else:
?>
            <button id="show-sign-in-page-button" class="btn-
plain">Sign In</button>
            <button id="show-sign-up-page-button"
class="btn">Sign Up</button>
<?php
    endif;
?>
        </div>
    </header>
    <main role="main">
```

When the user is signed in, she sees the Your Account and Sign Out buttons; otherwise, she sees both a Sign In and a Sign Up button. Figure 4-1 shows the `FootPower!` home page when a user is not signed in.

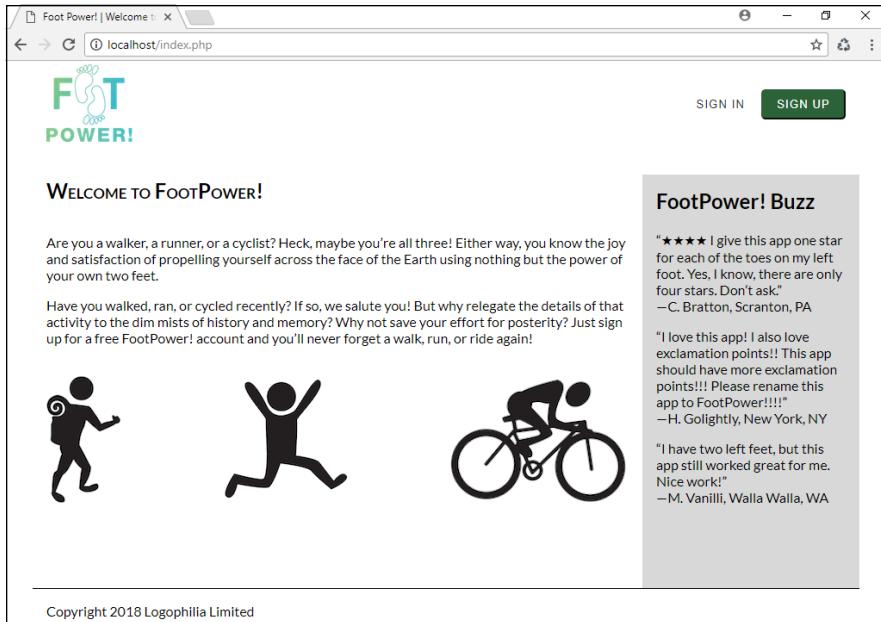


FIGURE 4-1:
The FootPower!
home page when
a user is not
signed in.

Setting Up the Back End to Handle Users

Most web apps that manage users need to implement at least the following tasks:

- » **Signing up new users:** Includes not only capturing the user's email address (to use as a username) and password, but also sending out a verification email to make sure the user isn't a bot or spammer
- » **Signing in users:** Enables each user to access her own data
- » **Signing out users:** Prevents others from accessing a user's account when his computer is left unattended
- » **Updating user data:** Enables each user to change her password and to reset a forgotten password
- » **Deleting users:** Enables a user to remove his account and data from the server

The rest of this chapter shows you how to implement each of these functions. Before I get to that, here's the bird's-eye view of what I'll be doing:

1. Build a class for handling user interactions. That class includes one method for each of the preceding tasks.

- 2.** Provide the user with an interface for signing up, signing in, signing out, modifying account data, and deleting the account.
- 3.** To start processing a user task, set up an event handler for each account-focused interface element. If you're using a sign-in form, for example, then you might set up a submit event handler for that form.
- 4.** Use each event handler to send the form data to a single PHP script via Ajax. Importantly, that form data includes the value of a hidden field that specifies the type of "user verb" being performed (sign up, sign in, reset password, and so on).
- 5.** In the PHP script, create a new object from the class of Step 1, check the user verb sent by the Ajax call, and then call the corresponding class method. For example, if the event is signing up a new user, the script would call the class method that handles creating new user accounts.

The next couple of sections cover setting up the first part of the user class and building the PHP script that handles the Ajax requests.

Starting the web app's user class

The class for your web app's users needs to do at least the following three things:

- » Accept a parameter that references the current MySQLi object.
- » Define a method for each of the user verbs.
- » Define any helper functions required by the user verbs.

With these goals in mind, here's the skeleton class file:

```
<?php
class User {

    // Holds the app's current MySQLi object
    private $_mysqli;

    // Use the class constructor to store the passed MySQLi
    // object
    public function __construct($mysqli) {
        $this->_mysqli = $mysqli;
    }
}
```

```
// Here are the user chores we need to handle
public function createUser() {

}

public function verifyUser() {

}

public function signInUser() {

}

public function sendPasswordReset() {

}

public function resetPassword() {

}

public function getDistanceUnit() {

}

public function updateDistanceUnit() {

}

public function deleteUser() {

}

}

?>
```

The class declares the private property `$_mysqli`, which it uses to store the current instance of the `MySQLi` object (created earlier in the `initialization.php` script). Store this file in `private/classes/user_class.php`.

To create an instance of this class, you'd use a statement similar to the following:

```
$user = new User($mysqli);
```

Creating a user handler script

The various user verbs will be initiated via Ajax calls to a single PHP script. Each Ajax call needs to specify the user verb required, and the PHP code routes the request to the corresponding method in the `User` class.

Here's the PHP script, which I'll save as `public/handlers/user_handler.php`:

```
<?php

    // Initialize the app
    include_once '../../../../../private/common/initialization.php';

    // Include the User class
    include_once '../../../../../private/classes/user_class.php';

    // Initialize the results
    $server_results['status'] = 'success';
    $server_results['control'] = '';
    $server_results['message'] = '';

    // Make sure a user verb was passed
    if (!isset($_POST['user-verb'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'form';
        $server_results['message'] = 'Error: No user verb specified!';
    }
    // Make sure a token value was passed
    elseif (!isset($_POST['token'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'form';
        $server_results['message'] = 'Error: Invalid user session!';
    }
    // Make sure the token is legit
    elseif ($_SESSION['token'] !== $_POST['token']) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'form';
        $server_results['message'] = 'Timeout Error! Please refresh the page and try again.';
    }
    // If we get this far, all is well, so go for it
    else {

        // Create a new User object
        $user = new User($mysqli);

        // Pass the user verb to the appropriate method
        switch ($_POST['user-verb']) {
```

```
// Sign up a new user
case 'sign-up-user':
    $server_results = json_decode($user->createUser());
    break;

// Sign in an existing user
case 'sign-in-user':
    $server_results = json_decode($user->signInUser());
    break;

// Send a request to reset a user's password
case 'send-password-reset':
    $server_results = json_decode($user->sendPasswordReset());
    break;

// Reset a user's password
case 'reset-password':
    $server_results = json_decode($user->resetPassword());
    break;

// Get the user's distance unit
case 'get-distance-unit':
    $server_results = json_decode($user->getDistanceUnit());
    break;

// Update distance unit
case 'update-unit':
    $server_results = json_decode($user->updateDistanceUnit());
    break;

// Delete a user
case 'delete-user':
    $server_results = json_decode($user->deleteUser());
    break;

default:
    $server_results['status'] = 'error';
```

```

        $server_results['control'] = 'token';
        $server_results['message'] = 'Error: Unknown
user verb!';
    }
}
// Create and then output the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
echo $JSON_data;
?>
```

After initializing the app by including `initialization.php`, the code also includes the `User` class file. The code then sets up an array named `$server_results`, which holds the results that the script sends back to the front end:

- » `$server_results['status']` will be either success or error.
- » `$server_results['message']` holds the success or error message to display.

The code next runs through a series of checks: making sure a verb was passed, making sure a token value was passed, and then comparing that token value with the session token. If the code gets past those tests, a `switch()` statement runs through the possible values for `$_POST['user-verb']` and calls the corresponding `User` method.

In the rest of this chapter, I fill in the details for the various `User` methods and the front-end interfaces that support them.

Signing Up a New User

The process of signing up a new user takes four general steps:



REMEMBER

1. Present the user with a form that asks for the person's username (usually just her email address) and a password.
2. Send the data to the server and provisionally add the user to the `users` table.
3. Send to the user a verification email that includes a unique link that the user must click to verify her account.
4. Verify the user.

Once the user is verified, and each subsequent time the user signs in to the app, you need to set a session variable that the app can use to check whether the user is signed in. I like to keep things simple here and just set `$_SESSION['username']` to the current account's username.

Building the form

When the user clicks the Sign Up button, he sees the `sign_up.php` page:

```
<?php
    include_once '../private/common/initialization.php';
    if(isset($_SESSION['username'])) {
        $page_title = 'You're Already Signed Up';
    } else {
        $page_title = 'Sign Up For a Free FootPower! Account';
    }
    include_once 'common/top.php';

    // Is the user already signed in?
    if(isset($_SESSION['username'])):
?>
        <section>
            <p>
                You already have an account, so nothing to
                see here.
            </p>
            <p>
                Did you want to <a href="create_data.
                php">log an activity</a>, instead?
            </p>
            <p>
                Or perhaps you want to <a href="sign_out.
                php">sign out</a>?
            </p>
        </section>
<?php
    else:
?>
            <p>Your feet will thank you.</p>
            <form id="user-sign-up-form">
                <div class="form-wrapper">
                    <div class="control-wrapper">
```

```

        <label for="username">Email</label>
        <input id="username" class="form-
control" name="username" type="email" aria-label="Type your
email address." required/>
        <span id="username-error" class="error
error-message"></span>
    </div>
    <div class="control-wrapper">
        <label for="password">Password</label>
        <div>
            <input id="password" class="form-
control" name="password" type="password" minlength="8"
aria-label="Type your password." required>
            <br>
            <input id="password-toggle"
type="checkbox"><label for="password-toggle" class="label-
horizontal">Show password</label>
        </div>
        <span id="password-error" class="error
error-message"></span>
    </div>
    <button id="sign-me-up-button" class="btn
btn-form" type="submit">Sign Me Up</button>
    <span id="form-error" class="error error-
message form-error-message"></span>
    <span id="form-message" class="form-
message"></span>
    <input type="hidden" id="user-verb"
name="user-verb" value="sign-up-user">
        <input type="hidden" id="token" name="token"
value="<?php echo $_SESSION['token']; ?>">
    </div>
</form>
<?php
    endif;
    include_once 'common/sidebar.php';
    include_once 'common/bottom.php';
?>
```

This page plays it safe and checks to see if the user is already logged in, in which case it lets the user know and offers some links. Otherwise, the code displays the Sign Up form, shown in Figure 4-2.

The form has a header "SIGN UP FOR A FREE FOOTPOWER! ACCOUNT". Below it is a sub-header "Your feet will thank you.". There are two input fields: "Email" and "Password". Next to the "Password" field is a checkbox labeled "Show password". At the bottom is a green button labeled "SIGN ME UP".

FIGURE 4-2:
The FootPower!
form for signing
up a new user.

Sending the data to the server

Clicking Sign Me Up invokes the form's submit event, so you need to add a handler for this:

```
$( '#user-sign-up-form' ).submit(function(e) {  
  
    // Prevent the default submit  
    e.preventDefault();  
  
    // Disable the Sign Me Up button to prevent double  
    // submissions  
    $('#sign-me-up-button').prop('disabled', true);  
  
    // Clear and hide all the message spans ($ = "ends with")  
    $('span[id$="error"]').html('').css('display', 'none');  
    $('#form-message').html('').css('display', 'none');  
  
    // Get the form data and convert it to a POST-able format  
    formData = $(this).serializeArray();  
  
    // Submit the data to the handler  
    $.post('/handlers/user_handler.php', formData,  
    function(data) {  
  
        // Convert the JSON string to a JavaScript object  
        var result = JSON.parse(data);  
  
        if(result.status === 'error') {  
  
            // Display the error  
            $('#' + result.control + '-error').html(result.message).css('display', 'inline-block');  
        }  
    });  
});
```

```

        // Enable the Sign Me Up button
        $('#sign-me-up-button').prop('disabled', false);

    } else {
        $('#form-message').html(result.message).
        css('display', 'inline-block');
    }
});

});

```

This code prevents the default submission, disables the Sign Me Up button to prevent the user from accidentally clicking it again, clears the messages, and then sends the form data to the server. When the `user_handler.php` script sees that the `user-verb` is set to `sign-up-user`, it routes the task to the `User` object's `createUser()` method. The first part of this method validates and sanitizes the username and password:

```

public function createUser() {

    // Store the default status
    $server_results['status'] = 'success';

    // Was the username sent?
    if(empty($_POST['username'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'username';
        $server_results['message'] = 'Um, you really do need to
enter your email address.';
    } else {

        // Sanitize it
        //username = htmlentities($username);
        $username = $_POST['username'];
        $username = filter_var($username, FILTER_SANITIZE_
EMAIL);
        if (!$username) {
            $server_results['status'] = 'error';
            $server_results['control'] = 'username';
            $server_results['message'] = 'Hmmm. It looks like
that email address isn\'t valid. Please try again.';
        } else {
    
```

```
// Make sure the username doesn't already exist in
the database
    $sql = "SELECT *
            FROM users
            WHERE username=?";
    $stmt = $this->_mysqli->prepare($sql);
    $stmt->bind_param("s", $username);
    $stmt->execute();
    $result = $stmt->get_result();

    // If the username already exists, num_rows will be
    greater than 0
    if ($result->num_rows > 0) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'username';
        $server_results['message'] = 'Whoops! That email
address is already being used. Please try again.';
    }
}

// If all is still well, check the password
if($server_results['status'] === 'success') {

    // Was the password sent?
    if(empty($_POST['password'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'password';
        $server_results['message'] = 'That\'s weird: the
password is missing. Please try again.';
    } else {

        // Sanitize it
        $password = $_POST['password'];
        $password = filter_var($password, FILTER_SANITIZE_
STRING);

        // Is the password still valid?
        if (!$password) {
            $server_results['status'] = 'error';
            $server_results['control'] = 'password';
            $server_results['message'] = 'Sorry, but the
password you used was invalid. Please try again.';
        }
    }
}
```

```

        // Is the password long enough?
        elseif (strlen($password) < 8 ) {
            $server_results['status'] = 'error';
            $server_results['control'] = 'password';
            $server_results['message'] = 'Sorry, but the
password must be at least 8 characters long. Please try
again.';
        } else {

            // If all's well, hash the password
            $password = password_hash($password, PASSWORD_
DEFAULT);
        }
    }
}

```

For the username, the code makes sure it was entered and that it's a legit email address. It also runs a prepared SQL SELECT statement to make sure the user isn't already signed up. The password is checked for validity, sanitized, and checked for length (minimum eight characters). If those checks pass, the password is hashed using PHP's `password_hash()` function (see Book 7, Chapter 2).

Sending a verification email

If both the username and password check out, the next step is to send the user a verification email. The `createUser()` method continues:

```

if($server_results['status'] === 'success') {

    // Create a random, 32-character verification code
    $ver_code = bin2hex(openssl_random_pseudo_bytes(16));

    // Send the verification email
    $send_to = $username;
    $subject = 'Please verify your FootPower! account';
    $header = 'From: FootPower! <mail@mcfedries.com>' . "\r\n" .
              'Content-Type: text/plain';
    $body = <<<BODY
You have a new account at FootPower!

Your username is the email address you provided: $username

Please activate your account by clicking the link below.

BODY>>>
}

```

```
https://footpower.mcfedries.com/verify_user.php?ver_ code&username=$username

If you did not create a FootPower! account, you can safely delete this message.

Thanks!

Paul
footpower.mcfedries.com
BODY;

$mail_sent = mail($send_to, $subject, $body, $header);
```

This code uses our old friends `bin2hex()` and `openssl_random_pseudo_bytes()` to generate a random 32-character string that's used as a unique verification code for the user. The code sets up the email by specifying the recipient, subject, headers, and message body. Note, in particular, that the body includes a link that the user must click to verify her account. That link's URL includes both the verification code and the username:

```
https://footpower.mcfedries.com/verify_user.php?ver_ code&username=$username
```

Finally, the code runs PHP's `mail()` function to send the message.



WARNING

For the `mail()` function to work, you need a mail server installed and configured. If you're coding the app in your local development environment, you almost certainly won't have a mail server running, so the `mail()` function will fail. You can comment out the function for now, then try it after you have your code on the web.

Adding the user to the database

Now it's time to add the user to the `users` table. Here's the rest of the `createUser()` method:

```
if($mail_sent) {

    // Create and prepare the SQL template
    $sql = "INSERT INTO users
        (username, password, verification_code)
    VALUES (?, ?, ?)";
    $stmt = $this->_mysqli->prepare($sql);
```

```

$stmt->bind_param("sss", $username, $password, $ver_code);
$stmt->execute();
$result = $stmt->get_result();

if($this->_mysqli->errno === 0) {
    $server_results['control'] = 'form';
    $server_results['message'] = 'You\'re in! We\'ve sent
you a verification email.<br>Be sure to click the link in that
email to verify your account.';
} else {
    $server_results['status'] = 'error';
    $server_results['control'] = 'form';
    $server_results['message'] = 'MySQLi error #: ' .
$this->_mysqli->errno . ': ' . $this->_mysqli->error;
}
} else {
    $server_results['status'] = 'error';
    $server_results['control'] = 'form';
    $server_results['message'] = 'Error! The verification email
could not be sent, for some reason. Please try again.';
}
}

// Create and then return the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS | JSON_
HEX_QUOT);
return $JSON_data;

```

The code checks the return value of the `mail()` function: If it's TRUE, the code continues. (If you're coding in a local development environment that doesn't have a mail server, add `$mail_sent = TRUE` before running the `if()` statement to ensure your code adds the user successfully.) The code prepares an SQL INSERT statement that adds the user's username, password, and verification code. After checking for errors, the code returns the JSON data to the front end.

Verifying the user

With the verification email sent, it's now up to the user to click the link in the sent message. That links calls up the `verify_user.php` page, which includes the following code:

```
<?php

    // Initialize the results
    $server_results['status'] = 'success';
    $server_results['control'] = '';
    $server_results['message'] = '';

    // Make sure a verification code was passed
    if (!isset($_GET['vercode'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'form';
        $server_results['message'] = 'Error: Invalid URL. Sorry
it didn\'t work out.';
    }
    // Make sure the username was passed
    elseif (!isset($_GET['username'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'form';
        $server_results['message'] = 'Error: Invalid user.';
    }
    // If we get this far, all is well, so go for it
    else {

        // Include the User class
        include_once '../private/classes/user_class.php';

        // Create a new User object
        $user = new User($mysqli);

        // Verify the new account
        $server_results = json_decode($user->verifyUser(),
TRUE);
    }
}
include_once 'common/top.php';

if(isset($_SESSION['username'])):
?>
```

The code initializes the usual \$server_results array, then uses \$_GET to check that both the verification code and the username were sent in the URL's query string. If all's well, a new User object is created and the verifyUser() method is called.

The `verifyUser()` method does a ton of important work in the app, so take a careful look at the code. Here's the first part:

```
public function verifyUser() {

    // Store the default status
    $server_results['status'] = 'success';

    // Get the query string parameters
    $ver_code = $_GET['vercode'];
    $username = $_GET['username'];

    // Sanitize them
    $ver_code = filter_var($ver_code, FILTER_SANITIZE_STRING);
    $username = filter_var($username, FILTER_SANITIZE_EMAIL);

    // Prepare the SQL SELECT statement
    $sql = "SELECT *
        FROM users
        WHERE verification_code=?
        AND username=?
        AND verified=0
        LIMIT 1";

    $stmt = $this->_mysqli->prepare($sql);
    $stmt->bind_param("ss", $ver_code, $username);
    $stmt->execute();
    $result = $stmt->get_result();

    // Was there an error?
    if ($this->_mysqli->errno !== 0) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'form';
        $server_results['message'] = 'MySQLi error #: ' .
        $this->_mysqli->errno . ': ' . $this->_mysqli->error;
    }
}
```

The first part of the method sets up the standard `$server_results` array, then grabs and sanitizes the verification code and the `username` from the URL's query string using `$_GET`. Then the code prepares an SQL `SELECT` statement that queries the `users` table for a record that matches both the verification code and the `username`, and where the `verified` field equals `0`. The code then checks for an error. If no error occurred, execution continues with the following code:

```
// Otherwise, if a row is returned, it means the user can be  
verified  
elseif ($result->num_rows === 1) {  
  
    // Set the success message  
    $server_results['message'] = 'Your account is now  
verified.<p>You\'re signed in, so go ahead and <a  
href="create_data.php">log a walk, run, or ride.</a>';  
  
    // Sign in the user  
    $_SESSION['username'] = $username;  
  
    // Get the user's ID and distance unit  
    $row = $result->fetch_all(MYSQLI_ASSOC);  
    $user_id = $row[0]['user_id'];  
    $distance_unit = $row[0]['distance_unit'];  
    $_SESSION['distance_unit'] = $distance_unit;  
  
    // Set the user's verified flag in the database  
    $sql = "UPDATE users  
            SET verified=1  
            WHERE username=?";  
  
    $stmt = $this->_mysqli->prepare($sql);  
    $stmt->bind_param("s", $username);  
    $stmt->execute();  
    $result = $stmt->get_result();  
  
    // Create a master data record (in this case, an  
activity log) for the user  
    $sql = "INSERT INTO logs  
            (user_id)  
            VALUES (?)";  
    $stmt = $this->_mysqli->prepare($sql);  
    $stmt->bind_param("i", $user_id);  
    $stmt->execute();  
    $result = $stmt->get_result();  
  
    // Get the user's log ID  
    $sql = "SELECT *  
           FROM logs  
           WHERE user_id=?  
           LIMIT 1";  
    $stmt = $this->_mysqli->prepare($sql);
```

```
$stmt->bind_param("i", $user_id);
$stmt->execute();
$result = $stmt->get_result();
$row = $result->fetch_all(MYSQLI_ASSOC);
$log_id = $row[0]['log_id'];
$_SESSION['log_id'] = $log_id;
```



REMEMBER

There is a ton of important app stuff going on here, so here's a summary of what's happening:

- » The `elseif` statement checks to see if a row was returned — in which case, `$result->num_rows` would be equal to 1. If that's true, then the rest of the code executes.
- » The success message is set.
- » The `$_SESSION['username']` variable is set to `$username`, meaning the user is signed in to her account.
- » The user's record is fetched and stored in the `$row` variable, which enables the code to then determine the user's ID and preferred unit of distance (miles or kilometers). The latter is used in other parts of the app, so it's stored in the `$_SESSION['distance_unit']` variable.
- » A prepared SQL UPDATE statement changes the user's `verified` field value to 1.
- » A prepared SQL INSERT statement creates a new master data record for the user. Note that this data record is tied to the user by the common `user_id` field value.
- » A prepared SQL SELECT statement returns the user's master data record, which enables the code to determine the ID of that record. The master data ID is used throughout the app, so it gets stored in the `$_SESSION['log_id']` variable.

Here's the rest of the `verifyUser()` method:

```
} else {
    // Handle the case where the user is already verified
    // Prepare the SQL SELECT statement
    $sql = "SELECT username
            FROM users
            WHERE verification_code=?
            AND username=?
            AND verified=1";
```

```
$stmt = $this->_mysqli->prepare($sql);
$stmt->bind_param("ss", $ver_code, $username);
$stmt->execute();
$result = $stmt->get_result();

// Was there an error?
if($this->_mysqli->errno === 0) {
    $server_results['status'] = 'error';
    $server_results['control'] = 'form';
    $server_results['message'] = 'MySQLi error #: ' .
$this->_mysqli->errno . ': ' . $this->_mysqli->error;
}
// Otherwise, if a row is returned, it means the user is
already verified
elseif ($result->num_rows > 0) {
    $server_results['status'] = 'error';
    $server_results['control'] = 'form';
    $server_results['message'] = 'Yo, you\'re already
verified.<p>Perhaps you\'d like to <a href="create_data.
php">log a walk, run, or ride</a>?';
} else {
    $server_results['status'] = 'error';
    $server_results['control'] = 'form';
    $server_results['message'] = 'Yikes. A database
error occurred. These things happen.';
}
}

// Create and then return the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
return $JSON_data;
}
```

This portion of the code handles the case where the user is already verified. For example, the user might click the verification link a second time, or reload the `verify_user.php` page.



TIP

The `users` table has a `creation_date` field that defaults to the date and time each user is added. This enables you to purge users who never verify their accounts. For example, you could run an SQL `DELETE` command that purges any records where the `creation_date` value is more than a month old.

Signing a User In and Out

The user gets signed in automatically during the verification procedure, but the user will also need to sign in manually if, say, the session token expires or the user signs out manually (discussed later in the “Signing out a user” section). To handle sign-ins, I created the `sign_in.php` page.

Checking for a signed-in user



REMEMBER

All pages that deal with user interactions need a defensive strategy:

- » For a page that requires the user to be signed in, handle the case where the user accesses the page while signed out.
- » For a page that requires the user to be signed out, handle the case where the user accesses the page while signed in.

For your sign-in page, the assumption is that the user is signed out, but he just might end up on the page while signed in. This means your code needs to check whether the `$_SESSION['username']` variable is set. Here's how I do this in `sign_in.php`:

```
<?php
    include_once '../private/common/initialization.php';

    // Set the page title depending on whether the user is
    // signed in
    if(isset($_SESSION['username'])) {
        $page_title = 'You're Signed In to Your Account';
    } else {
        $page_title = 'Sign In to Your Account';
    }
    include_once 'common/top.php';

    // Is the user already signed in?
    if(isset($_SESSION['username'])):
?>
        <section>
            <p>
                You're already signed in, so nothing to see
                here.
            </p>
        </section>
```

```
<p>
    Did you want to <a href="create_data.
php">log an activity</a>, instead?
</p>
<p>
    Or perhaps you want to <a href="sign_out.
php">sign out</a>?
</p>
</section>
<?php
    else:
?>
    The sign-in form code will go here
<?php
    endif;
    include_once 'common/sidebar.php';
    include_once 'common/bottom.php';
?>
```

This code actually checks the `$_SESSION['username']` variable twice:

- » At the top of the script, I use the result of `isset($_SESSION['username'])` to set the `$page_title` variable accordingly.
- » The second time, if `isset($_SESSION['username'])` returns TRUE, then I display a message to the user telling him he's already signed in and offering a couple of links to move on.

Adding the form

If the user isn't signed in, then the code from the previous section displays the sign-in form:

```
<form id="user-sign-in-form">
    <div class="form-wrapper">
        <div class="control-wrapper">
            <label for="username">Email</label>
            <input id="username" class="form-control"
name="username" type="email" aria-label="Type your email
address." required/>
            <span id="username-error" class="error error-
message"></span>
        </div>
```

```
<div class="control-wrapper">
    <label for="password">Password</label>
    <div>
        <input id="password" class="form-control" name="password" type="password" minlength="8" aria-label="Type your password." required>
        <br>
        <input id="password-toggle" type="checkbox"><label for="password-toggle" class="label-horizontal">Show password</label>
    </div>
    <span id="password-error" class="error error-message"></span>
</div>
<button id="sign-me-in-button" class="btn btn-form" type="submit">Sign Me In</button>
<span id="form-error" class="error error-message form-error-message"></span>
<span id="form-message" class="form-message"></span>
<input type="hidden" id="user-verb" name="user-verb" value="sign-in-user">
<input type="hidden" id="token" name="token" value=<?php echo $_SESSION['token']; ?>>
</div>
</form>
<div>
    <a href="request_new_password.php">Forgot your password?</a>
</div>
```

Figure 4-3 shows the form.

The form is contained within a light gray box. At the top, the title "SIGN IN TO YOUR ACCOUNT" is centered in bold capital letters. Below the title are two input fields: one for "Email" and one for "Password". To the right of the "Password" field is a small checkbox labeled "Show password". Below these fields is a large green rectangular button with the white text "SIGN ME IN". At the bottom of the form is a link in blue text that underlines "Forgot your password?".

FIGURE 4-3:
The FootPower!
sign-in form.

The form looks quite simple, but it has a few interesting features:



TIP

- » Both `<input>` tags are followed by `` tags that are used to display field-specific error messages.
- » The Password field is accompanied by a Show Password checkbox that, when checked, shows the password in plain text instead of dots. Enabling the user to see the password means you don't have to burden the user with having to enter the password twice as a verification. To show the password, the code changes the `<input>` tag's type value to `text`. Here's the click event handler that controls this (this code is in `public/js/user.js`):

```
$('#password-toggle').click(function() {  
  
    // Is the checkbox checked?  
    if($(this).prop('checked') === true) {  
  
        // If so, change the <input> type to 'text'  
        $('#password').attr('type', 'text');  
        $('label[for=password-toggle]').text('Hide  
password');  
    } else {  
  
        // If not, change the <input> type to 'password'  
        $('#password').attr('type', 'password');  
        $('label[for=password-toggle]').text('Show  
password');  
    }  
});
```

- » Below the `<button>` tag are two `` tags used to display the form-level error and success messages.
- » A hidden field sets the `user-verb` value to `sign-in-user`.
- » Below the form is a `Forgot your password?` link, which I discuss later in this chapter.

When the user fills in the form and then clicks Sign Me In, the form's `submit` event fires, and that event is handled by the following code in `public/js/user.js`:

```
$('#user-sign-in-form').submit(function(e) {  
  
    // Prevent the default submit  
    e.preventDefault();
```

```

// Disable the Sign Me In button to prevent double
submissions
$('#sign-me-in-button').prop('disabled', true);

// Clear and hide all the message spans ($ = "ends with")
$('span[id$="error"]').html('').css('display', 'none');
$('#form-message').html('').css('display', 'none');

// Get the form data and convert it to a POST-able format
formData = $(this).serializeArray();

// Submit the data to the handler
$.post('/handlers/user_handler.php', formData,
function(data) {

    // Convert the JSON string to a JavaScript object
    var result = JSON.parse(data);

    if(result.status === 'error') {

        // Display the error
        $('#' + result.control + '-error').html(result.
message).css('display', 'inline-block');

        // Enable the Sign Me In button
        $('#sign-me-in-button').prop('disabled', false);

    } else {

        // The user is now signed in, so display the
        home page
        window.location = 'index.php';
    }
});
});

```

This code is nearly identical to the sign-up code I talk about earlier.

Checking the user's credentials

When the `user_handler.php` script gets the sign-in form data, it detects that the `user-verb` value is `sign-in-user` and routes the Ajax request to the `User` object's `signInUser()` method:

```
public function signInUser() {

    // Store the default status
    $server_results['status'] = 'success';

    // Was the username sent?
    if(empty($_POST['username'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'username';
        $server_results['message'] = 'Doh! You need to enter
your email address.';
    } else {

        // Sanitize it
        $username = $_POST['username'];
        $username = filter_var($username, FILTER_SANITIZE_
EMAIL);
        if (!$username) {
            $server_results['status'] = 'error';
            $server_results['control'] = 'username';
            $server_results['message'] = 'Well, it appears that
email address isn\'t valid. Please try again.';
        } else {

            // Make sure the username exists in the database
            $sql = "SELECT *
                    FROM users
                    WHERE username=?
                    LIMIT 1";
            $stmt = $this->_mysqli->prepare($sql);
            $stmt->bind_param("s", $username);
            $stmt->execute();
            $result = $stmt->get_result();

            // If the username doesn't exist, num_rows will be 0
            if ($result->num_rows === 0) {
                $server_results['status'] = 'error';
                $server_results['control'] = 'username';
                $server_results['message'] = 'Sorry, but that
email address isn\'t associated with an account. Please try
again.';
            } else {


```

```

        // If all is still well, check the password
        // Was the password sent?
        if(empty($_POST['password'])) {
            $server_results['status'] = 'error';
            $server_results['control'] = 'password';
            $server_results['message'] = 'That\'s weird:
the password is missing. Please try again.';
        } else {

            // Sanitize it
            $password = $_POST['password'];
            $password = filter_var($password, FILTER_
SANITIZE_STRING);

            // Is the password still valid?
            if (!$password) {
                $server_results['status'] = 'error';
                $server_results['control'] = 'password';
                $server_results['message'] = 'Sorry, but
the password you used was invalid. Please try again.';
            } else {

                // Get the user data
                $row = $result->fetch_all(MYSQLI_ASSOC);

                // Confirm the password
                if(!password_verify($password, $row[0]
['password'])) {
                    $server_results['status'] = 'error';
                    $server_results['control'] =
'password';
                    $server_results['message'] = 'Sorry,
but the password you used was incorrect. Please try again.';
                } else {

                    // Sign in the user
                    $_SESSION['username'] = $username;
                    $user_id = $row[0]['user_id'];
                    $distance_unit = $row[0]['distance_
unit'];
                    $_SESSION['distance_unit'] =
$distance_unit;

                    // Get the user's log ID
                    $sql = "SELECT *

```

```

        FROM logs
        WHERE user_id=?;
$stmt = $this->_mysqli-
>prepare($sql);
$stmt->bind_param("i", $user_id);
$stmt->execute();
$result = $stmt->get_result();
$row = $result->fetch_all(MYSQLI_
ASSOC);
$log_id = $row[0]['log_id'];
$_SESSION['log_id'] = $log_id;
}
}
}
}
}

// Create and then return the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
return $JSON_data;
}

```

This code is a long series of validity checks and sanitization:

- » For the username, the code checks that it was sent, sanitizes it as an email address, then uses a prepared SQL SELECT statement to check that the username exists in the users table. If all that checks out, the code moves on to the password.
- » For the password, the code checks that it was sent, sanitizes it as a string, then fetches the user data from the SELECT result. The user's password is stored in the table as a hashed value, so to check the correctness of the received password you must use PHP's `password_verify()` function:



REMEMBER

```
password_verify(password, hashed_password)
```

- *password*: The password entered by the user in the sign-in form
- *hashed_password*: The hashed password value from the database

If both the username and password check out, then the code signs in the user by setting the `$_SESSION['username']` variable, and then sets the other session variables: `$_SESSION['distance_unit']` and `$_SESSION['log_id']`.

Signing out a user

Sigⁿing out a user means ending the user's session, so here's the full code of the sign_out.php page:

```
<?php  
    session_start();  
  
    // Free up all the session variables  
    session_unset();  
?  
<!-- Display the sign-in page -->  
<meta http-equiv="refresh" content="0;sign_in.php">
```

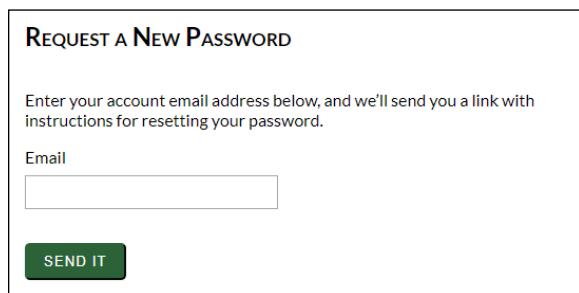
PHP's session_unset() function frees up all the session variables, then the user is redirected to the sign-in page.

Resetting a Forgotten Password

The user can change her password in one of two ways:

- » If the user has forgotten her password, she can click the `Forgot your password?` link in the sign-in form.
- » If the user wants to change her password, she can click the `Change Your Password` link in the `Your Account` page (`your_account.php`).

Either way, the user winds up at the Request a New Password page (`request_new_password.php`), shown in Figure 4-4.



The screenshot shows a web form titled "REQUEST A NEW PASSWORD". The instructions say: "Enter your account email address below, and we'll send you a link with instructions for resetting your password." Below the instructions is a text input field labeled "Email" and a green "SEND IT" button.

FIGURE 4-4:
The FootPower!
Request a New
Password form.

Here's the page code:

```
<?php
    include_once '../private/common/initialization.php';
    $page_title = 'Request a New Password';
    include_once 'common/top.php';
?>
<p>
    Enter your account email address below, and
    we'll send you a link with instructions for resetting your
    password.
</p>
<form id="user-send-password-reset-form">
    <div class="form-wrapper">
        <div class="control-wrapper">
            <label for="email">Email</label>
            <input id="username" class="form-
control" name="username" type="email" aria-label="Type your
email address." required/>
            <span id="username-error" class="error
error-message"></span>
        </div>
        <button id="send-reset-password-button"
class="btn btn-form" type="submit">Send It</button>
        <span id="form-error" class="error error-
message form-error-message"></span>
        <span id="form-message" class="form-
message"></span>
        <input type="hidden" id="user-verb"
name="user-verb" value="send-password-reset">
        <input type="hidden" id="token" name="token"
value="<?php echo $_SESSION['token']; ?>">
    </div>
</form>
<?php
    include_once 'common/sidebar.php';
    include_once 'common/bottom.php';
?>
```

Note that the hidden user-verb value is send-password-request. The user_handler.php script routes this verb to the User object's sendPasswordReset() method:

```
public function sendPasswordReset() {

    // Store the default status
    $server_results['status'] = 'success';

    // Was the email address entered?
    if(empty($_POST['username'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'username';
        $server_results['message'] = 'Um, you really do need to
enter your email address.';
    } else {

        // Sanitize it
        $username = $_POST['username'];
        $username = filter_var($username, FILTER_SANITIZE_
EMAIL);
        if (!$username) {
            $server_results['status'] = 'error';
            $server_results['control'] = 'username';
            $server_results['message'] = 'Hmmm. It looks like
that email address isn\'t valid. Please try again.';
        } else {

            // Make sure the email address exists in the
            database
            $sql = "SELECT *
                    FROM users
                    WHERE username=?
                    LIMIT 1";
            $stmt = $this->_mysqli->prepare($sql);
            $stmt->bind_param("s", $username);
            $stmt->execute();
            $result = $stmt->get_result();

            // If the email doesn't exist, num_rows will be 0
            if ($result->num_rows === 0) {
                $server_results['status'] = 'error';
                $server_results['control'] = 'username';
            }
        }
    }
}
```

```
$server_results['message'] = 'Sorry, but that
email address isn't associated with an account. Please try
again.';
} else {

    // Get the user's verification code
    $row = $result->fetch_all(MYSQLI_ASSOC);
    $ver_code = $row[0]['verification_code'];
}

}

}

// If we're still good, it's time to get the reset started
if($server_results['status'] === 'success') {

    // Send the password reset email
    $send_to = $username;
    $subject = 'Reset your FootPower! password';
    $header = 'From: FootPower! <mail@mcfedries.com>' .
    "\r\n".
        'Content-Type: text/plain';
    $body = <<<BODY
You're receiving this message because you requested a password
reset for your FootPower! account.

Please click the link below to reset your password.

https://footpower.mcfedries.com/reset\_password.php?ver\_code=\$ver\_code&username=\$username

If you do not have a FootPower! account, you can safely delete
this message.

Thanks!

Paul
footpower.mcfedries.com
BODY;
    if(mail($send_to, $subject, $body, $header)) {

        // Unset the user's verified flag in the database
        $sql = "UPDATE users
                SET verified=0
                WHERE username=?";
```

```

        $stmt = $this->_mysqli->prepare($sql);
        $stmt->bind_param("s", $username);
        $stmt->execute();
        $result = $stmt->get_result();

        if($this->_mysqli->errno === 0) {
            $server_results['control'] = 'form';
            $server_results['message'] = 'Okay, we\'ve sent
you the reset email.<br>Be sure to click the link in that
email to reset your password.';
        } else {
            $server_results['status'] = 'error';
            $server_results['control'] = 'form';
            $server_results['message'] = 'MySQLi error
#: ' . $this->_mysqli->errno . ': ' . $this->_mysqli->error;
        }
    } else {
        $server_results['status'] = 'error';
        $server_results['control'] = 'form';
        $server_results['message'] = 'Error! The reset email
could not be sent, for some reason. Please try again.';
    }
}
// Create and then return the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
return $JSON_data;
}

```

This method is very similar to the `verifyUser()` method I discuss earlier, but there are two main differences to note:

- » `sendPasswordReset()` uses a prepared SQL UPDATE statement to set the user's `verified` field in the database to 0.
- » `sendPasswordReset()` sends an email message to the user with a link to the `reset_password.php` page, with the user's verification code and username in the query string. When the user clicks that link, she's sent to the page shown in Figure 4-5.

RESET YOUR PASSWORD

You're resetting the password for mail@mcfedries.com.

If this is not your FootPower! email address, please [send a new password reset request](#).

Password

Show password

RESET PASSWORD

FIGURE 4-5:
The FootPower!
Reset Your
Password form.

Here's the code for the `reset_password.php` page:

```
<?php
    include_once '../private/common/initialization.php';

    // Initialize the results
    $server_results['status'] = 'success';
    $server_results['control'] = '';
    $server_results['message'] = '';

    // Make sure a verification code was passed
    if (!isset($_GET['vercode'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'form';
        $server_results['message'] = 'Error: Invalid URL. Sorry
it didn\'t work out.';
    }
    // Make sure the email address was passed
    elseif (!isset($_GET['username'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'form';
        $server_results['message'] = 'Error: Invalid email
address.';
    }
    // If we get this far, all is well, so go for it
    else {

        // Get the query string parameters
        $ver_code = $_GET['vercode'];
        $username = $_GET['username'];

        // Sanitize them
        $ver_code = filter_var($ver_code, FILTER_SANITIZE_
STRING);
```

```

$username = filter_var($username, FILTER_SANITIZE_
EMAIL);

}

$page_title = 'Reset Your Password';
include_once 'common/top.php';

if($server_results['status'] === 'error'):
?>
    <div class="result-message"><?php echo $server_
results['message'] ?></div>

<?php
else:
?>
    <p>
        You're resetting the password for <?php echo
$username ?>.
    </p>
    <p>
        If this is not your FootPower! email
address, please <a href="request_new_password.php">send a new
password reset request</a>.
    </p>
    <form id="user-reset-password-form">
        <div class="form-wrapper">
            <div class="control-wrapper">
                <label for="password">Password</label>
                <div>
                    <input id="password" class="form-
control" name="password" type="password" minlength="8"
aria-label="Type your password." required>
                    <br>
                    <input id="password-toggle"
type="checkbox"><label for="password-toggle" class="label-
horizontal">Show password</label>
                </div>
                <span id="password-error" class="error
error-message"></span>
            </div>
            <button id="reset-password-button"
class="btn btn-form" type="submit">Reset Password</button>
            <span id="form-error" class="error error-
message form-error-message"></span>
        </div>
    </form>

```

```
        <span id="form-message" class="form-
message"></span>
        <input type="hidden" id="username"
name="username" value="<?php echo $username ?>">
        <input type="hidden" id="vercode"
name="vercode" value="<?php echo $ver_code ?>">
        <input type="hidden" id="user-verb"
name="user-verb" value="reset-password">
        <input type="hidden" id="token" name="token"
value="<?php echo $_SESSION['token']; ?>">
    </div>
</form>
<?php
endif;
include_once 'common/sidebar.php';
include_once 'common/bottom.php';
?>
```

The submit event handler sends the form data to `user_handler.php`, which uses the hidden `user-verb` value of `reset-password` to route the Ajax request to the `User` object's `resetPassword()` method:

```
public function resetPassword() {

    // Store the default status
    $server_results['status'] = 'success';

    // Get the form data
    $username = $_POST['username'];
    $ver_code = $_POST['vercode'];
    $password = $_POST['password'];

    // Sanitize the username and verification code, just to
    // be safe
    $username = filter_var($username, FILTER_SANITIZE_EMAIL);
    $ver_code = filter_var($ver_code, FILTER_SANITIZE_STRING);

    // Verify the user:
    // First, prepare the SQL SELECT statement
    $sql = "SELECT *
            FROM users
            WHERE username=?"
            . " AND verification_code=?"
            . " AND verified=0";
```

```

$stmt = $this->_mysqli->prepare($sql);
$stmt->bind_param("ss", $username, $ver_code);
$stmt->execute();
$result = $stmt->get_result();
$row = $result->fetch_all(MYSQLI_ASSOC);

// If a row is returned, it means the user is verified so
// the password can be reset
if ($result->num_rows > 0 AND $this->_mysqli->errno === 0) {

    // Was the password sent?
    if(empty($password)) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'password';
        $server_results['message'] = 'That\'s weird: the
password is missing. Please try again.';
    } else {

        // Sanitize it
        $password = filter_var($password, FILTER_SANITIZE_
STRING);

        // Is the password still valid?
        if (!$password) {
            $server_results['status'] = 'error';
            $server_results['control'] = 'password';
            $server_results['message'] = 'Sorry, but the
password you used was invalid. Please try again.';
        }
        // Is the password long enough?
        elseif (strlen($password) < 8 ) {
            $server_results['status'] = 'error';
            $server_results['control'] = 'password';
            $server_results['message'] = 'Sorry, but the
password must be at least 8 characters long. Please try
again.';
        } else {

            // If all's well, hash the password
            $password = password_hash($password, PASSWORD_
DEFAULT);

            // Set the distance unit session variable
            $distance_unit = $row[0]['distance_unit'];
    }
}

```

```
        $_SESSION['distance_unit'] = $distance_unit;
    }
}
} else {
    $server_results['status'] = 'error';
    $server_results['control'] = 'form';
    $server_results['message'] = 'Oh, man, a database error
occurred! Please try again.';
}

// If we're still good, it's time to reset the password and
// reverify the user
if($server_results['status'] === 'success') {

    // Get the user's ID
    $row = $result->fetch_all(MYSQLI_ASSOC);
    $user_id = $row[0]['user_id'];

    // Set the user's password and verified flag in the
    // database
    $sql = "UPDATE users
            SET password=?, verified=1
            WHERE username=?";

    $stmt = $this->_mysqli->prepare($sql);
    $stmt->bind_param("ss", $password, $username);
    $stmt->execute();
    $result = $stmt->get_result();

    // Was there an error?
    if ($this->_mysqli->errno === 0) {

        // if not, sign in the user
        $_SESSION['username'] = $username;

        // Get the user's log ID
        $sql = "SELECT *
                FROM logs
                WHERE user_id=?";
        $stmt = $this->_mysqli->prepare($sql);
        $stmt->bind_param("i", $user_id);
        $stmt->execute();
        $result = $stmt->get_result();
    }
}
```

```

        // Set the log_id session variable
        $row = $result->fetch_all(MYSQLI_ASSOC);
        $log_id = $row[0]['log_id'];
        $_SESSION['log_id'] = $log_id;

    } else {
        $server_results['status'] = 'error';
        $server_results['control'] = 'form';
        $server_results['message'] = 'Yikes. A database
error occurred. Please try again.';
    }
}
// Create and then return the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
return $JSON_data;
}

```

This code is very similar to `verifyUser()`, which I discuss earlier.

Deleting a User

The final user task the app needs to handle is deleting a user's account. This is accomplished by clicking the Delete Your Account link in the Your Account page (`your_account.php`). This displays the `delete_account.php` page, shown in Figure 4-6.

DELETE YOUR FOOTPOWER! ACCOUNT?

Whoa, are you sure you want to do this? You'll lose all your data!

Password

Show password

YEP, I'M SURE

FIGURE 4-6:
The FootPower!
Delete Your
Account form.

Here's the delete_account.php page code:

```
<?php
    include_once '../private/common/initialization.php';
    $page_title = 'Delete Your FootPower! Account?';
    include_once 'common/top.php';

    // Is the user signed in?
    if(isset($_SESSION['username'])):
?>
    <p>
        Whoa, are you sure you want to do this? You'll
        lose all your data!
    </p>
    <form id="user-delete-form">
        <div class="form-wrapper">
            <div class="control-wrapper">
                <label for="password">Password</label>
                <div>
                    <input id="password" class="form-
control" name="password" type="password" minlength="8"
aria-label="Type your password." required>
                    <br>
                    <input id="password-toggle"
type="checkbox"><label for="password-toggle" class="label-
horizontal">Show password</label>
                </div>
                <span id="password-error" class="error
error-message"></span>
            </div>
            <button id="delete-user-button" class="btn
btn-form" type="submit">Yep, I'm Sure</button>
            <span id="form-error" class="error error-
message form-error-message"></span>
            <span id="form-message" class="form-
message"></span>
            <input type="hidden" id="username"
name="username" value="<?php echo $_SESSION['username'] ?>">
            <input type="hidden" id="user-verb"
name="user-verb" value="delete-user">
            <input type="hidden" id="token" name="token"
value="<?php echo $_SESSION['token']; ?>">
        </div>
    </form>
```

```

<?php
    else:
?>
    <!-- Display the sign-in page -->
    <meta http-equiv="refresh" content="0;sign_in.php">
<?php
    endif;
    include_once 'common/sidebar.php';
    include_once 'common/bottom.php';
?>

```

When the user clicks the Yep, I'm Sure button, the form's submit event handler sends the form data to the `user_handler.php` script, which uses the hidden user-verb value of `delete-user` to route the Ajax request to the `User` object's `deleteUser()` method:

```

public function deleteUser() {

    // Store the default status
    $server_results['status'] = 'success';

    // Get the username and password
    $username = $_POST['username'];
    $password = $_POST['password'];

    // Sanitize the username, just to be safe
    $username = filter_var($username, FILTER_SANITIZE_EMAIL);

    // Make sure the username exists in the database
    $sql = "SELECT *
            FROM users
            WHERE username=?
            LIMIT 1";
    $stmt = $this->_mysqli->prepare($sql);
    $stmt->bind_param("s", $username);
    $stmt->execute();
    $result = $stmt->get_result();
    // Get the user's ID
    $row = $result->fetch_all(MYSQLI_ASSOC);
    $user_id = $row[0]['user_id'];

    // If the username doesn't exist, num_rows will be 0
    if ($result->num_rows === 0) {

```

```
$server_results['status'] = 'error';
$server_results['control'] = 'form';
$server_results['message'] = 'Sorry, but we can\'t find
your account. Please try again.';
} else {

    // Now check the password
    // Was the password sent?
    if(empty($_POST['password'])) {
        $server_results['status'] = 'error';
        $server_results['control'] = 'password';
        $server_results['message'] = 'That\'s weird: the
password is missing. Please try again.';
    } else {

        // Sanitize it
        $password = filter_var($password, FILTER_SANITIZE_
STRING);

        // Is the password still valid?
        if (!$password) {
            $server_results['status'] = 'error';
            $server_results['control'] = 'password';
            $server_results['message'] = 'Sorry, but the
password you used was invalid. Please try again.';
        } else {

            // Confirm the password
            if(!password_verify($password, $row[0]
['password'])) {
                $server_results['status'] = 'error';
                $server_results['control'] = 'password';
                $server_results['message'] = 'Sorry, but the
password you used was incorrect. Please try again.';
            } else {

                // Delete the user
                $sql = "DELETE
                    FROM users
                    WHERE username=?
                    LIMIT 1";
                $stmt = $this->_mysqli->prepare($sql);
                $stmt->bind_param("s", $username);
```

```

        $stmt->execute();
        $result = $stmt->get_result();

        // Was there an error?
        if ($this->_mysqli->errno !== 0) {
            $server_results['status'] = 'error';
            $server_results['control'] = 'form';
            $server_results['message'] = 'MySQLi
error #: ' . $this->_mysqli->errno . ': ' . $this->_mysqli-
>error;
        } else {

            // Get the user's log ID
            $sql = "SELECT *
                    FROM logs
                    WHERE user_id=?
                    LIMIT 1";
            $stmt = $this->_mysqli->prepare($sql);
            $stmt->bind_param("i", $user_id);
            $stmt->execute();
            $result = $stmt->get_result();
            $row = $result->fetch_all(MYSQLI_ASSOC);
            $log_id = $row[0]['log_id'];

            // Delete the user's activities
            $sql = "DELETE
                    FROM activities
                    WHERE log_id=?";
            $stmt = $this->_mysqli->prepare($sql);
            $stmt->bind_param("i", $log_id);
            $stmt->execute();
            $result = $stmt->get_result();

            // Was there an error?
            if ($this->_mysqli->errno !== 0) {
                $server_results['status'] = 'error';
                $server_results['control'] = 'form';
                $server_results['message'] = 'MySQLi
error #: ' . $this->_mysqli->errno . ': ' . $this->_mysqli-
>error;
            } else {
                // Delete the user's master data
                record (log)

```

```

        $sql = "DELETE
                  FROM logs
                  WHERE log_id=?"
                  LIMIT 1";
$stmt = $this->_mysqli-
>prepare($sql);
        $stmt->bind_param("i", $log_id);
$stmt->execute();
$result = $stmt->get_result();

        // Was there an error?
if ($this->_mysqli->errno !== 0) {
        $server_results['status'] =
'error';
        $server_results['control'] =
'form';
        $server_results['message'] =
'MySQLi error #: ' . $this->_mysqli->errno . ':' . $this->_
mysqli->error;

        } else {
        // Free up all the session
variables
        session_unset();
    }
}
}
}
}
}
}

// Create and then return the JSON data
$JSON_data = json_encode($server_results, JSON_HEX_APOS |
JSON_HEX_QUOT);
return $JSON_data;
}

```

After performing the usual data validation and sanitization, the code runs three prepared SQL DELETE statements to delete the user from the users table, delete the user's data from the activities table, and delete the user's log from the logs table.



Coding Mobile Web Apps

Contents at a Glance

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- » Understanding the main principles of coding a mobile-first site
- » Getting started with jQuery Mobile
- » Delivering images responsively to mobile users
- » Storing user data in the web browser instead of on the server

Chapter **1**

Exploring Mobile-First Web Development

Don't be afraid to start small. Some of the biggest successes in mobile today came from small experiments and teams of passionate web designers and developers. You don't need to know everything about mobile — just take what you do know and go.

— LUKE WROBLEWSKI

If you've been hanging around the web for a while, you probably remember the days when you'd surf to a site using a small screen such as a smartphone or similar portable device, and instead of seeing the regular version of the site, you'd see the "mobile" version. In rare cases, this alternate version would be optimized for mobile viewing and navigation, but more likely it was just a poor facsimile of the regular site with a few font changes and all the interesting and useful features removed.

Seen from the web developer's viewpoint, the poor quality of those mobile sites isn't all that surprising. After all, who wants to build and maintain two versions of the same site? Fortunately, the days of requiring an entirely different site to

support mobile users are long gone. Yes, using responsive web design enables you to create a single site that looks and works great on everything from a wall-mounted display to a handheld device. But in modern web development, there's a strong case to be made that all web pages should be built from the ground up as though they were going to be displayed only on mobile devices. In this chapter, you explore the principles and techniques behind this mobile-first approach to web development.

What Is Mobile-First Web Development?

As I discuss in Book 7, Chapter 1, when you develop a web page to look good and work well on a desktop-sized screen, there are a number of responsive tricks you can employ to make that same code look good and work well on a mobile device screen:

- » You can use percentages for horizontal measurements.
- » You can use relative units such as em and rem for vertical measurement and font sizes.
- » You can use media queries to remove elements when the screen width falls below a specified threshold.



REMEMBER

That third technique — the one where you remove stuff that doesn't fit on a smaller screen — is known in the web coding trade as *regressive enhancement* (RE). RE has ruled the web development world for many years, but lately there's been a backlash against it. Here's why:

- » RE relegates mobile screens to second-class web citizens.
- » RE leads to undisciplined development because coders and designers inevitably stuff a desktop-sized screen with content, widgets, and all the web bells and whistles.



REMEMBER

What's the solution? You've probably guessed it by now: *progressive enhancement*, which means starting with content that fits on a base screen width and then adding components as the screen gets bigger. When that original content represents what's essential about your page, and when that base screen width is optimized for mobile devices — especially today's most popular smartphones — then you've got yourself a *mobile-first* approach to web development.

Learning the Principles of Mobile-First Development

Let me be honest right off the top: Mobile-first web development is daunting because if you’re used to having the giant canvas of a desktop screen to play with, starting instead with a screen that’s a mere 320- or 400-pixels across can feel a tad claustrophobic. However, I can assure you that it only seems that way because of the natural tendency to wonder how you’re possibly going to shoehorn your massive page into such a tiny space. Mobile-first thinking takes the opposite approach by ignoring (at least at the beginning) large screens and, instead, focusing on what works best for mobile screens which, after all, represent the majority of your page visitors. Thinking the mobile-first way isn’t hard: It just means keeping a few key design principle in mind.

Mobile first means content first

One of the biggest advantages of taking a mobile-first approach to web development is that it forces you to prioritize. That is, a mobile-first design means that you include in the initial layout only those page elements that are essential to the user’s experience of the page. This essential-stuff-only idea is partly a response to having a smaller screen size in which to display that stuff, but it’s also a necessity for many mobile users who are surfing with sluggish Internet connections and limited data plans. It’s your job — no, scratch that, it’s your duty as a conscientious web developer — to make sure that those users aren’t served anything superfluous, frivolous, or in any other way nonessential.

That’s all well and good, I hear you thinking, but define “superfluous” and “frivolous.” Good point. The problem, of course, is that one web developer’s trivial appetizer is another’s essential meat and potatoes. Only you can decide between what’s inconsequential and what’s vital, depending on your page goals and your potential audience.

So the first step towards a mobile-first design is to decide what’s most important in the following content categories:



REMEMBER

- » **Text:** Decide what words are essential to get your page’s message across. Usability expert Steve Krug tells web designers to “Get rid of half the words on each page, then get rid of half of what’s left.” For a mobile-first page, you might need to halve the words once again. Be ruthless. Does the user really need to see that message from the CEO or your “About Us” text? Probably not.

- » **Images:** Decide what images are essential for the user, or whether any images are needed at all. The problem with images is that, although everyone likes a bit of eye candy, that sweetness comes at the cost of screen real estate and bandwidth. If you really do need to include an image or two in your mobile-first page, then at least serve up smaller images to your mobile visitors. To learn how to do that, see “Delivering images responsively,” later in this chapter.
- » **Navigation:** All users need to be able to navigate your site, but the recent trend is to create gigantic menus that include links to every section and page on the site. Decide which of those links are truly important for navigation and just include those in your mobile-first layout.
- » **Widgets:** Modern web pages are festooned with widgets for social media, content scrollers, photo lightboxes, automatic video playback, and, of course, advertising. Mobile users want to see content first, so consider ditching the widgets altogether. If there’s a widget you really want to include, and you’re sure it won’t put an excessive burden on either the page’s load time or the user’s bandwidth, push the widget to the bottom of the page.

Pick a testing width that makes sense for your site



REMEMBER

For most websites, testing a mobile-first layout should begin with the smallest devices, which these days means smartphones with screens that are 320 pixels wide. However, you don’t necessarily have to begin your testing with a width as small as 320px. If you have access to your site analytics, they should tell you what devices your visitors use. If you find that all or most of your mobile users are on devices that are at least 400 pixels wide, then that’s the initial width you should test for your mobile-first layout.

Get your content to scale with the device

For your mobile-first approach to be successful, it’s paramount that you configure each page on your site to scale horizontally with the width of the device screen. You do that by adding the following `<meta>` tag to the head section of each page:

```
<meta name="viewport" content="width=device-width, initial-scale=1.0">
```

This instructs the web browser to do two things:

- » Set the initial width of the page content to the width of the device screen.
- » Set the initial zoom level of the page to 1.0, which means the page is neither zoomed in nor zoomed out.

Build your CSS the mobile-first way

When you’re ready to start coding the CSS for your page, understand that the style definitions and rules that you write will be your page defaults — that is, these are the styles the browser will display on all devices, unless you’ve defined one or more media queries to override these defaults. (I talk more about mobile-first media queries shortly.) You shouldn’t have to write any special rules as long as you follow a few basic tenets of responsive web design:



REMEMBER

- » Use the relative units % or vw for horizontal measures such as width and padding.
- » Use the relative units rem or em for vertical measures and font sizes.
- » Make all your images responsive.
- » Use flexbox for the page layout, and be sure to apply `flex-wrap: wrap` to any flexbox container.

It’s also important to make sure that your mobile-first layout renders the content just as you want it to appear on the mobile screen. This means avoiding any tricks such as using the flexbox `order` property to mess around with the order of the page elements.

Finally, and perhaps most importantly, be sure to hide any unnecessary content by styling that content with `display: none`.

In the end, your mobile-first CSS should be the very model of simplicity and economy.

Pick a “non-mobile” breakpoint that makes sense for your content

Your mobile-first CSS code probably includes several elements that you’ve hidden with `display: none`. I assume you want to show those elements eventually (otherwise, you’d have deleted them altogether), so you need to decide when

you want them shown. Specifically, you need to decide what the minimum screen width is that will show your content successfully.

Notice I didn't say that you should decide when to show your hidden content based on the width of a target device. For example, many developers consider a screen to be "wide enough" when it's at least as wide as an iPad screen in portrait mode, which is 768 pixels. Fair enough, but will future iPads use this width? In fact, the current iPad Pro is 1,024 pixels wide in portrait mode.



TIP

Devices change constantly and it's a fool's game to try and keep up with them. Forget all of that. Instead, decide what minimum width is best for your page when the hidden content is made visible. How can you do that? Here's one easy way:

1. Load your page into the Chrome web browser.

2. Display Chrome's developer tools.

Press either Ctrl+Shift+I (Windows) or ⌘+Shift+I (Mac).

3. Use your mouse to adjust the size of the browser window:

- If the developer tools are below or undocked from the browser viewport, drag the right or left edge of the browser window.
- If the developer tools are docked to the right or left of the browser viewport, drag the vertical bar that separates the developer tools from the viewport.

4. Read the current viewport dimensions, which Chrome displays in the upper right corner of the viewport.

The dimensions appear as width x height, in pixels, as pointed out in Figure 1-1.

5. Narrow the window to your mobile-first testing width (such as 320px).

6. Increase the width and, as you do, watch how your layout changes.

In particular, watch for the width where the content first looks the way you want it to appear in larger screens. Make a note of that width.



REMEMBER

The width where your full content looks good is the basis for a CSS media query breakpoint that you'll use to display the elements that were hidden in the mobile-first layout. For example, say that your mobile-first layout hides the `aside` element and that you found that your full content looks right at a width of 742px. You then can set up the following media query (using 750px for a round number):

```
@media (min-width: 750px) {  
    aside {  
        display: block;  
    }  
}
```

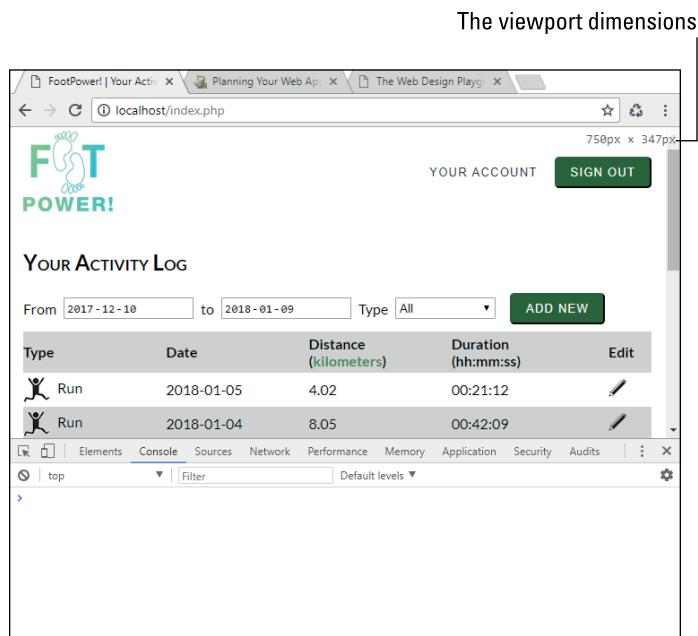


FIGURE 1-1:
With Chrome’s developer tools displayed, as you change the width of the browser window, Chrome displays the current viewport width and height.

This media query tells the browser that when the screen width is 750px or more, display the aside element.

Going Mobile Faster with jQuery Mobile

I talk quite a bit about jQuery in Book 4, and it’s safe to say that jQuery makes web development faster, easier, and even more pleasurable. I also introduce jQuery UI in Book 4, Chapter 3, and I show that it’s an easy way to incorporate sophisticated components such as dialog boxes and tabs into your web projects. Now I’m going to talk briefly about yet another jQuery library: jQuery Mobile, which offers widgets optimized for mobile web apps.

What is jQuery Mobile?

Most folks nowadays have a mobile device of some description, which means that most of us are used to doing our digital duties using mobile interfaces. These interfaces include standard mobile elements such as fixed headers and footers, navigation bars, list views, tabs, switches that turn on and off, and hidden menus invoked by a “hamburger” icon.

Coding elements such as these is possible, but it would be a ton of work. Fortunately, you can skip all of that because the hardcore geeks at jQuery Mobile have done it all for you. jQuery Mobile is a set of mobile-optimized widgets that make it easy for you to design your mobile web app to have the look and feel of a native mobile app.

Best of all, the jQuery Mobile components work just like the jQuery UI widgets I talk about in Book 4, Chapter 3, so you already know how to use them. Now all you have to do is incorporate jQuery Mobile into your app.

Adding jQuery Mobile to your web app

jQuery Mobile consists of two files:



REMEMBER

- » A JavaScript (.js) file that you add to your page by using a `<script>` tag with a reference to the external script file.
- » A CSS (.css) file that you add to your page by using a `<link rel="stylesheet">` tag with a reference to the external CSS file.

How do you get these files? You have three ways to go about it:



REMEMBER

- » **Download the files and use the default jQuery Mobile styles.** In this case, surf to jquerymobile.com/download and click the ZIP File link. The file you get will have a name like `jquery.mobile-1.x.y.zip`, where `x` and `y` denote the current version. Decompress the ZIP file and then copy the `jquery.mobile-1.x.y.min.js` and `jquery.mobile-1.x.y.min.css` files to your mobile web app's JavaScript and CSS folders. Then set up your `<link>` and `<script>` tags to reference the files:

```
<link rel="stylesheet" href="/css/jquery.mobile-1.x.y.min.css">
<script src="/js/jquery.mobile-1.x.y.min.js"></script>
```

(Remember to replace `x` and `y` with the actual version numbers of your downloaded file.)

- » **Use custom jQuery Mobile styles.** In this case, surf to themeroller.jquerymobile.com and use the ThemeRoller app to set your custom colors, fonts, and other styles. Click the Download Theme ZIP File button, type a theme name, and then click Download ZIP. Decompress the downloaded ZIP file, copy the CSS file from the Themes folder, and then add it to your mobile web app's CSS folder. Then set up your `<link>` tag to reference the file:

```
<link rel="stylesheet" href="/css/custom.min.css">
```

Replace *custom* with the custom theme name you provided. Note that this only gives you the CSS for jQuery Mobile. You still need to download the jQuery Mobile JavaScript file, as I describe previously.

- » **Link to a remote version of the file.** Several content delivery networks (CDNs) store the jQuery Mobile files and let you link to them. Here are the tags to use for Google's CDN:

```
<link rel="stylesheet" href="https://ajax.googleapis.com/
    ajax/libs/jquerymobile/1.x.y/jquery.mobile.css">
<script src="https://ajax.googleapis.com/ajax/libs/
    jquerymobile/1.x.y/jquery.mobile.min.js"></script>
```

Again, in both cases, be sure to replace *x* and *y* with the actual version numbers of the latest version of jQuery Mobile.

I hold off talking about specific jQuery Mobile widgets until Book 8, Chapter 2, where I build a mobile web app using a number of jQuery Mobile components.



WARNING

You also need to add jQuery to your page, as I describe in Book 4, Chapter 1. However, as I write this, jQuery Mobile is only compatible with version 2 of jQuery, so be sure to link to that version, not version 3.

Working with Images in a Mobile App

When planning a mobile web app, you always need to consider the impact of images, both on your design and on your users.

Making images responsive

On the design side, you need to ensure that your images scale responsively, depending on the screen width or height. For example, if the user's screen is 1,024 pixels wide, an image that's 800 pixels wide will fit no problem, but that same image will overflow a 400-pixel-wide screen. As I mention in Book 7, Chapter 1, you create responsive images with the following CSS rule:

```
image {
    max-width: 100%;
    height: auto;
}
```



REMEMBER

Here, *image* is a selector that references the image or images you want to be responsive. Setting `max-width: 100%` enables the image width to scale smaller or larger as the screen (or the image's container) changes size, but also mandates that the image can't scale larger than its original width. Setting `height: auto` cajoles the browser into maintaining the image's original aspect ratio by calculating the height automatically based on the image's current width.



TIP

Occasionally, you'll want the image height to be responsive instead of its width. To do that, you use the following variation on the preceding rule:

```
image {  
    max-height: 100%;  
    width: auto;  
}
```

Delivering images responsively

On the user side, delivering images that are far larger than the screen size can be a major problem. Sure, you can make the images responsive, but you're still sending a massive file down the tubes, which won't be appreciated by those mobile surfers using slow connections with limited data plans.

Instead, you need to deliver to the user a version of the image file that's appropriately sized for the device screen. For example, you might deliver the full-size image to desktop users, a medium-sized version to tablet folk, and a small-sized version to smartphone users. That sounds like a complex bit of business, but HTML5 lets you handle everything from the comfort of the `` tag. The secret? The `sizes` and `srcset` attributes.



REMEMBER

The `sizes` attribute is a collection of *expression-width* pairs:

- » The *expression* part specifies a screen feature, such as a minimum or maximum width, surrounded by parentheses.
- » The *width* part specifies how wide you want the image displayed on screens that match the expression.

For example, to specify that on screens up to 600 pixels wide you want an image displayed with a width of `90vw`, you'd use the following *expression-width* pair:

```
(max-width: 600px) 90vw
```

A typical `sizes` attribute is a collection of *expression-width* pairs, separated by commas. Here's the general syntax to use:

```
sizes="(expression1) width1,  
      (expression2) width2,  
      etc.,  
      widthN"
```

Notice that the last item doesn't specify an expression. This tells the web browser that the specified width applies to any screen that doesn't match any of the expressions.

Here's an example:

```
sizes="(max-width: 600px) 90vw,  
      (max-width: 1000px) 60vw,  
      30vw"
```



REMEMBER

The `srcset` attribute is a comma-separated list of image file locations, each followed by the image width and letter `w`. Here's the general syntax:

```
srcset="location1 width1w,  
       location2 width2w,  
       etc.">
```

This gives the browser a choice of image sizes, and it picks the best one based on the current device screen dimensions and the preferred widths you specify in the `sizes` attribute. Here's a full example, and Figure 1-2 shows how the browser serves up different images for different screen sizes:

```

```



WARNING

The `sizes` and `srcset` attributes don't always work the way you might expect. For example, if the browser finds that, say, the large version of the image is already stored in its cache, then it will usually decide that it's faster and easier on the bandwidth to just grab the image from the cache and scale it, instead of going back to the server to download a more appropriately sized file for the current screen.

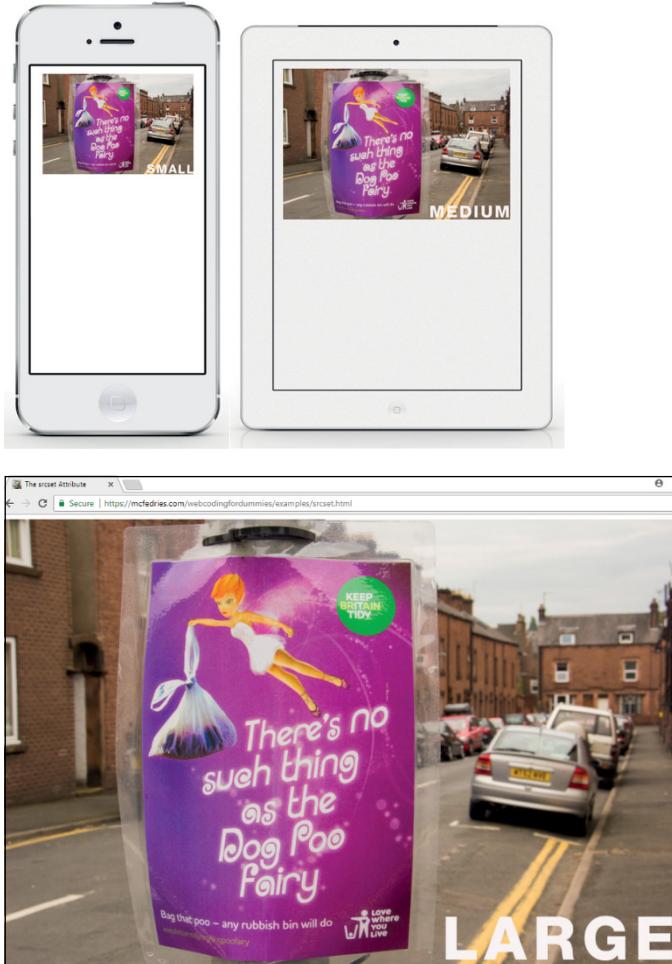


FIGURE 1-2:
With the `` tag's sizes and `srcset` attributes on the job, the browser serves up different versions of the image for different screen sizes.

Storing User Data in the Browser

I spend big chunks of this book talking about using MySQL to store data on the server, using PHP to access that data, and using JavaScript/jQuery Ajax calls to transfer data between the browser and the server. It's a robust and time-tested technique, but no sane person would describe it as trivial.

What's a web developer to do, then, when she wants to save just a few small or temporary tidbits of data for the current user? For example, perhaps her mobile web app enables each user to set custom background and text colors. That's just two pieces of data, so setting up the MySQL-PHP-Ajax edifice to store that data would be like building the Taj Mahal to store a few towels.

Fortunately, our developer doesn't have to embark on a major construction job to save small amounts of data for each user. Instead, she can take advantage of a technology called *web storage* that enables her to store data for each user right in that person's web browser.

Understanding web storage

Web storage is possible via an HTML5 technology called the Web Storage API (application programming interface), which defines two properties of the `window` object:

- » `localStorage`: A storage space created within the web browser for your domain (meaning that only your local code can access this storage). Data within this storage can't be larger than 5MB. This data resides permanently in the browser until you delete it.
- » `sessionStorage`: The same as `localStorage`, except that the data persists only for the current browser session. That is, the data is erased when the user closes the browser window.



WARNING

It's also possible for users to delete web storage data by using their browser's command for removing website data. If your mobile web app really needs its user data to be permanent (or, at least, completely under your control), then you need to store it on the server.

Both `localStorage` and `sessionStorage` do double-duty as objects that implement several methods that your code can use to add, retrieve, and delete user data. Each data item is stored as a key-value pair.



REMEMBER

Adding data to storage

You add data to web storage using the `setItem()` method:

```
localStorage.setItem(key, value)  
sessionStorage.setItem(key, value)
```

- » `key`: A string that specifies the key for the web storage item.
- » `value`: The value associated with the web storage key. The value can be a string, number, Boolean, or object. Note, however, that web storage can only store strings, so any value you specify will be converted to a string when it's stored.

Here's an example:

```
localStorage.setItem('bgcolor', '#ba55d3');
```

It's common to store a collection of related key-value pairs as a JSON string. For example, suppose you collect your data into a JavaScript object:

```
var userData = {  
    bgcolor: "#ba55d3",  
    fgcolor: "#f8f8f8",  
    subscriber: true,  
    level: 3  
}
```

Before you can add such an object to web storage, you have to *stringify* it — that is, turn it into a JSON string — using the `JSON.stringify()` method:

```
localStorage.setItem('user-settings', JSON.stringify(userData));
```



REMEMBER

When you store user data using web storage, that data is only available to the user in the same web browser running on the same device. For example, if you save data for a user running, say, Safari on an iPhone, when he returns to your site using, say, Chrome on a desktop computer, that data will not be available to him. Therefore, a good reason for going to the trouble to store user data on the server is that this makes the data available no matter what browser or device the user brings to your site.

Getting data from web storage

To retrieve an item from web storage, use the `getItem()` method:

```
localStorage.getItem(key)  
sessionStorage.getItem(key)
```

» *key*: A string that specifies the key for the storage item

Here's an example:

```
var userBG = localStorage.getItem('bgcolor');
```

If you stored a JavaScript object as a JSON string, use `JSON.parse()` to restore the object:

```
var userData = JSON.parse(localStorage.getItem('user-  
settings'));
```

Removing data from web storage

If you no longer require data in web storage, use the `removeItem()` method to delete it:

```
localStorage.removeItem(key)  
sessionStorage.removeItem(key)
```

» `key`: A string that specifies the key for the storage item

Here's an example:

```
localStorage.removeItem('bgcolor');
```

If you want to start fresh and delete everything from web storage, use the `clear()` method:

```
localStorage.clear();  
sessionStorage.clear();
```


IN THIS CHAPTER

- » Building a mobile web app from the ground up
- » Putting a few jQuery Mobile widgets through their paces
- » Setting up the app's structure with HTML
- » Defining the look of the app with CSS
- » Making the app do something useful with JavaScript and jQuery

Chapter 2

Building a Mobile Web App

Learning the art of programming, like most other disciplines, consists of first learning the rules and then learning when to break them.

— JOSHUA BLOCH

In this chapter, I show you how to build an app that's designed for the mobile web. In particular, my goal here is to build an app that satisfies three of the most common criteria in mobile web app development. For starters, the app must work well first and foremost on a smartphone. That is, it must be a mobile-first design, as I describe in Book 8, Chapter 1. Second, the app must look at least a little like the so-called native apps that are available in the App Store for iOS and Google Play for Android. Although the code will live on the web, this isn't a website we're building, it's a web app, so it should look applike. Our new friend jQuery Mobile, which I introduce in Book 8, Chapter 1, will help with that. Finally, the app should be self-contained, meaning that it doesn't require a back end either to get the data it requires or to save any data that the user creates.

All of this might sound limiting, but constraints are the essence of creativity and can be liberating in the sense that they focus your attention on a smaller subset of

what's possible. You'll be amazed at the incredible things you can build on even the smallest web development canvas. The screens you're coding for might be small, but that doesn't mean your ambitions can't be big.

Building the Button Builder App

The example I demonstrate in this chapter is called Button Builder, and it's a mobile web app that generates the CSS code for a button. That might strike you a tad trivial at first blush, but creating beautiful and unique buttons isn't easy. For example, here's some typical button code:

```
.btn {  
    background-color: hsl(0, 68%, 30%);  
    background-image: linear-gradient(to bottom, hsl(0, 68%,  
    50%) 0%, hsl(0, 68%, 30%) 100%);  
    border-color: hsl(0, 0%, 0%);  
    border-radius: 10px;  
    border-style: solid;  
    border-width: 3px;  
    color: hsl(0, 0%, 100%);  
    font-family: Verdana, sans-serif;  
    font-size: 1.25rem;  
    font-style: normal;  
    font-variant: normal;  
    font-weight: normal;  
    letter-spacing: 1.5px;  
    padding-bottom: 10px;  
    padding-left: 20px;  
    padding-right: 20px;  
    padding-top: 7px;  
}  
.btn:hover {  
    background-color: hsl(0, 68%, 30%);  
    background-image: linear-gradient(to bottom, hsl(0, 68%,  
    30%) 0%, hsl(0, 68%, 50%) 100%);  
}
```

There are no less than 19 CSS declarations here, and getting them to work in harmony to create a pleasing button is no easy task. The app I'm going to build makes button production a snap by offering controls such as text boxes, sliders, and color pickers to change a button's properties and display the results — and the underlying CSS code — in real time.

Getting Some Help from the Web

The Button Builder app has two features that require some attention from the start:

- » **Color pickers:** I need color pickers for the button's text, background, and border colors. Unfortunately, as I write this, the standard HTML5 color picker (that is, an `<input>` tag with `type="color"`) doesn't work in iOS, so I need an alternative. My favorite third-party color picker is Spectrum, written by Brian Grinstead. It's simple, small, and works perfectly in all browsers. You can download it from <http://bgrins.github.io/spectrum>, and then include the files `spectrum.css` and `spectrum.js` in your project.
- » **Copy to clipboard:** Button Builder will have a Copy the Button CSS command, which copies the CSS code to the device clipboard, enabling you to then paste the code into a text editor, an email message, or wherever you need it. One of the most popular tools for enabling this copying feature is Clipboard.js. You can either download it from <https://clipboardjs.com> and then include the file `clipboard.min.js` in your project, or you can use one of the content delivery networks (CDNs) that are linked from the Clipboard.js page.

Building the App: HTML

The Button Builder app, like most mobile web apps, consists of just a single page: `index.html`. In the next few sections, I go through the process of building the HTML for this page.

Setting up the home page skeleton

To get started, set up the skeleton for the page. Here's the top part of the page:

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="utf-8">
    <meta name="viewport" content="width=device-width,
initial-scale=1.0">
    <title>Button Builder</title>
```

```

<!-- External CSS Files -->
<link href="https://fonts.googleapis.com/css?family=Source+Sans+Pro:400,700|Source+Code+Pro" rel="stylesheet">
<link href="https://ajax.googleapis.com/ajax/libs/jquerymobile/1.4.5/jquery.mobile.css" rel="stylesheet">
<link href="css/spectrum.css" rel="stylesheet">
<link href="css/styles.css" rel="stylesheet">

<!-- External JavaScript Files -->
<script src="https://ajax.googleapis.com/ajax/libs/jquery/2.2.4/jquery.min.js"></script>
<script src="https://ajax.googleapis.com/ajax/libs/jquerymobile/1.4.5/jquery.mobile.min.js"></script>
<script src="js/spectrum.js"></script>
<script src="js/clipboard.min.js"></script>
<script src="js/code.js"></script>

<!-- Custom CSS for the button will appear here -->
<style id="button-css" type="text/css">
</style>

<script>
$(document).ready(function() {

});

</script>
</head>

```

There are four main sections to note here:



REMEMBER

- » The external CSS files include a couple of Google fonts (Source Sans Pro and Source Code Pro), the jQuery Mobile CSS, the Spectrum CSS, and the app's CSS (`styles.css`).
- » The external JavaScript files include the jQuery and jQuery Mobile libraries, the code for Spectrum and Clipboard.js, and the app's JavaScript (`code.js`).

- » The `<style>` tag is where the app writes the custom CSS for the button. Note that this tag gets overwritten by the app, so if you want to store any CSS in a `<style>` tag, you need to create a separate style element.
- » The `<script>` tag includes jQuery's standard `ready` event handler, which is where the app initialization and event handlers will reside.

Here's the rest of `index.html`:

```
<body>
  <main role="main" data-role="page" class="ui-responsive-
  panel">
    <header data-role="header" data-position="fixed">
    </header>
    <article role="contentinfo" class="ui-content">
    </article>
    <aside id="menu-panel" role="complementary" data-
    role="panel" data-display="overlay" data-theme="a">
    </aside>
  </main>
</body>
</html>
```

Within the `<body>` tag, there are four elements you should note:



REMEMBER

- » `main`: Holds all the HTML for the app. Note, in particular, that it has the attribute value `data-role="page"`. The `data-role` attribute is used by jQuery Mobile to specify what type of widget to apply to an HTML element. A Page widget is the main container for a jQuery Mobile app. The class `ui-responsive-panel` sets up the page as a responsive panel, meaning it accommodates any screen size and includes a "hamburger" button that, when tapped or clicked, reveals a menu of options.
- » `header`: Defines a header at the top of the screen. In Button Builder, the header will hold the app title, the menu button, and the button preview. Adding `data-position="fixed"` configures the header to stay on screen even when the user scrolls vertically.
- » `article`: Holds the app's content. For Button Builder, this will be a series of jQuery Mobile Collapsible widgets that hold the controls that enable the user to build a custom button.
- » `aside`: Holds the app's menu commands. It's a jQuery Mobile Panel widget that appears when the user taps or clicks the menu button in the header. Setting `data-display` to `overlay` means the menu slides in on top of the main panel. Other display modes you could try are `push` and `reveal`.

Configuring the header

Here's the HTML for the app's header element:

```
<header data-role="header" data-position="fixed">
  <h1>Button Builder</h1>
  <a href="#menu-panel" data-icon="bars" data-iconpos="left"
    style="height: 3rem; background-color: #e8e8e8; border: none;
    box-shadow: none;"></a>
  <div id="button-preview" class="control-row button-preview-
    wrapper">
    <label for="built-button">Preview:</label>
    <div id="built-button" class="btn">Button</div>
  </div>
</header>
```

There are three elements to note:



REMEMBER

- » h1: Defines the app title.
- » a: Defines the button that the user clicks to display the menu. The href attribute links to the ID (menu-panel) of the aside that contains the menu commands. The data-icon attribute adds a built-in jQuery Mobile icon: In this case, bars is the three horizontal lines that have come to be known as the *hamburger* icon.
- » div: Holds the text Preview: and a nested div that the app uses to apply the custom CSS, which is applied to the btn class.

Figure 2-1 shows the app header.

FIGURE 2-1:
The Button
Builder header
showing the app
title, menu icon,
and a preview
of the custom
button.



TIP

To eyeball the complete list of jQuery Mobile icons, see <http://api.jquerymobile.com/icons>.

Creating the app menu

Here's the HTML for the app's menu:

```
<aside id="menu-panel" role="complementary" data-role="panel"
       data-display="overlay" data-theme="a">
  <ul data-role="listview">
    <li data-icon="delete"><a href="#" data-
       rel="close">Close menu</a></li>
    <li data-icon="check"><a id="save-button"
       href="#" data-rel="close">Save Your Button</a></li>
    <li data-icon="action"><a id="copy-button"
       href="#" data-rel="close">Copy the Button CSS</a></li>
    <li data-icon="recycle"><a id="reset-button"
       href="#" data-rel="close">Reset the Button CSS</a></li>
  </ul>
</aside>
```

Note, in particular, the nested `` tag, which is configured as a jQuery Mobile ListView widget. This displays each `li` element as an item in a vertical list, as shown in Figure 2-2, which shows the menu that appears when the user clicks or taps the menu icon.



FIGURE 2-2:
The Button
Builder menu.

Adding the app's controls

Now it's time to populate the app with the actual controls for manipulating the button to get the look you want. The app divides the controls into four sections:

- » **Text Styles:** Customizes the button text, especially the typography
- » **Box Styles:** Customizes the button's box model, especially the padding and border

» **Color Styles:** Customizes the button's text, background, and border colors

» **CSS Code:** Displays the custom CSS created by the preceding controls

Each of these sections is a jQuery Mobile Collapsible widget, which is a useful mobile web app tool because it enables you to place a large amount of content onto a page, but hides that content behind section headings. When the user taps or clicks a heading, the content is revealed.

Here's the skeleton code that creates these Collapsible widgets:

```
<div id="text-settings-collapsible" data-role="collapsible"
    data-inset="false">
    <h2>Text Styles</h2>
    <section>
        </section>
    </div>

    <!-- Box Settings -->
    <div id="box-settings-collapsible" data-role="collapsible"
        data-inset="false">
        <h2>Box Styles</h2>
        <section>
            </section>
        </div>

    <!-- Color Settings -->
    <div id="color-settings-collapsible" data-role="collapsible"
        data-inset="false">
        <h2>Color Styles</h2>
        <section>
            </section>
    </div>

    <!-- CSS Code -->
    <div id="css-code-collapsible" data-role="collapsible" data-
        inset="false">
        <h2>CSS Code</h2>
        <section id="css-code" class="css-code">
            </section>
    </div>
```



REMEMBER

Some notes:

- » Each `div` element is given a `data-role` value of `collapsible`, which tells jQuery Mobile to configure the `div` as a Collapsible widget. These widgets normally have margins around them, but adding `data-inset="false"` tells jQuery Mobile to do without those margins.
- » Each `<h2>` tag defines the text that appears in the header of each Collapsible widget.
- » The `section` elements are where the app's controls will appear. The exception here is the `css-code` section, which the app itself populates with the generated CSS for the custom button.

Figure 2-3 shows the app with the Collapsible widgets added.

The screenshot shows the 'Button Builder' application interface. At the top, there is a title bar with the text 'Button Builder'. Below the title bar, there is a 'Preview:' section containing a red button labeled 'Button'. To the right of the preview, there is a vertical list of collapsible sections, each represented by a plus sign icon and a section name: 'Text Styles', 'Box Styles', 'Color Styles', and 'CSS Code'. The entire interface is contained within a light gray frame.

FIGURE 2-3:
Button Builder
with the
Collapsible
widget sections
added.

Adding the text controls

Here's the HTML I used for the Text Styles section:

```

<h2>Text Styles</h2>
<section>
    <div class="control-row">
        <label for="button-text">Button text:</label>
        <input id="button-text" type="text" value="Button"
               aria-label="Enter the button text">
    </div>
    <div class="control-row">
        <label for="font-family">Font family:</label>
        <select id="font-family" data-role="selectmenu" aria-
               label="Select a font family">
    
```

```
        <option value="Arial, sans-serif">Arial</option>
        <option value="Tahoma, sans-serif">Tahoma</option>
        <option value="'Trebuchet MS', sans-serif">Trebuchet
MS</option>
        <option value="Verdana, sans-serif">Verdana</option>
        <option value="Georgia, serif">Georgia</option>
        <option value="Palatino, serif">Palatino</option>
        <option value="'Times New Roman', serif">Times New
Roman</option>
        <option value="'Courier New', monospace">Courier
New</option>
    </select>
</div>
<div class="control-row">
    <label for="font-size">Font size (rem):</label>
    <input id="font-size" type="range" min="0.5" max="3"
step=".05" data-unit="rem" aria-label="Select a font size in
rems">
</div>
<div class="control-row">
    <label for="letter-spacing">Letter spacing (px):</label>
    <input id="letter-spacing" type="range" min="0" max="6"
step=".05" data-unit="px" aria-label="Select the letter
spacing in pixels">
</div>
<div class="control-row">
    <label for="font-weight">Bold:</label>
    <select id="font-weight" data-role="flipswitch" aria-
label="Toggle bold on and off">
        <option value="normal">Off</option>
        <option value="bold">On</option>
    </select>
</div>
<div class="control-row">
    <label for="font-style">Italic:</label>
    <select id="font-style" data-role="flipswitch" aria-
label="Toggle italics on and off">
        <option value="normal">Off</option>
        <option value="italic">On</option>
    </select>
</div>
<div class="control-row">
```

```

        <label for="font-variant">Small caps:</label>
        <select id="font-variant" data-role="flipswitch" aria-
label="Toggle small caps on and off">
            <option value="normal">Off</option>
            <option value="small-caps">On</option>
        </select>
    </div>
</section>

```

There are seven controls here:



REMEMBER

- » **Button text:** The text that appears on the button face.
- » **Font family:** The typeface for the button text (CSS property: `font-family`). This `select` element is given a `data-role` value of `selectmenu`, which turns it into a jQuery Mobile SelectMenu widget.
- » **Font size:** The type size, measured in rem (CSS property: `font-size`). When you give an `input` element a type value of `range`, jQuery Mobile automatically enhances the input with a Slider widget, which enables the user to drag the slider to set the input value.
- » **Letter spacing:** The space between the button text letters, measured in pixels (CSS property: `letter-spacing`).
- » **Bold:** Toggles bold on and off (CSS property: `font-weight`). The `data-role` value of `flipswitch` turns this `select` into a jQuery Mobile FlipSwitch widget, which enables the user to choose between two values by tapping to “flip” the switch. The standard values are `On` and `Off`, but you can use the `option` elements’ `value` attributes to set custom values (`normal` and `bold`, in this case).
- » **Italic:** Toggles italics on and off (CSS property: `font-style`).
- » **Small caps:** Toggles small caps on and off (CSS property: `font-variant`).



REMEMBER

Note here that most of the controls use `id` values that are the same as the associated CSS property. For example, the `id` value of the Font Size control is `font-size`. As I describe a bit later, this makes it easy for the app’s code to know which CSS property to generate for each control.

When the user taps Text Styles, the controls shown in Figure 2–4 appear.



FIGURE 2-4:
The controls in
Button Builder's
Text Styles
section.

Adding the box controls

Check out the HTML code for the Box Styles section:

```
<h2>Box Styles</h2>
<section>
    <div class="control-row">
        <label for="padding-top">Padding top (px):</label>
        <input id="padding-top" type="range" min="0" max="60"
step="1" data-unit="px" aria-label="Enter the top padding">
    </div>
    <div class="control-row">
        <label for="padding-right">Padding right (px):</label>
        <input id="padding-right" type="range" min="0" max="60"
step="1" data-unit="px" aria-label="Enter the right padding">
    </div>
    <div class="control-row">
        <label for="padding-bottom">Padding bottom (px):</label>
        <input id="padding-bottom" type="range" min="0" max="60"
step="1" data-unit="px" aria-label="Enter the bottom padding">
    </div>
    <div class="control-row">
        <label for="padding-left">Padding left (px):</label>
        <input id="padding-left" type="range" min="0" max="60"
step="1" data-unit="px" aria-label="Enter the left padding">
    </div>
    <div class="control-row">
        <label for="border-radius">Border radius (px):</label>
        <input id="border-radius" type="range" min="0" max="25"
step="1" data-unit="px" aria-label="Enter the border radius">
    </div>
```

```
<div class="control-row">
    <label for="border-width">Border width (px):</label>
    <input id="border-width" type="range" min="0" max="10"
step="1" data-unit="px" aria-label="Enter the border width">
</div>
<div class="control-row">
    <label for="border-style">Border style:</label>
    <select id="border-style" data-role="selectmenu" aria-
label="Select a border style">
        <option value="solid">solid</option>
        <option value="dashed">dashed</option>
        <option value="dotted">dotted</option>
        <option value="double">double</option>
    </select>
</div>
</section>
```

The first four controls set the padding values, in pixels (CSS properties: padding-top, padding-right, padding-bottom, and padding-left). The next two controls set the border radius, in pixels (CSS property: border-radius), and the border width, in pixels (CSS property: border-width). The Border Style select element sets the border style (CSS property: border-style).

Figure 2-5 shows the Box Styles section.

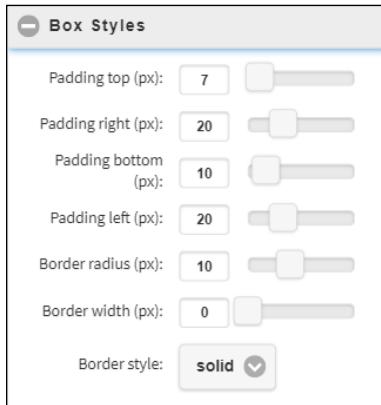


FIGURE 2-5:
The controls in
Button Builder's
Box Styles
section.

Adding the color controls

Here's the HTML code that populates Button Builder's Color Styles section:

```
<h2>Color Styles</h2>
<section>
    <div class="control-row">
        <label for="color">Text color:</label>
        <input id="color" type="text" aria-label="Select a text
color">
    </div>
    <div class="control-row">
        <label for="background-color">Background color:</label>
        <input id="background-color" type="text" aria-
label="Select a background color">
    </div>
    <div class="control-row">
        <label for="border-color">Border color:</label>
        <input id="border-color" type="text" aria-label="Select
a border color">
    </div>
    <div class="control-row">
        <label for="gradient">Gradient:</label>
        <input id="gradient" type="checkbox" data-
role="flipswitch" aria-label="Toggle the background gradient
on or off" checked>
    </div>
    <div class="control-row">
        <label for="hover">Hover effect:</label>
        <input id="hover" type="checkbox" data-role="flipswitch"
aria-label="Toggle the hover effect on or off" checked>
    </div>
</section>
```

This section uses three Spectrum color pickers: Text Color (CSS property: `text-color`), Background Color (CSS property: `background-color`), and Border Color (CSS property: `border-color`). There are also a couple of jQuery Mobile FlipSwitch widgets that toggle two effects:

- » **Gradient:** When On, applies a gradient effect to the button's background color (CSS property: `background-image`)
- » **Hover effect:** When On, adds the `.btn-hover` class to the CSS, which swaps the gradient colors when the user hovers the pointer over the button



TECHNICAL
STUFF

USING HUE, SATURATION, AND LUMINANCE TO SPECIFY CSS COLORS

In the Button Builder app, I define most of the colors using the *HSL* method, which uses the following three components:

- **Hue:** Specifies a position, in degrees, on the color wheel. Acceptable values are between 0 and 359, where lower numbers indicate a position near the red end of the spectrum (with red equal to 0 degrees), and higher numbers move through the yellow, green, blue, and violet parts of the spectrum. Hue is pretty much equivalent to the term *color*.
- **Saturation:** Sets a given hue's purity, expressed as a percentage. 100% means that the hue is a pure color, whereas lower numbers indicate that more gray is mixed with the hue until, at 0%, the color becomes part of the grayscale.
- **Luminance:** Sets the hue's brightness, as a percentage. Lower percentages are darker (with 0% producing black), and higher numbers are brighter (with 100% creating white).

To apply the HSL method in CSS, use the `hsl()` function as the value of a color property (such as `text-color` or `background-color`):

```
hsl(hue, saturation, luminance)
```

- *hue*: Specifies the hue with a value between 0 and 359.
- *saturation*: Specifies the saturation with a value between 0% and 100%.
- *luminance*: Specifies the luminance with a value between 0% and 100%.

I used HSL in Button Builder because it helps to simplify both the gradient and hover effects:

- For the gradient, I set the bottom color to be the same as the background color, and then I defined the top color to be the background color with the luminance reduced by 20 percentage points (from 50% to 30%):

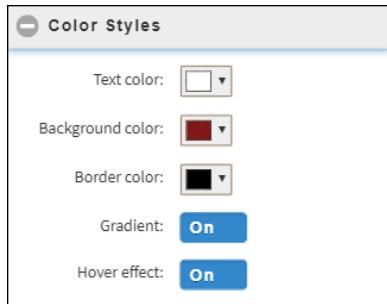
```
background-color: hsl(0, 68%, 30%);  
background-image: linear-gradient(to bottom, hsl(0, 68%, 50%)  
    0%, hsl(0, 68%, 30%) 100%);
```

- For the hover, I reversed the top and bottom colors in the gradient:

```
background-color: hsl(0, 68%, 30%);  
background-image: linear-gradient(to bottom, hsl(0, 68%, 30%)  
    0%, hsl(0, 68%, 50%) 100%);
```

Figure 2–6 shows the controls in the Color Styles section.

FIGURE 2-6:
The controls in
Button Builder's
Color Styles
section.



Building the App: CSS

Most of the heavy lifting for the Button Builder CSS is handled by jQuery Mobile, so the custom CSS mostly involves either app-specific rules or tweaks to the jQuery Mobile styles.

I begin with a standard CSS reset:

```
* {  
    box-sizing: border-box;  
}  
body {  
    margin: 0 auto;  
    padding: 0;  
    font-weight: normal;  
    font-style: normal;  
    font-size: 100%;  
}
```

From there, I set up a few rules for some of the page elements:

```
html,  
body {  
    font-family: 'Source Sans Pro', Verdana, sans-serif;  
    overflow-x: hidden;  
}
```

```
main {
    padding-top: 0 !important;
}
h1, h2 {
    font-family: 'Source Sans Pro', Verdana, sans-serif;
    font-weight: bold;
}
label {
    font-family: 'Source Sans Pro', Verdana, sans-serif;
}
a {
    letter-spacing: 1.5px;
}
```

This is mostly typography, but I set `overflow-x: hidden` on the `html` and `body` elements to prevent horizontal scrolling on narrow devices.

Next I style a few app classes:

```
.button-preview-wrapper {
    border-top: 2px solid #ddd;
    padding: 1rem 0;
    background-color: #fff;
}
.button-preview-wrapper label {
    font-size: 1.25rem;
    font-weight: bold;
}
.control-row {
    display: flex;
    align-items: center;
}
.control-row label {
    width: 40%;
    margin-right: 1rem;
    text-align: right;
}
.css-code {
    font-family: 'Source Code Pro', 'Courier New', monospace;
    white-space: pre;
    overflow-x: auto;
}
```

These classes style the button preview div, the rows used to display each control, and the appearance of the CSS code.

From there I add a few tweaks to the jQuery Mobile classes:

```
.ui-header .ui-title {  
    margin: 0;  
    padding: .5rem 0;  
    color: hsl(217, 66%, 32%);  
    font-size: 2rem;  
    font-style: italic;  
    overflow: visible;  
}  
.ui-input, ui-input-text {  
    width: 100%;  
}  
.ui-flipswitch .ui-btn.ui-flipswitch-on {  
    text-indent: -3.6em;  
}  
.ui-flipswitch .ui-flipswitch-off {  
    margin-top: -2rem;  
    text-indent: 3em;  
}  
.ui-slider-track {  
    width: 125%;  
    touch-action: none  
}
```

This is mostly just fiddling with properties to get things looking good. However, note the `text-indent` and `margin-top` values applied to the `ui-flipswitch` class. These are necessary to get the FlipSwitch widget to display the text values properly. You might have to fiddle with these in your own code.

Finally, because this is a mobile-first app, I added a media query to handle screens with widths greater than or equal to 800px:

```
@media (min-width: 800px) {  
    .ui-mobile-viewport,  
    .ui-header,  
    .ui-content  
    {  
        width: 800px !important;  
        margin: 0 auto !important;  
    }  
}
```

All this code does is set the width of the app's three main jQuery Mobile areas to 800px and center them within the viewport with `margin: 0 auto`.

Building the App: JavaScript and jQuery

With the app's HTML structure in place and the CSS styles making everything look respectable, it's time to wire everything together with JavaScript and jQuery.

A mobile web app that uses internal data will often need to perform four tasks using that data:



REMEMBER

- » Initialize the data.
- » Use the data to set the value of each of the app's controls.
- » Get the values from the app's controls and store them in the app's data structure.
- » Generate the app's output from the data.

The specifics of these tasks are covered in the next four sections.

Setting up the app data structures

Like many mobile web apps, Button Builder doesn't require data from a server. Instead, it uses its own internal data structures to store four chunks of button-related data:

- » The button text
- » Whether the button has a gradient (true or false)
- » Whether the button uses a hover effect (true or false)
- » The button's CSS property-value pairs

I use two JavaScript objects to store the data: one that holds the default button data and one that holds the custom button data generated by the user. Here's the code that defines the default button data:

```
var defaultButton = {};  
defaultButton.text = 'Button';  
defaultButton.gradient = true;
```

```
defaultButton.hover = true;
defaultButton.styles = {};
defaultButton.styles['background-color'] = 'hsl(0, 68%, 30%)';
defaultButton.styles['background-image'] = 'linear-gradient(to
    bottom, hsl(0, 68%, 50%) 0%, hsl(0, 68%, 30%) 100%)';
defaultButton.styles['border-color'] = 'hsl(0, 0%, 0%)';
defaultButton.styles['border-radius'] = '10px';
defaultButton.styles['border-style'] = 'solid';
defaultButton.styles['border-width'] = '0px';
defaultButton.styles['color'] = 'hsl(0, 0%, 100%)';
defaultButton.styles['font-family'] = 'Verdana, sans-serif';
defaultButton.styles['font-size'] = '1.25rem';
defaultButton.styles['font-style'] = 'normal';
defaultButton.styles['font-variant'] = 'normal';
defaultButton.styles['font-weight'] = 'normal';
defaultButton.styles['letter-spacing'] = '1.5px';
defaultButton.styles['padding-bottom'] = '10px';
defaultButton.styles['padding-left'] = '20px';
defaultButton.styles['padding-right'] = '20px';
defaultButton.styles['padding-top'] = '7px';
```

Notice that the object's `styles` property is itself an object.

For the custom button, the app declares the following:

```
var customButton = {};
customButton.styles = {};
```

Setting the app's control values

You could initialize the app's controls by adding `value` attributes where appropriate, but it's almost always better to set up a default data object and then use that object to populate the controls via code. That way, if you decide to change the defaults, you need only edit the object's values. Also, if your app offers a "reset" feature, as does Button Builder, then you can also use the default data to perform the reset.

Here's the function that sets the Button Builder's control values:

```
function setButtonValues(button) {
    // Set the Button Text value
    $('input[id=button-text]').val(button.text);
    $('input[id=button-text]').textinput('refresh', true);
```

```
// Set the Gradient value
if (button.gradient) {
    $('input[id=gradient]').prop('checked', true);
} else {
    $('input[id=gradient]').prop('checked', false);
}
$('input[id=gradient]').flipswitch('refresh', true);

// Set the Hover value
if (button.hover) {
    $('input[id=hover]').prop('checked', true);
} else {
    $('input[id=hover]').prop('checked', false);
}
$('input[id=hover]').flipswitch('refresh', true);

// Loop through the styles
for (var propertyName in button.styles) {

    // Skip the background-image property, which doesn't
    have a setting
    if (propertyName !== 'background-image') {

        // Set the control ID from the property name
        var propertyID = '#' + propertyName;

        // Get the current property value
        var PropertyValue = button.styles[propertyName];

        // Is it a color property?
        if (propertyName.includes('color')) {

            // If so, apply the color to the color picker
            $(propertyID).spectrum('set', PropertyValue);
        }
        // Otherwise, is the property associated with a
        <select> tag?
        else if ($(propertyID)[0].tagName === 'SELECT') {

            // If so, is it a SelectMenu widget?
            if ($(propertyID).attr('data-role') ===
            'selectmenu') {
                // If so, set the SelectMenu's selected
                option
            }
        }
    }
}
```

```

        $('select[id=' + propertyName + '] >
option[value="' + PropertyValue + '"]').attr('selected', true);
        $('select[id=' + propertyName + ']').
selectmenu('refresh', true);
    } else {

        // Otherwise, set the FlipSwitch's selected
option
        $('select[id=' + propertyName + '] >
option[value="' + PropertyValue + '"]').attr('selected', true);
        $('select[id=' + propertyName + ']').
flipswitch('refresh', true);
    }
} else {

    // For all other inputs, first remove the unit
(rem or px)
    PropertyValue = PropertyValue.replace(/rem|px/, '');

    // Set the control's value
    $('input[id=' + propertyName + ']').
val(PropertyValue);
    $('input[id=' + propertyName + ']').
textinput('refresh', true);
}
}
}

```

This function takes a button object — which will either be `defaultButton` or `customButton` — as a parameter. The function begins by setting the values for the Button Text box and the Gradient and Hover switches. Notice that jQuery Mobile requires that I invoke a `refresh` event on a changed control. For example:

```
$( 'input[id=button-text]' ).textInput('refresh', true);
```

From there, the code loops through the object's styles sub-object, setting and then refreshing the controls depending on the control type.

Getting the app's control values

Before a mobile web app can generate any output, it needs to gather all the current values of the app's controls and then store them in the app data structure. Here's the Button Builder code that does this:

```
function getButtonValues() {  
  
    // Reference all the controls (that is, all the <input> and  
    // <select> tags)  
    var $controls = $('article').find('input, select');  
  
    // Loop through all the controls  
    $controls.each(function() {  
  
        // In most cases, the ID of each setting is also the CSS  
        // property name  
        var cssProperty = $(this).attr('id');  
  
        // Use a switch() to handle the exceptions  
        switch (cssProperty) {  
  
            // Write the button text  
            case 'button-text':  
  
                // Get the user's button text  
                var newButtonText = $(this).val();  
  
                // Apply the text to the button  
                $('.btn').text(newButtonText);  
  
                // Store the button text  
                customButton.text = newButtonText;  
  
                break;  
  
            // Apply a gradient to the button background  
            case 'gradient':  
  
                // Is the Gradient Flipswitch widget set to On?  
                if($('#gradient').prop('checked')) {  
  
                    // Turn on the button's gradient flag  
                    customButton.gradient = true;  
                } else {
```

```

        // Turn off the button's gradient flag
        customButton.gradient = false;
    }

    // Build the gradient CSS
    buildGradient(customButton);

    break;

    // Apply a hover effect to the button background
    case 'hover':

        // Is the Hover Flipswitch widget set to On?
        if($('#hover').prop('checked')) {

            // Turn on the button's hover flag
            customButton.hover = true;
        } else {

            // Turn off the button's hover flag
            customButton.hover = false;
        }

        // Build the hover CSS
        buildHover(customButton);

        break;

        // For everything else, store the property-value
        // pair in the customButton.styles object
        default:

            // First, check for a unit associated with the
            property
            var unit = $(this).attr('data-unit');

            // Does the unit exist?
            if(unit !== null) {

                // If so, add it to the property value
                if(cssProperty === 'box-shadow') {
                    customButton.styles[cssProperty] =
$(this).val() + unit + ' 3px 3px #666';
                } else {

```

```
customButton.styles[cssProperty] =  
$(this).val() + unit;  
    }  
} else {  
    // Otherwise, just store the property value  
    customButton.styles[cssProperty] = $(this).  
val();  
}  
}  
});
```

This function first sets up a jQuery reference to all the controls — that is, all the `<input>` and `<select>` tags. The code loops through these controls, getting the associated CSS property name from the control's `id` value, then using a `switch()` statement to handle the exceptions: the button text and the gradient and hover flags. The default case handles the actual CSS property-value pairs, and these are stored in the `customButton.styles` object.

Writing the custom CSS code

Here's the function that generates Button Builder's custom CSS code:

```
function generateButtonCode(button) {  
    // Set the button text  
    $('.btn').text(button.text);  
  
    // Build the gradient code  
    buildGradient(button);  
  
    // Build the hover code  
    buildHover(button);  
  
    // Sort the styles by property name  
    var alphaStyles = {};  
    Object.keys(button.styles).sort().forEach(function  
        (propertyName) {  
        alphaStyles[propertyName] = button.styles[propertyName];  
    });  
  
    // Build the CSS string  
    var strCSS = "\n.btn {\n";
```

```

        for (var propertyName in alphaStyles) {
            strCSS += TAB + propertyName + ": " +
alphaStyles[propertyName] + "; \n";
        }
        strCSS += "}\n";
        strCSS += hoverStyles;

        // Add the code to the CSS Code section
        $('#css-code').text(strCSS);

        // Build the <style> tag
        var strStyleTag = '<style id="button-css" type="text/css">' +
strCSS + '</style>';

        // Replace the current <style> tag with the new one
        $('#button-css').replaceWith(strStyleTag);

        // Adjust the <article> padding so that it clears the new
        // header size
        $('article').css('padding-top', $('header').height() + 2);
    }
}

```

This function takes a button object as a parameter, then generates the new button and CSS, as follows:

- » The button text is updated.
- » The new gradient effect is generated by calling the buildGradient() function (not shown), which creates and stores the background-image property-value pair.
- » The new hover effect is generated by calling the buildHover() function (not shown), which creates the .btn:hover CSS rule.
- » The button's styles object is sorted alphabetically by property name.
- » The CSS rule for the .btn class is generated and then added to the CSS Code section of the app.
- » The .btn and .btn:hover rules are embedded in a <style> tag, which is then used to replace the existing <style id="button-css"> tag. Doing this refreshes the preview button with the new CSS rules.
- » The <article> tag's padding-top property is adjusted to the header element's height, plus 2px, to ensure that as the preview button grows or shrinks (say, because of font size changes), the header and article remain in the same relative position to each other.

Running the code

How does the code for setting the control values, getting the control values, and generating the CSS code get called? This happens in `index.html`, as part of the jQuery ready event handler. The first time you run the app (and each subsequent time if no custom button has been saved), the initial button is generated by calling the following two functions using the `defaultButton` object as a parameter:

```
setButtonValues(defaultButton);
generateButtonCode(defaultButton);
```

To handle control changes, the app uses the following event handler:

```
$(‘input, select’).on(‘blur change input keyup contextmenu’,
    function(e) {

        // Prevent the default whatever
        e.preventDefault();

        // Get all the custom button values
        getButtonValues();

        // Write the CSS code
        generateButtonCode(customButton);
});
```

This handler listens for several event types on the `input` and `select` elements. If invoked, the handler prevents the default action, then runs the `getButtonValues()` and `generateButtonCode()` functions.

Saving the custom CSS

When the user taps or clicks Button Builder’s Save Your Button command, the following event handler leaps into action:

```
$('#save-button').click(function() {

    // Get the button’s control values
    getButtonValues();

    // Save them
    localStorage.setItem('button-builder-data', JSON.
        stringify(customButton));
});
```

This handler calls `getButtonValues()` to populate the `customButton` object, and it then uses the `setItem()` function to store a JSON stringified version of the object in `localStorage`.

You now need to update the app's ready event handler to check for a saved button:

```
var buttonData = localStorage.getItem('button-builder-data');

// Did we get anything back from localStorage?
if (buttonData) {

    // If so, objectify it and store it in our global
    // customButton object
    customButton = JSON.parse(buttonData);

    // Apply the button's styles
    setButtonValues(customButton);
    generateButtonCode(customButton);
} else {

    // If not, build the button using the default CSS values
    setButtonValues(defaultButton);
    generateButtonCode(defaultButton);
}
```

First, the app checks for a saved button. If a saved button exists, the app gets the saved data, stores it as a JavaScript object in the `customButton` variable, and then calls `setButtonValues()` and `generateButtonCode()` to apply the saved button CSS. Otherwise, the default button code is used.

Copying the custom CSS

To handle Button Builder's Copy the Button CSS command, the `ready` event's callback function includes the following `Clipboard.js` code:

```
var buttonCSSClipboard = new Clipboard('#copy-button', {
    text: function(trigger) {
        var textToCopy = $('#css-code').text();
        return textToCopy;
    }
});
```

This binds a new Clipboard object to the Copy the Button CSS command (which has an id value of copy-button). When this command is tapped or clicked, Clipboard.js grabs the text from the CSS Code section and copies it to the device clipboard.

Resetting the CSS to the default

To handle Button Builder's Reset the Button CSS command, the ready event's callback function includes the following handler code:

```
$('#reset-button').click(function() {  
  
    // Rebuild the button using the default CSS values  
    setButtonValues(defaultButton);  
    generateButtonCode(defaultButton);  
});
```

This code resets the button's default CSS by invoking both the setButtonValues() and generateButtonCode() functions using the defaultButton object as the parameter.

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About the Author

Paul McFedries is the president of Logophilia Limited, a technical writing company, and has worked with computers large and small since 1975. While now primarily a writer, Paul has worked as a programmer, consultant, database developer, and website developer. Paul has written more than 90 books that have sold over four million copies worldwide. Paul is also the proprietor of Word Spy (wordspy.com), a website that has been tracking recently coined words and phrases since 1995. Paul invites everyone to drop by his personal website at mcfedries.com, or to follow him on Twitter (@paulmcf and @wordspy).

Author's Acknowledgments

If we're ever at the same cocktail party and you overhear me saying something like "I wrote a book," I hereby give you permission to wag your finger at me and say "Tsk, tsk." Why the scolding? Because although I did write this book's text and take its screenshots, those represent only a part of what constitutes a "book." The rest of it is brought to you by the dedication and professionalism of Wiley's editing, graphics, and production teams, who toiled long and hard to turn my text and images into an actual book.

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Dedication

Since this book will be published just before Mother's Day, it seems only right to dedicate it to my late mother, who spent nearly 90 years on this Earth bringing love to her family and friends and a light-up-the-room smile to everyone she met. She was more of a crossword solver than a web coder, but I know she'd appreciate having this book dedicated to her memory because she was always proud of her "wee son." Mum, you are missed.

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